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Assessment of Climate Change Vulnerability of Hakha Township, Chin State, Myanmar 2017–2050: Scenarios for Resilience Building

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Assessment of Climate Change Vulnerability of Hakha Township, Chin State, Myanmar, 2017–2050: Scenarios for Resilience Building

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International Centre for Integrated Mountain Development (ICIMOD)
Khumaltar, Lalitpur, Kathmandu, Nepal, G.P.O. Box 3226
Tel: (977) 1 5275222, 5275223 Fax: (977) 1 5275238, 5275239
info@icimod.org www.icimod.org

United Nations Human Settlements Programme
P.O. Box 30030, Nairobi 00100, Kenya
infohabitat@unhabitat.org
www.unhabitat.org

United Nations Environment
UN Avenue, Gigiri
PO Box 30552 Nairobi, Kenya
www.unep.org

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Project team
Programme and methodology coordinators: Pasquale Capizzi (MCCA), Vishwas Chitale (ICIMOD)
Lead authors: Vishwas Chitale, Montse Gibert, Sanjeev Bhuchar, Pasquale Capizzi, Hung Ling
Contributing authors: Phyoe Thet Khaing (ICIMOD), Felicity Cain (MCCA)
Local survey team: Hung Ling, Tin Yu Maw, Stephen Wah
Reviewers: Nina Raasakka, Bill Wolfe, Shradha Ghale, Dhrupad Choudhury
Editors: Samuel Thomas, Rachana Chettri
Graphic design: Dharma Ratna Maharjan (from the original BRIDGE Creative design)

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About the project

The International Centre for Integrated Mountain Development (ICIMOD), in collaboration with UN-Habitat and UN-Environment, initiated, coordinated, and conducted the vulnerability assessment and prepared the report under the guidance of the Ministry of Natural Resources and Environmental Conservation (MoNREC) of the Union of the Republic of Myanmar. The study was funded by the European Union under the Myanmar Climate Change Alliance Programme (MCCA) and by the Support to Rural Livelihoods and Climate Change Adaptation in the Himalayas (Himalica) initiative at ICIMOD. ICIMOD's Resilient Mountain Solutions (RMS) initiative supported the final stages of the production of this assessment report. All activities under the MCCA were possible thanks to the generous support of the European Union with the Global Climate Change Alliance (GCCA).

GCCA is a flagship initiative of the European Union helping the world's most vulnerable countries to respond to climate change. GCCA is a major climate initiative that since 2007 has funded 72 projects of national, regional, and worldwide scope in Africa, Asia, the Caribbean and the Pacific. www.gcca.eu #GCCAPlus

The Environmental Conservation Department (ECD) of MoNREC facilitated the cooperation, and access to data and information at the national and local levels. The General Administration Department (GAD) of the Ministry of Home Affairs facilitated surveys and community consultations at the township level. All census data has been provided by the Department of Population (Ministry of Labour, Immigration and Population). The MCCA is funded by the European Union.

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PREFACE

Myanmar is among the world's most vulnerable countries to natural hazards. The rugged and fragile terrain of its hilly and mountainous northern region and the remoteness of the northern states make this part of the country particularly vulnerable to disasters, resource scarcity, and the impacts of climate change.

The people of Myanmar are regularly exposed to multiple climate-induced disasters such as flash floods and landslides, droughts, and strong winds. Limited access to infrastructure and dependence on climate-sensitive sectors such as rain-fed agriculture, which has low socio-economic returns, further weakens their ability to withstand and recover from shocks.

There is strong evidence that climate change is affecting Myanmar. These changes will continue to impact the country over the coming decades, and unless urgent action is taken at national, regional, and local levels, people will suffer disproportionately. The International Centre for Integrated Mountain Development (ICIMOD), with guidance from the Ministry of Natural Resources and Environment Conservation (MoNREC) and in collaboration with UN-Habitat, conducted a comprehensive study in Hakha Township, the capital of Chin State, Myanmar, to assess the vulnerability of its ecosystem, infrastructure, and socio-economic conditions in relation to present and projected climatic conditions. The findings of this study indicate an increase in temperature by +1.5–2.7°C, increased number of hot days (17 days/year), fewer rainy days, and an increase in total annual precipitation by 23% under RCP 8.5 by 2050. The potential impacts of these changes include heavier rains and floods, more heat waves, stronger winds/storms, and increased drought. Due to these climate events, more frequent landslides, loss of farmland and crops, human health issues, increased pest and disease infestations in crops and animals, water shortages, and the destruction of houses, roads, and other infrastructure are foreseen.

Considering these predicted impacts, Hakha Township needs urgent adaptation planning supported by strong scientific analysis and evidence that will help build its resilience. This report provides insights into the need for building the resilience of Hakha Township. These insights hold true for most other hilly states in Myanmar.

To support Myanmar in addressing climate change issues, the Myanmar Climate Change Alliance (MCCA) was launched in 2013 with support from the Global Climate Change Alliance (GCCA). It is being implemented by the United Nations Human Settlements Programme (UN-Habitat) and the United Nations Environment Programme (UN Environment) in cooperation with the Environment Conservation Department (ECD) at MoNREC. As the key achievement of this MCCA Programme, Myanmar Climate Change Policy, Strategy and Master Plan (2018-2030) have been just recently issued.

ICIMOD supported the MCCA in filling gaps in Myanmar's earlier Local Adaptation Plans, which looked at the coastal and arid zones – by contextualizing a vulnerability assessment framework for uplands and hill states, as a step towards preparation of Myanmar's NAP. The work was done under the Support to Rural Livelihoods and Climate Change Adaptation in the Himalaya (Himalica) Initiative, which was funded by the European Union.

We believe that the framework applied in this report, which specifically analyzes vulnerability to climate-induced disasters such as landslides and flash floods, will contribute to making Myanmar's ongoing NAP process more comprehensive.

Hla Maung Thein
Director General
Environmental Conservation Department (ECD)
Ministry of Natural Resources and Environmental Conservation (MoNREC)

David Molden, PhD
Director General
International Centre for Integrated Mountain Development (ICIMOD)

EXECUTIVE SUMMARY

This assessment analyses the vulnerability of the ecosystem, infrastructure, and socio-economic conditions in Hakha Township located in Chin State, Myanmar in relation to present and projected climatic conditions. It concludes that the current vulnerability of Hakha Township is high, and with the predicted changes in climate, decision makers in Hakha Township will need to plan for increased flash floods and landslides, strong winds, increased temperature, and erratic rainfall with greater amounts of rain within a shorter monsoon season. Based on these findings, required actions for building resilience over the medium to long term are proposed in this report.

In 2017–18 the Myanmar Climate Change Alliance (MCCA), implemented by UN-Habitat and UN-Environment, in partnership with the Ministry of Natural Resources and Environmental Conservation and in collaboration with the International Centre for Integrated Mountain Development (ICIMOD), conducted a detailed climate change vulnerability assessment of Hakha Township, which is located in the mountainous China State of Myanmar. Chin State spans 36,019 km^2 and is bordered by Sagaing Division and Magway Division to the east, Rakhine State to the south, Bangladesh to the south-west, and the Indian states of Mizoram to the west and Manipur to the north (Figure 1). The capital of the state is in Hakha and the population is approximately 478,801 as per the 2014 Census.

The present study analyses current vulnerability and predicts future vulnerability of Hakha Township by projecting future changes in climate for a period up to 2050. On this basis, scenarios that describe the potential impact of climate change and adaptation solutions to avoid the worst-case future scenario are proposed. These solutions have been compiled after several consultations with local communities and decision makers following a bottom-up approach. The study also describes the expected outcomes and results, and priority activities identified by communities during the course of the assessment. We use downscaled climate projections that were developed using ICIMOD datasets at a 10 x 10 km grid for predicting climate change impacts for the period up to 2050. The projections show an increase in temperature by as much as 1.7°C in 2050. Rainfall patterns are also predicted to change, with a possible increase in total annual rainfall by 150–300 mm and a shortening of the rainy season that will bring more frequent heavy rainfall events.

This will lead to an increase in flash floods and landslides that can damage infrastructure such as human settlements and basic facilities. Shortening of the rainy season, increasing surface runoff, and increased evaporation due to higher temperature in future climatic scenarios may intensify and multiply drought events, posing the threat of food and water scarcity and undermining development efforts.

The study demonstrates that Hakha Township is currently vulnerable to present climate conditions, and its vulnerability will increase greatly under future climate change scenarios. This is mainly due to the current socio-economic, infrastructure, and ecological system conditions, and the expected impacts of climate change on these systems.

Three Possible Adaptation Scenarios for the Period up to 2050

1. In the Business as Usual (BAU) scenario, authorities and communities do not recognize the urgent need to address different aspects of vulnerability arising due to predicted climate change. Therefore, changes in climate may have an exponential effect on the Township, analyzed in this report under three systems – ecosystems, socio-economic, and infrastructure – ultimately affecting people's livelihoods, health, and safety by 2050. In this scenario, insufficient knowledge of predicted climate change impacts and integration of such knowledge in planning negates mid- to long-term planning. Decisions are taken to respond to short-term needs such as excessive timber extraction for building houses, clearing of forests for shifting cultivation practices, constructing infrastructure in areas at high risk of disasters, or failing to construct resilient houses with storm-resistant techniques, etc. without considering the long-term consequences. Under this scenario, livelihoods, infrastructure, and environmental conditions will not allow people to improve living conditions in the township. In

addition, projected changes in climate will interact with and exacerbate existing vulnerabilities, and new, unforeseen vulnerabilities may also emerge in the process.

2. Resilience is built to maintain current living standards scenario, in which the township and communities recognize the urgent need to take action, but also recognize investment, time, economic, technical, and skill constraints. In this scenario, an adaptation plan is adopted, and activities that can be implemented without large investments are consistently undertaken, such as the protection of the environment, the strengthening of economic associations to create a more resilient and diversified livelihood and income, and the integration of measures for resilient infrastructure. Under this scenario, decisions on land use and town-planning would need to take into account current and projected climate risks, to prevent risk and vulnerability, e.g., choosing sites with low disaster risk for future infrastructure. In this scenario, the township and communities are able to plan their adaptation needs considering climate constraints, and communicate them to the districts, states and regions, NGOs, and development partners. This scenario is the minimum required to prevent increased vulnerability and to enable continued development.

3. Resilience is built that enables economic and social development despite changes in climate by 2050, considering the different vulnerabilities of men and women. There is effective strategic planning, coordination and monitoring, and adequate time and resources are allocated – not only to

The hilly and fragile terrain of Hakha makes the Township more vulnerable to diasters

maintain basic safety conditions but also to achieve sustainable development goals. Based on this assessment, the first of its kind in Hakha Township, planning work that follows is strategic, and guides township planning and budget expenditure to the district and other authorities. It requires investment from national authorities and international partners to achieve three main results: 1) a healthy ecosystem is maintained and enhanced to protect and provide ecosystem services for people; 2) a diversified, inclusive, and resilient economy is sustained to improve the economic conditions of the township; 3) resilient infrastructure and connectivity are set up to protect and enable people. In this scenario, efforts are sustained in an inclusive manner over a long period of time, and by a number of actors, but particularly the local and national government.

1 PURPOSE OF THE REPORT

The purpose of this report is to help decision makers in Hakha Township, in Chin State, and at the national level understand risks related to climate change for the period up to 2050, plan accordingly, and channel investments to build resilience for both the short and long term.

To achieve this, the study focuses on the current vulnerability of Hakha Township in the following three sectors: ecosystem, infrastructure, and socio-economic conditions along with governance and administration mechanisms. The study predicts changes based on climate change projections for the period up to 2050, and anticipates further vulnerability of Hakha Township in the future.

On this basis, the report envisions future scenarios for the township affected by climate change, with downscaled climate projections under two different representative concentration pathways (RCPs) i.e. RCP 4.5 and RCP 8.5 as per the Fifth Assessment Report

(AR5) of the Intergovernmental Panel on Climate Change (IPCC), 2015.

Finally, it provides recommendations for building the resilience of Hakha Township to avoid a severe future scenario. These are based on the results of a planning exercise conducted with communities and authorities in Chin State to prepare a local resilience and adaptation plan, with expected outcomes and results for resilience building, and prioritized activities identified and listed by communities during the course of the assessment.

The report draws on information that is readily available, such as disaggregated census data, or on information that is easy to obtain through desk review and consultations. The indicators chosen for the vulnerability index are simple and are available from the census data. Thus the study can serve as a baseline that can be easily updated at regular intervals as part of monitoring the resilience building actions and can also be easily replicated in other parts of Myanmar.

1.1 BACKGROUND

Myanmar is one of the most vulnerable countries to natural hazards. Chin State, which lies in the hilly and mountainous northern region, is highly vulnerable due to its rugged and fragile terrain and remoteness, as well as resource scarcity and evident impacts of climate change. People and assets are exposed to multiple climate-induced disasters such as flash floods and landslides, droughts, strong winds, and erratic rainfall patterns. People's ability to withstand and recover from shocks is weak due to low socio-economic outcomes resulting from high dependence on climate sensitive sectors such as rainfed agriculture and limited access to infrastructure.

Infrastructure in Hakha Township is highly exposed to climate-induced disasters

Most of Myanmar is affected by rapid onset disasters such as floods and droughts, which occur due to erratic rainfall and have immediate and devastating consequences. Other slow onset phenomena such as groundwater salinization in the delta due to sea-level rise, or the reduction of agricultural productivity due to higher temperatures and changing rainfall patterns in the monsoon season in the dry-zone and mountainous regions, also have significant effects on the society and economy of Myanmar. In 2012, the Department of Meteorology and Hydrology (DMH) of the Ministry of Transport and Communication (MTC) confirmed that changes have been observed in the climate over the last 60 years including an increase in mean temperatures, highly variable rainfall patterns, increased dry spells, a shorter monsoon season (from about 144 days in 1988 to the current estimated 125); as well as stronger tropical storms, cyclones, and floods, which occur with more frequent return periods and in unexpected locations. The latest projections prepared in 2016 confirm the confidence in further changes, which will result in increased vulnerability.

Myanmar's economy is transitioning towards the tertiary sector and manufacturing. The country generates revenues from the energy it produces and sells to other countries. Most people in Myanmar still largely depend on rain-fed agriculture. Agriculture contributes to 34–37% of the country's gross domestic product (GDP), and provides employment to 70–80% of the workforce. Therefore, Myanmar's capacity to attain its ambitious development objectives by 2030 may be affected unless it urgently adapts to present and future changes in climate.

There is strong evidence that climate change is affecting Myanmar. These changes will continue to impact the country over the next decades, and unless urgent action is taken at national, regional, and local levels, people will suffer disproportionately. To support Myanmar to address these issues, the European Union funded the Myanmar Climate Change Alliance (MCCA) Programme in 2013, which is implemented by UN-Habitat and UN-Environment under the Ministry of Natural Resources and Environmental Conservation (MoNREC) and it's Environmental Conservation Department. Its main goal is to mainstream climate change in the political, institutional, and development agenda of the country. To achieve this, it aims to increase institutional, policy, and technical capacities to address climate change.

The MCCA has achieved three results:

1. The government, civil society, and the private sector in Myanmar are more aware of the implications of climate change
2. The government has the capacity and support needed to integrate climate change considerations in policies, strategies, plans, and operations
3. The lessons drawn on climate change from State- and local-level activities influence policy making and are communicated to relevant decision makers in the relevant sectors.

In 2015, to achieve its third result, the MCCA, in agreement with several national and local stakeholders, selected one township in the dry zone (Pakokku in Magway Region), one in the delta area (Labutta in the Ayeyawady Region), and one in Hakha in the mountainous region to assess vulnerabilities and, based on the findings from this assessment, launch a Township Climate Change Adaptation Programme to help communities adapt to the negative effects of climate change in the short, medium, and long term. The present assessment report is part of this work and will inspire the development of a vulnerability assessment method to be replicated in other townships of Myanmar.

1.2 OBJECTIVE OF THE ASSESSMENT

The main objective of this assessment is to inform the authorities in Township; district, regional, and national authorities in Myanmar; and development partners about the expected consequences of climate change and, on this basis, to help them to plan and act to adapt to climate change. It provides important information to increase current understanding of present and future vulnerabilities. The assessment can therefore serve as a tool for communities and townships to plan ahead, build resilience, and mitigate the negative impacts of climate change.

Specifically, the assessment delivers the following benefits to stakeholders at different levels:

1. Increased understanding of the underlying causes of vulnerability: the negative effects of natural hazards, and the effects of the changing climate over the short, medium, and long term
2. Increased awareness of the sources and location of vulnerabilities for people and assets in the township
3. Increased understanding of how the ecological, socio-economic, and infrastructure systems interact to sustain life in the township, and how climate change may affect them
4. Identification of the spatial dynamics of present and future vulnerability
5. Definition of short- to long-term scenarios of development
6. Based on the above, increased capacity to plan and implement adaptive pathways for the township, which are spatially relevant and guide the correct allocation of resources

The vulnerability assessment illustrates how climate change will heighten risks and exacerbate already significant challenges. Hakha Township has a poverty rate higher than the national average. Social development indicators for the township, such as tertiary education, are well below those for the rest of Myanmar. The township's economy is dependent on climate-sensitive sectors. Environmental challenges such as manmade degradation, exposure to extreme natural events, and incipient effects of climate change hamper development. Most notably, the ecosystems in Hakha are degrading as a result of deforestation as trees are felled at small and large scales for charcoal, agriculture, and timber.

Also, the rugged topography of the township makes spatial interaction difficult. The nearest airport in Kalaymyo is around 8–10 hours by road, and movement is frequently hindered – particularly by landslides during rainy season – limiting the ability of mountain communities to travel and trade. At the national level, there is increasing data on and understanding of the observed impacts of climate change and projections of the expected changes and initial analyses related to risks and vulnerabilities associated with climate change in sectors such as agriculture and the natural environment. However, there is very little information on the expected effects of climate change on the ground.

In general, there is a scarcity of studies with a focus on mountain systems in Myanmar, especially in Chin State. In addition, existing studies do not predict the impacts of future climate change. Most importantly, no studies analyse the interaction between different sectors in section ecosystems, infrastructure, and socio-economic development to sustain livelihoods and social development in the township and how climate change is going to affect this interplay.

The vulnerability assessment covers this gap by:

1. Delivering an accurate development profile of Hakha relating to the physical and natural environment, administrative and demographic features, infrastructure, and socio-economic conditions.
2. Overlaying present and projected climate hazards onto Hakha's ecosystems, socio-economic infrastructure, and spatial conditions to understand the current and future impacts of extreme natural events as well as changes in temperature and rainfall patterns.
3. Designing scenarios for the period up to 2050 that may occur based on the level of adaptation actions taken. The result of this includes a comprehensive analysis of the present situation and future development that comprehensively considers climate change. Planners at the state/regional and national level will be able to use the findings of the report to make more informed strategic planning decisions. This analysis supports a strategic approach over the long term that will identify objectives for climate-resilient development, and design actions that make the best use of available resources to achieve them.

1.3 PRINCIPLES AND METHODOLOGY

THERE ARE FIVE OVERARCHING PRINCIPLES GUIDING THE ASSESSMENT:

1. Simplicity – to ensure ease of replication in other townships and countries within the region
2. Measurability and availability of data – to ensure ease of update and scaling of the study
3. Inclusiveness – to ensure participation of communities along with the decision makers at different levels: state government, regional government, and township level authorities
4. Comprehensiveness – to ensure relevance of the findings
5. Spatial relevance – to guide actual adaptation interventions

To respect these principles, the assessment uses the following:

- Open-source software for spatial analysis, such as Q-GIS, which do not involve any cost and in turn reduce costs, enabling scaling up and scaling out as well as replication monitoring.
- Data that is available at either the international, national, or local level and easily obtained upon the submission of a written request from user agencies. The assessment does not make use of satellite imagery that needs to be purchased, or is provided gratuitously.
- Data from the Census 2014, disaggregated at the village tract and urban ward levels, is a key source of information. In addition to being a vast source of information and insight, future census data will be crucial for monitoring changes in the structure of the townships, which can be analysed again in the future.
- Involving different stakeholders throughout the township and the villages through simple questionnaires, community focus group discussions, and participatory mapping.
- Studying the three main systems that define the township – ecosystems, socio-economic conditions, and infrastructure – which experience the impacts of climate change in Hakha Township. The analyses of predicted impacts on different sectors need to be analysed separately so that the assessment is designed in a way that can capture sector-wise impacts and the interaction between systems for effective adaptation planning.
- Identification of the current and future spatial structure of the township; this is essential to support planning and direct interventions for adaptation and to understand how changes in one part of the township or the region may affect others.
- Equal participation of men and women and, where possible, using gender-disaggregated data.

- Engagement of the national government and the township throughout the process to ensure ownership of the results and replication.

PROCESS

The vulnerability assessment uses an iterative process and is conducted in close consultation with authorities at the national and township levels. The assessment involves national and township level technical meetings, local community participatory workshops, surveys with village administrators, a desk review of studies, and the creation of datasets based on available georeferenced data.

METHODOLOGY AND TECHNIQUES

The methodology works as follows:

1. It establishes a basis for analysis by describing the context and key socio-economic, ecological, and infrastructure features and the spatial structure of the township. This provides insights into the current situation and sources of vulnerability. A vulnerability index is presented, which gives an account of the most vulnerable locations in the township.
2. Through data analysis and community risk mapping it analyses the exposure of people and assets to recurrent natural hazards and their potential for rapid and slow onset disaster.
3. It overlays downscaled projections of climate change for the township on the current conditions analysed in the assessment and studies how these new climatic conditions will affect people and assets in the township.
4. It defines future scenarios that may materialize without adaptive action and contrasts them with potential adaptive pathways, which inform adaptation and resilience planning.

There is no one-size-fits-all approach to understanding the additional vulnerability that will occur because of climate change, or to identifying the adaptation measures that follow from it. Instead, the assessment combines several methods and tools that best fit the requirements of the location being studied.

To generate a comprehensive account of the township vulnerability, the following key methods/tools were applied

Vulnerability index

The assessment defines vulnerability as a function of exposure, sensitivity, and adaptive capacity. However, because there are no direct indicators of adaptive capacity, and to maintain the principle of simplicity, the vulnerability index does not attempt to measure adaptive capacity. Nine simple indicators define the sensitivity of each system analysed in this report (ecological, socio-economic, and infrastructure systems), eight of which are based on the data available in the census. The total score is multiplied by the intensity of natural hazards, as measured through historic data and community consultations. This results in an indication of the level of risk for each village tract/urban ward.

Purpose of the method: To provide an overview of the locations most vulnerable to current natural hazards and climatic conditions. Because there is no single way to establish comprehensive indices of vulnerability, this tool is used in connection with others to provide in-depth analysis.

Downscaled climate models

The assessment studies historic trends and downscaled projections for the township, mostly based on data provided by the Department of Meteorology and Hydrology (DMH), for the relevant weather stations.

Temperature and precipitation projections are derived using an ensemble approach, comprising a set of models used for downscaling the global projections – Himalayan Climate Change Adaptation Programme (HICAP) projections report – creating two scenarios, low and high, corresponding to two Representative Control Pathways (RCPs) of global greenhouse gas emissions developed by the Intergovernmental Panel on Climate Change (IPCC), RCP 4.5 and 8.5.

Purpose of the method: To provide evidence of the historic climatic trends and projected changes at the township level, enabling accurate analysis of current and future vulnerabilities in several systems and supporting tailored design of adaptive pathways for the future.

Spatial analysis

The spatial and territorial analysis uses a matrix of functions (MoF) to assess the relations amongst villages and urban wards in the township. To do that, the MoF describes the services and functions available in each ward and village tract of the township and what the hierarchy of these settlements is. It also describes their importance to one another, where functions are missing and, importantly, how balanced the spatial development of the township is. Applied to climate change, it increases understanding of how the current spatial structure of the township enables

or inhibits the resilience of the area to the changes in climate. The MoF is developed by collecting data with a simple questionnaire to determine where services are available. Key functions are listed, processed, and mapped through GIS. Technical annexes are available on request.

Purpose of the method: To support national, regional, and local government decision-making by setting out a spatial vision and strategy specific to a particular region with a view to maximizing the benefits from investments and bringing about more balanced territorial development patterns. In this context, it provides authorities at the township, regional, and national levels the evidence to intervene in specific areas but with the aim of generating climate change resilience for the whole township.

Socio-economic system analysis

This analysis utilizes quantitative and qualitative surveys. The quantitative analysis draws on several sources: the census, sector-specific data gathered at the national and local levels (such as Myanmar's agriculture at a glance data, and locally sourced planning data), and data gathered for the MoF. It also uses data from the township planning department to calculate output per capita, and make estimations of income, factoring in the relatively high number of economically inactive people. This assessment also generates qualitative information through consultations that makes it both participatory and valu-based. Community focus groups sessions were held with clusters of villages throughout the township, resulting in an even geographical spread of consultations. The consultations included female-only consultations as part of the gender analysis methodology to ensure the vulnerability assessment could capture the differentiated vulnerabilities of men and women. The Poverty and Vulnerability Assessment (PVA) and the Situational Analysis on Transformations in Shifting Cultivation in Chin State conducted by ICIMOD were also used for this study.

Purpose of the method: To build an understanding of the main sources of livelihoods, productive sectors, and social conditions that enable development, such as the education level of locals and their involvement in productive sectors, among others. This increases understanding of how dependency on a single source of livelihood may affect the overall resilience of the township when new climatic features affect that specific source of livelihood. Through this, the assessment unveils to what extent livelihoods and productive sectors in the township are resilient to current and future climatic conditions.

Ecosystems analysis

Four types of ecosystem services, or benefits that nature provides to people – provisioning, regulating, cultural, and supporting – are analysed to find which services are most used by the township and how climate change is affecting the quality and availability of these services. The assessment, through both local consultations and desk review, analyses their availability in the township and their role in sustaining life. The key services are presented in this report.

Purpose of the method: To analyse how the township depends on services provided by the environment. Some services have multiple functions. For instance, mangroves have a regulating value as they protect people from storm-surges, but they also provide provisioning services by creating a habitat for fish feeding and breeding. They also play an important supporting function by controlling erosion and maintaining/improving soil quality. They have, in some cases, cultural value, as they define ecosystems and landscapes. Defining to what extent the ecosystem is vulnerable, and how much climate change will affect it, is key to understanding the resilience capacity of the township, and the required adaptation actions. Thorough understanding of the ecosystem services provided in each township also enhances the understanding of which ecosystem-based adaptation approaches can be proposed as adaptation measures.

Infrastructure and connectivity system analysis

Data gathering for the Infrastructure analysis was conducted through a mix of local surveys, census data, and analysis of datasets in a GIS environment. It reflects both the conditions of the built environment and its spatial distribution. The analysis provides a description of the predominant construction techniques and materials, which are key to understanding the vulnerability of critical assets such as housing, schools, and health posts to natural hazards, especially of heightened intensity resulting from climate change related droughts, cyclones, and floods. Importantly, it analyses the architectural features and the overall safety of the units through their sanitation facilities and water harvesting capacities, for example. It also analyses distribution and access through roads and waterways, which provide insights into how isolation and distance contribute to vulnerability in many areas, and how climate change exacerbates this. Finally, it provides an analysis of the distribution of key safety infrastructure, such as cyclone shelter availability, and whether this is strategically located.

Purpose of the method: To provide a spatial analysis of the sensitivity of the built environment and its connectivity to natural hazards and climatic conditions. These are important features that enable or inhibit the resilience of communities, development, and very basic safety against adverse natural hazards.

Future vulnerability scenarios in a GIS environment

Key features of the ecological, socio-economic, and infrastructure systems are contrasted with the projected climatic changes for the township. A coefficient for climate change for each projected change is assigned and multiplied against a given feature, such as crops. For instance, a coefficient expressed as a percentage was assigned for the increase in temperature and multiplied by the type of crops, soil, and irrigation systems in a given location. Literature suggests that a 1°C increase may result in a 10–50% reduction in rice yields. The multiplied effect of the increased temperature on the known crops is illustrated in a GIS environment. The maps show a reduction in the number of people who will be able to make a living from agriculture as a result of the changes.

Purpose of the method: To build scenarios that show how the new climatic scenarios will have a practical impact on infrastructure, agriculture, and the economy. It is extremely important to understand that these are not forecasts, and that they are based on three key assumptions: first, that no adaptive measures will be taken (business as usual); second, that literature and experience in the different sectors are accurate in predicting what may happen to a sector, in relation to a new climatic feature. Finally, all projections are themselves built on future emission scenarios, the RCP 4.5 and 8.5. Extreme scenarios are used in this report to ensure that planning considers the worst-case scenarios.

Local participatory risk mapping

Maps designed through consultation with communities and local administrators assess the most exposed locations, where disasters occur or recurrently affect people, infrastructure, and crops. This ground truthing work, mixed with an analysis of recorded historical data, gives the assessment depth and accuracy.

Disaggregated Census Data, 2014

Disaggregated data at the urban ward and village tract levels – through several tables related to education, demography, disabilities, and construction – among others, informs all aspects of the assessment, as it provides geographically-relevant socio-economic and infrastructure information.

Integrating gender considerations

The assessment presents socio-economic information that reflects gender-disaggregated data where available, and female-only consultations. This means

that the assessment furthers the understanding of female and male sources of income and differing household roles and responsibilities, and the different perspectives of men and women. The assessment integrates gender considerations throughout this report.

LIMITATIONS OF THE ASSESSMENT

Climate change is a complex phenomenon where many aspects of society, the economy, and the environment intersect. The assessment follows the principle of simplicity as much as possible, but its development nevertheless required diverse expertise; so this assessment is not a rapid tool, but requires thorough analysis and critical thinking. In technical terms, only the GIS and spatial representation of issues require advanced technical skills. These are available in Myanmar, but more training and capacity-building on spatial analysis and scenarios building are needed. The assessment team had access to a large number of datasets, inventories and data, and most of these were contrasted with reality on the ground. However, some of the agriculture, forestry, and ecological data and information (species types, biodiversity) was sometimes outdated or not verified. The findings take this into account.

2 TOWNSHIP PROFILE

Hakha Township lies in the mountainous Chin State, which spans 36,019 km^2 and is bordered by Sagaing Division and Magway Division to the east, Rakhine State to the south, Bangladesh to the south-west, and the Indian states of Mizoram to the west and Manipur to the north. The township is characterized by a complex hilly topography with moderate to steep slopes. Hakha Township is endowed with rich natural resources, which have been exploited by local people for food, water, energy, income, and other purposes. The Township is highly vulnerable to climate-induced disasters such as flash floods, landslides, storms, forest fires, and drought.

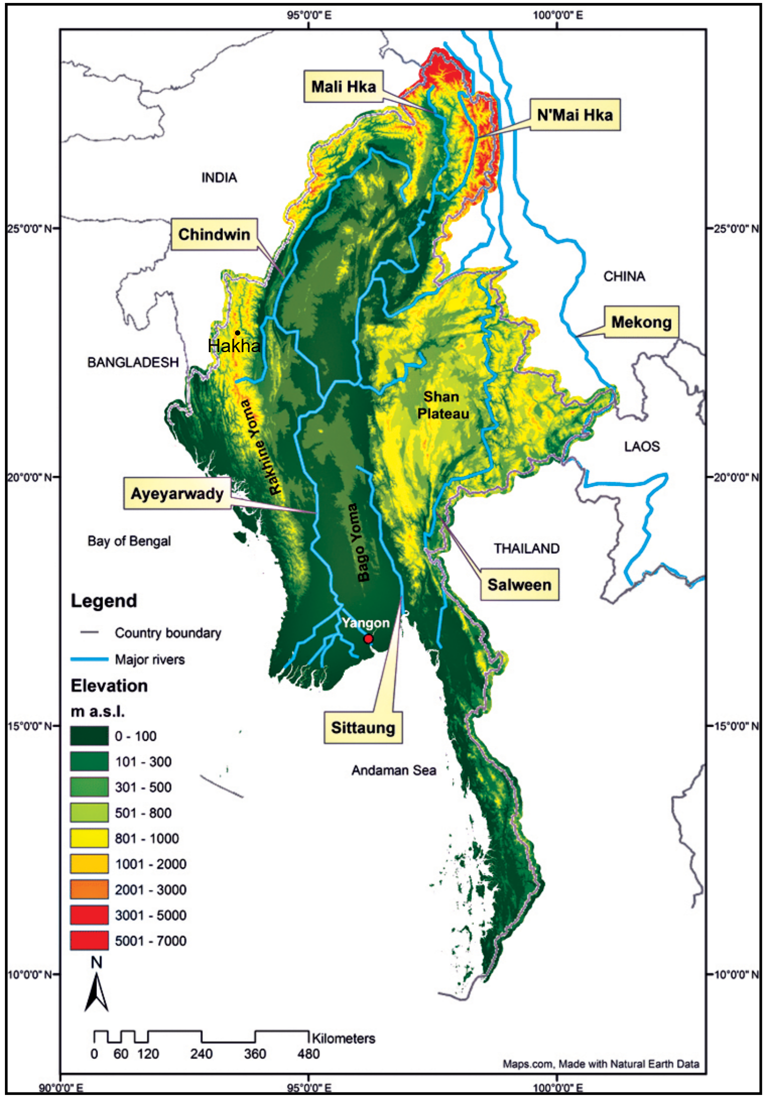
Hakha Township's demographic and socio-economic characteristics make it vulnerable to shocks; now more so than ever because of climate change. In particular, migration trends, low economic outputs, non-diversified livelihoods sources, and lack of vocational training make Hakha insufficiently resilient and dependent on climate-sensitive sources of income. In addition, social trends show unequal access to economic opportunities for women.

Hakha town hosts the administration of both the Hakha Township and the Hakha District, which is one of the six districts in Chin State. Moreover, the Chin State Regional Government is also located in Hakha Township. Proper adaptation planning and resilience building is the need of the hour. Such efforts will enable the township to adapt to the impacts of climate change and mitigate the degradation of ecosystems.

2.1 PHYSICAL AND ENVIRONMENTAL OVERVIEW

Myanmar (9’30 to 28’31 N and 9’10 to 101’11 E) has five physiographic regions: the northern mountains, the western ranges, the eastern plateau, the central basin and lowlands, and the coastal plains. According to Bender and Bannert (1983), the country has four major divisions: Sino-Myanmar Ranges; Indo-Myanmar Ranges; Rakhine coast area; and Inner Myanmar Tertiary Basin. Chin State lies in the northern mountains of the Indo-Myanmar Ranges and spans 36,019 km². Chin State has a border with Sagaing Division and Magway Division to the east, Rakhine State to the south, Bangladesh to the southwest, and the Indian states of Mizoram to the west and Manipur to the north (Figure 1). Hakha is the capital of Chin State.

Figure 1: Map of Myanmar



Bender, F. & Bannert, D. (1983). Geology of Burma.

As per the 2014 Census, Chin State has a population of 478,801. Khonumtung (Mount Victoria), with an altitude of 3,200 m, is the highest peak in the State. The terrain is generally mountainous with few transportation links. Chin State is the poorest state, with the highest poverty rates and least developed areas in Myanmar. However, the state is endowed with beautiful mountain landscapes and made vibrant by the cultures of ethnic groups such as the Mros, Khamis, Bamars, Lautu, Senthang, Zotung, and Zophei.

Climate and ecology

Chin State has a subtropical climate with distinct seasons. The average temperature ranges from 7°C during winter period (from December to February) to 30°C during the summer months (from March and April). Most of the rainfall (up to 600 mm) occurs during June, July, August, and September. The rest of the year is relatively dry (DHM, 2016).

The watersheds of Northern Chin State are degraded due to over exploitation of forest resources and traditional slash and burn shifting cultivation practices with shorter fallow cycles. The state was impacted by ravaging flash floods and landslides in July 2015 due to an extreme rainfall event. Due to climate change, it is very likely that the frequency of hydro-meteorological hazards is going to multiply. Therefore, the protection of vital ecosystems is now more urgent than ever.

Northern Chin is part of a Global Ecoregion called the Naga-Manipuri-Chin Hills Moist Forests. Due to land degradation and habitat loss, the biodiversity of Northern Chin State is declining. Wild mammals such as monkeys, deer (barking deer and sambar), wild

The water system of Chin State is being threatened by the degradation of ecosystems

boar, porcupines, jungle cats, jungle fowls, gibbons, wild goat (serow or goral) and possibly bears (which local communities say are focused in northern Chin) are decreasing in number. Large wild mammals such as Indian bison, elephant, tiger, and rhinoceros seem to have gone “extinct”. Even the Hornbill, which is the state symbol of Chin is difficult to find nowadays.

Freshwater ecosystems

Northern Chin State is rich in water resources. Many springs, streams, and watercourses are found in the mountain ranges. Streams and rivers flow from north to south, forming valleys and gorges. The Meitei Gun River flows through the northern half of Chin State. The longest waterfall in Chin State is the Bungtla Waterfall near Matupi. The Tio River borders India to the north, the Bawinu River (Kaladan River) meets with the Tio River in the central part of the state and Kaladan River enters from India and flows down past Paletwa and exits into Rakhine State. Tashon near Falam is a beautiful, historically significant village where spring water is supplied by traditional bamboo pipes.

Climate and disaster risk

Climate change projections for Chin State indicate an increase in temperature by +1.5–2.7°C, increased number of hot days (17 days/year), fewer rainy days, and an increase in total annual precipitation by 23% by 2050. The potential impacts of these changes will be heavier rains and floods, more heat waves, stronger winds/storms, and increased drought. Due to these hazards, more frequent landslides, loss of farmland and crops, human health issues, more/new pests and diseases in crops and animals, destruction of houses, roads, and other infrastructure and water shortages are foreseen. These primary impacts will then lead to a loss of local livelihoods, food and nutritional insecurity, less investment in education, electricity shortages, and displacement of vulnerable populations and migration. It is therefore very important to ensure that communities are already pro-actively taking steps to adapt and build socio-ecological resilience.

Infrastructure

Currently, transportation and communication networks present the main constraints to socio-economic and livelihood development and are highly vulnerable to hazards. Housing construction is vulnerable to strong winds and storms because they seldom integrate disaster resistant techniques and are not adapted to future increased frequency and intensity of hazards. The lack of climate-sensitive land-use plans increase potential vulnerability of all households, especially in high-slope areas, where heavy rains will increase landslides in the future. Availability of fresh water for drinking mainly relies on natural springs, making the entire township vulnerable to future rain variability and increased temperatures in the mid and long term, as aquifers will take longer to recharge. Coverage of disaster and climate-resilient basic services is very limited, which reduces communities' resilience to climate hazards and jeopardizes their future coping capacities to more intense climate hazards.

Environment

Livelihoods are being enhanced at the cost of the resilience of ecosystem services. Due to a lack of alternatives, communities are extracting firewood, fodder, timber, stones, non-timber forest products (e.g., elephant foot yam) for cash, which has led to the degradation of ecological reserves and their diversity. Forest patches are degraded also due to landslides, forest fires caused by slash and burn practice, and the disposal of debris from ongoing road expansion work. Local communities report springs and streams are drying and that the water table in the lowlands is declining. This has led to water shortages, particularly in the summer months of March and April. This has direct impact on women who have to travel longer distances to fetch water for household needs.

Socio-economic

The occupational diversity of rural households is very limited. Rain-fed shifting cultivation or Taungya is the dominant primary occupation in the assessed villages, except in Cangva, where dry terrace-based paddy cultivation is the main production system. Secondary sources of livelihood are varied, with forest produce, animal husbandry, daily wage, stone collection, small business, salaried jobs, trading, carpentry, masonry, and migration contributing to meeting cash requirements, as agriculture is still mainly subsistence oriented. In recent times, households have been trying to diversify their livelihood portfolio, and the better-off are investing in dry or wet terrace farming (for paddy and vegetable cultivation), in orchards (for banana, pineapple, avocado, mango, lemon, onion, mustard, garlic, and cabbage), in home gardens and cash crop cultivation (e.g., ginger), and in fish ponds with support from government and non-governmental organizations. However, these options are not readily available to a majority of households, particularly women-headed households, as they do not have access to finance, land entitlement, credit, technical knowledge, and irrigation facilities.

Energy sources in Chin State

Myanmar has extreme energy poverty compared to other developing countries. The main sources of energy are coal, oil, natural gas, hydropower, and biomass. About 77% of the energy supply is from these conventional sources. According to the International Energy Agency (IEA), Yangon city has the highest electrification rate of 63%, whereas the rural areas are poorly electrified, with only 16% electrification rate.

Northern Chin State was not on the national power grid until very recently. Falam and Tedim towns were connected to the national grid in late 2016. For a long time, people in Northern Chin State have relied on petrol-fueled generators for electricity supply. These are gradually being replaced with solar panels imported from China or India. Due to limited capacities, the available solar systems are used mainly for lighting. They cannot be used for cooking, heating, or supplying power to home appliances and farm equipment such as irrigation pumps.

Some settlements have micro or mini hydropower stations. Such stations have good potential in Northern Chin State where several perennial streams flow. However, due to the low performance of turbines and a decrease in stream flow during the dry season, people are not able to harness the full potential of micro-hydropower. Many stations also get damaged during flash floods and landslides. At present, there are 11 projects related to micro-hydro with the combined capacity to generate around 3.48 MW, two small hydropower projects which can produce 2.8 MW and one large hydro scheme which produces 200 MW energy (Table 1). They supply only 20% of the total energy consumption in Chin State.

Table 1: The potential of micro-hydro, small hydro, and large hydro power plants in Myanmar

State and Division	Micro-hydro Capacity (1 kW to 1MW)		Small Hydro Capacity (1 to 10 MW)		Large Hydro Capacity (>10 MW)		Total	
	Number of projects	Capacity (MW)	Number of projects	Capacity (MW)	Number of projects	Capacity (MW)	Number of projects	Capacity (MW)
Kachin State	17	5.33	14	48.180	6	1,852,000	37	1,905,020
Chin State	11	3.48	2	2800	1	200,000	14	204,280
Shan State	35	10.64	24	63,900	11	4,161,000	70	4235603
Sagaing State	5	0.806	3	13300	6	2,889,000	14	2,903,106
Mandatary Division	3	0.650	2	6,250	9	3,475,000	14	3,481,900
Nagwat Division	1	0.100	2	11,000	2	93,000	5	104,100
Rakhine State	6	1,915	–	–	4	804,500	10	806,415
Kayah State	2	0.158	–	–	4	3,740,000	6	3,740,158
Bage Division	4	1,890	–	–	7	391,000	11	392,890
Kayin State	3	0.864	1	3,000	4	16,248,000	8	16,271,844
Mon State	65	1,260	–	–	2	256,500	4	255,748
Taninthayl Division	9	1,706	2	19,500	2	440,000	13	461,206
Total	**101**	**28,787**	**50**	**167,930**	**58**	**34,568,000**	**209**	**34,764,290**

Source: Ministry of Electric Power, Hydropower Potential of Myanmar (State and Division Wise) (Yangon: Ministry of Electric Power, 2006)

Wind power generation in Northern Chin State has very high potential. Once the highway construction work is complete, it will be possible to bring wind turbines, large and small, up to the mountain ridges. Large wind turbines could conceivably provide electricity to the entire State population with a surplus to export to lowland Burma. As of now, wind energy potential remains untapped.

The current sources of energy for cooking are firewood (93.7%), charcoal (4.8%), electricity (0.8%), LPG (<0.1%), kerosene (0.2%), biogas (0.2%), and others (0.1%). The main sources of energy for lighting are candles (29.4%), electricity (15.4%), kerosene (5.9%), battery (9.1%), generators (3.6%), private water mills (12.0%), solar energy (16.1%), and others (8.5%).

Remittances

Migration for work and business is common across Myanmar. Northern Chin State has very high migration rates. The 2014 Census shows that 33,975 men and 17,570 women have migrated from Chin to Thailand, Malaysia, Singapore, China, Korea, Japan, India, the USA, and other countries. The majority have migrated to Malaysia and the USA. Almost two thirds of the migrants have stayed in United Nations High Commissioner for Refugees (UNHCR) resettlement facilities in developed countries.

Remittance is an important source of income for a majority of the households in Northern Chin. The money is used for both household and community purposes such as the development of village sports/ football grounds, mini-hydro power stations, rice mills, schools, and clinics; providing loans for livelihood security; and on health care, education, and other daily subsistence requirements.

2.2 DEMOGRAPHIC OVERVIEW

According to data from the 2014 Census, Hakha Township has one of the highest populations in Chin State. The Township's demographic and socio-economic characteristics reveal a number of issues that make it vulnerable to shocks, regardless of the impacts of climate change or climate-related hazards. These issues are likely to exacerbate the impacts of climate change in the future. The female population of Chin State is 249,197, which is higher than the male population (229,604) because of high rates of outmigration of male members. However, the population of Chin State still ranks among the lowest three compared with other states and regions in the country.

The 2014 Myanmar Population Housing Census (MPHC) shows that Myanmar has a total population of 51,486,253, out of which, 24,824,586 are men and 26,661,667 are women. The total population for Chin State is 478,801 persons of which 229,604 are men and 249,197 are women. There has been a 30% increase in the population in Chin state between 1983 and 2014. The population density has increased from nine persons per km^2 in 1973 to 13.3 persons per square kilometre in 2014. Based on the census data of 2014, 79% live in rural areas while 21% in areas that are classified as urban by the General Administration Department (GAD).

The population pyramid of Hakha Township (Figure 2) shows the sex composition and rural urban distribution of the population. Based on Census data, the highest age ratio is 15–19 years, a group also referred to as 'teenagers' in urban areas, followed by children, i.e., age groups 10–14, 5–9 and 0–4. Then it sharply declines to age groups 25–29, 30–34 and 35–39. The age 50 and above groups also shows a significant decline in this pyramid graph, and the age 70 and above groups have the lowest ratio. In the rural areas, the highest percentage comprises age groups 0–4, 5–9 and 10–14, which indicates that children make up the largest portion of the population in rural areas. The teenager population in urban areas is high, but the population of young people in rural areas has declined significantly as they migrate for job and business opportunities. In both rural and urban areas, older adult populations make up the lowest percentage of the total.

Figure 2: Age wise distribution of urban and rural population in Hakha Township

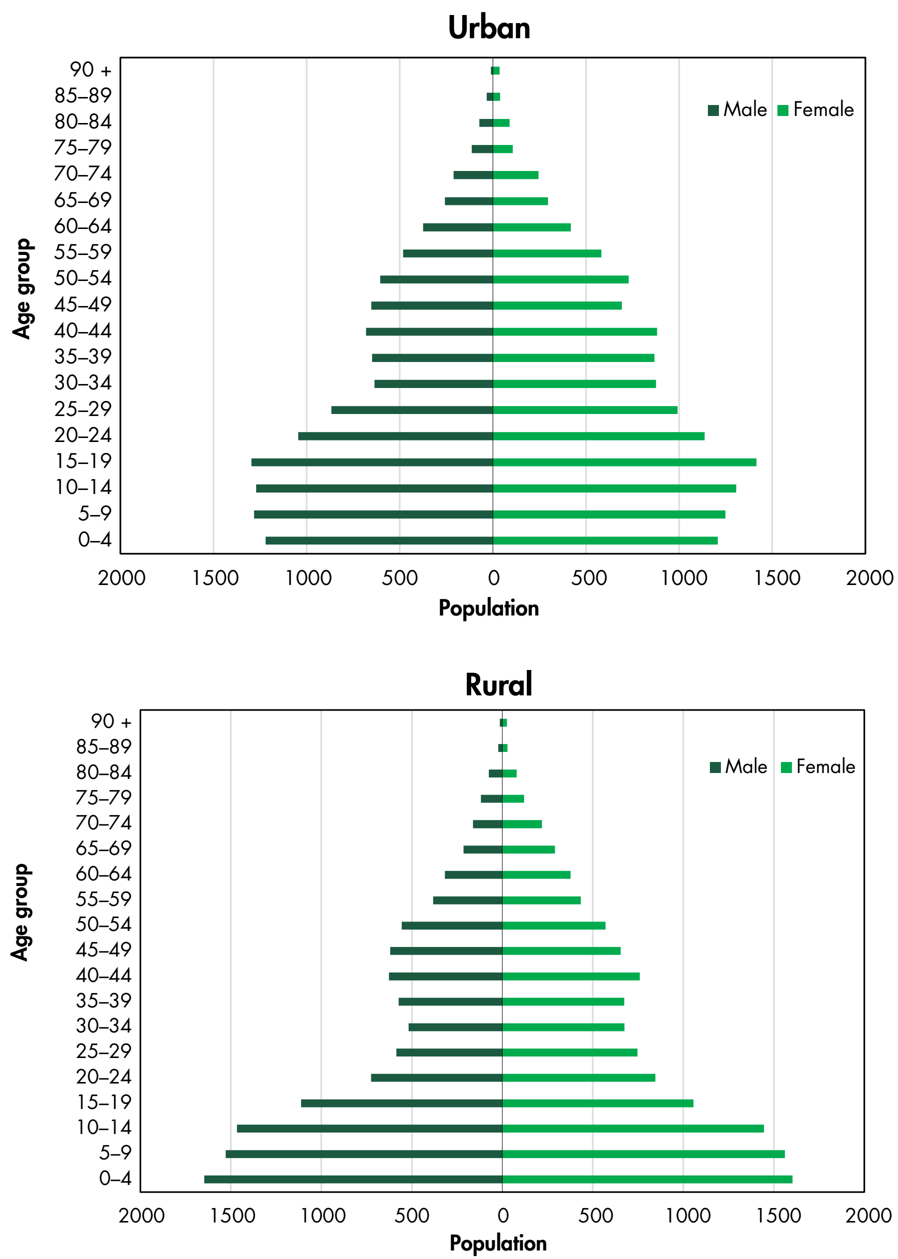
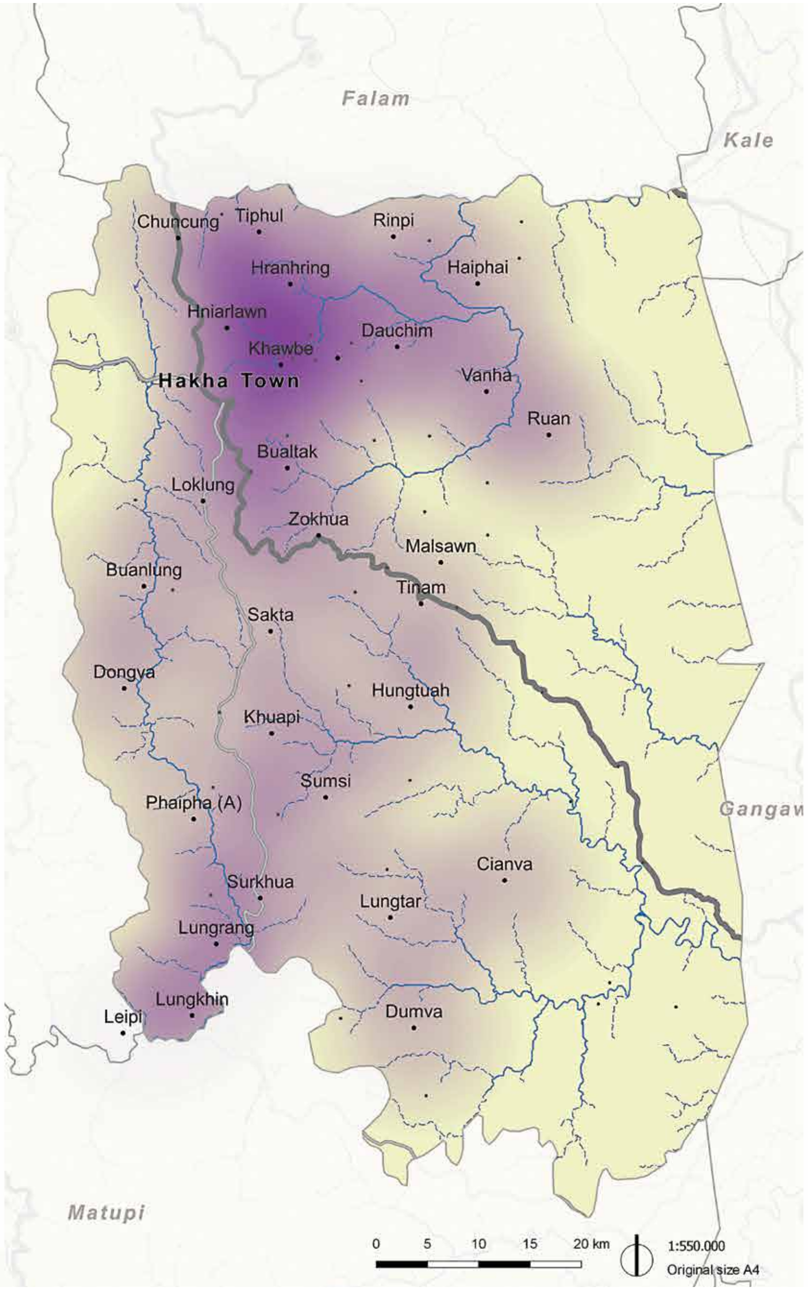


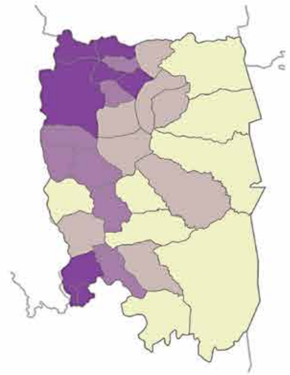
Figure 3: The geographical distribution of trends in demography in Hakha Township

The total population for Chin State in 2014 was 478,801, of which 229,604 were men and 249,197 were women.

The population density increased from nine persons per km² in 1973 to 13.3 persons per km² in 2014. Based on the census data from 2014, 79% of the population live in rural areas while 21% in areas that are classified as urban by General Administration Department (GAD).



Population density

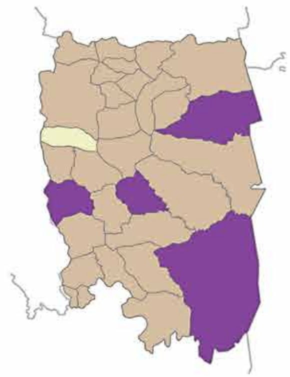


The spatial distribution of the population density shows that north-western areas of the township (around Hakha town) are the most densely populated, while eastern areas are the lowest.

Density (No. people/km²)

- 2-4
- 4-7
- 7-14
- 14-89

Population distribution by sex

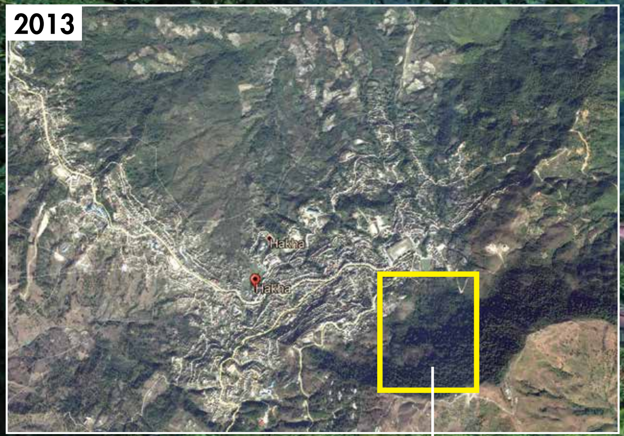


Female population is higher in almost all the village tracts across the township.

Sex ratio

- <100
- 100
- >100

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017



This image shows intact patch of forest in 2013

Landslide occurred in 2015 due to excessive rain

This drainage was constructed following the 2015 landslides, recognizing that upstream deforestation and unsustainable urbanization contributed to the disaster

2.3 ADMINISTRATION AND GOVERNANCE OVERVIEW

Hakha town hosts the administrations of both Hakha Township and Hakha District, which is one of the six districts of Chin State. The Chin State Regional Government is also located in Hakha Township. The township urgently needs proper adaptation planning and resilience building to adapt to the impacts of climate change and degradation of ecosystems.

Township governance in Myanmar largely revolves around regional and national programmes. The township administration and the state-level government should work towards making the GAD and the activities of other departments at the township level more transparent, particularly with respect to the tendering and procurement process in Chin State. Township administration, the establishment of new committees to facilitate township-level coordination, and the coordination of planning and implementation between different departments remain challenging.

At the township-level, the Village Tract Administrator (VTA) and the Village Tract Coordinator (VTC) are key mechanisms through which communities can be involved in local decision-making processes. Many of the challenges associated with communication are structural in nature, including the large number of departments, the double accountabilities shouldered by some departments (the Township Administration, the Department of Planning), and the vertical nature of sector planning and budgeting.

The majority of township development priorities are decided by consensus among the Township Management Committee (TMC), the Township Development Supportive Committee (TDSC) and the Township Municipal Affairs Committee (TMAC). The relative dormancy of the Township Farmland Committee (TFMC) and the limited activity of the Township Planning and Implementation Committee (TPIC) need further consideration. The development of women's capacity in political leadership and democratic politics should be pursued at the state and township level.

3 VULNERABILITY ANALYSIS AND RISK PROFILE

Hakha is exposed to several climatic hazards, in particular storms and flash floods, which result in landslides, droughts, and heat waves. Stronger winds associated with cyclonic systems in the Bay of Bengal have also been known to have an increasing impact in the last decade. These hazards affect crops, transportation, infrastructure, and human health. Hakha is also suffering from long-term climatic changes, which include erratic rainfall patterns and increasing unseasonal temperatures with direct impacts such as water scarcity, diseases, and pests. The topography and geological conditions of Hakha exacerbate the sensitivity thereby increasing the risk of disasters.

The current conditions of its socio-economic, infrastructure, and ecological systems make Hakha highly vulnerable to the impacts of climate change.

The entire township is at high risk, with specific risks associated with the concentration of people and assets in Hakha Town, unplanned urbanization processes, and deforestation in both the town and surrounding villages. The isolation of villages also increases their vulnerability.

Housing infrastructure is vulnerable to strong winds, flash floods, and landslides owing to the use of building materials, non-resilient construction techniques, and high risk sites mostly prone to landslides. Connectivity is the main constraint to socio-economic development as the transport network is insufficient and liable to be interrupted by landslides. There are very limited occupational levels in rural households; the economy is non-diversified and migration rates are very high. There are fewer opportunities for women than there are for men.

3.1 DEFINING VULNERABILITY IN THE CONTEXT OF MYANMAR AND HAKHA TOWNSHIP

Vulnerability and resilience are multi-semantic notions. In this report, their use is based on the following definitions or sources.

This assessment uses a tailored definition of vulnerability informed by the Intergovernmental Panel on Climate Change's (IPCC) 4th and 5th assessment reports (ARs) that refer to the interaction of hazards, exposures, sensitivities, and adaptive capacities of people, communities, and settlements to predict the level of risk they may potentially incur. This is informed by definitions outlined in different ARs of the IPCC. The tailored approach has several benefits; firstly, this assessment focuses on ecosystems, their vulnerability, and their potential to support people to adapt to climate change. Secondly, the assessment focuses on the spatial distribution and dynamic of vulnerability, by understanding the spatial distribution of different functions and services that will play a crucial role in adaptation planning. Finally, the definition used here recognizes that the pre-existing, underlying vulnerabilities in socio-economic realities, infrastructure, and ecosystems interact with climate change and climate-related hazards to enhance risk and vulnerability. In calculating the vulnerability index in Section 3.5, definitions from the IPCC's 4th and 5th assessment frameworks (or reports) to keep the index calculations simple. The broader overall framework is captured in Figure 4.

We also use data and analysis conducted under the Poverty and Vulnerability Assessment (PVA) framework of ICIMOD. The PVA is a household survey that ICIMOD has developed to identify, understand, and monitor poverty and vulnerability. A total of 390 households (HHs) from Hakha Township including 90 urban HHs were covered in the PVA study during 2013–14. The PVA instrument covers several dimensions: a) socio-economic conditions of households, b) income and expenditure, including food security and nutrition, c) gender roles in household decision making, d) different aspects of governance, and e) social capital (Gerlitz, J. Y. et al. 2017)*.

Resilience

There is no univocal definition of resilience or urban resilience, and globally there is debate on how to measure resilience. This report uses the term 'resilience' as defined by UN-Habitat and UN-Environment and also by major resilience expert entities. Here 'resilience' refers to *the ability of systems regulating natural, built environment and socio-economic dynamics to withstand and to recover from any plausible hazards, including both chronic stressors (for instance, deforestation) and acute shocks (for instance, landslides*). The report also recognizes that in complex systems, such as those studied by this assessment, there is no single equilibrium to be sought and restored after a shock. There are multiple, co-existing equilibriums, and both human settlement and ecological systems change continuously. This report analyses prevailing conditions of the environment, infrastructure, socio-economic systems, governance, and population, to understand how these enable or hinder resilience in the township.

For more details, see Arup, 2014. *Facing up to the future: the City Resilience Index*. (Retrieved from http://www.arup.com/city_resilience_index). For a review of urban resilience trends, see UN-Habitat, 2017. *Trends in Urban Resilience, 2017* (Retrieved from https://unhabitat.org/books/trends-in-urban-resilience-2017/

Gerlitz, J. Y., Macchi, M., Brooks, N., Pandey, R., Banerjee, S. & Jha, S. K. (2017). The multidimensional livelihood vulnerability index–an instrument to measure livelihood vulnerability to change in the Hindu Kush Himalayas. Climate and Development, 9(2), 124-140.

3.2 CLIMATIC FEATURES, NATURAL HAZARDS, AND OBSERVED IMPACTS

- Increased incidences of flashfloods and landslides due to heavy rainfall during the shorter monsoon season pose risks to basic infrastructure such as houses, schools, health posts, and roads, and affect people's mobility and access to basic services.
- Prolonged drought due to erratic rainfall and a larger dry season pose threats to agriculture and consequently to food security.
- The shorter monsoon season and higher temperatures result in faster evaporation and are causing water scarcity.
- Communities will face increased disaster risks due to climate change if adaptation measures are not adopted.

Unsustainable road construction practices in Hakha Township result in many landslides every year.

Hakha faces a number of direct impacts resulting from both climate hazards and long-term climate change. While some of these are observed in a number of areas across Myanmar, others are specific to, or are more pronounced, in Hakha. In many cases, climate features that have been observed in the past are projected to continue their present trajectory – and become more severe – in the future. This means that hazards and their observed impacts, as highlighted by community members, are likely to also become more serious in the future, without adaptation measures.

According to communities consulted in this assessment, due to projected changes in climatic features for Chin (i.e., +1.5–2.7°C, +17 hot days, +6–23% of rainfall in less time), flood risks will increase leading to more landslides; there will be more heat waves, stronger winds, and increased risk of droughts. Landslides will lead to the destruction of houses, land, roads and infrastructure, resulting in the displacement of people and loss of livelihoods. Heavier rains will have impacts on farmland and crops, resulting in a decline in crop yields, leading to a loss of livelihoods, food and nutrition insecurity, and increased migration. Heat waves will have impacts on human and animal health, which will again have impacts on peoples' livelihoods and well-being. Increased temperature will lead to increased water stress, which have impacts on health and energy (micro-hydropower) generation. Increased temperatures will also trigger more pest and disease infestation in crops and livestock, leading to a decline in productivity and income. Reduced incomes will have impacts on education, food security, and other factors related to well-being.

Hakha receives around 1,800 mm (72 inches) of rainfall annually of which about 90% of is received during May–October. Long-term data collected by the Department of Meteorology and Hydrology (DMH, Chin) during 1981–2017 (Figure 4) shows that rainfall is variable with the onset of the monsoon, and that there will be variations in dry spells as well as rainy days. The highest annual rainfall recorded – about 95 inches – was in 2015. Forty-five inches were received in July, leading to unprecedented disasters in Hakha town and villages.

Figure 4: The trend of precipitation from 1981–2017

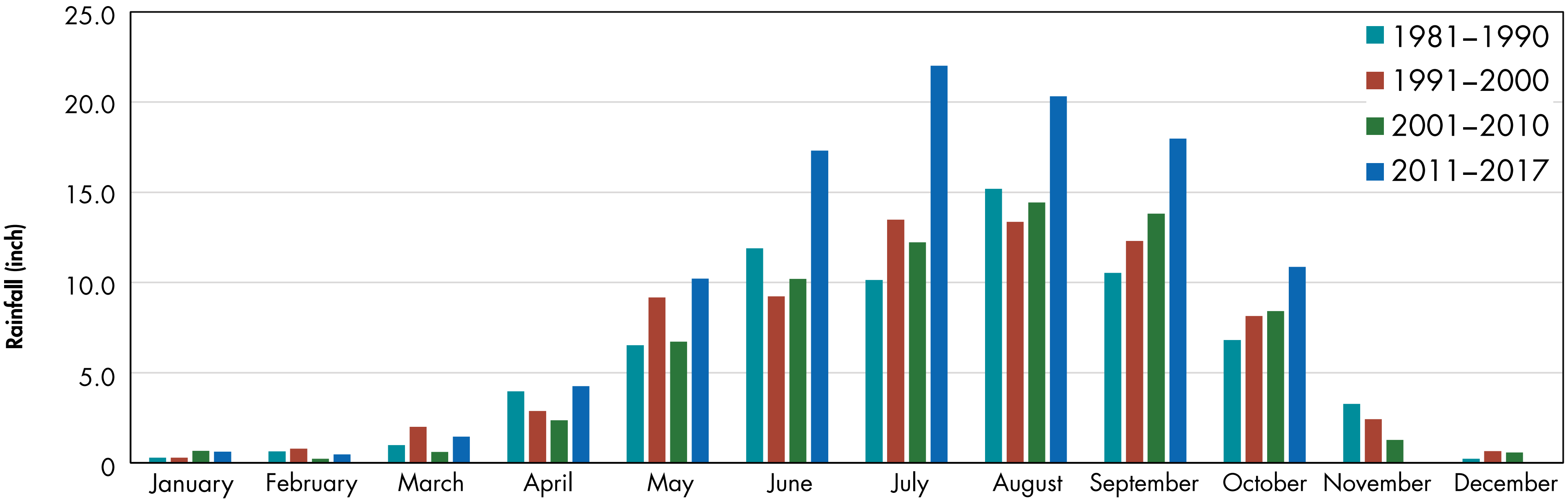
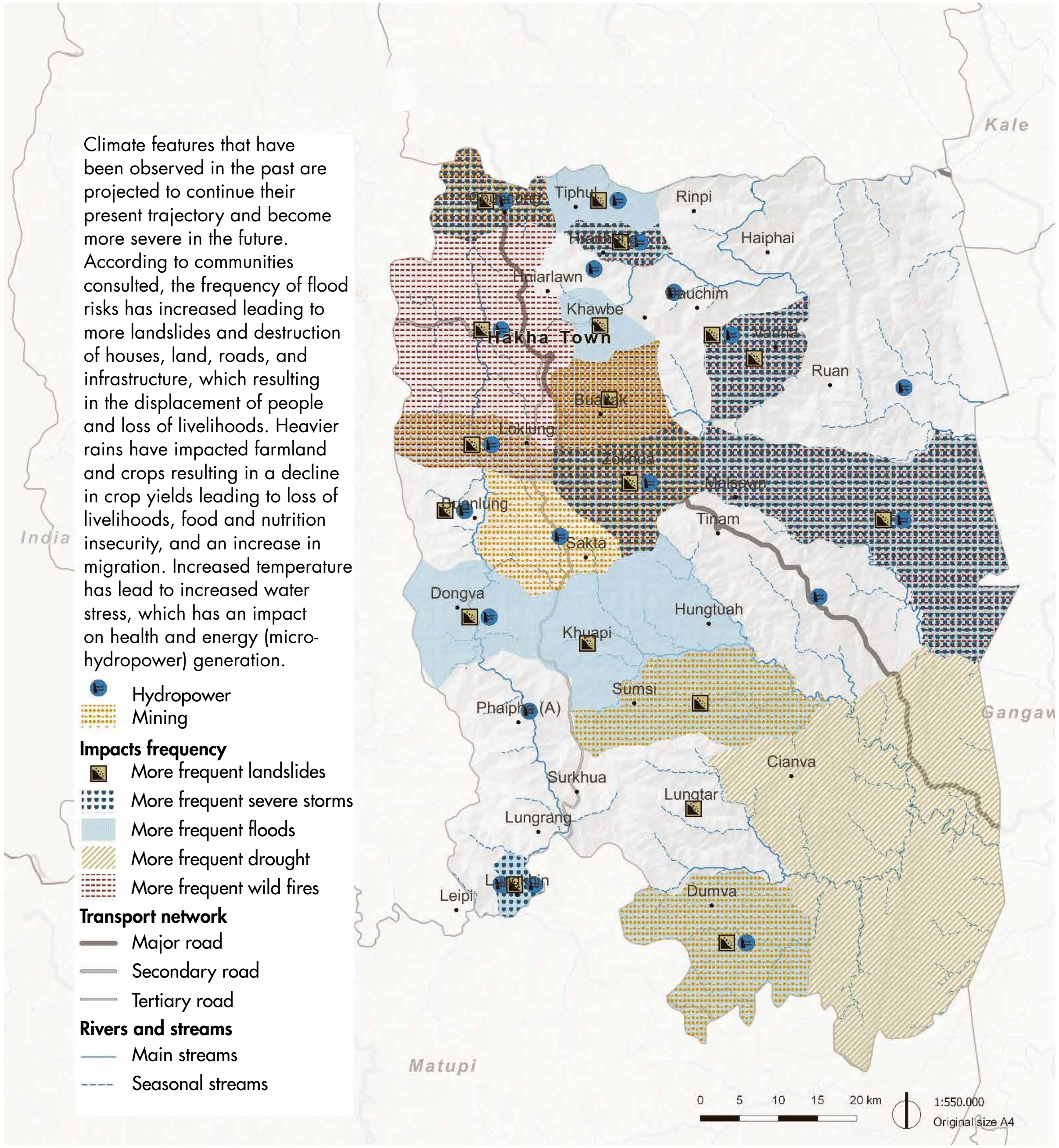


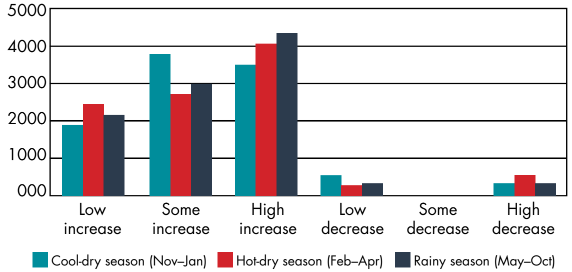
Figure 5: Climatic features, natural hazards, and their impacts in Hakha Township



Perceived changes in climate

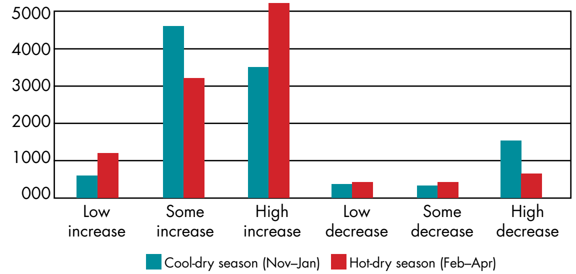
Temperature

An increase in temperature is perceived in all seasons, especially during the hot rainy season



Rainfall

A significant increase in rainfall is perceived in both seasons



Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

3.3 TOWNSHIP CONDITIONS – SOURCES OF VULNERABILITY

ECOSYSTEMS

- Forests are the most dominant land cover in the township but currently experiencing high levels of degradation and deforestation.
- There is large-scale exploitation of forest ecosystems, which involves extraction of timber for building material and fuelwood for cooking, grazing for livestock, and extraction of non-timber forest plants for medicinal purposes.
- Most of the agricultural production is rain-fed, making it very senstive to changes in climate and thus to food scarcity.
- Most of the drinking water in Hakha Township comes from natural springs located in surrounding areas, which are getting affected by changes in temperature and erratic rainfall. This poses the threat of future water scarcity.
- Uncontrolled hunting and poaching and the spread of invasive plants are causing a decline in biodiversity.
- Unsustainable farming practices such as short-term shifting cultivation are affecting soil fertility and causing soil erosion in many places.

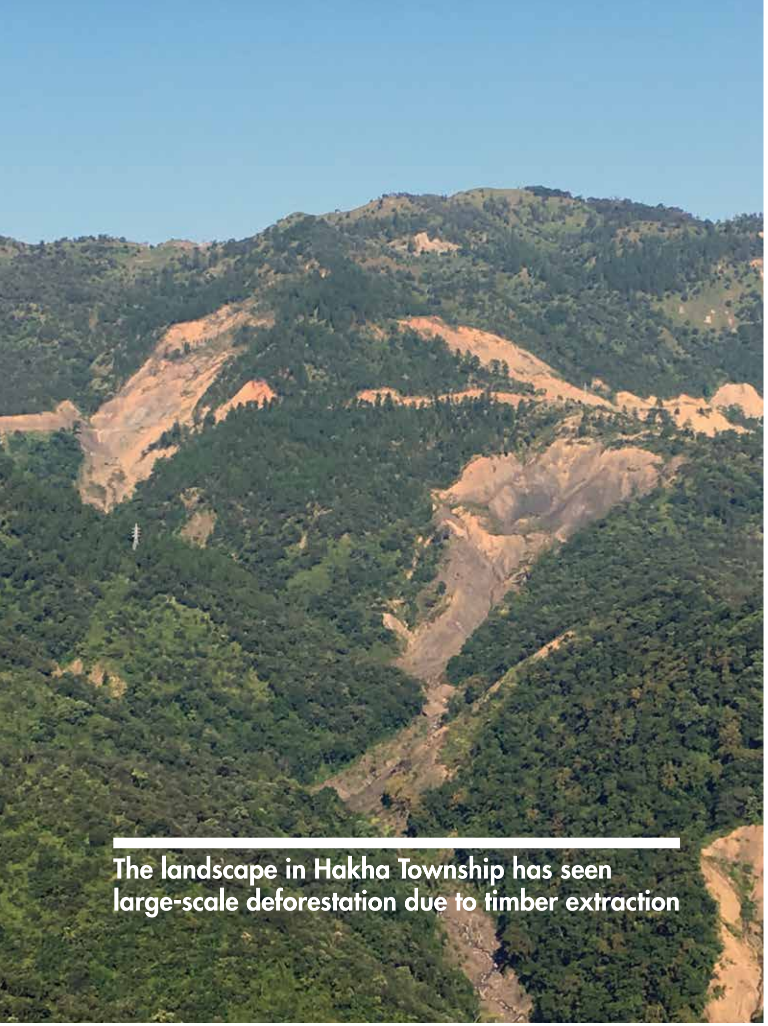
Forest ecosystems in Hakha Township have experienced high levels of degradation and deforestation over the last few decades due to the very high dependence of local communities on forests. Locals obtain timber for construction, fuelwood for heating and cooking, herbs for medicinal purposes, and grasses for fodder from nearby forests. The main provisioning services in Hakha Township are paddy, vegetables, maize, and wild fruits, with minor contribution of beans, tea, coffee, and oil crops. The production of most of these is rain-fed, which makes them more vulnerable to observed changes and future projections of climate, where erratic rainfall patterns may impact these provisioning services and affect food security in Hakha.

Livelihoods are being enhanced at the cost of natural resources

In the mountain context, social and ecological systems are connected and important for ensuring sustainable livelihoods of rural and urban dwellers. Field observations and discussions show that livelihoods and ecosystems in Hakha Township are not well balanced. Due to a lack of sustainable options, the dependence of local communities on firewood, fodder, timber, stones, and non-timber forest products is very high, and this has led to the over-extraction and degradation of natural resources and the depletion of biodiversity. Forest patches are degraded by landslides, forest fires caused by slash and burn agricultural practices, and road construction. During participatory assessments, local community members reported that many springs and streams are drying, and in lowland villages the water table is going down. This is leading to water shortages, particularly during the dry months of March and April, and having adverse impacts on the wellbeing of women and girls who have to fetch water.

Unsustainable farming practices in Chin State are affecting soil fertility

The quality of secondary or fallow forests is declining due to the shorter shifting cultivation cycle. The cycle has been reduced to 10–15 years due to increasing population and land use changes. This is leading to a loss of soil fertility and crop yields. Biodiversity is on the decline and local communities indicate that large animals like deer are now rare. Hunting is one of the causes of biodiversity loss. Orchids and lichens from forests and fish from natural streams are extracted unsustainably. This loss of large-bodied predators, herbivores' and natural decomposers will have a cascading effect on food webs, resulting in transformations in the structure of ecosystems and can cause an explosion in the populations of native and invasive species.

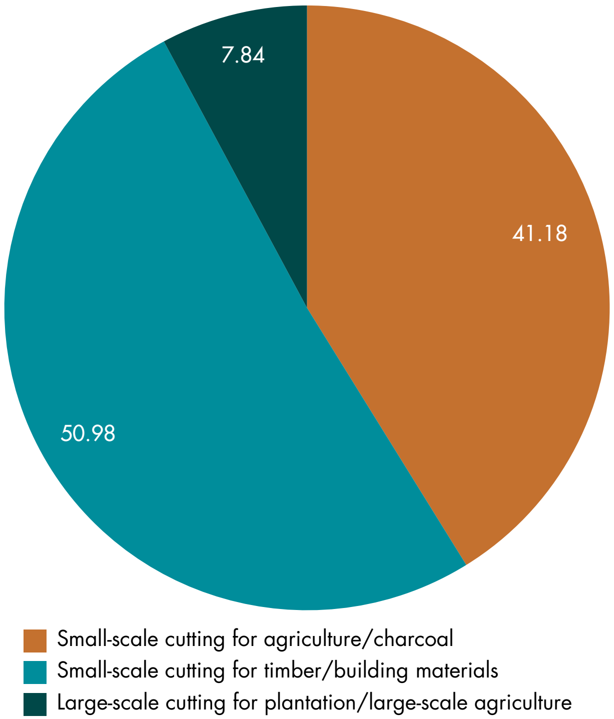


The landscape in Hakha Township has seen large-scale deforestation due to timber extraction

Main factors causing degradation of ecosystems

The extraction of forest resources is one of the major drivers of deforestation and degradation of forest ecosystems in Hakha Township. Wood is extracted mainly for timber, which is used as a building material, and for fuelwood. Trees are also felled to clear the land for agriculture. Intensive deforestation has increased the frequency of landslides and many villages in Hakha Township have suffered damage to houses and roads due to landslides.

Figure 6: Major causes of deforestation in Hakha Township



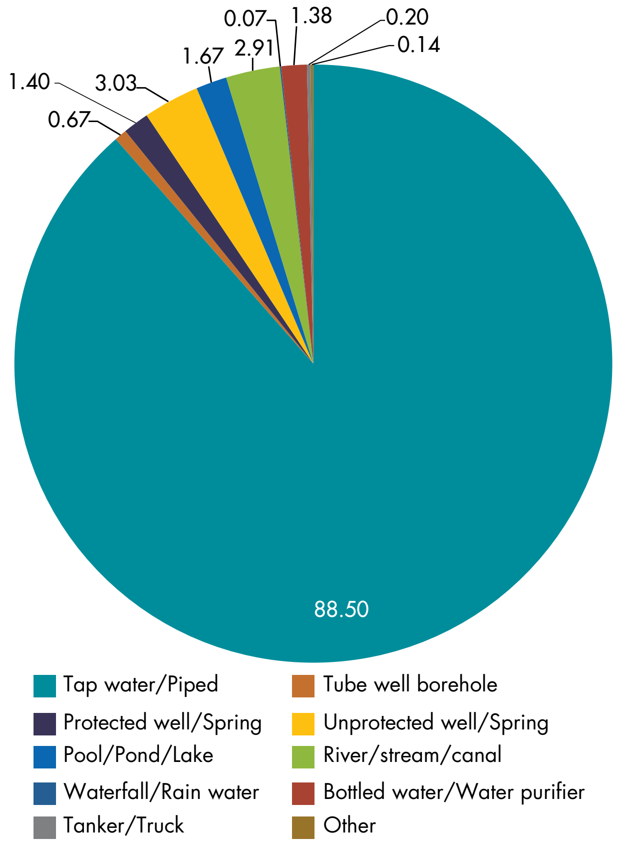
Source: Census, 2014*

The unsustainable extraction of forest resources has also caused degradation of forests in many places (Figure 6). Figure 8 shows newly added/degraded forests from the last 15 years. Mining and hydropower infrastructure are other factors that are causing the degradation of natural ecosystems. If the pattern of unsustainable mining for stones continues, it will make the land unstable in many places along higher slopes and might increase the frequency of landslides in the future.

Water: A crucial ecosystem service

Hakha is highly dependent on natural springs for drinking and non-drinking water. More than 85% of households in urban and rural areas in the township depend on springs, which make them vulnerable to climate change impacts more (Figure 7). Currently, during the summer months of March and April, when springs have less water, women and girls have to

Figure 7: High dependence on natural springs for water makes the population of Hakha Township more prone to climate change impacts



Source: Census, 2014*

*Department of Population, Ministry of Immigration and Population. August 2014 travel a longer distance to fetch water. This increases the workload of women and girls in the township. Due to increasing temperatures, erratic rainfall, and high levels of soil erosion, springs are not sufficiently recharged, leading to a decline in spring discharge. Effective measures are needed to revive springs and ensure water availability in the future.

Hydrology and ground water, crucial ecosystem services, are linked to both household-level choices and external drivers such as climate variability. As more farmers in Hakha opt for water-demanding cash crops and intensive cultivation of vegetables and spice crops on steep slopes, low rainfall during critical crop growth phases and accelerated soil erosion due to heavy rains may further deplete groundwater resources and create competitive extraction of water. Intensive extraction of water at the household level will reduce water availability in the larger landscape system and also for other households due to the subtractive nature of the resource. Therefore, a ground water dependent agriculture and livelihood systems are at risk of the negative impacts of climatic disturbances. People are aware of the close link between social and ecological systems, but the feedback and response loops are weak. This results in the poor management of resources. For the time being, people are managing their natural ecosystems for the benefit of the stakeholders, which is important, but not for the ecological systems.

The biodiversity of Hakha Township is declining due to uncontrolled hunting and poaching and large-scale spread of invasive alien plants. This poses a threat to the native flora and fauna and calls for urgent action focused on the conservation of these ecosystems.

Extraction of forest resources is one of the major drivers of deforestation and degradation of forest ecosystems in Hakha Township

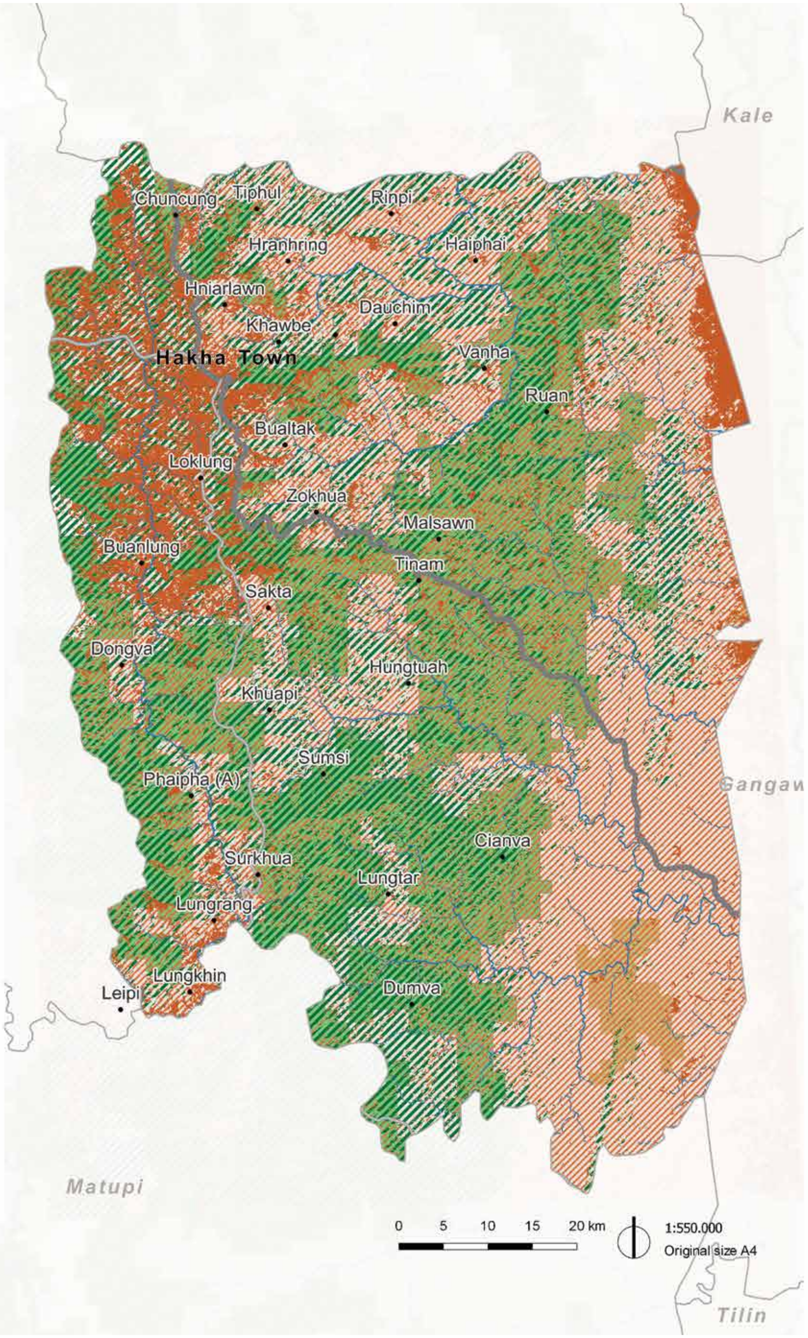
Current efforts to reduce the degradation of natural ecosystems

In Hakha, developing sustainable livelihoods through the sustainable management of natural resources is very important for resilience building. There are some government and community initiatives that manage natural resources. These promote tree plantations, maintain green belts along roads, invest in improved drainage systems (in Hakha town), impose restrictions on the use of wood for construction and fuelwood (e.g., 1 metric ton or 12x6 feet wood/hh/year), manage reduced water supply schedules during the dry months (from 6–8 am and 4–5 pm), and facilitate water resource catchment protection. The stakeholders are aware of the over-extraction of resources but there is no organized system to respond at the state and local levels. The capacity of existing ecosystems to provide goods and services that support the quality of life of present and future generations while subject to a variety of "shocks" is very low. This feature makes Hakha extremely vulnerable to climatic and non-climatic changes. The government has launched large-scale actions such as road construction aimed at helping Chin communities improve their connectivity and livelihoods, but these infrastructure interventions are also adversely modifying the ecosystem processes, including water and mineral cycling.

Figure 8: Distribution of forest cover in Hakha Township in 2014

Due to a lack of sustainable options, the community's dependence on firewood, fodder, timber, stones, non-timber forest products, and water resources is very high. This results in over-extraction, leading to the degradation of natural resources and depletion of biodiversity. Forest patches are visibly degraded by landslides and forest fire due to slash and burn agricultural practices and road construction.

The quality of secondary or fallow forests is declining due to a shorter shifting cultivation cycle. The cycle has reduced to 10–15 years due to increasing population and land use changes. This is leading to loss of soil fertility and crop yields.



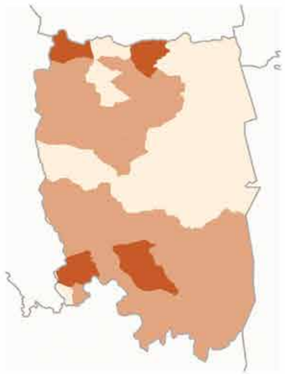
Quality of forest (2014)
- Intact forest
- Degraded forest
- Deforestation areas

Vegetation cover
- Deciduous forest
- Scrubland
- Agriculture

Transport network
- Major road
- Secondary road
- Tertiary road

Main streams
- Main streams
- Seasonal streams

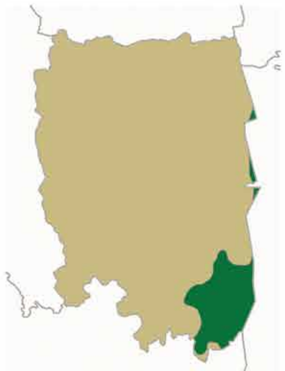
Types of vegetation



Extraction of forest resources is one of the major drivers of deforestation and the degradation of forest ecosystems in Hakha Township

- Small-scale cutting for agri/charcoal
- Small-scale cutting for timber
- Large-scale cutting for plantation

Soil types



Soil classification concerns the grouping of soils with a similar range of properties (chemical, physical, and biological) into units that can be geo-referenced and mapped

- Chin Hill Complex Soil
- Red Brown Forest Soil

Topography

The steep topography of Hakha Township exacerbates the sensitivity of its soil thereby increasing disaster risk

Slopes in degrees
- 0–15
- 15–30
- 30–45
- >45

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

INFRASTRUCTURE CONDITIONS

- The current transportation and communication networks of Hakha Township are the main constraints to socio-economic and livelihood development in the area, and are highly vulnerable to hazards.

- Housing structures are vulnerable to strong winds and storms because construction practices seldom integrate disaster-resistant techniques and are not adapted to future hazards of increased frequency and intensity.

- A lack of climate-sensitive land-use plans increases the potential vulnerability of all households, especially in high-slope areas, where heavy rains will increase landslides in the future.

- The availability of fresh water for drinking depends on natural springs, making the entire township vulnerable to future rain variability and increased temperatures in the mid and long term, as aquifers will take longer to recharge.

- Coverage of disaster- and climate-resilient basic services is very limited, reducing communities' resilience to climate hazards and jeopardizing their future coping capacities in the face of more intense climate hazards.

Current transportation and communication networks are the main constraints to socio-economic and livelihood development in Hakha, and are highly vulnerable to hazards

As in most mountainous areas, mobility seems to present the main constraint to socio-economic and livelihood development for rural communities. Currently, the transport network mainly relies on the primary paved road (in construction) and a network of secondary and tertiary unpaved roads/trails, which make these rural communities highly vulnerable to strong storms and unusually heavy rainfall. Around 30% of village tracts reported that over the last 30 years landslides and floods have become more frequent, damaging roads and bridges, and, in the worst cases, isolating villages for several days from markets, medical facilities, schools, and other core community services. In addition, none of the village tracts reported having storm water drainage systems which increase these communities' vulnerability to climate hazards.

On average, more than 35% of households in the township do not possess any means of transportation; this figure increases to more than 80% in some southern village tracts. In addition, there are no public buses, and the majority of the communities rely on informal local transportation (sports utility vehicles) that are poorly adapted to stronger rains and storms. This reduces people's mobility, especially in the wet season. Chin State and Hakha are no exception. At 11%, the state has a very low Road Access Index (RAI) scoring (ADB, 2016)#.

Ten village tracts have access to a public electricity network on the grid, mainly located along the main roads of the township, while the telecommunication network is limited to wards in Hakha town. Some village tracts reported having Disaster Management Committees, but very few have Early Warning Systems (EWS). Communities get climate warnings from Village Tract Administrators and National Radio and Television weather forecasts, generally a week in advance. Disaster warning systems have improved since 2015 and several Rice Banks have been constructed. However, more preparedness is needed to increase the resilience of the township.

These mobility and communication constraints already jeopardize rural livelihoods, but will worsen in emergency situations following the projected extreme weather events. Changes in precipitation patterns and increase in mean temperature are likely to bring stronger rains and cyclones damaging the already underdeveloped transport infrastructure, reducing people's mobility.

The projected stronger rains and winds may increase communities' vulnerability, especially in those villages where accessibility is very limited. These locational barriers should be considered while planning responses to climate warnings.

Housing structures are vulnerable to strong winds and storms because construction practices seldom integrate disaster resistant techniques and are not adapted to future hazards of increased frequency and intensity

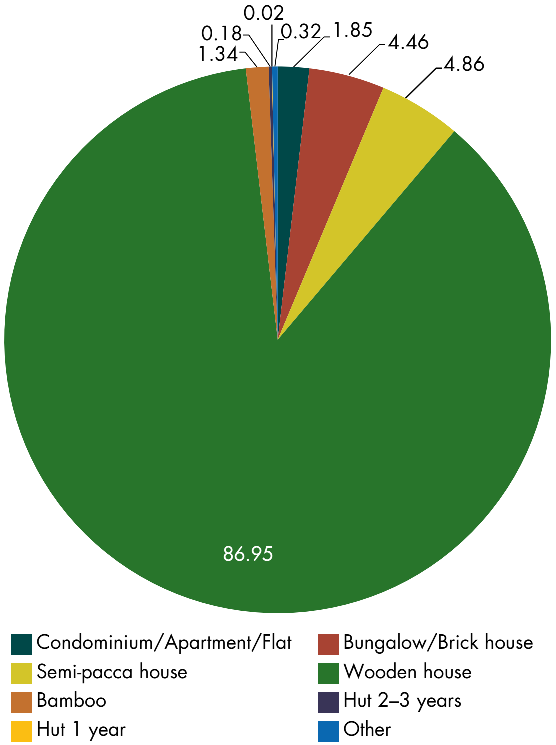
The Census 2014* shows that 87% of the conventional housing units in Hakha are wooden (Figure 9). Communities reported that local builders construct most houses, but they do not include disaster resistant techniques (i.e., adequate foundations for steep slopes). Although the Census shows a significant shift to durable materials (Figure 10) in roofs (93% of households), walls are still built with wood (87% of households). Yet there is no indication that building techniques are improving or adapting to the heightened intensity of rains and storms. This may inevitably lead to more landslides and reduce housing safety. Heavy rains in 2015 led to significant landslides, damaging and destroying houses. In fact, more than 50% of village tracts reported that over the last 30 years landslides and floods have become more frequent, damaging houses more than once a year. Although strong storms/winds were reported to be less frequent over the last 30 years, dwellings in 40% of the village tracts are still damaged every year.

In addition, forest coverage is decreasing due to human activities such as wood harvesting. Firewood is by far the main source of cooking fuel (used by 87% of households), while only 3% of the population has

*Department of Population, Ministry of Immigration and Population. August 2014

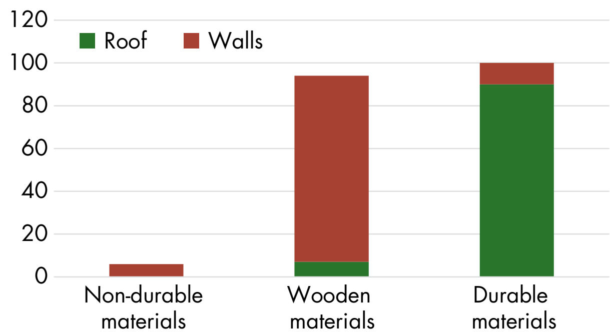
#ADB (2016) Rural Roads and Access Project: Initial Poverty and Social Analysis, September 2016, Myanmar

Figure 9: Conventional homes categorized by type of housing unit



Source: Census, 2014*

Figure 10: Conventional homes categorized by main construction material



Source: Census, 2014*

*Department of Population, Ministry of Immigration and Population. August 2014

access to electricity. About 35% of the households reported using modern and sustainable sources of energy for lighting, and this proportion is higher in urban areas than in rural areas.

Although several regulations are being implemented to control wood cutting, such as the delimitation of community forests (covering an area of one mile from each village where cutting is prohibited) and limits on the quantity one is allowed to cut (two tonnes per year per family), communities reported that the main cause of deforestation is small-scale cutting for agriculture/charcoal and for timber/building materials.

This limited access to energy sources and wood harvesting practices are unsustainable and will inevitably increase deforestation, which will increase exposure to landslides and erosion.

The lack of climate-sensitive land-use plans increases the potential vulnerability of all households, especially in high-slope areas, where heavy rains will increase landslides in the future

There is a weak understanding of the risks of floods and landslides linked to strong winds and storms. Land-use planning does not efficiently and systematically consider locations and siting, and orientation of public buildings and settlements. There is no mechanism for integrating additional features resulting from changes in climate to plan for new infrastructure.

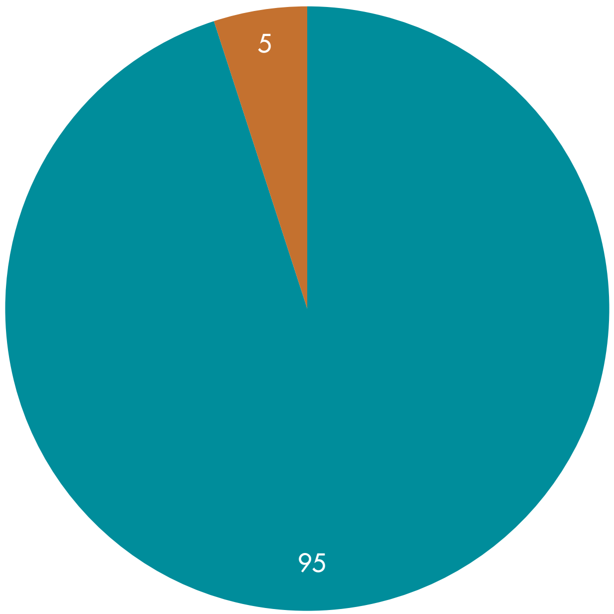
A local committee generally deliberates on which areas are suitable for new housing and reach a decision based on common consensus. However, specific topographic and geological information is seldom used and there is a lack of climate-sensitive land-use plans, which increases the potential vulnerability of all households, especially in high-slope areas where heavy rains will increase landslides in the future.

People mainly depend on natural springs for fresh water for drinking, which makes the entire township vulnerable to future rain variability and increased temperatures in the mid and long term, as aquifers will take longer to recharge

The 2014 Census reported that 69.5% of households at the Union level had access to improved drinking water sources against 30.5% without access. In Chin State, the proportion of households with access to drinking water is close to the national average (70.2%), while in Hakha Township, the figure is significantly above average (95%) (Figure 11).

Around 95% of the population relies on underground water sources (mainly natural springs). Water supply pipes use gravity to transport water. This system, if adequately addressed, can allow villagers an important degree of autonomy in terms of operation and maintenance. However, reliance on spring sources typically means that water sources are far from village sites, which can represent challenges to water distribution and exposes the system to greater damage, as piped networks traverse flood- and landslide-prone landscapes (Figure 12). Moreover, villagers' limited technical or financial capacity to expand service delivery in response to rising demand, coupled with the difficulty of bringing construction equipment into remote mountainous sites, can represent a huge challenge in providing access to protected water.

Figure 11: Type of water supply for potable use in Hakha Township



Source: Census, 2014*

Some households reported that they do not have access to any water supply system, and have to collect water daily from nearby seasonal streams (a task carried out by women). More than 70% of village tracts reported water availability as the main impact of temperature rise, especially during the dry season when they need to set aside two hours in the morning and two hours in the afternoon just to collect water. There is a lack of infrastructure for water storage at the community level such as water tanks and reservoirs and in schools, health posts, and other public buildings. In addition, very few households reported using rain-harvesting systems.

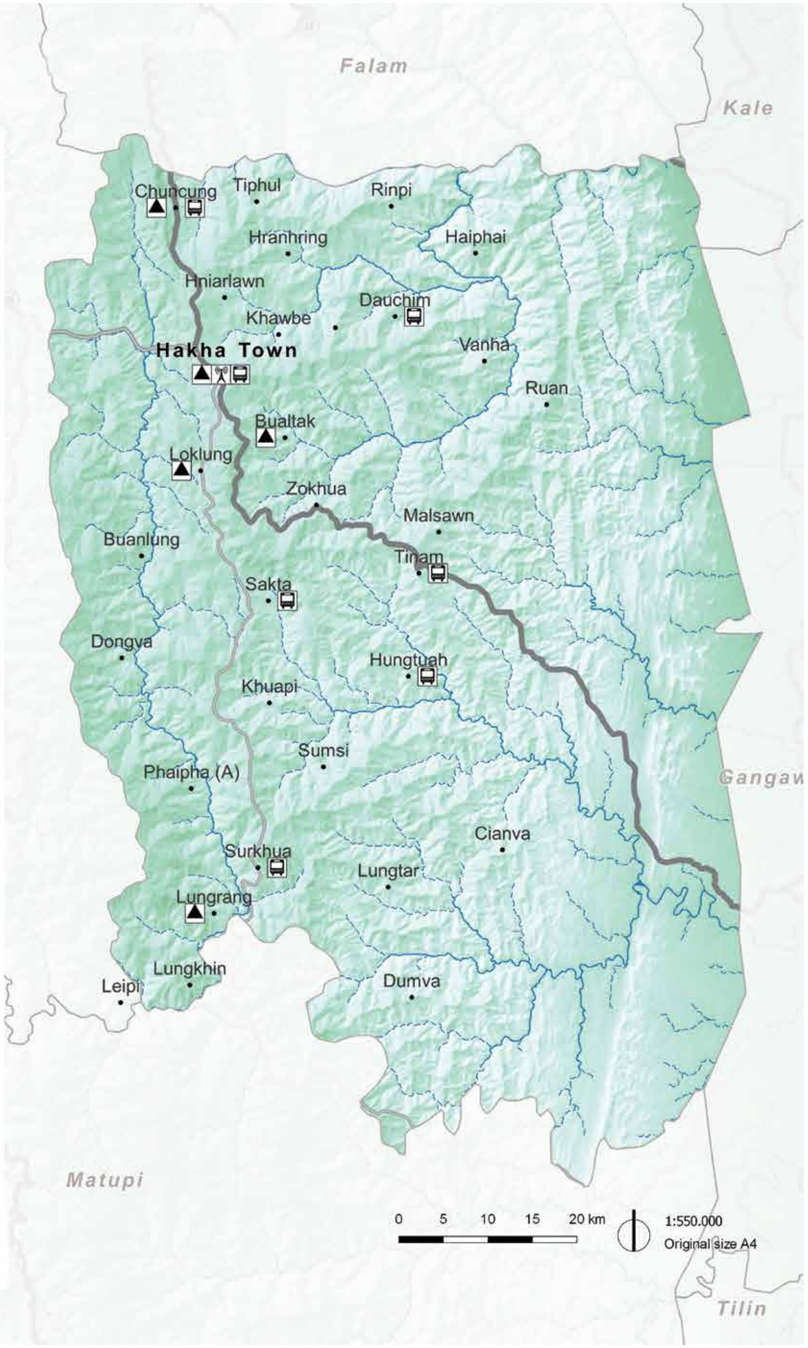
*Department of Population, Ministry of Immigration and Population. August 2014

This makes the entire township susceptible to rain variability and increased temperatures, in the mid and long term, as the water consumption rate may be higher than water cycle's capacity to replenish itself. The projected changes in precipitation patterns and increase in mean temperature may affect groundwater sources, as aquifers will take longer to recharge, leading to the need for further investments in improving infrastructure (tanks capacity, boreholes depth, etc.). In addition, intense runoff and soil erosion caused by more intense rains may cause damage to more water facilities.

Figure 12: Spatial distribution of main transport and communication infrastructure

The current transportation and communication systems seem to be the main constraint to rural socio-economic and livelihood development and are highly vulnerable to hazards. Around 30% of village tracts reported that over the last 30 years, landslides and floods have become more frequent, damaging roads and bridges, and in the worst cases, isolating them for several days from markets, medical facilities, schools, and other core community services.

More than 35% of households in the township do not posses any transportation item, rising to more than 80% in some southern village tracts. Access to both a public electricity network on the grid and a telecommunication network is very limited. These mobility and communication constraints already jeopardize rural livelihoods, but will worsen in emergency situations following the projected extreme weather events.



Main transportation routes

At the regional level, Hakha Township is crossed by the main paved road, representing the main merchandise transportation system, linking Gangaw Town with Falam further down to Laylay Town and India.

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

Coverage of improved sanitation is very good. According to the 2014 Census, more than 95% of the households use water seals (improved pit latrine).

Coverage of disaster and climate resilient basic services is limited; this reduces the resilience of communities to climate hazards and jeopardizes their future coping capacities in the face of more intense climate hazards

Health and education coverage is very weak across the township. Around 65% of the village tracts reported that access to health and education facilities was very difficult (20%) and difficult (45%).

There is one township hospital (TH) located in Hakha town, seven rural health centres (RHCs), and six sub-rural health centres (SRHCs), mainly located in village tracts along the main roads. As shown in Figure 13, the lack of health facilities is more pronounced in eastern areas.

Twenty-two village tracts have access to basic education facilities, which suggests that at least primary education is available to almost all children in the township, if we allow for some travel time. However, secondary education coverage is very weak, as only Hakha town and the village tracts of Chuncung and Sakta have high schools, which would suggest lower rates of enrolment as families have to send their children to Hakha, and this places an extra burden on the is already low incomes. Tertiary education is only available at universities located in Hakha town, while there is a lack of technical and vocational training centres.

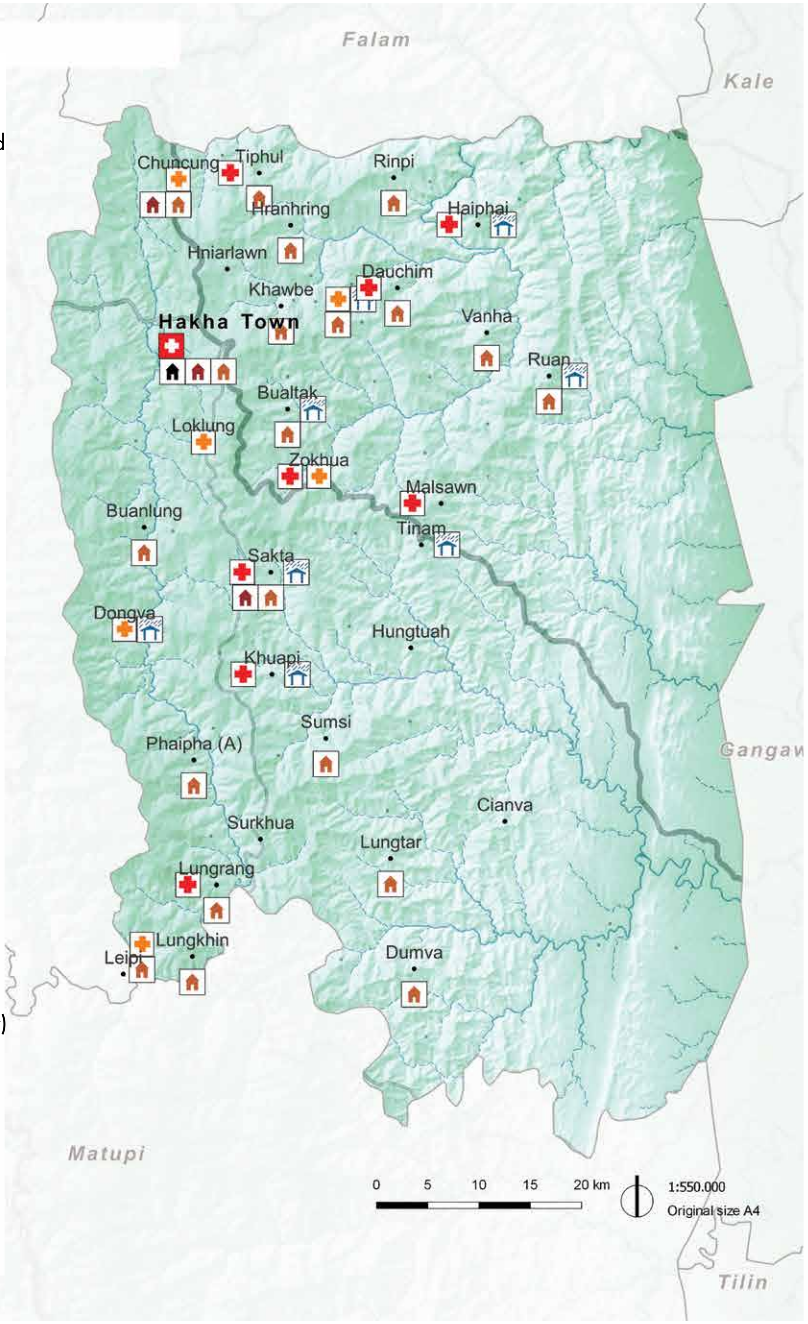
Communities reported a lack of community shelters that provide critical emergency shelter. Most public buildings (health centres and schools) are often not disaster resilient and therefore cannot be used for double purpose in the case of storms and floods. Similarly, churches are sometimes used as temporary shelters, but their limited capacity and resources do not cover all communities.

Figure 13: Spatial distribution of basic services and shelters

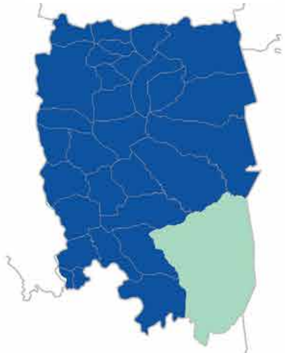
Coverage of disaster and climate resilient basic services is limited, reducing communities' resilience to climate hazards and jeopardizing their future coping capacities to more intense climate hazards.

Around 65% of the village tracts reported that access to health and education facilities is difficult, and that there is a lack of community shelters providing critical emergency shelters.

The availability of fresh water for drinking use mainly relies on natural springs, making the entire township vulnerable to future rain variability and increased temperatures in the mid and long term, as aquifers will take longer to recharge.

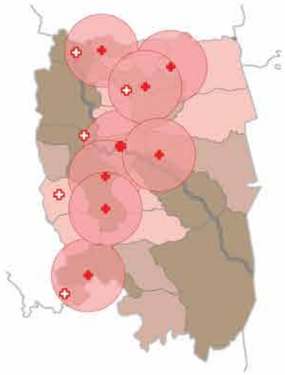


Main water sources



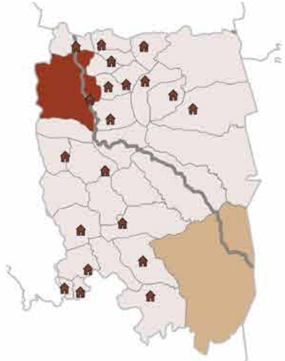
According to Census 2014, around 95% of the population relies on underground water sources (mainly natural springs)

Rural health coverage



Rural Health centres (RHC) and sub-rural health centres (SRHC), mainly located in village tracts along the main roads, configure the health coverage. There is a lack of health facilities in eastern areas

Primary education coverage



22 village tracts have access to basic education facilities, which suggests that at least primary education is available, if we allow for some travel time, except in south-eastern areas.

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

SOCIO-ECONOMIC CONDITIONS

- Rural households depend primarily on livelihoods based on rain-fed agriculture. This makes them highly vulnerable to climate change and variations.

- Rural communities have low access to services and infrastructure – health, education, market, finance, energy, technical assistance, and information.

- Hakha's urban population is highly dependent on daily wages and remittances; employment opportunities are low due to lack of skills and industries.

- While there is some level of food self-sufficiency, food security is more dependent on external supply. This makes people more vulnerable during disasters when road connectivity gets disrupted.

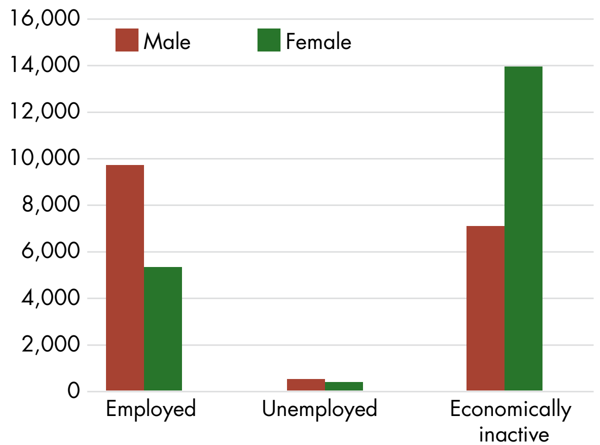
- Women have less access to resources and opportunities (for instance, financial services and land ownership) than men. Therefore, they are likely to face problems and hardships such as food insecurity and loss of livelihoods.

- Low levels of income and income generating options, education, and migration are mutually reinforcing.

As per the 2014 Census, Hakha Township has a total population of 48,352, of which about 48% is rural. Almost 23% of households are women-headed. The overall rate of labour force participation of individuals over 10 years old is about 43%. The employment to population rate is about 41% and the unemployment rate is 5% for men and 7% for women. A large proportion of the population (21,049) is economically inactive (Figure 14), with the numbers significantly higher for women than men, even when women and girls play an active role in household economy. About 57% of the economically inactive population resides in urban Hakha or wards.

Cash crops are the main source of livelihood for about 50% of villages in Hakha Township. About 45% of households depend on daily wages from masonry, road construction, carpentry, wood sawing, stone collection, wild fruit collection, and on-farm labour (Table 2). In urban Hakha, the main sources of income are daily wage, salaried employment, remittances and business or trade. Income from livestock, crops, vegetables, and fruit is very low.

Figure 14: Labour force participation size in Hakha Township



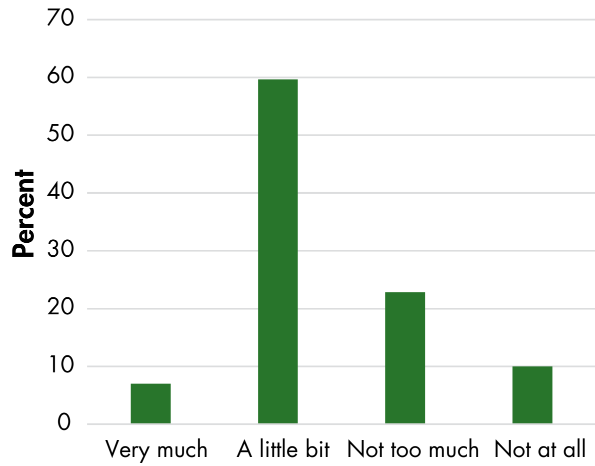
Out-migration is an important livelihood strategy for Hakha's rural and urban population. More than 90% of Hakha villages and wards reported outward migration for economic reasons. About 50% of villages engage in seasonal migration to India for work, while many others have migrated to the USA, Australia, Malaysia, Singapore, Thailand, Japan, Korea, and China for permanent or long-term migration. About 60% of households receive financial support through

Table 2: Income from different sources

Source of income	Average annual income per HH (MMK)	Percentage of HHs
Crop, vegetable, fruit sales	452,766	36
Livestock and livestock product sales	547,676	36
Fish sales	220,313	4
Forest products sales (firewood/NTFP)	400,000	2
Herb sales	400,000	0.3
Medicinal and aromatic plant sales	–	–
Daily wage	725,086	45
Salaried employment	1,726,500	15
Tourism	1,200,000	0.3
Business/trade	1,242,857	4
Interest on loans, or returns form share	100,000	0.3
Pensions	423,750	2
Remittances	770,364	28

Source: ICIMOD, 2013#
ICIMOD (2013). Poverty, Vulnerability and Adaptation studies in Chin and Shan, unpublished
(1 USD = 1,520 MMK as of February 2019)

Figure 15: The extent to which remittances from migrants helps a household



remittances, which contribute "a little bit" to the household needs (Figure 15). Only 13% receive income from handicraft – mainly from traditional wear woven by women.

All rural households are involved in crop and livestock integrated farming systems for food, nutrition, and income. Shifting cultivation or Taungya is the primary farming system in the upper villages of Hakha. However, shifting cultivation is largely subsistence-oriented and highly labour intensive, requiring nearly 260 person days annually for about two acres of shifting land with at least four crops. More than 70% of shifting cultivation work is performed by family members and exchange labour and about 30% by hired labour (Min, 2013). Smallholder farmers depend a lot more on exchange labour than on hired labour. Women-headed households face far more difficulties in agricultural operations due to shortage of labour and low financial capacity to hire labour.

The other systems for food and income are upland terraces, wet terraces, orchards, home gardens, fallow forests, and fish ponds. According to locals, banana, pineapple, corn, sesame, beans, chilli, garlic, onion, elephant foot yam, and small tubers from forests are the main products for income (Table 3). Elephant foot yam is sold at MMK 5,000–6,000 per viss (1 viss = 1.6 kg , 1 USD = 1,522 MMK as of April 2019) to traders after drying. Dried elephant foot yam is exported to China.

In villages located at lower elevations, such as Cangva, and those with moderate to flat slopes, terrace farming is more prevalent for growing paddy, maize, and mustard. However, due to lack of irrigation facilities, the terraces remain underutilised. Due to high demand for good quality timber and a favourable environment, households in these villages grow teak on their private land for income.

A bird's eye view of Chun Cung village with lopils, forest, terraces, and other production systems

Table 3: Resources for rural livelihoods in selected Hakha villages (ICIMOD and CORAD*, 2016)

Assets	Lungcawi village (67 households)	Phaipha B village (56 households)	Tiphul village (106 households)	Hrawngvun village (25 households)
Buffalo	45 heads/12 HHs	85 heads/30 HHs	Not known	10 heads/4 HH
Cows	65 heads/17 HHs	48 heads/16 HHs	182/72 HH	38 heads/5 HH
Draught cattle	30 heads/10 HHs	50 heads/18 HHs	62 heads/34 HH	
Pigs	67 heads/60 HHs	68 heads/35 HHs	200 heads/106 HH	70 heads/20 HH
Chicken	200 heads/67 HHs	220 heads/35 HHs	1,200 heads/106 HH	200 heads/25 HH
Horse	1 head/1 HH	30 heads/13 HHs	22 heads/10 HH	10 heads/5 HH
Shifting cultivation plots (Lopils)	6 lopils (about 1,100 acres)/67 HHs	11 lopils (3,300 acres)/56 HHs	7 lopils (7,000 acres)/106 HH	17 Lopils (680 acres)/25 HH
Paddy terrace destroyed in 2015 landslides	27 acres/16 HHs 6 acres	55 acres/30 HHs 15 acres	80 acres/85 HHs 40 acres	8 acres 8 acres
Orchard	3 acres/1 HH	1.5 acre/1 HH	15 acres/30 HHs	13 acres/11 HH
Home garden	60 HH	56 HHs	106 HHs	
Main cash crops	Elephant foot yam, hard wood	Elephant foot yam, corn	Garlic, onion, cabbage	Potato, corn
Corn huller	1 unit/1 HH	No data	No data	No data
Rice huller	3 units/3 HHs	3 units/3 HHs	4 units/4 HHs	No data
HHs with migrating member	21 HHs	41 HHs	60 HHs	18 HH
HHs receiving remittance	17 HHs	38 HHs	50 HHs	17 HHs

*ICIMOD and CORAD (2016). Situational analysis of shifting cultivation in northern Chin, unpublished

Animal husbandry is an important livelihood activity across Hakha. People rear animals for food, income and cultural requirements. Nearly every rural household keeps pigs and raises chicken using traditional methods. Some have buffaloes, cows, and horses. All the crop and livestock products are sold individually and not in organized groups, and without any value-addition. About 80% of the villages find it "difficult" to "very difficult" to sell the produce due to lack of marketing facilities and road connectivity.

Every household has access to shifting cultivation plots, forest resources, and water resources. Terraces, though not as abundant as shifting cultivation plots, are private property and have to be registered with the Settlement and Land Records Department (SLRD). Historically, the Chin Hills land tenure system had featured a mix of hereditary cultivation titles; the right of disposal belonging to the village chief, and communal land ownership by the village community as a whole.

Since tribal livelihood relied almost exclusively on subsistence *taungya* farming in the past, the local community had no knowledge of land registration, land title, or the official right to till land. But the gradual shift from *taungya* farming to permanent terraced farming or lowland paddy cultivation with commercial orientation has gradually affected community outlook. Rich farmers who can afford to develop permanent farming approach the SLRD for a survey of their lands, and mapping and land registration (U San Thein, 2012)*. Due to the high establishment cost, terrace construction work in northern Chin, including Hakha, is mostly supported by development organizations. Due to the fragile mountainous ecosystem with steep terrain, upland terraces are quite vulnerable to extreme rainfall. Many terraces, irrigation canals, and shifting plots were destroyed by heavy rains and landslides in 2015. There are no specific programmes on shifting cultivation even though many farmers consider agroforestry a potential option for improved livelihoods.

Most farmers in Hakha Township are smallholders with an average farm size per household of less than two acres. Manual labour and animal traction are employed for farming operations. Rice and maize are the most important cereal crops in Hakha Township.

Rice is the staple food of the Hakha people, closely followed by maize. In the past, people consumed more maize and millet, but most eat rice every day for every meal. Therefore, the availability of rice is very important for food security. Along with banana culms, rice bran, broken rice, and maize gruel are used as feed for fattening pigs. Average rice yield is about 2.5 MT/acre. The yields decline substantially, by up to 50%, if rainfall is below normal in any given year. Paddy yield has been found to decrease by about 500 kg/acre in many farms due to declining soil fertility and rise in pest and disease outbreaks. Crop yields were severely impacted by extreme rainfall in July 2015. Rodent infestation is another problem in a few villages; it affects crop production and people do not have much knowledge about addressing it. A few farmers

Women in Tinam village drying elephant foot yam for sale in October

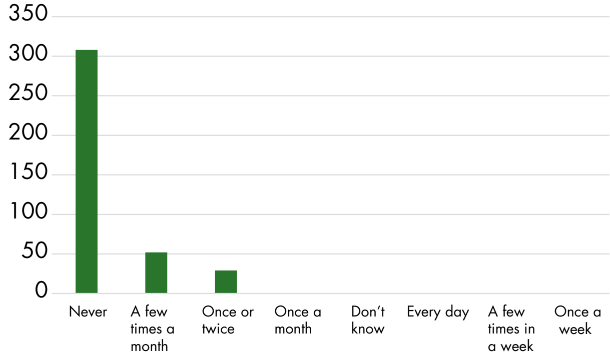
have tried new production methods such as the System of Rice Intensification for improving crop yield with less water on a small scale and have obtained positive results. In the villages visited by this assessment team, farmers reported cultivating four to five varieties of rice and two varieties of maize. They store their own seeds.

A majority of households are food secure for only 5–8 months from their own production systems and have to purchase rice from the market. However, almost 80% of these households have never eaten fewer meals as a result; 12.3% of households have fewer meals a few times a month (Figure 16).

In Hakha, food items such as rice, salt, and oil have to be imported from Kalay, Falam, and Gawgaw. U San Thein (2012) estimated a net rice deficit of 10% in Hakha Township, considering the total local rice production of 5,739 MT from about 4,700 acres in Hakha, a total consumption of about 9,700 MT/year and about 3,000 MT of external supply mainly

*U San Thein (2012): Study on the evolution of farming systems and livelihoods in Chin state, GRET

Figure 16: Number of households eating fewer meals in Hakha Township (N = 390 HHs)



Source: ICIMOD, 2013

Figure 17: Households in different income categories in Hakha Township (income range values in MMK)

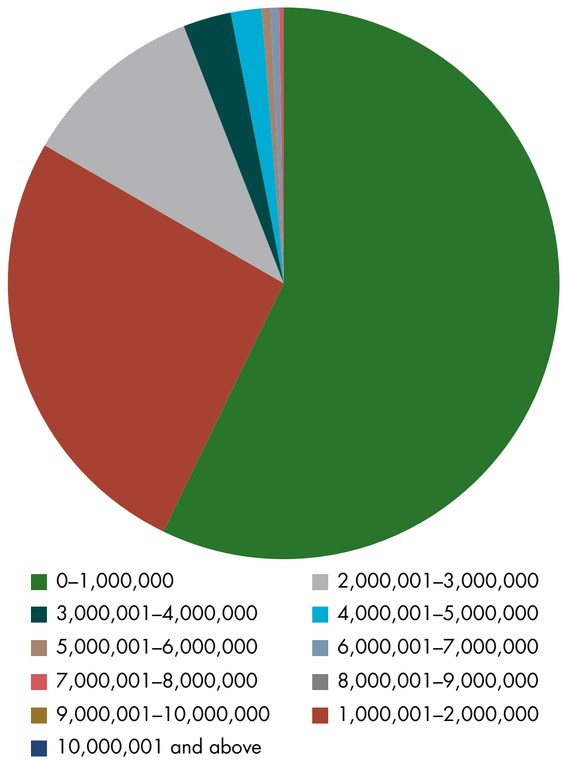
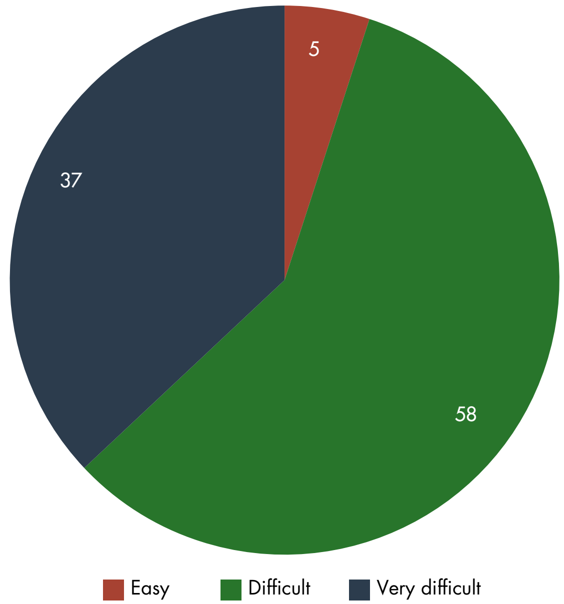


Figure 18: Ease of earning income



from Kalay. Overall, Hakha Township is only around 40% self-sufficient in rice. Food security is impacted during natural disasters, which not only disrupt food distribution systems but also result in price distortion of essential commodities. According to a World Food Programme Myanmar report, in late July 2015 Chin State was devastated by landslides resulting from heavy rainfalls. In the aftermath, housings and infrastructures were destroyed. Access to Chin State was cut off for many days. In such situations, women headed households and households with high dependence on daily wages suffer most. Very few villages are prepared for an emergency situation. Rice banks were established in many villages, but many are dysfunctional owing to local management issues.

A poverty and vulnerability assessment of Chin conducted by Gerlitz et al. (2014)* showed that the average annual household income of Hakha is also low (about USD 950) with more than 50% households falling in the lowest income category of MMK 0–1,000,000 (Figure 17). According to 95% of the village administrators surveyed, it is "difficult" to "very difficult" to earn in Hakha Township.

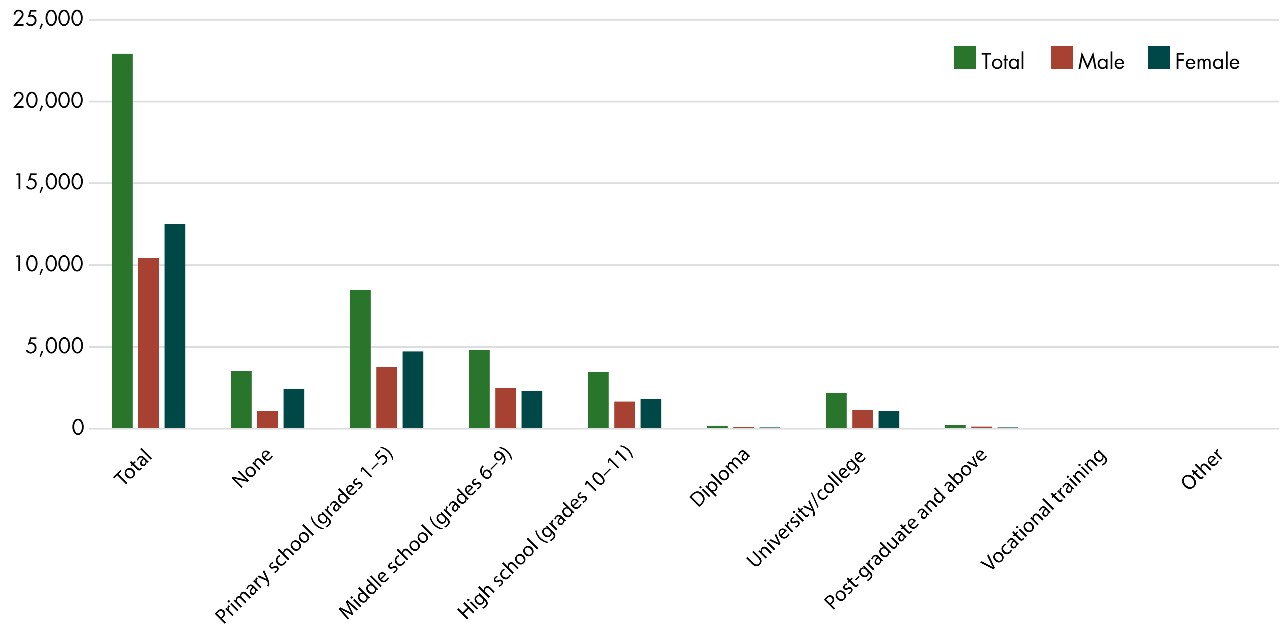
Crops, vegetables, fruits, and livestock are the main sources of annual income for 36% of households (Table 3). Average income from salaried jobs is about USD 1,300; however, only 15% of households have members who are in this category. Most salaried persons are based in Hakha Town.

The average annual expenditure of a household is estimated to be about MMK 648,500. Expenditures are quite high compared to income, with about 53% of households spending more than MMK 100,000 annually on medical treatments and health care Gerlitz et al., (2014)*. Water and vector borne diseases in humans are very common and include diarrhea, allergy, skin diseases, malaria, and dengue. Due to lack of health services, many patients need to go to Hakha, Kalay, or Gangaw for treatment, which is expensive, especially in terms of transportation. Many women stated health was a major problem.

The ability to adapt is also determined by a combination of factors such as access to and/or control over land, money, credit, information, health care, personal mobility and education. More than 52%

*Gerlitz, J., Banerjee, S., Hoermann, B., Hunzai, K., Macchi, M. & Tuladhar, S. (2014) Poverty and vulnerability assessment – A survey instrument for the Hindu Kush Himalayas. Kathmandu: ICIMOD

Figure 19: Educational level of Hakha Township population



of the population above 25 years in Hakha Township has either not received formal education or studied only up to the primary level (Figure 19). About 80% of the surveyed village administrators do not have savings in banks. More than 80% of its villages have access to credit and/or loan through microcredit institutions, village funds, private banks, agriculture development banks and traders. However, the interest rates are quite high and the credits are available only for a short time. Some loans from the agriculture development banks are accessible to only those household members who have land certificates (Form 7) for terraces. Many poor farmers, particularly women, are constrained by this discriminatory land and inheritance right as most of the land, livestock, and assets are owned by men (Table 4). In genreral, women also face discrimination in the payment of daily wages; they are paid MMK 1000/day less than men.

Table 4: Use and control of resources and daily activity by women and men, in Langcawi village, Chin State

Assets/ Resources	Who use (Men/ women/ both)	Who own/ control Men/ women/both	Remark
House	Both	Men	Son inherits as per Chin tradition. Daughter can inherit if parents do not have a son.
Paddy terrace	Both	Men	
Land	Both	Men	
Orchard	Both	Men	
Farming tools	Both	Both	
Cattle	Both	Men	
Pig/chicken	Both	Both	
Cash/money	Both	Both	
Sewing machine	Women	Women	
Furniture (cabinet, TV, settee)	Both	Both	
Gold/silver	Women	Women	
Motorcycle	Men	Men	
Traditional wear	Both	Both	

Time	Men's activities	Women's activities
5 am	Sleep	Get up, cook the morning meal, cook pig feed
6 am	Get up, cook breakfast	Bathe, feed pig/chicken, water home garden
7 am	Breakfast	Breakfast, go to farm
8 am	Go to farm	Arrive at farm
9 am	Start working on farmland	Start working on farmland
10 am	Work	Work
11 am	Work	Work
12 noon	Lunch time	Lunch time
1 pm	Start working	Start working
2 pm	Work	Work
3 pm	Work	Work
4 pm	Go back home	Go back home
5 pm	Arrive home, cook dinner	Arrive home, cook dinner
6 pm	Dinner	Dinner
7 pm	Rest	Wash clothes, feed pig, clean room, others
8 pm	Worship, meeting	Worship, meeting , care for children,
9 pm	Go to bed	Go to bed
10 pm	Sleep	Sleep

Source: ICIMOD and CORAD, 2016

Figure 20: Main sources of living and crops

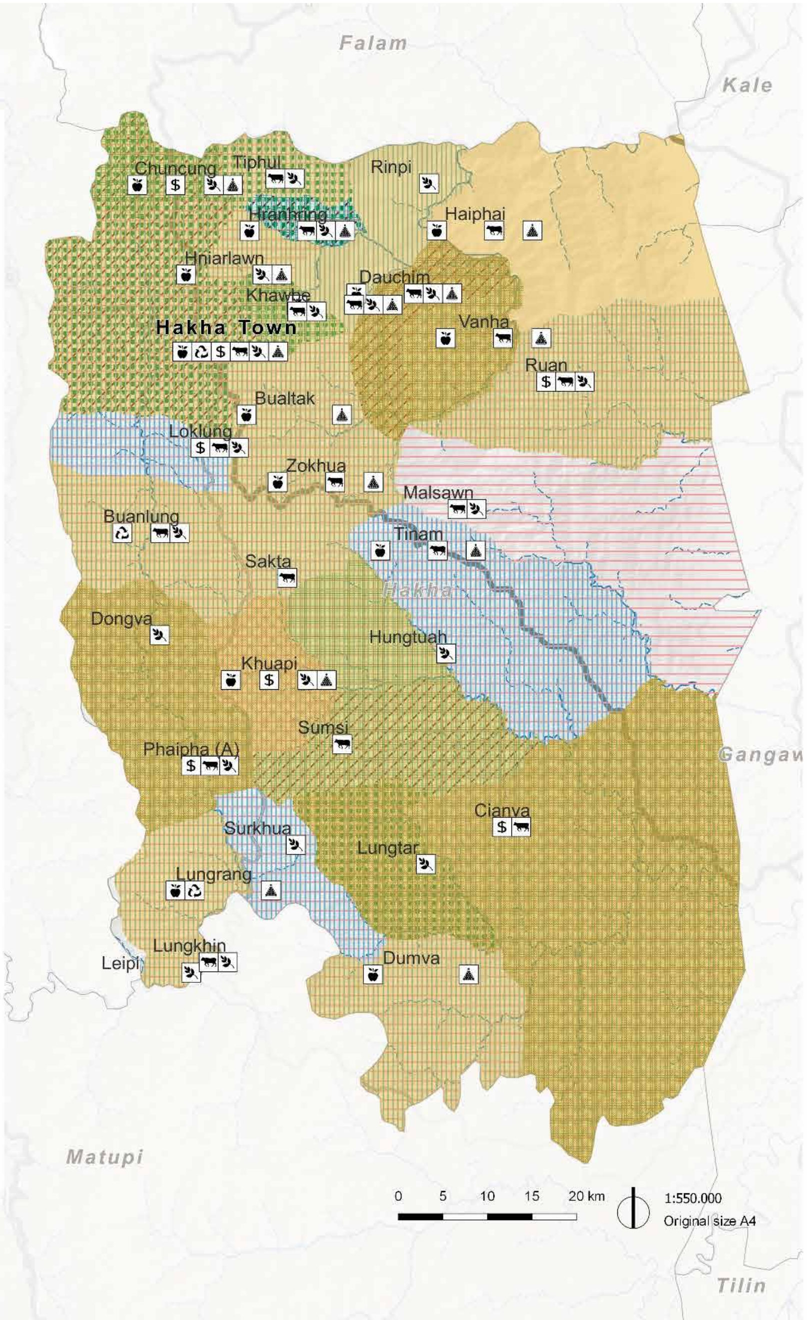
Rural households depend on rain-fed agriculture based livelihoods. While there is some level of self-sufficiency for food items, food security is more external market dependent. This makes people more vulnerable at the time of disasters when road connectivity is disrupted. Low levels of income and income generating options, education, and migration are mutually reinforcing.

Main sources of living
- Casual labour
- Livestock
- Trade
- Agriculture cash crops
- Agriculture self-subsistence
- Handicraft

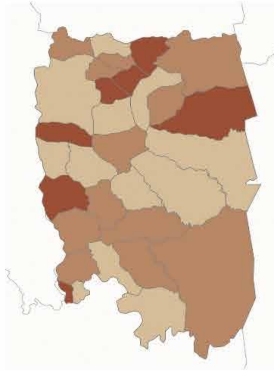
Main crops
- Maize
- Paddy rice
- Orchard
- Coffee
- Timber
- Wild fruits
- Vegetables

Transport Network
- Major road
- Secondary road
- Tertiary road

Main streams
- Main streams
- Seasonal streams



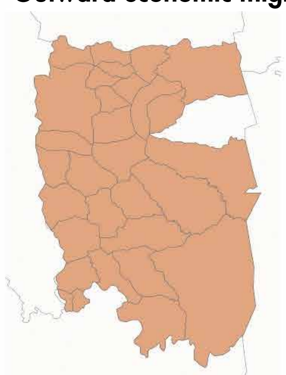
Labour force participation rate 10+(%)



Distribution of the population 10 years and over by labour force participation rate according to the Census, 2014

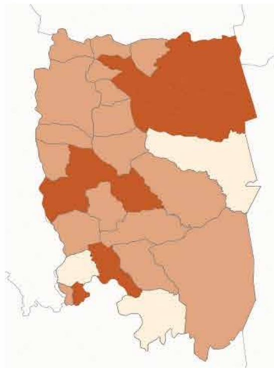
- 0–25
- 25–50
- 50–75
- 75–100

Outward economic migration occurance



Village tract where outward economic migration was reported

Earn sufficient income



Distribution of the village tracts by level of difficuty in earning sufficient income

- Very difficult
- Difficult
- Easy

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

3.4 SPATIAL DEVELOPMENT AND TERRITORIAL LINKAGES OF THE TOWNSHIP

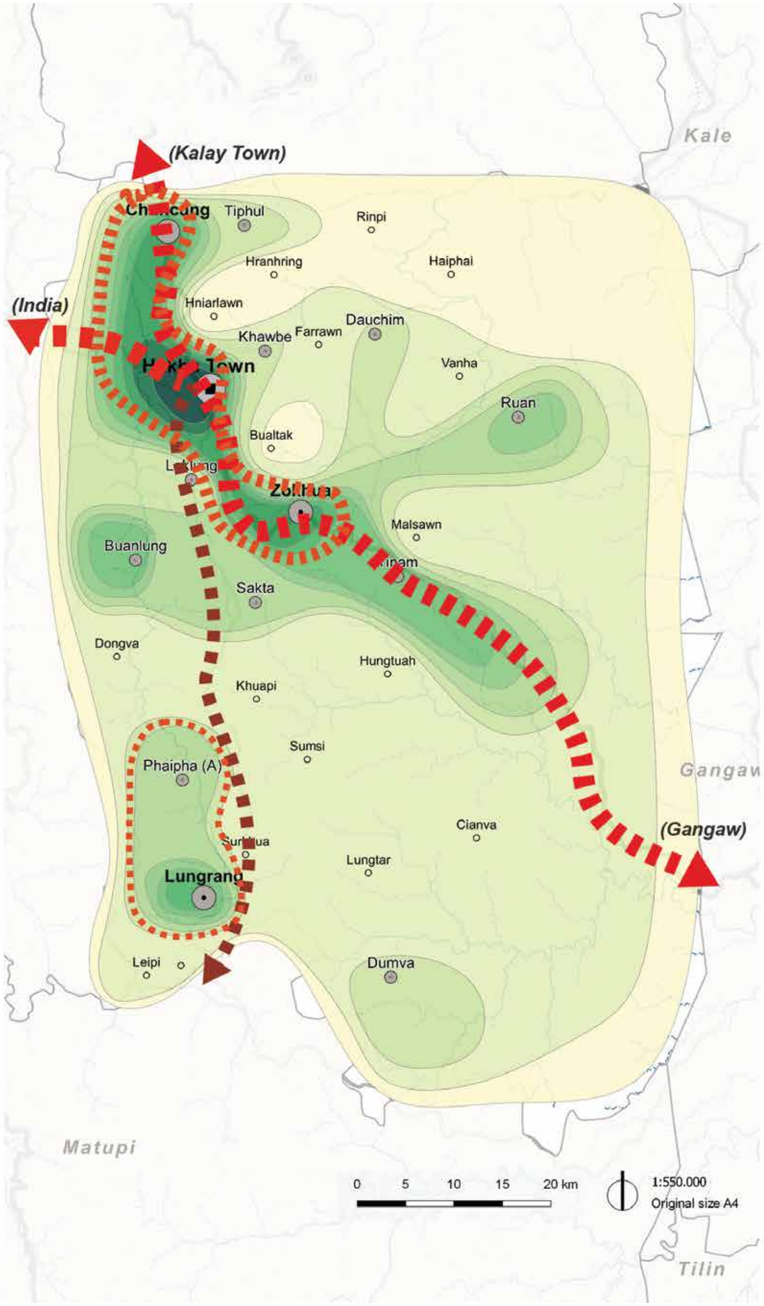
- The territorial and socio-economic development of the township is unbalanced, mainly focused on Hakha Town, and the neighbouring village tracts of Chuncung and Zokhua along the national road to Falam and Kalay Town (north) and Gangaw Town (east).
- Poor connectivity and the remoteness of different village tracts located in the township compel many villages to get their services from other nearby townships. For example, this is the case in Gangaw Township (to the south of Hakha) that provides many socio-economic functions to the southern areas of Hakha Township, while Kalay Town provides most of the transport facilities and represents the main market for the agricultural products and provisioning needs of the township.
- Access to better transportation infrastructure enables higher levels of socio-economic and infrastructure development.
- The lack of adequate road connectivity among the village tracts in the south-eastern areas of the township poses a main constraint to their socio-economic development, as they are highly dependent on Hakha Town.
- Although business and industrial development is still very weak across the whole township, village tracts where higher education facilities are available increase the range of private, professionals, and commercial opportunities.

Figure 21: Spatial structure of Hakha Township in 2017: Territorial and socio-economic linkages

+ 1.6°C warmer | + rainfall | + drought

At the regional level, Kalay Town represents the main market for the agricultural products and provisioning needs of the township, while Gangaw Town provides many socio-economic functions to the southern areas of the township. Furthermore, economic linkages with India are to be considered.

At the township level, Hakha Town provides the highest levels of health and education facilities, security services, and commercial and economic activities, while the bi-polar set of settlements of Lungrang and Phaipa (A), provides intermediate functions to the south eastern areas of the township.

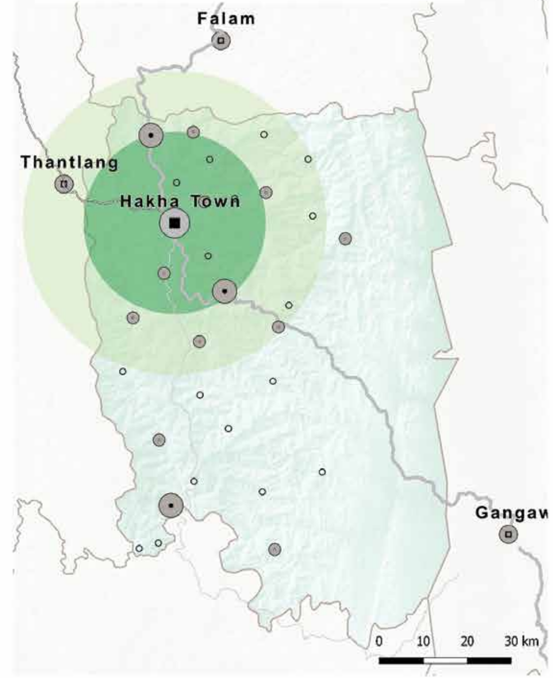


Level of hierarchy
- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6
- Level 7
- Level 8
- Level 9
- Level 10

Type of settlements
- Main urban centre
- Main village tract
- Intermediate village tract
- Local village tract

Spatial structure
- Primary cluster
- Secondary cluster
- Primary corridor
- Secondary corridor

Spatial distribution of the type of settlements



Hakha Town, where all transportation communication converges, shows the highest levels of urban and socio-economic development. Its territorial influence is mainly observed along the national road to Falam Town (north) and Gangaw Town (east).

Type of settlements
- Main urban centre
- Main village tract
- Intermediate village tract
- Local village tract
- Distance 15 km
- Distance 25 km

Road network
- Major road
- Secondary road
- Tertiary road

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

Table 5: Matrix of functions depicting the distribution of various services in village tracts and towns in Hakha Township in 2017

VTCODE	Total number of functions	Total centrality score	Level of hierarchy	Type of settlement
MMR004002000	54	1936.6	10	MUC
MMR004002005	30	469.3	8	
MMR004002007	31	417.6	8	MVT
MMR004002010	26	410.0	7	
MMR004002021	21	366.0	6	
MMR004002016	20	322.7	6	
MMR004002024	22	312.0	5	
MMR004002004	24	232.6	4	
MMR004002027	19	173.5	4	IVT
MMR004002022	22	201.4	3	
MMR004002003	16	131.9	3	
MMR004002014	16	119.4	3	
MMR004002013	19	158.9	3	
MMR004002009	20	150.5	3	
MMR004002030	17	140.8	2	
MMR004002001	17	135.1	2	
MMR004002028	15	132.7	2	
MMR004002023	15	127.6	2	
MMR004002025	15	126.8	2	
MMR004002002	18	125.8	2	
MMR004002019	16	121.3	2	
MMR004002029	15	119.9	2	
MMR004002026	18	119.3	2	LVT
MMR004002012	16	118.7	2	
MMR004002017	18	118.1	2	
MMR004002020	15	95.4	1	
MMR004002015	14	95.0	1	
MMR004002008	14	94.5	1	
MMR004002018	10	48.6	1	
MMR004002006	8	39.9	1	
MMR004002011	9	38.6	1	

Group	Function	Number of functions		
LOCAL VILLAGE TRACTS	Monastery/church	29	100	3.4
	Vegetables	28	100	3.6
	Paddy rice	28	100	3.6
	Public water network on grid (piped water)	28	100	3.6
	Maize	26	100	3.8
	Carpenters	24	100	4.2
	Agriculture(smallholder/self-sufficient)	24	100	4.2
	Midwife	24	100	4.2
	Playground	23	100	4.3
	Primary school	20	100	5.0
	Unmade (trail/track)	19	100	5.3
	Disaster Management Committee	17	100	5.9
	Middle school	17	100	5.9
	CHW	16	100	6.3
	Small basic needs stall	15	100	6.7
	Community-based organization	12	100	8.3
	Kindergarten	12	100	8.3
	Orchard	11	100	9.1
INTERMEDIATE VILLAGE TRACTS	Other casual labour	10	100	10.0
	Library	10	100	10.0
	Gravel road	10	100	10.0
	National non-government organizations (I/NGOs)	10	100	10.0
	Grocery stores	9	100	11.1
	Public rural health centre	8	100	12.5
	Weaving/sewing	8	100	12.5
	Hydroelectric power production	8	100	12.5
	Farmers' cooperatives	7	100	14.3
	Timber	7	100	14.3
	Bus stop	7	100	14.3
	Wild fruits	6	100	16.7
	Wood for charcoal	6	100	16.7
	Public sub rural health centre	6	100	16.7
	Petrol supply station	6	100	16.7
	Public electricity network on grid	5	100	20.0
	Private solar panel electricity supply	5	100	20.0
MAIN VILLAGE TRACTS	Coffee	5	100	20.0
	Pharmacy	5	100	20.0
	Street sellers	5	100	20.0
	Post office	5	100	20.0
	Restaurant	4	100	25.0
	Electricians	4	100	25.0
	Livestock market	4	100	25.0
	Bicycle repair garage	4	100	25.0
	Veterinary clinic	4	100	25.0
	Early warning system	4	100	25.0
	High school	3	100	33.3
	Paved road	3	100	33.3
	General market	3	100	33.3
	Plumbers	3	100	33.3
	Non-profit associations (NPAs)	3	100	33.3
	Motor vehicle repair garage (motorbike/car)	2	100	50.0
	Construction material shop	2	100	50.0
	Rain water harvesting pond	2	100	50.0
	Lawyers	2	100	50.0
	Disaster facilities (i.e Shelter)	2	100	50.0
	Oil crops (sesame, sunflower, groundnut)	2	100	50.0
MAIN URBAN CENTRES	Irrigation system	1	100	100.0
	Public lighting solar panel electricity supply	1	100	100.0
	Dentist	1	100	100.0
	Private clinic	1	100	100.0
	Bus transport on a daily basis	1	100	100.0
	Telecommunication transfer (mobile phone repeater)	1	100	100.0
	University	1	100	100.0
	Museum	1	100	100.0
	Police station	1	100	100.0
	Police check point	3	100	33.3
	Public township hospital	1	100	100.0
	Fire station	1	100	100.0
	Banks/western usnion	1	100	100.0
	Furniture shop	1	100	100.0
	Beans	1	100	100.0
	Doctor	1	100	100.0

Table 6: Village types and main characteristics

	Centrality Score	Main Characteristics	Level of Hierarchy	Name of Village tract/ward
Local Village Tract (LVT)	38,6–140,8	Transportation infrastructure is limited to tracks/trails, and access to mobile repeater and electricity is not available. Springs are the main source of freshwater, distributed through a gravity-fed system (piped water). Education up to middle school is available, while community health workers and midwives provide basic health services. Small-holder/self-sufficient agriculture (maize, paddy, and vegetables) is the main source of income.	1	Hai Phai, Hniar Lawn, Baultak, Lungtar, Hran Hring, Rinpi
			2	Malsawm, Farrawan. Sumsi, Surkhua, Bungtuah, Dongva, Van Har, Leipi, Khuapi, Cangva, Lungkhin
Intermediate Village Tract (IVT)	150,5–366,0	Better transportation services (gravel roads and buses) coupled with the presence of rural health facilities (public sub rural health centres, public rural health centres) allow more commercial and economic activities (hydroelectricity production, grocery stores) and professional services (other forms of casual labour)	3	Tiphul, Dumva, Khua Be, Lok Lung, Dauchim
			4	Sakta, Phaipha
			5	Ruan
			6	Tinam, Buanlung
Main Village Tract (MVT)	410,0–469,3	Access to the main road (paved) enables markets and increases the range of private professionals (electricians, plumbers, lawyers) and business and industrial opportunities (construction materials stores, motor vehicle repair garages)	7	Lungrang
			8	Khon Kwoon, Zokhua, Chuncung
Main Urban Centre (MUC)	1936,6	This type of settlement provides the highest levels of health (township hospital, doctor) and education coverage (universities) as well as security services (police station and fire station) and commercial services (banks).	10	Hakha Town (Kyaw Boke, Myo Haung, Myo Thit, Pyi Taw Tha, Zay Haung, Zaythit)

Source: Vulnerability Assessment Survey, November 2017

The overall objective of this chapter is to provide a comprehensive spatial analysis of the current situation to guide the socio-economic and infrastructure development of the township in the short and mid term and influence planners in the region/township who will be able to use the findings to make more informed, strategic planning decisions for the longer term.

The spatial and territorial analysis uses the Matrix of Functions (MoF) to:

- Determine a functional hierarchy of human settlements (wards/village tracts) based on the current availability of critical infrastructure and socio-economic services
- Visualize how balanced the infrastructure and socio-economic development of the township is, and most importantly, identify the degree of territorial linkages between settlements
- Support national, regional, and local government decision-making to focus/prioritize strategic interventions towards more balanced territorial development patterns

At this initial phase, the spatial analysis only covers the village tracts in Hakha Township. However, the understanding of the spatial and territorial linkages provides a good basis for future analysis of the linkages at the state/township level.

Functional hierarchy of human settlements

The analysis is based on data collected in all wards (6) and village tracts (30) of the township (through a survey filled out by village leaders/representatives) for inventorying the presence or absence of 90 functions under economic, administrative, social, or cultural sphere.

Data collected is fed into an unordered MoF (spreadsheet); columns represent functions and rows represent village tracts. Sorting by *"function weight"* and *"centrality score"* the ordered matrix is established and interpreted to group basic, intermediate, and central human settlements and determine a set of functions that should be covered for each category in the context of the region.

Looking at the image of the MoF and at the Centrality Index, basic, intermediate, and central villages are derived by establishing one or more levels of differentiation whenever an important gap appears between two successive values of the index.

The functions are then analysed to define a profile for each category based on the combination and diversity of specific provisioning ecosystem services, physical infrastructure, and social and economic activities.

It is worth mentioning that out of the 90 functions inventoried, 72 functions are present, mainly covering ecosystem provisioning services and basic infrastructure and public services. Most settlements except the wards in Hakha Town show weak economic development, relying mainly on agriculture and livestock incomes.

Territorial linkages and infrastructure and socio-economic development

At the regional level, Kalay Town provides the highest levels of transport, education, and health services and represents the main market for the agricultural products and provisioning needs of the township, while Gangaw Town provides many socio-economic functions to the southern areas of the township.

Furthermore, economic linkages with neighbouring India are to be considered.

As shown in Figure 21, an analysis of the spatial distribution of the type of settlements and the cartographic representation of the levels of hierarchy based on isopleths allows us to make some assumptions regarding how balanced the spatial development of the township is, and the degree of influence (where present) of each settlement over neighbouring settlements.

Enhanced mobility networks enable economic growth

Human settlements with a higher level of accessibility (access to roads and the avalability of more means of transportation) show better coverage of public services and more economic services and opportunities.

Hakha Town, where all transport and communication converges, shows the highest levels of urban and socio-economic development. Its territorial influence is mainly observed along the primary corridor to Falam Town (north) and Gangaw Town (east), where Main Village Tracts (MVT) are located (15–25 km from Hakha Town). On the other hand, territorial linkages towards Matupi Township (south), along the secondary corridor, appear to be weaker.

Isolated settlements, only accessible by tracks, provide only the most basic health and education services and the population mainly relies on agriculture and livestock.

A lack of adequate road connectivity, especially in south-eastern areas of the township, seems to present major constraints to their socio-economic development, as they are highly dependent on Hakha.

- **Higher levels of education enable economic growth and off-farm job creation**

  Although business and industrial development is still very weak across the township, territorial analysis reveals that those village tracts where higher education facilities are available (high schools and universities) increase the range of private professionals and commercial opportunities.

- **The territorial and socio-economic development of the township appears to be rather unbalanced and mainly relies on two clusters of settlements**

  The northern tri-polar set of settlements centred on Hakha Town and the neighbouring village tracts of Chuncung and Zokhua.

Strategically located where all the transport and communication of the township converges, this tri-polar set of settlements provides the highest levels of health and education facilities, security services, and commercial and economic services in the township.

Hakha Town is considered the Main Urban Centre (MUC), providing the highest levels of education facilities and security services, and represents the main supply centre of goods and services of the township. Its territorial influence is mainly observed along the primary corridor to Falam/Kalay Town (north) and Gangaw Town (east), towards the neighbouring village tracts of Chuncung and Zokhua, both categorized as Main Village Tracts (MVT).

The southern bi-polar set of settlements centred on Lungrang and Phaipa (A).

Located along the southern secondary corridor towards Matupi Township (south), this bi-polar set of settlements provides intermediate functions to the southern areas of the township.

Lungrang is categorised as a Main Village Tract (MVT), providing basic health services and general market to the southern areas of the township. Its territorial influence is mainly observed along the secondary road to Hakha Town (north) towards the neighbouring village tract of Phaipa (A), categorised as an Intermedia Village Tract (IVT).

Northern tri-polar set of settlements

Village tracts	Hakha Town	10	Main Urban Centre (MUC)
	Chuncung	8	Main Village Tract (MVT)
	Zokhua	8	Main Village Tract (MVT)
Main functions provided	Infrastructure facilities and services	Public water network on grid (piped water), Paved road, bus stop, petrol supply station Mobile phone repeater, public electricity network on grid, post office	
	Socio-economic and security services	High school, university Public township hospital, private clinic, pharmacy, doctor General market, banks/Western Union Disaster facilities (i.e., shelter), police station, fire station	
	Eco-system Provisioning services	Oil crops (sesame, sunflower, groundnut), beans	

Southern bi-polar set of settlements

Village tracts	Lungrang	8	Main Village Tract (MVT
	Phaipa (A)	4	Intermediate Village Tracts (IVT)
Main functions provided	Infrastructure facilities and services	Public electricity network on grid Rain water harvesting pond	
	Socio-economic and security services	Public rural health centre, pharmacy, dentist Middle school General market	
	Eco-system provisioning services	Orchard, coffee	

3.5 CURRENT VULNERABILITY INDEX

- The report calculates an index of vulnerability by village tract and urban wards. This allows us to identify the locations with higher vulnerability levels. This index is derived using a total of nine relevant indicators including three from each sector.
- We consider access to drinking water, forest quality, and access to irrigation water under the ecosystems component; education level, output per capita, and labour force participation rate under the socio-economic component; and type of housing, access to transport and access to protection services and facilities under the infrastructure component.
- Together these make up the sensitivity of the village tracts and urban wards. Under hazards, the index considers landslides, floods, storms, wildfires, heat waves, and droughts. The total score for sensitivity is multiplied by the total score for hazards.

Most places in Hakha Township experience multiple disasters, but to varying degrees. The most prominent disasters are landslides, floods, storms, wildfires, heat waves, and droughts. The sensitivity index (Table 7) clearly shows the current vulnerability of all the village tracts and wards in Hakha Township. Highest vulnerability was observed in Myo Thit, Bualtak, Buanlung, Haiphai, and Hranhring. The sensitivity index score of these VTs and wards is comparable to other VTs and wards with a lower vulnerability index; however they have a higher vulnerability score because of higher exposure to various disasters. These places experience almost all the disasters and suffer concurrent damage due to those. Hakha Town and the VTs and wards located on the south and east in the proximity of Hakha Town depicted low to moderate vulnerability. This is mainly due to higher per capita income, access to transport services, and access to protection services along with low exposure to disasters.

Table 7: Vulnerability index (VI) for different villages in Hakha Township

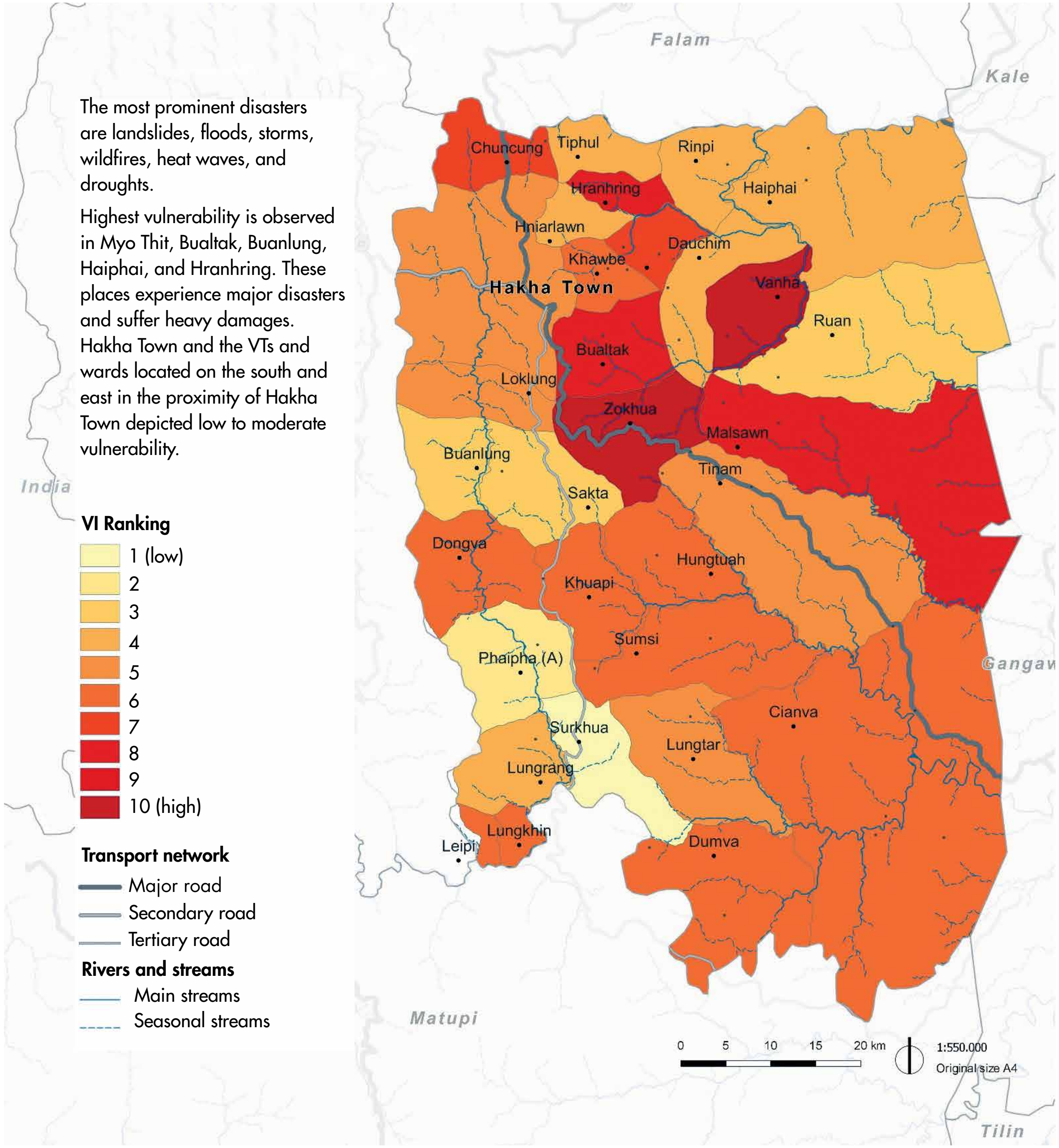
		Eco-systems			Socio-economic			Infrastructure				Intense rains			Increase in mean temperature					
VTCODE	Village name	Access to drinking water	Quality of the forest	Access to irrigation water	Level of education completed	Income per capita	Labour force participation rate	Type of housing units	Access to transport services	Access to protection services (DMC, EWS, shelter)	Total sensitivity index	Landslide	Flood	Storms	Wildfire	Heat wave	Drought	Total exposure index	Total	VI Ranking
MMR004002017	Khuabe(VT)	4	2	4	4	1	2	4	2	1	24	2	1	2	1	1	1	8	192	1
MMR004002022	Sumsi(VT)	4	4	4	4	1	2	4	1	2	26	2	1	2	1	1	1	8	208	2
MMR004002024	Dumva(VT)	4	4	4	4	3	3	4	1	1	28	2	2	2	1	1	2	10	280	3
MMR004002027	Bungtuah(VT)	4	4	4	4	1	3	4	1	4	29	3	2	1	1	2	1	10	290	3
MMR004002016	Dauchim(VT)	4	4	4	4	2	3	4	1	1	27	2	2	1	3	1	2	11	297	3
MMR004002014	Cangva(VT)	2	4	2	4	1	3	4	1	4	25	3	1	2	1	3	2	12	300	4
MMR004002021	Myo Haung(W)	4	4	4	4	2	3	4	3	2	30	2	1	2	1	3	1	10	300	4
MMR0040020005	Zokhua(VT)	4	4	4	4	3	3	4	1	1	28	2	2	3	1	2	1	11	308	4
MMR004002011	Vanhar(VT)	4	4	4	4	3	3	4	3	2	31	2	2	2	1	2	1	10	310	4
MMR004002002	Lungrang(VT)	4	4	4	4	1	2	4	4	2	29	2	1	2	1	3	2	11	319	4
MMR0040020004	Tiphul(VT)	4	4	4	4	4	3	4	3	2	32	2	2	2	1	2	1	10	320	4
MMR004002004	Farrawn(VT)	4	2	4	4	2	2	4	1	2	25	3	3	2	1	2	2	13	325	4
MMR004002012	Loklung(VT)	4	4	4	4	3	2	4	1	2	28	2	1	2	3	2	2	12	336	4
MMR0040020006	Hniarlawn(VT)	4	4	4	4	3	3	4	2	2	30	3	1	2	1	3	2	12	360	5
MMR004002018	Ruan(VT)	4	4	4	4	2	2	4	2	2	28	2	2	2	3	2	2	13	364	5
MMR004002010	Tinam(VT)	4	4	4	4	3	3	4	1	1	28	2	2	2	3	2	2	13	364	5
MMR0040020003	Sakta(VT)	4	4	4	4	3	3	4	1	2	29	2	2	2	3	3	1	13	377	5
MMR004002003	Zay Haung(W)	4	2	4	3	1	3	4	2	3	26	3	3	2	3	2	2	15	390	5
MMR004002019	Kyaw Boke(W)	4	4	4	3	1	3	4	2	2	27	2	2	2	3	3	3	15	405	6
MMR004002025	Khuapi(VT)	4	4	4	4	2	3	4	2	2	29	2	2	2	3	3	2	14	406	6
MMR004002030	Malsawm(VT)	4	4	4	4	3	3	4	1	2	29	2	2	2	3	3	2	14	406	6
MMR004002029	Zay Thit(W)	4	2	4	3	1	3	4	2	3	26	3	3	3	3	2	2	16	416	6
MMR0040020002	Chuncung(VT)	4	4	4	4	3	3	4	2	2	30	3	3	2	3	1	2	14	420	6
MMR004002001	Pyi Taw Thar(W)	4	4	4	3	1	3	3	2	3	27	3	3	2	3	3	2	16	432	6
MMR004002026	Rinpi(VT)	4	4	4	4	1	1	4	2	3	27	3	3	2	3	3	2	16	432	6
MMR004002028	Leipi(VT)	4	4	4	4	1	2	4	4	4	31	3	3	2	3	2	1	14	434	6
MMR004002023	Lungkhin(VT)	4	4	4	4	3	3	4	2	4	32	3	3	2	3	2	1	14	448	6
MMR004002020	Dongva(VT)	4	4	4	4	2	2	4	4	2	30	3	3	2	3	2	2	15	450	6
MMR0040020001	Surkhua(VT)	4	4	4	4	1	3	4	4	3	31	3	2	2	3	3	2	15	465	7
MMR004002005	Phaipha (A)(VT)	4	4	4	4	1	2	4	1	4	28	3	3	3	3	3	2	17	476	8
MMR004002013	Lungtar(VT)	4	4	4	4	1	3	4	4	4	32	3	3	3	3	1	2	15	480	8
MMR004002006	Myo Thit(W)	4	4	4	3	1	3	4	1	4	28	3	3	3	3	3	3	18	504	9
MMR004002008	Bualtak(VT)	4	4	4	4	4	3	4	1	4	32	3	3	2	3	2	3	16	512	9
MMR004002009	Buanlung(VT)	4	4	4	4	3	3	4	1	2	29	3	3	3	3	3	3	18	522	9
MMR004002015	Haiphai(VT)	4	4	4	4	2	3	4	3	2	30	3	3	3	3	3	3	18	540	10
MMR004002007	Hranhring(VT)	4	2	4	4	4	3	4	3	2	30	3	3	3	3	3	3	18	540	10

1-4 (low to high); and 1-10 (low to high)

Figure 22: Vulnerability index map of Hakha Township

The most prominent disasters are landslides, floods, storms, wildfires, heat waves, and droughts.

Highest vulnerability is observed in Myo Thit, Bualtak, Buanlung, Haiphai, and Hranhring. These places experience major disasters and suffer heavy damages. Hakha Town and the VTs and wards located on the south and east in the proximity of Hakha Town depicted low to moderate vulnerability.



Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

3.6 SUMMARY OF VULNERABILITIES

- Hakha is very vulnerable to acute shocks, particularly those resulting from landslides generated by heavy rains associated with poor land-use planning and deforestation in a steep topography and fragile geological conditions. Droughts occur more frequently, causing crop failure and water scarcity. Long-term climatic processes such as shorter monsoon seasons and erratic rainfall affect agricultural productivity and animal health as they introduce new pests and diseases.

- The infrastructure and connectivity of Hakha Township is very sensitive to prevalent natural hazards, given the inadequate construction techniques and poor siting in steep hills with non-existent or non-enforced risk mapping and land-use planning. Connectivity remains a challenge despite the improved road network. The rapid pace of construction, which does not take into consideration the geological particularities of the area and deforestation affect the durability of the roads that are constructed. The dominant use of timber for construction represents 51% of deforestation causes.

- The socio-economic conditions of the township also present sensitivities that pose risks for the people and the economy. Although there is moderate food self-sufficiency, food security largely depends on access to external markets, which is costly and erratic given the connectivity challenges. The rural economy of the township is mostly dependent on rain-fed agriculture, while in urban region, daily wages from unskilled labour contribute a high percentage to the economy. The growing construction sector, in particular the road network, employs most of this unskilled labour. Even though outward migration is high, remittances contribute only a little bit to the household economy. The demographic profile of the township indicates that a large proportion of out-migrants is composed of the working age population (15–64). This would certainly lead to labour shortages in the community. Female-headed households face more difficulties due to labour shortages combined with low financial capacity to hire labour. In addition, access to legal landholding is difficult for women, which disempowers them economically and socially.

- Communities in Hakha, both rural and urban, largely depend on ecosystem services that are undergoing rapid degradation. In particular, springs provide more than 80% of the drinking water in the Township, but during the dry season, their carrying capacity is reduced. Deforestation and degradation of forests is rampant due to widespread use of timber for construction and firewood for cooking (90% of overall energy consumption in the rural areas). Only 3% of the population has access to electricity; 35% of households reported using modern sustainable sources of energy for lighting, which indicates that modern sustainable sources of energy are used more for lighting than for cooking.

- Vulnerability is widespread but it peaks in isolated village tracts; access is the main discriminatory aspect of vulnerability here. However, the high rate of concentration of people and assets in Hakha Town, combined with unsustainable land-use planning and insufficient drainage services, pose a high risk of disasters while the presence of many services (education, health, connectivity etc.) and employment opportunities make the town comparatively safer than surrounding villages but still very vulnerable.

The following sections summarize the sensitive aspects of each system discussed in this report: ecological, socio-economic, and infrastructure and transport systems. The interplay of these sensitivities with the exposure level and natural hazards depicts the vulnerability of the township.

ECOSYSTEMS

There is great dependence on forests for timber; more than 80% of the households in Hakha Township use timber from forests as the main building material.

Large-scale degradation of natural ecosystems and deforestation has been observed in various places in Hakha Township. The main driver of degradation and deforestation is the extraction of wood for timber and fuelwood. These ecosystems will degrade further as forests become more become scarce. Communities with great dependence on these systems will face resource availability challenges.

INFRASTRUCTURE

Housing construction is vulnerable to strong winds and storms because construction practices seldom integrate disaster-resistant techniques and are not adapted to the increased frequency and intensity of hazards predicted for the future.

Although the 2014 Census shows a significant shift to durable materials for roofs (93% of households), walls and main structures are still built using wood (87% of households). This is a potential source of vulnerability because with less wood available from the forests due to deforestation and with increasing prices of durable sheets, people will have to compromise the quality of the material used for building houses.

SOCIO-ECONOMIC

Production systems are not diverse. They are highly dependent on paddy and maize cultivation and livestock.

This means that if one of these two sectors is affected by a climate change-related hazard, there is no mechanism to provide income for a large section of the population. This economic system, dependent on two sectors for more than 70% of people's livelihoods, does not have the flexibility to withstand or recover quickly from shocks.

ECOSYSTEMS

Due to lack of energy options/sources, communities heavily depend on fuelwood, which causes degradation and deforestation.

Fuelwood is the main source of energy for most households in Hakha Township. Forests therefore face threats due to the over-exploitation of wood. There is an urgent need to introduce energy-efficient options such as improved cooking stoves, solar based cookers, etc. to reduce dependence on forests for energy.

INFRASTRUCTURE

Access to electricity is very limited. People mainly rely on traditional unsustainable sources of energy – firewood for cooking, and kerosene candles and generators for lighting.

Grid electricity is only available in Hakha Town and some neighbouring village tracts. Electrification is a challenge because coverage has an impact on industry and thus on economic output. Few communities reported having access to private solar panels.

Households mainly rely on firewood for cooking. Such unsustainable extraction of an integral forest resource makes households increasingly vulnerable as depletion is much faster than replenishment. Increasing prices and reducing regulating services vis-à-vis storms and storm-surges, water cycle replenishment, soil management.

SOCIO-ECONOMIC

Low educational outcomes and an almost total lack of vocational training is a problem because there are few skilled people able to work in high value-added sectors.

The only economic sectors that provide reliable employment are agriculture and livestock, which are highly climate sensitive, and daily wage labour (often in agriculture, forestry, and road construction), which is very insecure. Shifting cultivation produces very low output per capita, which translates to low incomes. There are three main causes of this: little value-addition, poor soil fertility management and high dependency on rain water rather than on irrigation.

Low levels of education and a lack of skills result in a vicious cycle that contributes to both climate change vulnerability and poverty. Because skill levels are low and the majority of people do not have education beyond the primary level, people are resigned to unskilled low-paying labour. Therefore, people cannot accumulate savings to invest in livelihood diversification or upskilling. This situation, combined with remoteness, makes Hakha Township less attractive to those looking to invest in higher value-added, non-climate-dependent industries like manufacturing. There is a shortage of skilled and semi-skilled people to work in these sectors.

ECOSYSTEMS

Mining and deforestation have not only caused the overall ecosystem to degrade, but have also increased the frequency of disasters.

Mining may not be a prominent phenomenon in the township. However it has led to forest degradation and deforestation at several places. This has increased surface runoff, leading to an increase in the frequency of disasters such as landslides. Protected areas/ restricted forests need to be demarcated to control this degradation.

INFRASTRUCTURE

Current transportation and communication constraints already jeopardize rural livelihoods but the problem will worsen in emergency situations following the projected extreme weather events.

The transport network mainly relies on the primary paved road (in construction) and a network of secondary and tertiary unpaved roads/trails, which make these rural communities highly vulnerable. In addition there is no public bus and many of the communities rely on informal local transportation sports utility vehicles that are poorly adapted to stronger rains and storms, reducing people's mobility, especially during the rainy season.

The projected stronger storms and unusually heavy rainfall will heavily damage roads and bridges more frequently, and, in the worst cases, will isolate them for several days from markets, medical facilities, schools, and other core community services.

SOCIO-ECONOMIC

Women are disproportionately affected by the socio-economic impacts of climate change.

Women are far more likely to be economically inactive than men. Even though women play an active role in earning household incomes (through farming, food, or trading, for example), they tend to identify themselves as not participating in the labour force, or being employed informally. Women's income-earning activities, which involve trade or handicraft, are also more easily disrupted by transportation issues, which occur frequently. This means that they are unable to access markets, and can face disproportionate disruption when disasters affect transportation links.

ECOSYSTEMS

A large section of the population is dependent on rain-fed agriculture, which increases risks and vulnerability to changing climatic conditions.

Communities in Hakha Township mainly rely on rain-fed agriculture, which poses a higher risk of food scarcity. Future climate projections suggest more dry weather with higher temperature and erratic rainfall. This will put pressure on farmers to produce more within short durations and with a higher risk of crop damage due to untimely disasters.

INFRASTRUCTURE

Coverage of disaster and climate resilient basic services is limited, reducing communities' resilience and capacity to cope with more intense climate hazards in the future.

Primary education is available to almost all children in the township, if we allow for some travel time. However, secondary education coverage is very weak as only Hakha Town and the village tracts of Chuncung and Sakta have high schools. Primary health coverage is very weak across the township, especially in the eastern areas where there is a lack of health facilities. These very limited health services indicate that populations are highly exposed to health risks. In fact, climate hazards (storms, floods, and landslides) may interrupt the already fragile road access, preventing people from getting any external supply.

SOCIO-ECONOMIC

ECOSYSTEMS

Incentives for ecosystem services is lacking.

Currently there are no incentives for ecosystem services. This is leading to an overexploitation of the ecosystems leading to degradation.

INFRASTRUCTURE

Disaster risk reduction and preparedness has improved since 2015. However, locational barriers should be considered as a contributing factor while planning a response to climate warnings.

Some village tracts reported having a Disaster Management Committee, but very few have early warning systems (EWS). Disaster warning has improved since 2015, as several rice banks have been constructed, but more preparedness is needed.

The projected stronger rains and winds may increase communities' vulnerability, especially in those villages where accessibility is very limited. These locational barriers should be considered as a contributing factor towards ensuring response to climate warnings.

SOCIO-ECONOMIC

4

CLIMATE CHANGE PROJECTIONS, FUTURE RISKS, AND VULNERABILITIES

In this chapter, we discuss the projected changes in climate by year 2050 and the potential impacts of these changes on the current ecological, socio-economic, and infrastructure conditions.

We conclude that Hakha Township will experience changes in both temperature and precipitation, with higher seasonal variability, which will lead to increased risk of rapid onset disasters, such as flash floods, landslides, droughts, and heat waves. We also discuss the effects of transformative climatic processes, such as increased average and peak temperatures, and erratic rainfall patterns, which will pose further threats to agriculture by affecting the availability of water.

According to the most severe climate change scenario (RCP 8.5), by year 2050, mean annual temperature will increase by upto 1.7°C. This change will be associated with more hot days and increased risk of heat waves.

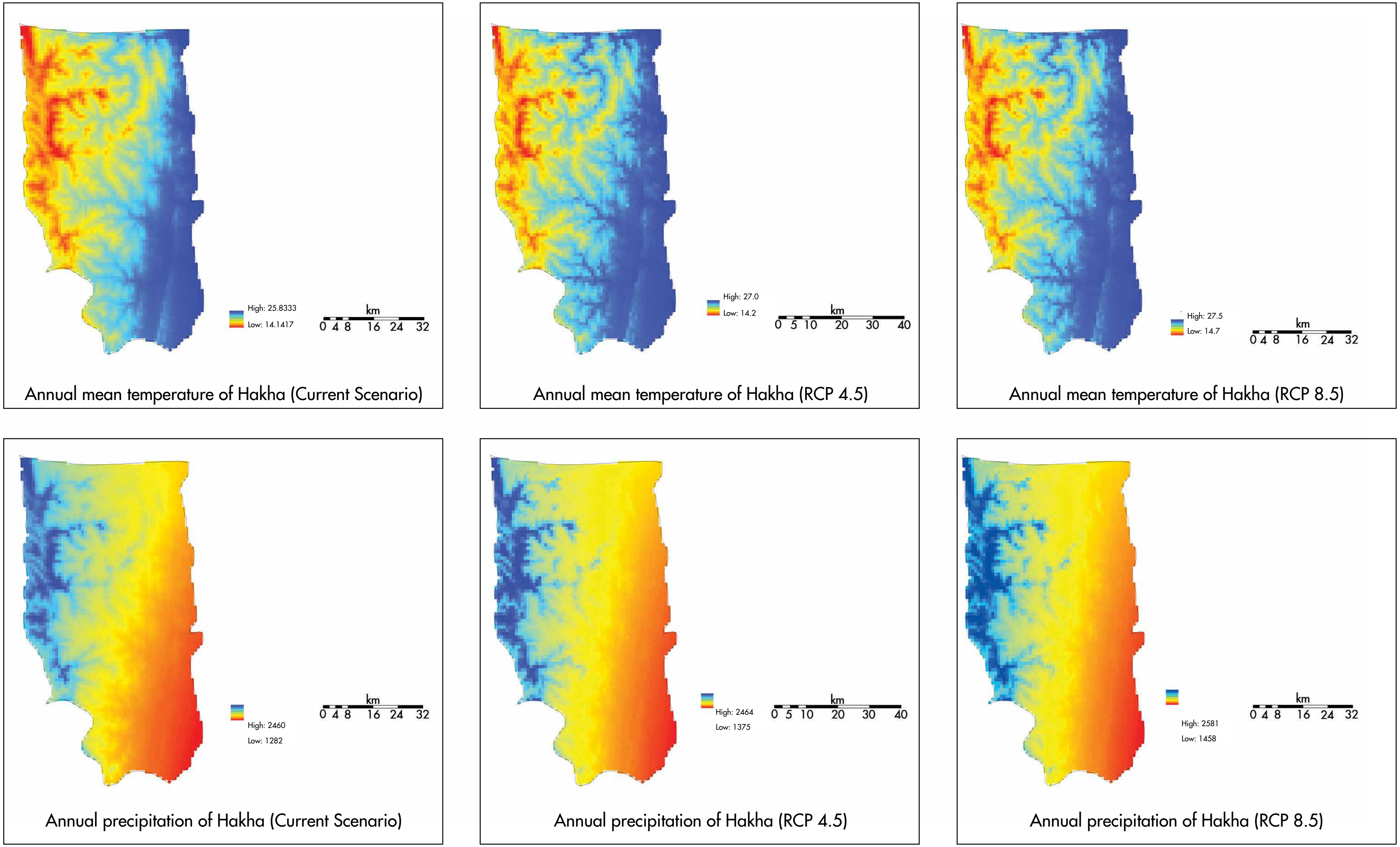
It is predicted that the monsoon season will shorten, with late onset and early withdrawal, and with up to a 300 mm increase in rainfall during the rainy season. This will entail longer dry spells with higher risks of drought during the dry season and conversely, heavy rainfall over short periods during the wet season. The latter are associated with a higher risk of floods and landslides, and potential destruction of crops and assets. Future climate scenarios show that Hakha will also be more exposed to strong winds.

Decision makers will therefore need to plan for increased risks of floods and landslides, stronger winds, droughts, and associated risks such as wildfires, crop failures, and water shortages in Hakha Township.

4.1 CLIMATE CHANGE MODELLING METHODOLOGY

We used a climate model developed under the Himalayan Climate Change Adaptation Programme (HICAP) at ICIMOD, which is a Weather Research and Forecasting (WRF) model, driven by the Norwegian Earth System Model (NorESM) GCM model to develop climate change projections. This model was developed for two scenarios of future changes in greenhouse gases corresponding to low and high estimates of change (from RCP 4.5 and RCP 8.5) (Figure 23) to project annual and seasonal temperature and rainfall changes for 2010–2030 and 2030–2050. Comparing model results with local observations for a reference period, the output was corrected for various under- and over-estimations. Observed climate analysis uses weather station data from 1981–2010 based on data provided by the Myanmar Department of Meteorology and Hydrology (DMH). It is important to realize that the downscaled model data does not use local weather station data as an input. The WRF model instead is forced by historical and scenario emissions and driven by the NorESM GCM, which includes many components, such as greenhouse gases, circulation models, etc. Thus, precipitation and temperature are outputs and not inputs to the model.

Figure 23: Current and projected climatic conditions in Hakha Township



Source: ICIMOD (2016)

4.2 CLIMATE CHANGE PROJECTIONS

Temperature

Climate change projections for Chin State indicate an increase in temperature by +1.5–2.7°C, an increase in the number of hot days (17 days/year), a decrease in the number of rainy days, and an increase in total annual precipitation by 23% by 2050 (Figure 23).

Annually, the number of days with temperatures above 25°C is projected to increase from an average of 105 days/year from 1996 to 2005 to 125 days/year by 2050.

The annual number of warm days will increase by up to 17 days by 2050. The number of warm nights will also increase drastically, and there will also be an increase in the number of warm spells per year.

Precipitation

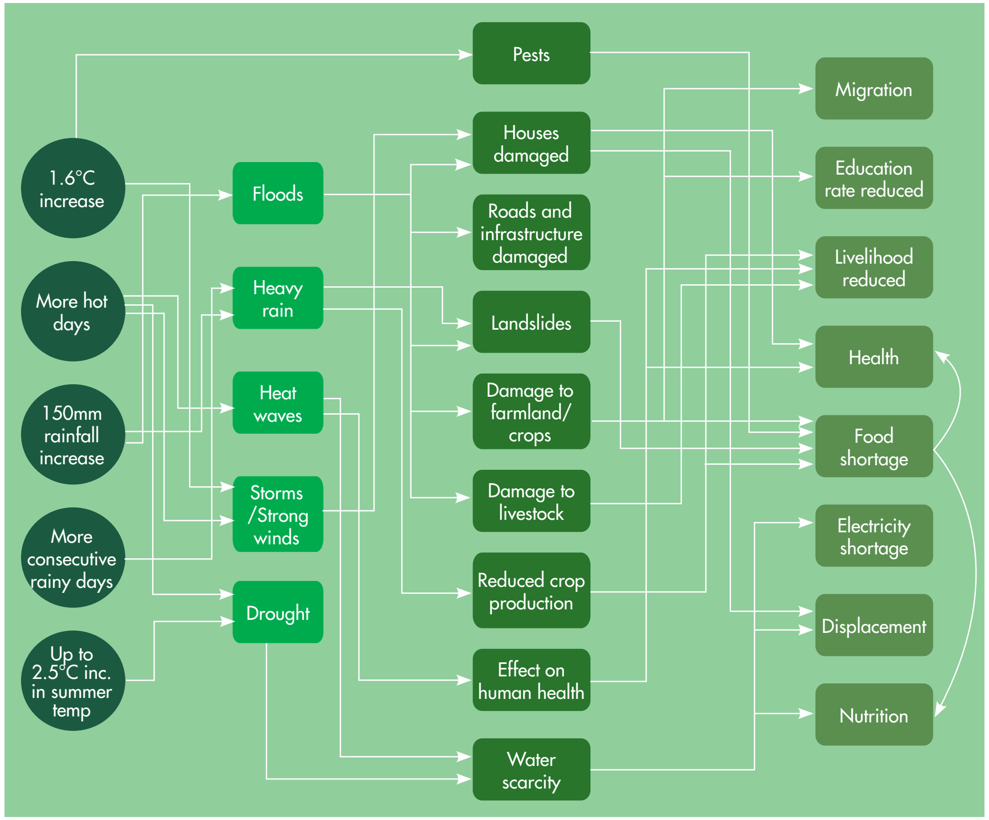
Annual total precipitation is projected to experience a negligible increase in the dry season. However, the period from June to October is projected to see a major increase. This suggests that there will be more rainfall during the monsoon and post-monsoon periods.

Inter-annual variations are even larger than the variations between seasons. May and July (already evident since 2010) and June and October (from 2030 onwards) are expected to see the greatest changes. The dry period will become drier in the long term (especially February–March).

4.3 POTENTIAL IMPACT PATHWAYS

Based on an analysis of secondary data and models, and in consultation with the communities, this assessment suggests a "path to impact" graphic as shown in Figure 24. The figure shows how changes in climatic features will alter the hazard profile of the township. This in turn may generate a chain of primary and secondary impacts – with varying degrees of correlation – that may occur from now to 2050. The "path to impact" graphic also shows the complex correlation between hazards and impacts, including how a given primary impact can cause multiple secondary impacts. The graphic takes the present conditions of vulnerability as starting points. This is not a forecast, but an effective visual representation of the effects climate change can have on Hakha.

Figure 24: Pathway depicting climatic features, hazards, and impacts



The left-hand column shows a full range of projected changes in the climate as discussed in Section 4.2 of this report. The second column shows what the team and communities have identified to be the five major hazards that are already affecting Hakha and are likely to become more severe in the future because of projected climate change. These hazards include floods, heavy rains, heat waves, strong-winds, and drought. The primary impacts that result from these hazards are listed in the next column. Here, we see that some impacts are caused by multiple hazards. For example, crop failure and pests can result from the interplay of several hazards. By understanding this relationship, we can begin to see which people are more likely to be vulnerable; farmers are highly vulnerable because the crops on which they depend for their livelihood can be impacted by numerous hazards. Secondary impacts consider the broader, knock-on effects in the township. Continuing the example of crop failure, the graphic shows that this results in worsening nutritional outcomes because many farmers keep a substantial amount of their crops for household consumption. Crop failure can also cause out-migration because the local people will have to leave the township in order to seek work, either to Mandalay, Yangon, or abroad, and to an extent from villages to Hakha town. Primary and secondary impacts can also cause a vicious cycle. For example, crop failure and a lack of water for agriculture can reduce agricultural productivity while increasing food prices and reducing food security. This in turn can drive migration and indebtedness, as people either seek work elsewhere or borrow money/food to meet their basic needs. These impact pathways do not take into account that communities and authorities have certain coping mechanisms to prevent or mitigate impacts, since in many cases they do not exist.

4.4 FUTURE RISK PROFILE AND VULNERABILITIES

The population's capacity to benefit from agriculture and forestry will decline by 2050.

Future vulnerabilities

- Overall, climate change will have adverse impacts on agriculture, livestock, forest, and freshwater resources in the long run. Yields of main crops (rice and maize) and livestock will decline. Supply of forest products such as elephant foot yam and tubers will become unpredictable and scarce. Food and income insecurity will increase. The impacts will be more profound on poor households.
- Due to increased food insecurity, out-migration of youth and adults, especially men, will be exacerbated. Due to male migration, the workload of women, children, and the elderly will increase significantly.
- Pests and diseases in crops and livestock and vector-borne and water-borne diseases in humans will increase drastically. Farmers will start applying more chemical pesticides, causing severe harm to ecosystems. People will consume low quality surface and ground water, which will increase their health problems and subsequent expenditures.
- Water resources will dwindle. This will have a disproportionate effect on women and girls. They will face increased hardships, largely because the responsibility of collecting water mostly rests with women.

Assumptions

- It is assumed that no specific adaptive measures are implemented. If measures are implemented, the social, gender, and economic dimensions of adaptation are not considered.

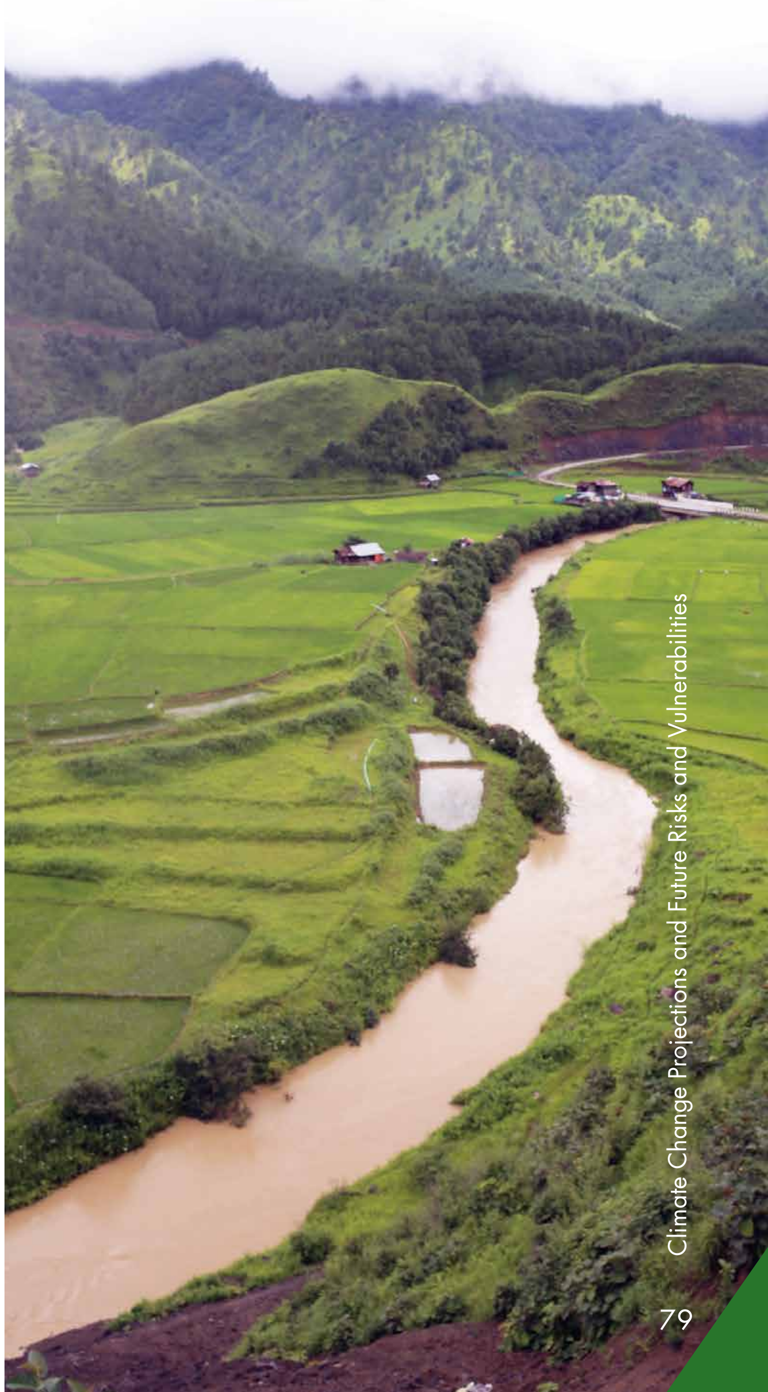


Table 8: Impacts of climate change on ecosystem services

	Hazards	Ecosystem services	Main projected impacts
+ 1.6°C warmer	**Higher average temperatures**	*Soil*	Increasing temperatures will result in more frequent, intense, and in some cases, longer dry spells, reducing soil moisture and increasing erosion of already degraded, loose soils, and causing loss of soil fertility due to reduction in soil organic carbon[1], reducing agricultural productivity.
		Freshwater	Higher temperatures will increase evaporation for surface waters, leading to reduced water availability, especially during the dry season, reducing agricultural productivity.
		Crops	Increased temperatures alone will limit crop productivity, reducing already low yields and, regardless of water availability and soil impacts, will further decrease productivity. There could be a drastic increase in pests and disease outbreaks in many crops. Pests and diseases could spread to areas where they have never existed before. Yield losses in rice, maize, and mustard can be also expected[2]. Increases in temperature will decrease meat and milk quality, and the hatchability of poultry, and increase the possibility of disease in livestock.
– days of rain	**Fewer rainfall days and shorter rainy season**	*Soil*	Forest fires will become a more severe threat, exacerbating soil degradation and reducing soil organic matter.
		Freshwater	Water shortages that affect crop production will approximately increase in frequency as the number of rainy days decreases and evaporation increases. Groundwater recharge rates will likely decline, with fewer rainy days in the dry season, which could potentially increase salinity concentrations in some aquifers and further limit water availability.
		Crops	A shorter rainy season, in combination with impacts on soils, evaporation, and reduced water availability, will further limit already low crop productivity.
+/– Rainfall	**More heavy rain, less useful and more damaging**	*Soil*	Intense rains following lengthier dry periods will increase the runoff rate, soil erosion, and landslides.
		Freshwater	Severe inundation will further damage water infrastructure. Inundation combined with higher average temperatures will increase water and vector-borne diseases like diarrhoea and malaria.
		Crops	Increasingly frequent and intense storms and resulting floods will significantly reduce already highly variable yields, increasing the risks of production and reducing reliance on agriculture for livelihoods.

[1] Malla, G. (2008). Climate change and its impact on Nepalese agriculture. The Journal of Agriculture and Environment, Volume 9.

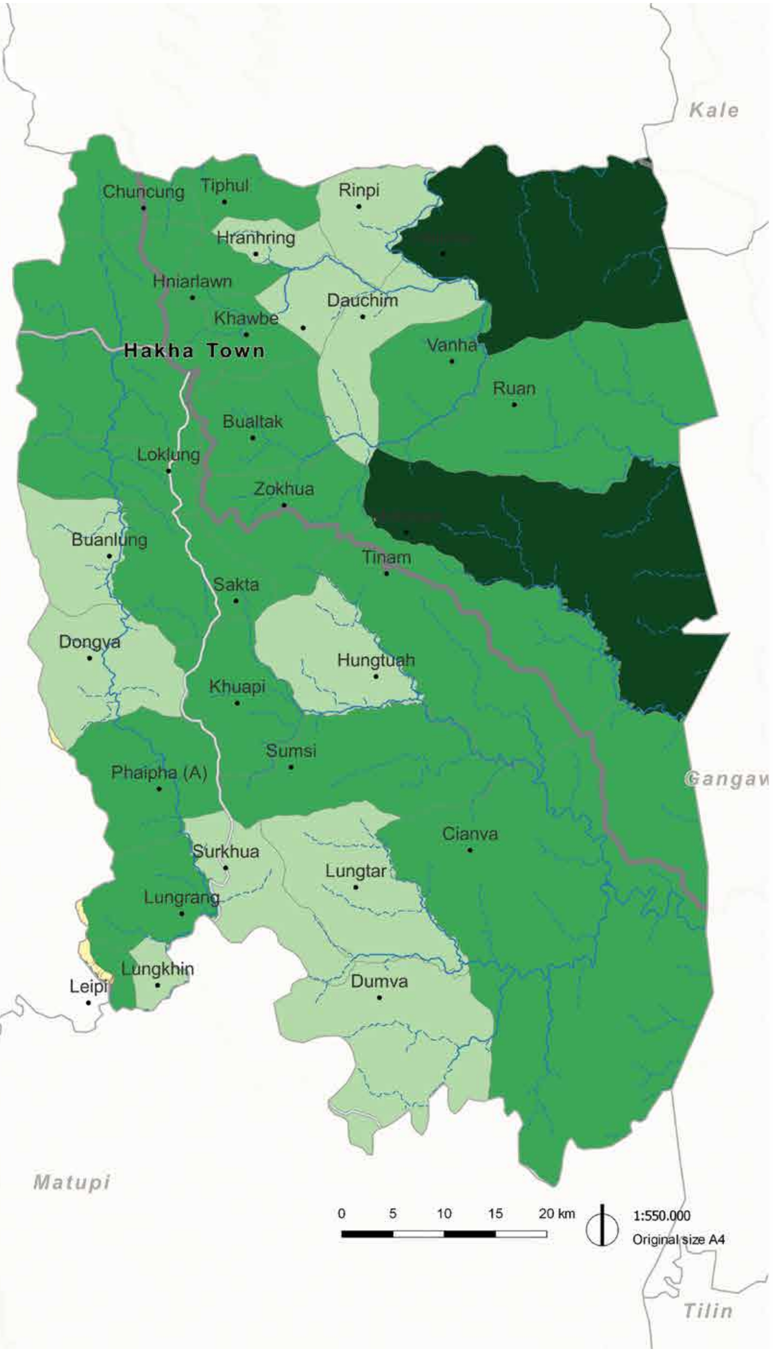
[2] Impact of Climate Change on Mountain Agriculture of Himachal Pradesh under RKVY. Retrieved from http://14.139.224.135/myapp/cgrt/index_files/Project_Reports_Completed/CGRT15.State%20Adhoc.Misc.2022-34-Impact%20of%20Climate%20Change–10-13.pdf

Figure 25: Capacity of the population to benefit from agriculture in 2017

All rural households employ a crop- and livestock-integrated farming system for food, nutrition, and income. Shifting cultivation or "Taungya" is the primary farming system in the uplands of Hakha. However, it is oriented more towards self-subsistence and is very labour intensive. More than 70% of the shifting cultivation work is performed by family members and exchange labour.

In villages such as Cangva, located at lower elevations and having moderate to flat slopes, terrace farming is more common for growing paddy.

Several terraces, irrigation canals, and lopils/shifting cultivation plots were destroyed due to heavy rains and landslides in 2015. The percentage of population to benefit from agriculture is calculated from community consultations on the main resources for rural livelihoods.

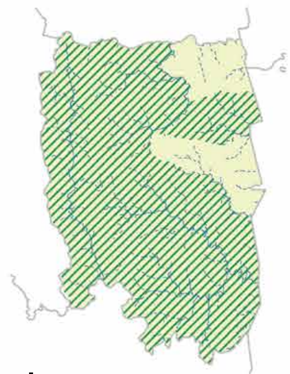


Population (%)
- 25–50
- 50–75
- 75–100

Transport network
- Major road
- Secondary road
- Tertiary road

Rivers and streams
- Main streams
- Seasonal streams

Main crops



Shifting cultivation is the primary farming system in the upland villages of Hakha, while in lower elevations with moderate to flat slopes, terrace farming is more common for growing paddy.

- Shifting cultivation
- Paddy

Soil types

Soil classification concerns the grouping of soils with a similar range of properties (chemical, physical, and biological) into units that can be geo-referenced and mapped. The classification has generally been based on the distribution of important land resources for agriculture.

Soil types
- Chin Hill Complex Soil
- Red Brown Forest Soil

Topography

The steep topography in Hakha Township exacerbates sensitivity, thereby increasing risks of disasters.

Soil types
- 0–15
- 15–30
- 30–45
- >45

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

Figure 26: Capacity of the population to benefit from agriculture in 2050

+ 1.6°C warmer | + rainfall | + drought

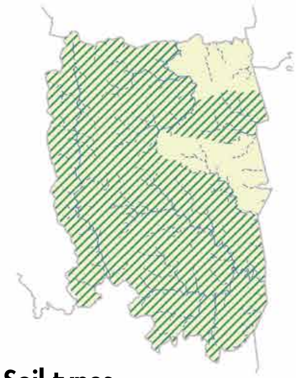
Average rice yield is about 2.5 T/acre. The yields decline substantially (by up to 50%) during the dry years. Paddy yield has decreased by about 500 kg/acre in many farms due to a decline in soil fertility. Communities reported crop yields were severely affected by extreme rainfall in July 2015. The capacity of the population to benefit from agriculture is calculated by applying a coefficient of impact on the 2017 baseline, given the changes in temperature and rainfall which will reduce soil fertility, lower yields, and more frequently damage crops.

Population (%)
- 0.0–25.0
- 25.0–50.0

Transport network
- Major road
- Secondary road
- Tertiary road

Rivers and streams
- Main streams
- Seasonal streams

Main crops



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Soil types
- 0–15
- 15–30
- 30–45
- >45

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

Deforestation will increase forest degradation, reducing people's capacity to depend on forestry as a viable livelihood option by 2050.

Forests are the source of timber and non-timber products that are critical income and livelihood resources for rural communities.

The very high dependence of communities in Hakha Township on natural ecosystems is a major reason for ecosystem degradation

	Hazards	Ecosystem services	Main projected impacts
+ 1.6°C warmer	**Higher average temperatures**	*Vegetation cover*	The increase in temperatures might enhance the frequency of forest fires, and pest and disease infestations in forests. This includes increased establishment of invasive species such as *Eupatorium*. This will threaten biodiversity and influence the availability and abundance of pollinators.
– days of rain	**Fewer rainfall days and shorter rainy season**	*Vegetation cover*	This can lead to a decline in non-timber forest products, fodder, and forage, which can lead to resource conflicts[3]
+/– Rainfall	**More heavy rain, less useful and more damaging**	*Soil*	The increase in magnitude and frequency of extreme events such as flooding is expected to cause soil erosion, degradation of watersheds, and massive landslides.
		Vegetation cover	Changes in precipitation patterns might affect the survival of seedlings and saplings.

[3] Sharma, E.; Chettri, N.; Tse-ring, K.; Shrestha, A.B.; Fang, Jing; Mool, P.; Eriksson, M. (2009). Climate change impacts and vulnerability in the Eastern Himalayas. Kathmandu: ICIMOD

Future vulnerabilities

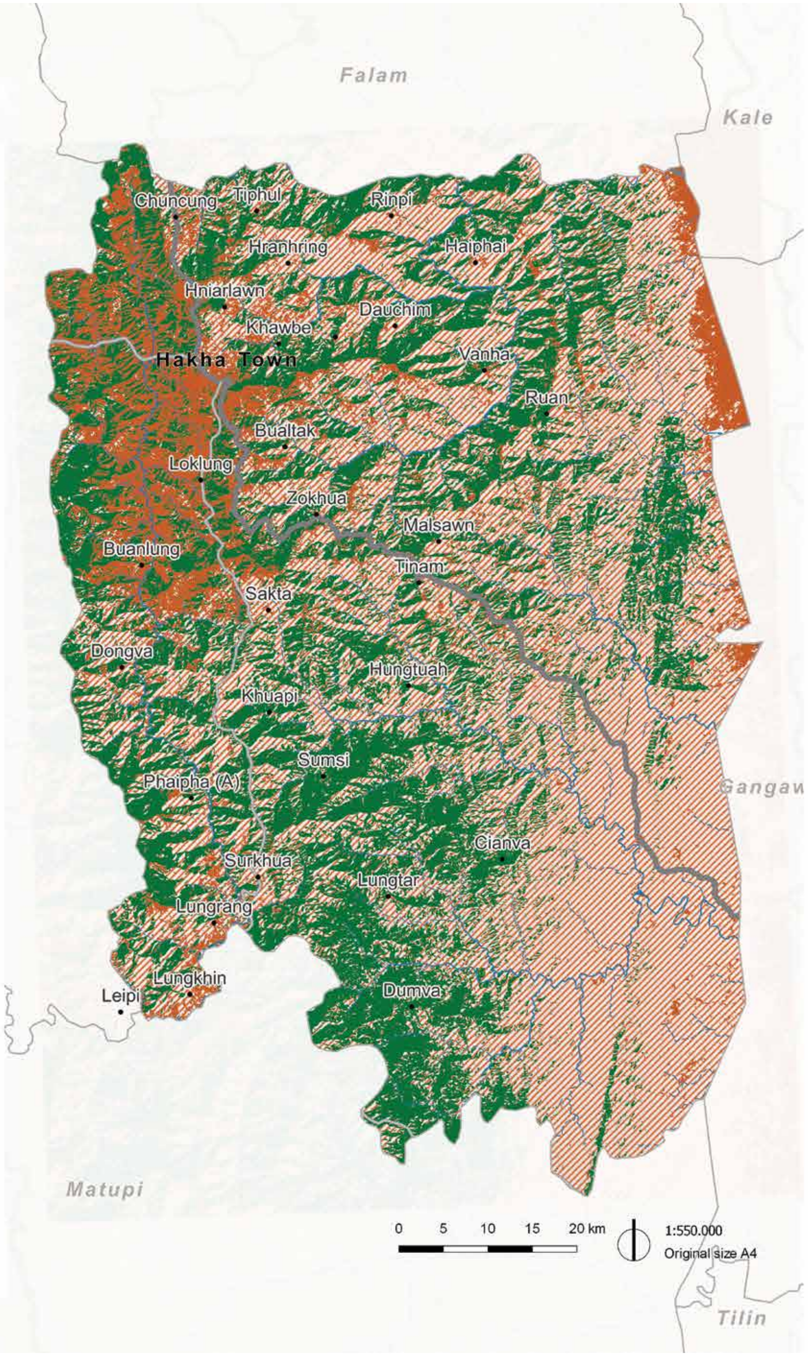
- Current deforestation trends will increase forest degradation, reducing the numerous basic ecosystems services they provide that support climate resilience. Erosion control, defences against heavy storms, and natural habitats may also be lost.
- This continuing deforestation, both within lowland areas and upstream, will make communities in floodplain areas highly vulnerable to more frequent and severe intense rainfall events.
- In addition, the capacity of the population to benefit from forestry sources to build their houses and for fuel wood will be highly compromised, forcing them to travel even farther and increasing costs.

Assumptions

- Given the observed deforestation trends, it is assumed that the quality of forest coverage will worsen in 2050 (compared to 2014), if no adaptive measure is considered.

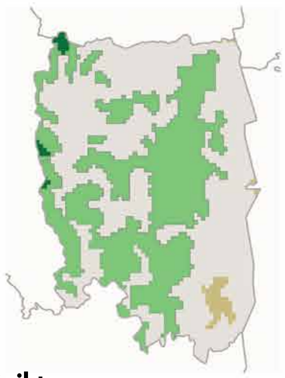
Figure 27: Forest coverage in 2017

The unsustainable extraction of forest resources has caused degradation of forests in many places. Extraction of forest resources is one of the major drivers for deforestation and degradation of forest ecosystems in Hakha Township. The extraction of wood is mainly for use as timber for building, followed by fuelwood, and clearing land for agriculture. Intensive deforestation has increased the frequency of landslides and many villages in Hakha Township have suffered from damage to dwellings and roads due to landslides. In addition, the quality of secondary or fallow forests is declining due to shorter shifting cultivation cycles. The cycle has reduced to 10–15 years due to increasing population and land use changes.



Vegetation cover

Land cover map from 2000 (UNEP)



Soil types

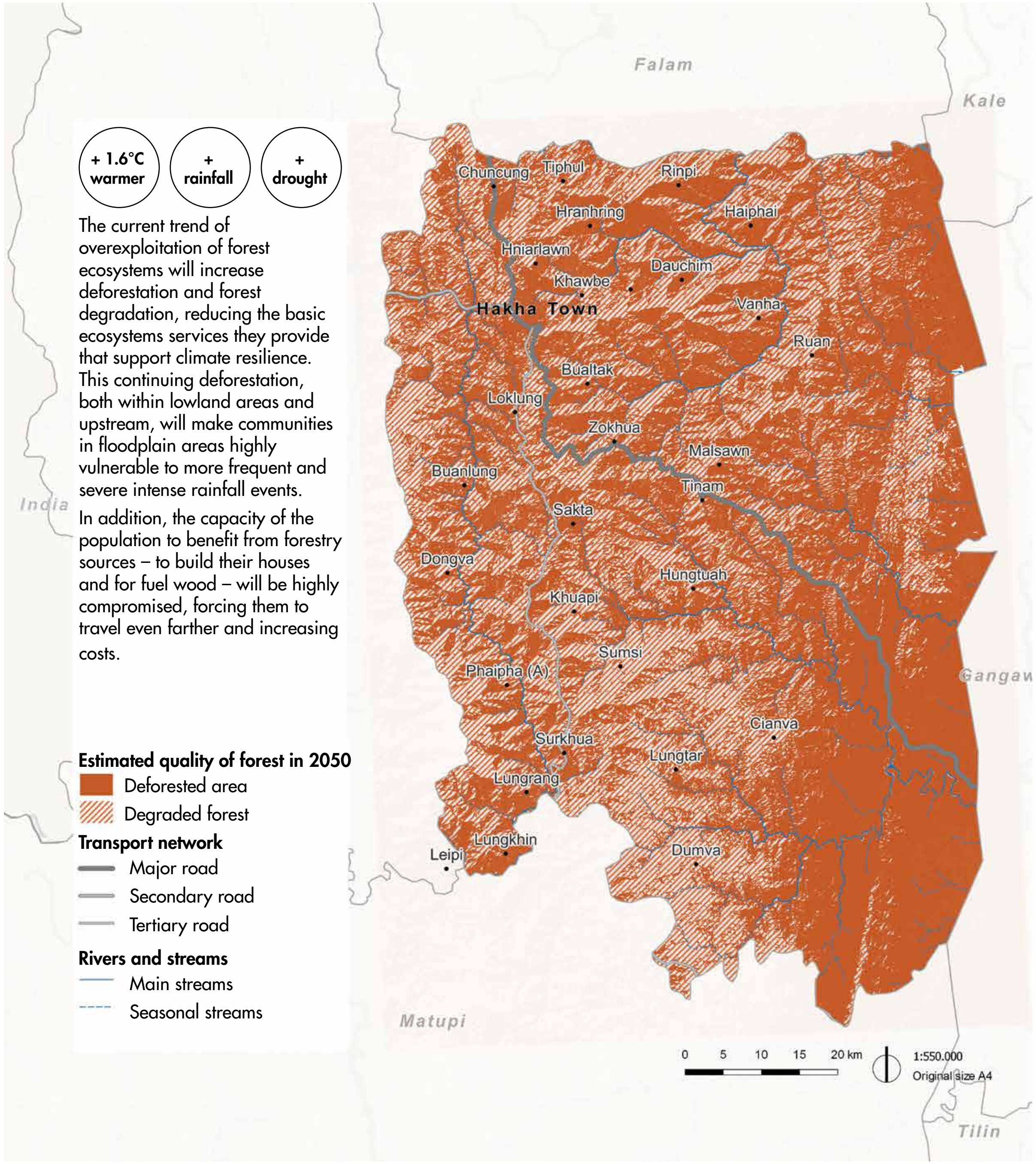
Soil classification concerns the grouping of soils with a similar range of properties (chemical, physical, and biological) into units that can be geo-referenced and mapped. The classification has generally been based on the distribution of important land resources for agriculture.

Topography

The steep topography in Hakha Township exacerbates sensitivity, thereby increasing risks of disasters.

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

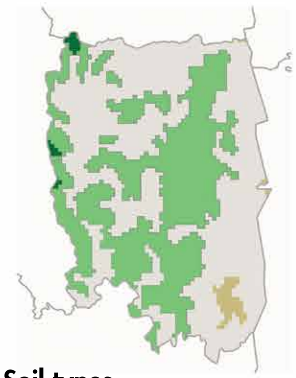
Figure 28: Forest coverage in 2050



The current trend of overexploitation of forest ecosystems will increase deforestation and forest degradation, reducing the basic ecosystems services they provide that support climate resilience. This continuing deforestation, both within lowland areas and upstream, will make communities in floodplain areas highly vulnerable to more frequent and severe intense rainfall events.

In addition, the capacity of the population to benefit from forestry sources – to build their houses and for fuel wood – will be highly compromised, forcing them to travel even farther and increasing costs.

Vegetation cover



Land cover map from 2000 (UNEP)

- Evergeen forest
- Deciduos forest
- Scrubland
- Agriculture

Soil types

Soil classification concerns the grouping of soils with a similar range of properties (chemical, physical, and biological) into units that can be geo-referenced and mapped. The classification has generally been based on the distribution of important land resources for agriculture.

Soil types

- Chin Hill Complex Soil
- Red Brown Forest Soil

Topography

The steep topography in Hakha Township exacerbates sensitivity, thereby increasing risks of disasters.

Slopes in degrees

- 0–15
- 15–30
- 30–45
- >45

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

The population's access to surface freshwater for drinking relies mainly on three ecosystems services (freshwater sources, geology, and vegetation cover) that will be highly impacted by the projected changes in climate

	Hazards	Ecosystem services	Main projected impacts
+ 1.6°C warmer	**Higher average temperatures**	*Vegetation and soils*	Higher temperatures will lead to even greater evaporation and aridity, as water availability and soil moisture decline, limiting vegetation growth, which will limit groundwater recharge and flood retention services.
		Surface water	Availability of freshwater will decline as evaporation increases.
– days of rain	**Fewer rainfall days and shorter rainy season**	*Groundwater sources*	Fewer rainy days will result in reduced recharge during the wet season, reducing availability during the dry season.
		Surface water	Less time for rain water harvesting and storage, reducing availability, especially towards the end of the dry season.
+/– Rainfall	**More heavy rain, less useful and more damaging**	*Vegetation and soils*	Loss of vegetation cover, increased runoff rate, and soil erosion, damaging water storage facilities.
		Groundwater sources	Decreased sub-surface flow and recharge as most runoff flows downstream rather than recharging local aquifers.
		Surface water	Reduced availability, as flows from intense rainfall events are difficult to capture and can even damage storage infrastructure.

Future vulnerabilities

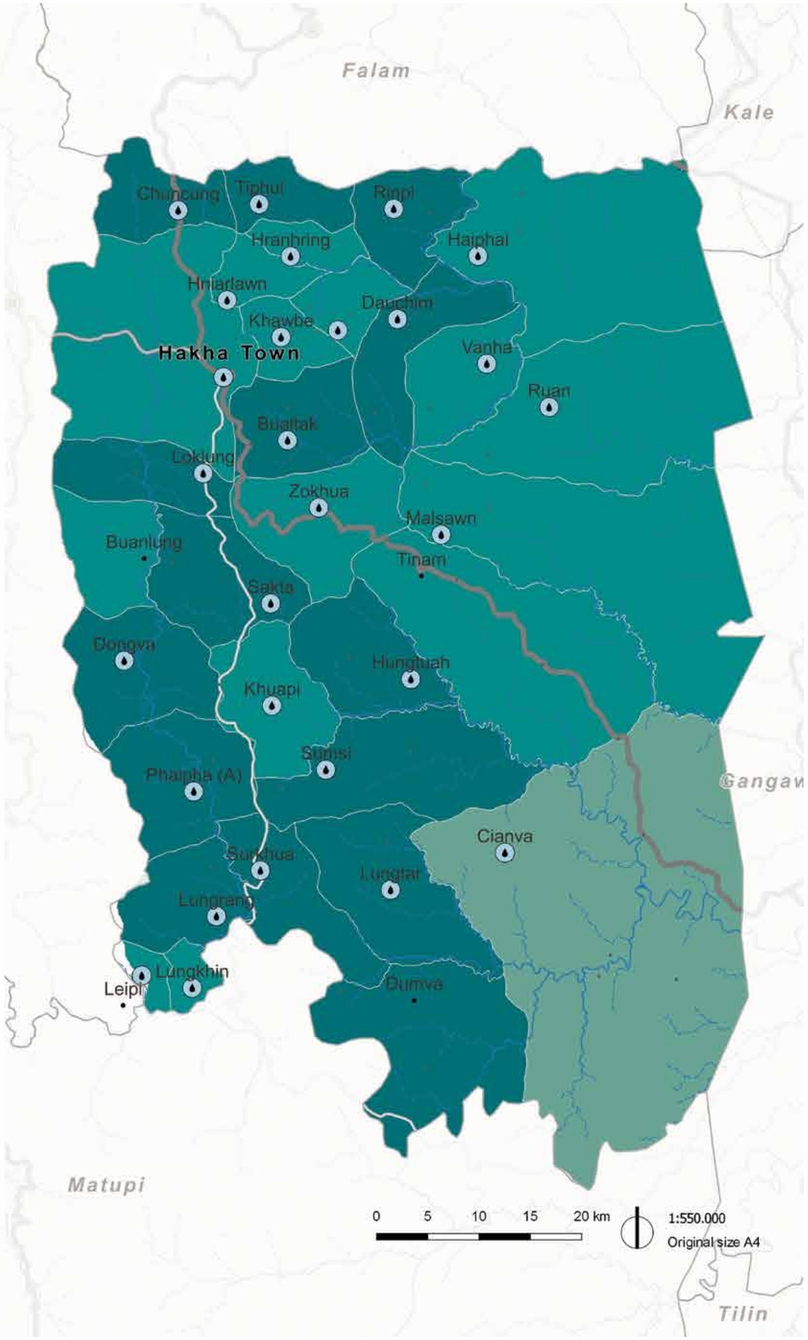
- The projected changes in precipitation patterns and increase in mean temperature can easily lead to higher rates of evaporation and additional months of drought.
- This means that in the mid-term, groundwater sources will also be affected, as aquifers will take longer to recharge, leading to the need for further investments on infrastructure improvement (tank capacity, borehole depth, etc.).
- In addition, stronger storms and unusually heavy rainfall will inevitably damage water infrastructure and facilities for longer periods of time.

Assumptions

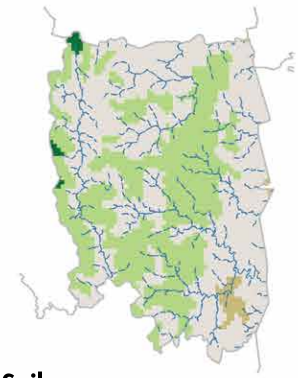
- It is assumed that no specific adaptive measure is implemented and the projected climate changes in temperature and rainfall lead to more frequent drought periods and more damaging storms, reducing communities' freshwater sources and damaging water supply and systems for longer periods.

Figure 29: Access to fresh water sources in 2017

Availability of fresh water for drinking mainly relies on natural springs, making the entire township vulnerable to future rain variability and increased temperatures in the mid and long term, as aquifers will take longer to recharge. The percentage of households having access to freshwater sources is calculated by applying the Census 2014 data coefficients of impacts to those village tracts where changes in water availability were reported.



Vegetation cover



Land cover map from 2000 (UNEP)

- Evergeen forest
- Deciduos forest
- Scrubland
- Agriculture
- Main streams
- Seasonal streams

Soils

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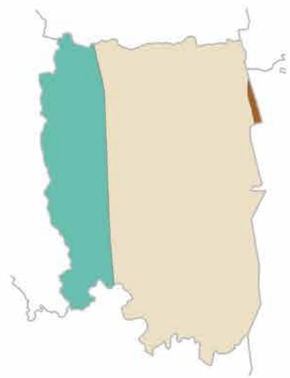
- Chin Hill Complex Soil
- Red Brown Forest Soil

Geology



Aggregated Geology by Suite based on Geology of Myanmar digitized from scanned map. Geologocal Age and type of RX are recorded as attributes.

- Alluvial
- Limestone and ultrabasic
- Sedimentary and locals

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

Figure 30: Access to fresh water sources in 2050

+ 1.6°C warmer | + rainfall | + drought

Access to freshwater for drinking use in 2050 – if no adaptation measures are implemented – is calculated by applying coefficients of impacts on the 2017 baseline data by type of water sources and infrastructure used. The projected changes in temperature and rainfall will result in a longer and more frequent and severe droughts, increased evaporation and more intense rainfall events, affecting groundwater sources, as aquifers will take longer to recharge. In addition, intense runoff and soil erosion caused by more intense rains may result in more water facilities damaged.

Percentage of HHs

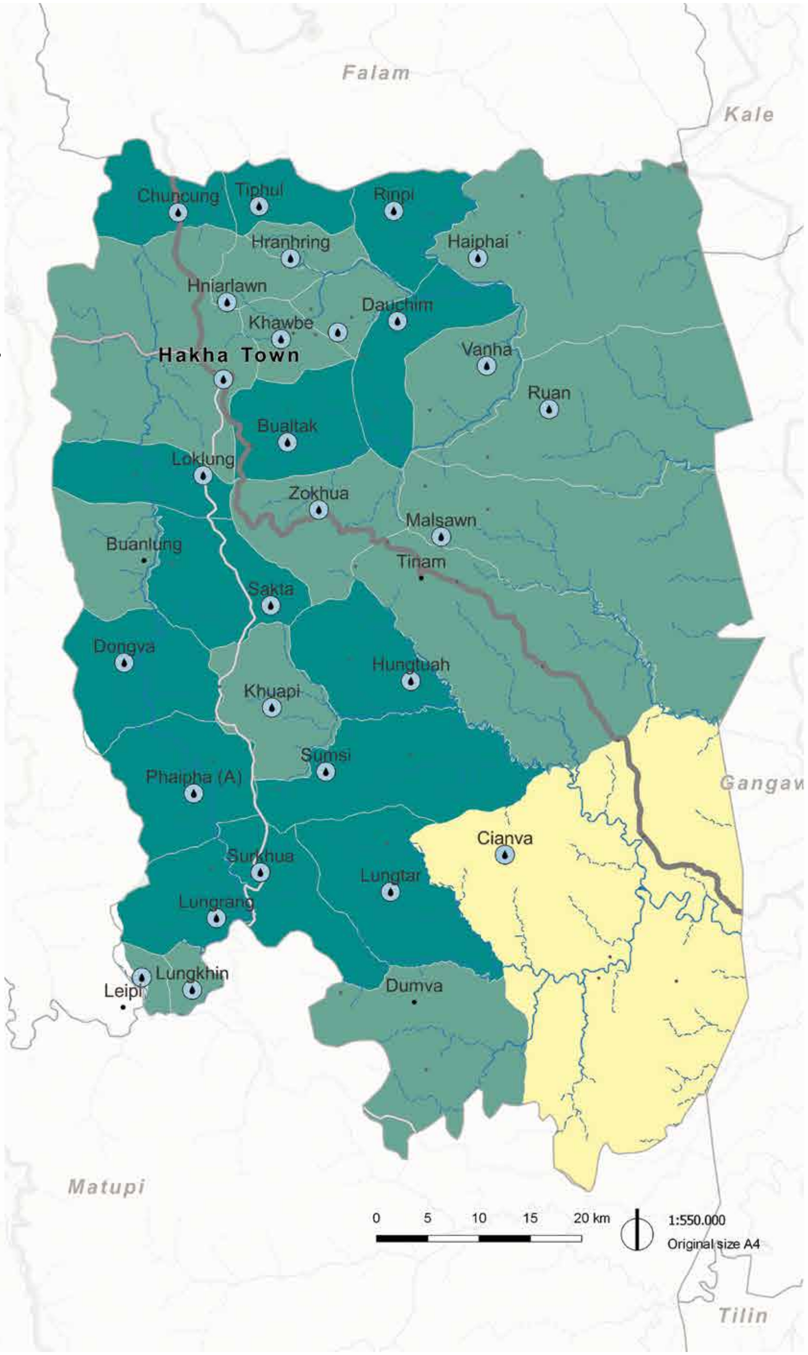
- 0–25
- 25–50
- 50–75
- Piped water

Transport network

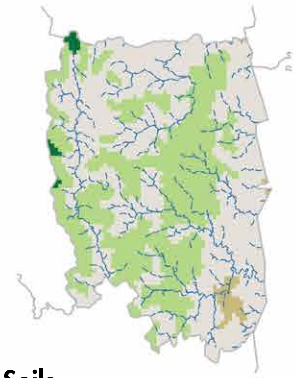
- Major road
- Secondary road
- Tertiary road

Main streams

- Main streams
- Seasonal streams



Vegetation cover



Land cover map from 2000 (UNEP)

- Evergeen forest
- Deciduos forest
- Scrubland
- Agriculture
- Main streams
- Seasonal streams

Soils

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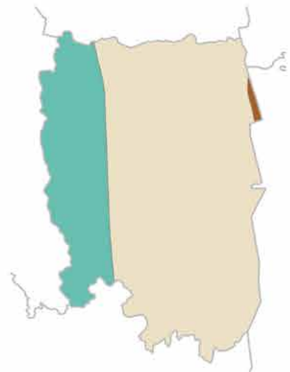
Soil types

- Chin Hill Complex Soil
- Red Brown Forest Soil

Geology



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- Alluvial
- Limestone and Ultrabasic
- Sedimentary and Locals

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

People's mobility and communication are expected to be further reduced by 2050 given the impacts of climate change.

As with most mountainous areas, mobility seems to be the main constraint to the socio-economic and livelihood development of rural communities in Hakha. Currently, the transport network relies on the primary paved road (in construction) and a network of secondary and tertiary unpaved roads/trails, which make these rural communities highly vulnerable to strong storms and unusually heavy rainfall.

Rural road networks are critical infrastructure that are highly exposed to climate change, as they mainly depend on the interaction of two main ecosystem services (vegetation cover and soil), which are highly impacted by heavy rainfall.

	Hazard	Ecosystem service	Main projected impacts
+ 1.6°C warmer	**Higher average temperatures**	*Soils*	Higher temperatures will increase rates of evapotranspiration and reduce the moisture content of the soil, making it vulnerable to erosion. This will worsen as the dry seasons become drier and the wet seasons become wetter, causing the first large rains of the wet season to impact dry, loose soils.
+ Rainfall	**There will be more intense rainfall events and more frequent and severe floods**	*Soils*	In highland areas, steep slopes are more vulnerable to landslides, as well as flash flood events. The lack of strong embankments and unsealed road surfaces in remote areas increases the impact of flooding. In lowland plains, the proximity of roads to rivers and lakes makes them susceptible to floods.
		Vegetation cover	Deforestation increases exposure to erosion and slope instability. Landslides in riverbank areas damage vegetation cover and destroy roads and bridges.

Future vulnerabilities

- Increased intense rainfall events will lead to increased incidences of landslides and flash floods, which will damage roads and destroy bridges. This is especially true for village tracts, where transport and connectivity rely on a network of rural unpaved roads on high, steep slopes. Damages to transport infrastructure will isolate village tracts for longer periods from markets, medical facilities, schools, and other core community services.

Assumptions

- The current rural road network is a critical infrastructure highly exposed to climate change. It is assumed that the observed landslide and flood impacts will worsen in all surveyed village tracts if no specific adaptive measures are considered.

Figure 31: Access to transport infrastructure in 2017

The current transport network mainly relies on the primary paved road (in construction) and a network of secondary and tertiary unpaved roads/trails, which make these rural communities highly vulnerable to strong storms and unusually heavy rainfall. Around 30% of village tracts reported that over the last 30 years landslides and floods have come more frequent, damaging roads and bridges, and, in the worst cases, isolating them for several from days from markets, medical facilities, schools, and other core community services. The level of accessibility in each village tract determined what percentage of the population had access to infrastructure in 2017.

Percentage of HHs

- 25–50
- 50–75
- 75–100

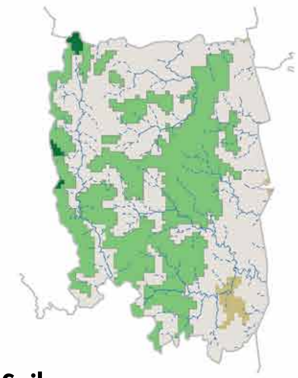
Transport network

- Major road
- Secondary road
- Tertiary road

Main streams

- Main streams
- Seasonal streams

Vegetation cover



Land cover map from 2000 (UNEP)

Vegetation cover

- Evergeen forest
- Deciduos forest
- Scrubland
- Agriculture
- Main streams
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Topography

The steep topography in Hakha Township exacerbate sensitivity, thereby increasing risks of disasters

Slopes in degrees

- 0–15
- 15–30
- 30–45
- >45

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

Figure 32: Access to transport infrastructure in 2050

+ 1.6°C warmer | + rainfall | + drought

If no adaptive measures are implemented, the lack of capacity to mitigate erosion through formal infrastructure, coupled with weak transport communication, will lead to communities becoming highly vulnerable to more landslides and inundation. The projected stronger storms and unusually heavy rainfall will inevitably reduce people's mobility, especially in village tracts only accessible by unpaved trails/tracks on sloping land, which will be more exposed to landslides, and flash flood events. Access to transportation network in 2050 – by considering the observed impacts on roads and bridges, will worsen in all surveyed village tracts due to the projected changes in climate.

Transport network

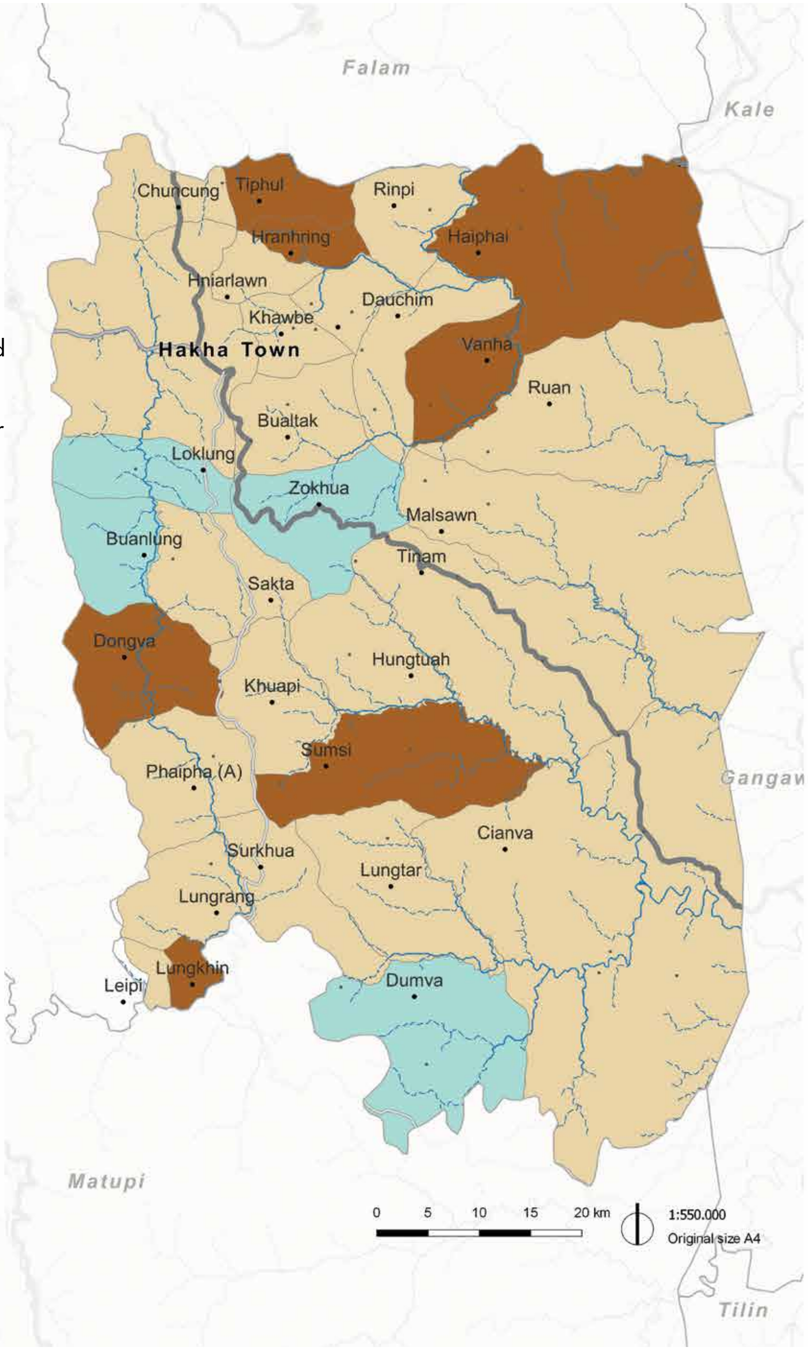
- Major road
- Secondary road
- Tertiary road

Rivers and streams

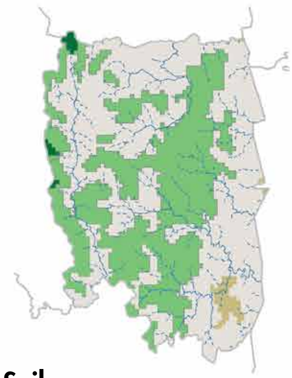
- Main streams
- Seasonal streams

Percentage of inhabitants

- 0.0–25
- 25–50
- 50–75



Vegetation cover



Land cover map from 2000 (UNEP)

Vegetation cover

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Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

5

OVERALL FINDINGS – SCENARIOS FOR HAKHA

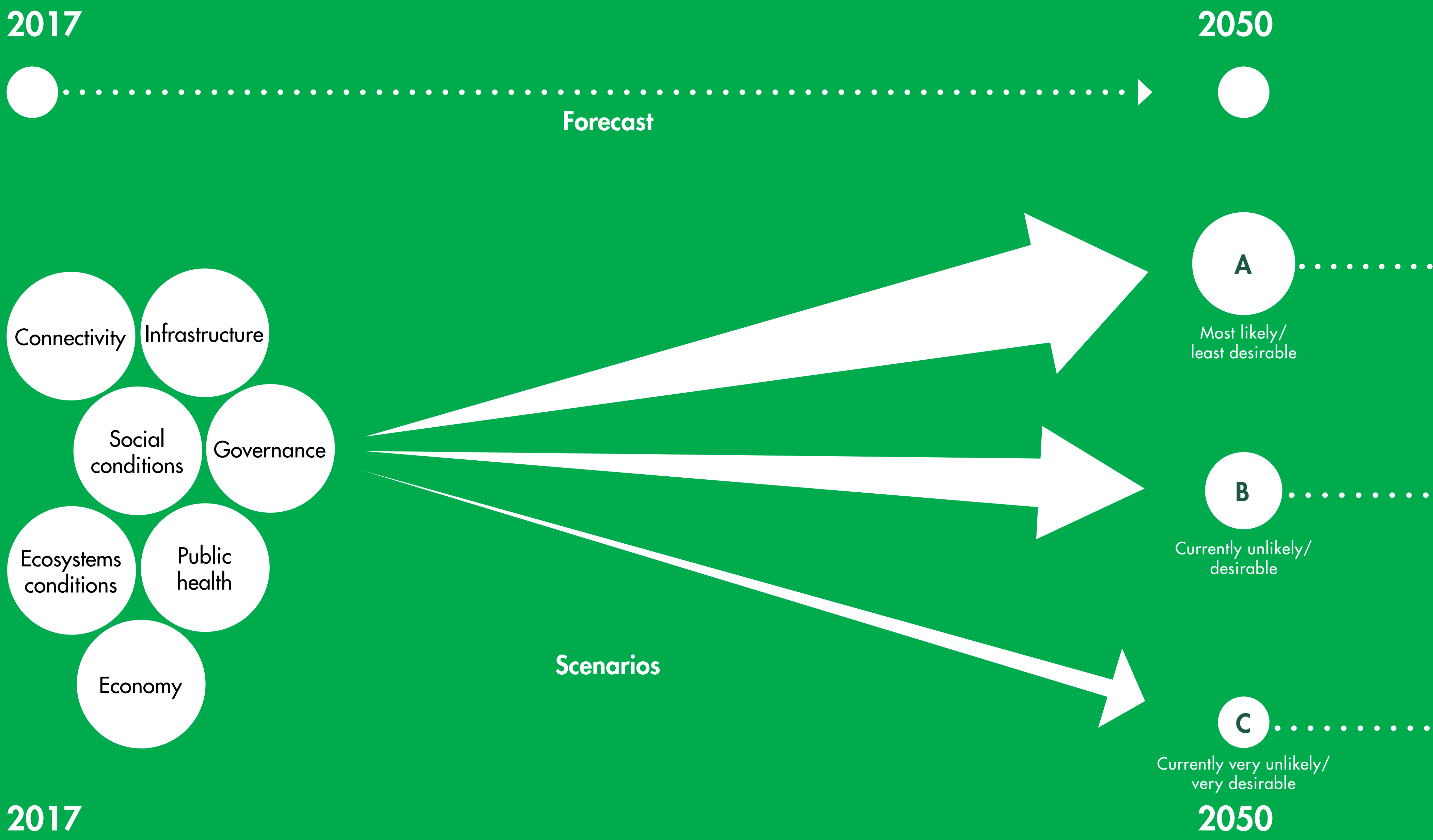
This assessment concludes that given the current and projected climatic conditions, Hakha does not possess the infrastructure and systems necessary to quality as a resilient township. Climate change will a have great impact unless resilience is prioritized and built overtime in Hakha. Climate change will increase the current social, economic, ecological, and infrastructure vulnerabilities. The assessment presents three broad scenarios for the future of Hakha, in descending order of probability and ascending order of desirability.

Scenario A, or 'Business as Usual', has the most negative impact and is currently also the most probable, considering the current conditions of the township. However, it is the least desirable scenario.

Scenario B, 'Moderate Resilience' describes a minimum standard of resilience to be achieved to protect people's lives, assets and production means. It is likelier to unfold than Scenario A, but is one that the Township and national authorities should strive to obtain. It represents the bare minimum standard that needs to be upheld to protect Hakha's people and economy.

Scenario C, 'Strong Resilience' is the most desirable future, but unfortunately also the least likely to happen keeping in mind the current conditions in the township. In this scenario, conservation of natural ecosystems, more resilient communities, and a diversified economy is achieved, so that the Township can actually thrive. The Township and the regional and national authorities should aspire to materialize this scenario. A local resilience and adaptation plan would be a first tool to this end.

Figure 33: Geographic representation of forecast and scenarios



5.1 DEFINING THE SCENARIOS

SCENARIO A: Business as Usual: no specific adaptation effort

Under Scenario A, authorities and communities recognize the need to address different aspects of vulnerability, but they do not take any significant action to build the resilience of the communities. The impacts of climate change are evident on the three systems analysed in this report socio-economic, infrastructure, and ecosystems. Ultimately, this increasingly affects people's livelihoods, health, and safety until 2050 and beyond.

SCENARIO B: Resilience is Built to Maintain Current Living Standards by 2050

Under Scenario B, the township, district, and national authorities together with development partners work to build a minimum standard of resilience that ensures at least the maintenance of current living standards and reduces the vulnerability of Hakha Township. This scenario is the minimum required to prevent increased vulnerability and enable continued development.

SCENARIO C: Resilience is Built that Enables Economic and Social Development Despite Changes in Climate by 2050

Under Scenario C, Hakha in 2050 sustains and continues socio-economic development that is less dependent on agriculture through a diversified economy, improved infrastructure, and healthy ecosystems. The tiny arrow in this figure does not mean that this is impossible, but signifies the need for political, technical, and financial commitment.

5.2 SCENARIOS FOR HAKHA 2050

SCENARIO A: Business as Usual: no specific adaptation effort

Under Scenario A, authorities and communities recognize the need to address different aspects of vulnerability, but they do not take any significant action to build the resilience of the communities. The impacts of climate change are evident on the three systems analysed in this report socio-economic, infrastructure, and ecosystems. Ultimately, this increasingly affects people's livelihoods, health, and safety until 2050 and beyond. This seems to be the current trajectory, represented by a larger arrow in Figure 33.

- Under this scenario, the spatial structure of Hakha is at risk from rapid onset disasters, causing a loss of crop productivity, which will lead to more food and nutrition insecurity.
- Due to lack of capacities and inefficient governance, unsustainable planning becomes more prevalent leading to greater risks of disasters – e.g. the construction of roads on slopes that are totally exposed to rains and leads to landslides. Unplanned urbanization in Hakha town led to a major disaster in 2015, leading to the destruction of more than 1,000 houses in Hakha.
- In the Business as Usual scenario, the livelihoods, infrastructure, and ecosystems systems will not allow people to improve living conditions in the township, given the current and projected future vulnerabilities to climate change.
- In addition, projected changes in the climate will interact with and exacerbate the existing vulnerabilities and as they do, new, unforeseen vulnerabilities may also emerge.

Under this scenario, considering that adaptation measures are not implemented and the unsustainable use of environmental resources continues, Hakha is unlikely to be able to support current and expected population growth and sustain the same living standard as in 2017, as vulnerabilities will grow further.

Under a Business as Usual scenario, people in Hakha will experience lower incomes because of the impacts of disasters such as droughts, flashfloods, landslides, and insect and pest attacks on agriculture and livestock farming. In addition, interrupted communication and connectivity during disasters will put the additional burden of having to buy food at increased costs.

Currently the trend of out-migration of male members of households is high in Hakha Township, which is likely to increase under this future scenario considering that no new employment opportunities will be generated in the township. This will particularly affect the youth, who make up the overwhelming majority of migrants, and will result in remittance being the dominant income for increasingly female-headed households. If present trends continue, this migration would be gender imbalanced, as more men will migrate than women, increasing the number of female-headed households, which will increase risk and vulnerability for those who are left behind – mostly children, adolescents, and women.

Infrastructure functionality will be increasingly compromised as infrastructure are exposed to flash-floods, landslides, and storms. This will translate into loss of assets such as houses, schools, and public buildings, and will cause increasing loss of life. Also, damages to medical facilities will increase the vulnerability of the population of the township. Transport will become more difficult as the limited road infrastructure will be recurrently damaged by landslides, interrupting the connectivity of Hakha town with other townships and other village tracts within the township. This in-turn can affect trading and socio-economic activities, thus increasing vulnerability and risk for communities in Hakha.

The impacts of climate change hazards exacerbate unsustainable resource use and will eventually reduce people's ability to benefit from the ecosystem. Deforestation and the degradation of forest ecosystems will lead to soil erosion and might also affect the water table, hence affecting forest ecosystem services in the township. This will affect the availability of timber, fuelwood, non-timber forest products, and fodder for grazing. The degradation of ecosystems will also lead to a decline in biodiversity and pose a threat to wildlife in the township by making them more exposed to poaching and hunting.

Soil quality issues will be exacerbated by erosion and a shorter but more intense monsoon season, which will have impacts on agricultural production. Water availability will continue to decline as a longer dry season will mean less time for the springs to recharge, which may not be enough to meet the daily increasing demand for water.

An analysis of the matrix of functions in 2050 (Table 9) under a business as usual scenario shows

Hakha's level of socio-economic and infrastructure development would decrease across the township.

As shown in Figure 34, an analysis of the spatial distribution of type of settlements and the cartographic representation of levels of hierarchy as based on isopleths allows for drawing some assumptions on the spatial development of the township in 2050, and the degree of territorial influence, where any, of each settlement over neighbouring settlements:

Spatial analysis of 2050 estimates less access to the following functions:

Ecosystem services	Socio-economic functions	Infrastructure facilities
Timber *Wood for charcoal*	*General market* *Livestock market* *Small basic needs stall* *Groceries shop*	*Unmade trail road* *Gravel roads* *Bus stop (except in paved roads)* *Rain water harvesting pond* *Irrigation system*

The territorial and socio-economic development of the township will be more unbalanced, mainly centered on the village tracts along the main axes of transportation.

Hakka town, where all transport communication converges, would still be well connected through the primary corridor to Falam/Kalay Town (north) and Gangaw Town (east), and to India. These two corridors would remain crucial to supporting the economy of the township in 2050.

Unpaved road infrastructure will be either completely or partially unusable resulting in the isolation of many village tracts, especially in southeastern areas of the township. This may affect Hakka Town severely, as the transportation of agricultural produce would be more difficult, resulting in the loss of specialized markets and most probably more people migrating to other areas. In turn, the dependency on Kalay and Gangaw towns for provisioning needs and services would inevitably increase, representing an additional burden on family incomes.

Hakka's level of socio-economic and infrastructure development will decrease.

At the township level, the future spatial structure will rely on Hakka Town and Chucung – strategically located where all the transport communication of the township converges – and the southern settlement of Lungrang.

The territorial influence of Hakka Town on southern areas will decrease, as village tracts show lower levels of socio-economic and infrastructure development. Southern areas of the township will be the least developed, mainly providing basic services.

SCENARIO B: Resilience is Built to Maintain Current Living Standards by 2050

Under Scenario B, the township, district, and national authorities together with development partners work to build a minimum standard of resilience that ensures at least the maintenance of current living standards and reduces the vulnerability of Hakha Township. This scenario is the minimum required to prevent increased vulnerability and enable continued development. The thinner arrow (in Figure 33), signifies that this trajectory is less likely to materialize.

- Under this scenario, recognizing future challenges, the township, district, and national authorities, together with development partners, work to build a minimum standard of resilience that ensures at least the maintenance of current living standards and reduces the vulnerability of Hakha Township.
- However, investment, time, and economic, technical, and skill constraints are recognized; an adaptation plan is adopted; and activities that can be implemented without large investment are consistently undertaken. This includes protection of the environment, the strengthening of economic associations to create more resilient livelihoods and incomes, the integration of measures to strengthen buildings and housing units so that they are able to withstand strong winds and the improvement of water-harvesting, among others.
- Decisions on land use and town planning increasingly take into account current and projected climate risks, to prevent hazardous situations, such as infrastructure being constructed near flood-prone areas and the need to clean drainage infrastructure.
- The township and communities are able to plan their needs considering climate constraints and communicate them to the district, state, and region, and NGOs and development partners.
- This scenario is the minimum required to prevent increased vulnerability and enable continued development, although townships can, over time, find that because of the cumulative effects of climate change and its exponential consequences, the actual actions required are greater than anticipated. Hakha in 2050 maintains current living standards by undertaking some adaptation measures. However, it broadly continues its present development trajectory.

To enable this scenario, current observed deforestation and forest degradation trends would need to halt. This would be necessary to maintain current living standards, especially in areas surrounding Hakha town, which are being deforested at a highly unsustainable rate. If this deforestation is not halted, soil erosion, risk of landslides, and problems selected to water scarcity are likely to increase.

In order to control deforestation, the introduction of non-wood building material and alternative energy sources will be required. This will reduce the pressure on natural ecosystems due to household scale cutting for energy and timber extraction for building material.

Table 9: Matrix of functions depicting the predicted distribution of various services in different towns in Hakha Township in 2050

	LOCAL VILLAGE TRACTS																		INTERMEDIATE VILLAGE TRACTS																	MAIN VILLAGE TRACTS																					MAIN URBAN CENTRE																			
VTCODE	Monastery/church	Vegetables	Paddy rice	Public water network on grid (piped water)	Maize	Carpenters	Agriculture (smallholder/self-sufficient)	Midwife	Playground	Primary school	Unmade (trail/track)	Disaster Management Committee	Middle school	CHW	Small basic needs stall	Community-based organization	Kindergarten	Orchard	Other casual labour	Library	Gravel road	National non-government organization (I/NGOs)	Grocery stores	Public rural health centre	Weaving/sewing	Hydroelectric power production	Farmers' cooperatives	Timber	Bus stop	Wild fruits	Wood for charcoal	Public sub-rural health centre	Petrol supply station	Public electricity network on grid	Private solar panel electricity supply	Coffee	Pharmacy	Street sellers	Post office	Restaurant	Electricians	Livestock market	Bicycle repair garage	Veterinary clinic	Early warning system	High School	Paved road	General market	Plumbers	Non-profit associations (NPAs)	Motor vehicle repair garage (motorbike/car)	Construction material shop	Rain water harvesting pond	Lawyers	Disaster facilities (i.e shelter)	Oil crops (sesame, sunflower, groundnut)	Irrigation system	Public lighting solar panel electricity supply	Dentist	Private clinic	Bus transport on daily basis	Telecommunication tramsfer (mobile phone repeater)	University	Museum	Police station	Police check point	Public township hospital	Fire station	Banks/western union	Furniture shop	Beans	Doctors	**Total number of functions**	**Total centrality score**	**Level of hierarchy**	**Type of settlement**
MMR004002000																																																																											51	2043.7	12	MUC
MMR004002005																																																																											30	551.4	9	MVT
MMR004002007																																																																											29	404.0	5	
MMR004002010																																																																											17	285.3	5	
MMR004002021																																																																												20	281.7	5	
MMR004002016																																																																											17	252.7	4	IVT
MMR004002024																																																																											21	209.2	3	
MMR004002004																																																																											19	185.9	3	
MMR004002027																																																																											16	178.1	3	
MMR004002022																																																																											15	124.6	2	
MMR004002003																																																																											15	122.0	2	
MMR004002014																																																																											16	120.7	2	
MMR004002013																																																																											14	119.6	2	
MMR004002009																																																																											14	115.3	2	
MMR004002030																																																																											13	110.7	2	
MMR004002001																																																																											14	110.5	2	
MMR004002028																																																																											15	110.3	2	
MMR004002023																																																																											14	107.6	2	
MMR004002025																																																																											12	99.0	1	
MMR004002002																																																																											13	95.8	1	
MMR004002019																																																																											13	95.5	1	LVT
MMR004002029																																																																											14	88.3	1	
MMR004002026																																																																											14	87.1	1	
MMR004002012																																																																											13	86.6	1	
MMR004002017																																																																											10	82.0	1	
MMR004002020																																																																											10	81.5	1	
MMR004002015																																																																											12	81.5	1	
MMR004002008																																																																											10	62.4	1	
MMR004002018																																																																											8	39.8	1	
MMR004002006																																																																											7	37.4	1	
MMR004002011																																																																											7	29.8	1	
Number of functions	29	28	28	9	26	24	24	24	23	20	0	17	17	16	1	12	12	11	10	10	0	10	2	8	8	8	7	0	2	6	0	6	6	5	5	5	5	5	5	4	4	0	4	4	4	3	3	0	3	3	2	2	0	2	2	2	0	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1				
	3.4	3.6	3.6	11.1	3.8	4.2	4.2	4.2	4.3	5.0	0.0	5.9	5.9	6.3	100	8.3	8.3	9.1	10	10	0.0	10	50	12.5	12.5	12.5	14.3	0.0	50.0	16.7	0.0	16.7	16.7	20.0	20.0	20.0	20.0	20.0	20.0	25.0	25.0	0.0	25.0	25.0	25.0	33.3	33.3	0.0	33.3	33.3	50.0	50.0	0.0	50.0	50.0	50.0	0.0	100	100	100	100	100	100	100	100	33.3	100	100	100	100	100	100				

Figure 34: Spatial structure in 2050: Territorial and socio-economic linkages

+ 1.6°C warmer | + rainfall | + drought

Hakha's socio-economic and infrastructure development levels may decrease, especially in villages tracts located in south eastern areas.

Road infrastructure will be either completely or partially unusable resulting in the isolation of many village tracts relying only on unpaved roads/trails. This would severely affect Hakha Town as the transportation of the agricultural production will be more difficult, resulting in the loss of specialized markets.

Level of hierarchy

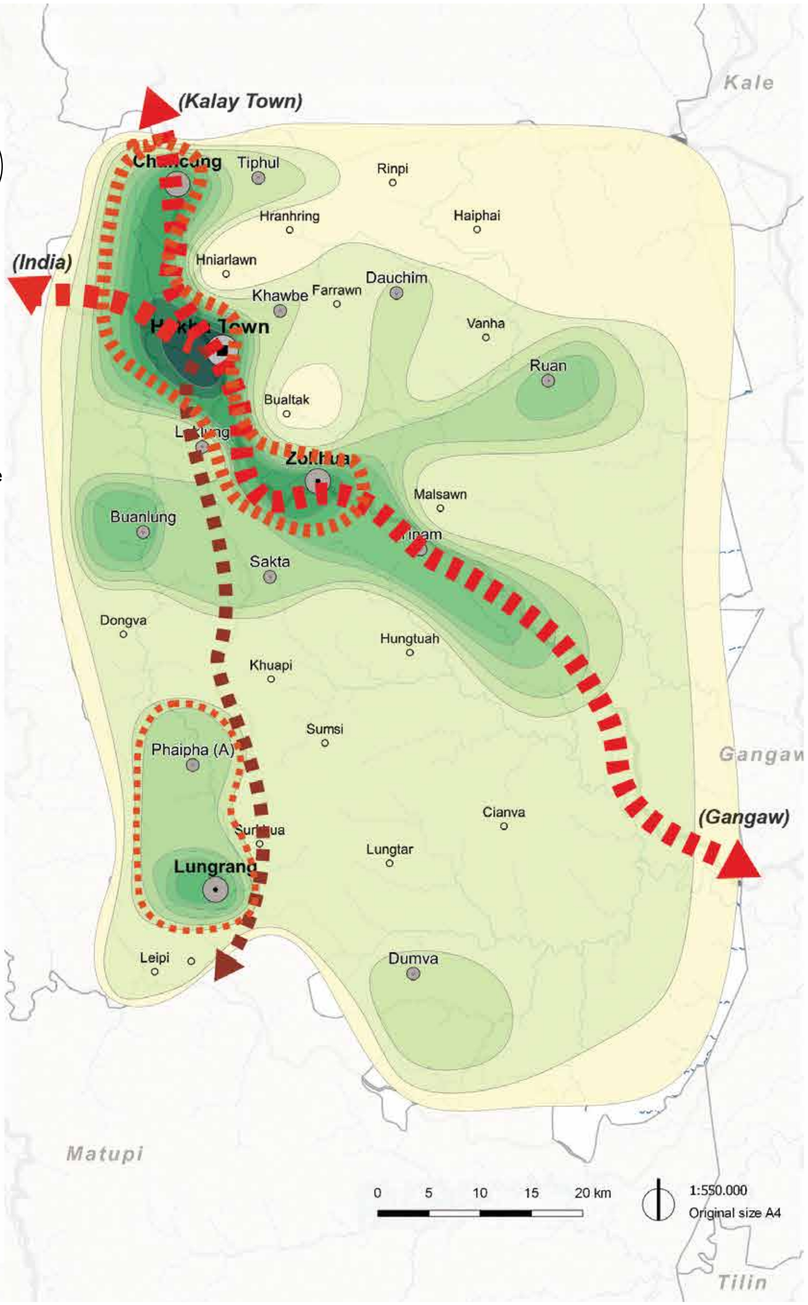
- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6
- Level 7
- Level 8
- Level 9
- Level 10
- Level 11
- Level 12

Type of settlements

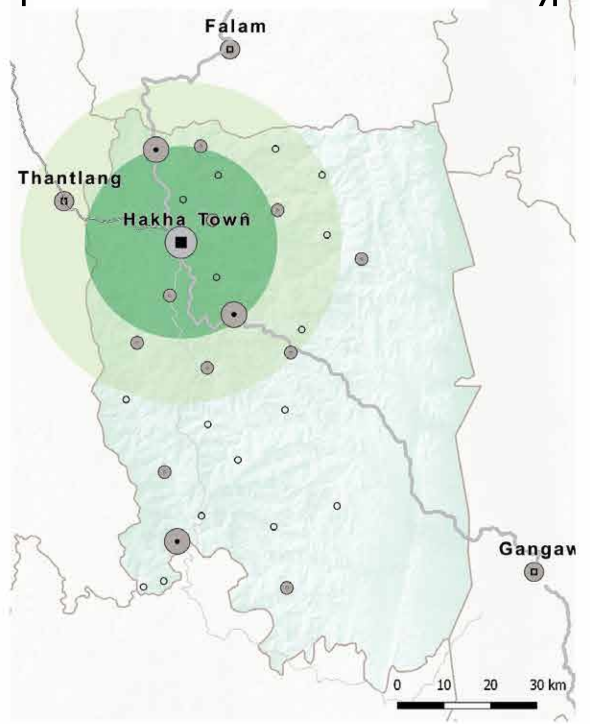
- MUC
- MVT
- IVT
- LVT

Spatial structure

- Primary cluster
- Primary corridor
- Secondary corridor



Spatial distribution of the different settlement types



In 2050, the socio-economic and infrastructure development of the township will be more unbalanced, and mainly concentrated in Hakha Town.

Dependency on Kalay and Gangaw towns for provisioning needs and services will inevitably increase.

Type of settlements

- Main urban centre
- Main village tract
- Intermediate village tract
- Local village tract
- Distance – 15 km
- Distance – 25 km

Road network

- Major road
- Secondary road
- Tertiary road

Data Sources: MIMU, Census 2014, Hakha Township Planning Department, UN Habitat 2017

Alternative practices would need to be developed and implemented in agriculture. In some areas, water scarcity could become a major problem in addition to the drought. To adapt to this, new drought-resistant crop varieties need to be introduced and high-value, low-volume products need to be explored – e.g., medicinal herbs and non-timber forest products. Efficient irrigation systems need to be designed in collaboration with the communities. This will enable communities to have ownership of the activities and add value to the systems, which will take into account community perceptions of climate change.

There would need to be some investment in infrastructure to ensure that functionality is maintained to present levels. In particular, water capture, storage, and distribution would need to be improved. This means that current water storage and supply networks would have to be enhanced, and systems put in place to prevent any unforeseen circumstances arriving due to water scarcity and drought. Transport infrastructure would also require improvements, particularly with improvement needed in road construction with a special focus on adapting to extreme events. Meanwhile, improvements in road transport and power infrastructure would also contribute to maintaining current levels of development.

SCENARIO C: Resilience is Built that Enables Economic and Social Development Despite Changes in Climate by 2050, Considering the Different Vulnerabilities of Both Men and Women

Under Scenario C, Hakha in 2050 sustains and continues socio-economic development that is less dependent on agriculture through a diversified economy, improved infrastructure, and healthy ecosystems. The tiny arrow in Figure 33 does not mean that this is impossible, but signifies the need for political, technical, and financial commitment.

Hakha in 2050
sustains and continues people's socio-economic development through a diversified economy, improved infrastructure, and healthy ecosystems that are less dependent on paddy cultivation and capture fisheries.

Agriculture needs to be made resilient to new climatic features through a combination of climate-resilient agricultural practices such as resistant crop varieties, better irrigation, improved storage and distribution of water, and soil and nutrient management. To generate wealth from agriculture, some value addition, such as milling and processing, should take place in the township. To enable this, investment is required in energy and transport infrastructure that will protect people, add greater connectivity, and allow for energy-intensive industries to run in a sustainable and carbon-efficient manner. Investment in renewable energy would be an important consideration in this case.

Investment in education and skills, coupled with infrastructure and agro-industrial and enterprise development through wise use of micro credits, loans, or investments from remittances will enable young people to stay in the township and find more remunerative employment. This is crucial to tackling the trend of outmigration of youth from the villages to urban townships and abroad. It will also create a virtuous cycle because people will be less likely to migrate and less likely to work in highly climate-sensitive sectors such as agriculture. Through strengthened private sector engagement, developing and implementing value chains of economically viable and high return cash crops, including traditional crops, could play an important role. Deforestation and degradation of forests needs be controlled immediately with action on the ground along with policy-level changes. The demand for timber for building houses, which puts additional pressure on the forests needs to be tackled with alternative sustainable options. Preventing deforestation is a challenge, and the root causes of it are complex. An essential set of measures will be needed to move away from dependence on wood for energy towards renewable sources. As long as people are dependent on wood to meet their essential energy requirements, the supply of fuelwood will continue depleting. Along with cleaner energy options, people are also using energy saving solutions such as improved stoves.

Improvements in the transport network and infrastructure will be required to ensure resilient and sustainable development. In particular, improvements will be needed in road transport. Improving the resilience of small/tertiary roads and increasing the number of village they access year-round while also ensuring their sustainability and securing alternative routes during disasters such as landslides are important. These measures will prevent remote areas from becoming isolated during the monsoon season.

Climate-sensitive planning represents a group of actions that will be essential for resilient economic and social development. Improvements in the transportation network could also link more people to high schools – which are still inaccessible for many – and health facilities.

Under this scenario, local institutions are equipped with knowledge and skills for addressing the increasing risk and uncertainty from climate change and other socio-economic changes in an inclusive manner. They are cooperating and collaborating with local, regional, and global institutions. Women have access and ownership to land and property, and credit and finance. Moreover, local communities and organizations are using digital services for risk reduction, agro-met services and market information.

Building resilience to climate change in Hakha Township is a great and urgent challenge, on which the lives and welfare of thousands of people depend. Poor livelihood options, inadequate infrastructure and land-use planning, and deforestation processes interplay to create a very vulnerable context for the township, which the projected changes in climate will exacerbate.

The disastrous 2015 Hakha landslide presents a major and recent example of the interplay between processes of ecosystem degradation and insufficient planning capacities or enforcement, compounded with urbanization processes and a changing climate with heavier rains. However, this assessment calls the attention of authorities and development partners to the fact that the effects of changes in climate on productive social, ecological, and infrastructural systems of the township will also include silent and transformative effects.

CONCLUSIONS AND RECOMMENDATIONS: PLANNING FOR ADAPTATION AND RESILIENCE IN HAKHA

Policy Recommendations

1. It is essential that the socio-economic resilience of Hakha's rural and urban populations is enhanced. This will require improving agriculture, livestock, forest production systems, and freshwater ecosystems in an integrated way to make them more climate resilient as these sectors will continue to provide employment and occupation to most of the economically active rural population. However, given the potential extent of climate change impacts, including flash floods, drought, and crop failure, it is also extremely important that existing production systems are made more resilient and productive means are diversified. Thus, actions should be taken to:

- Provide women and men farmers technical and institutional support for economically beneficial and climate-resilient agroforestry mixed models that are closely connected with or derived from traditional shifting cultivation and "scientific" knowledge systems. The models should integrate sustainable land management practices such as "slash and mulch" instead of "slash and burn", improved fallow management with enrichment planting of agro-ecologically appropriate leguminous trees and shrubs, integration of *Alnus nepalensis* (alder) for soil fertility improvement, etc. Improved home gardens featuring a combination of food, fruit, cash crops, fodder, timber, and off-season vegetables may be also scaled up.
- Reduce high dependency on external food supplies. The productivity and production of existing rice, maize, ginger, potato, and other traditional food systems should be increased through improved irrigation, System of Rice Intensification, adoption of heat- and drought-tolerant crop varieties, adaptation in the cropping calendar, use of improved compost and biochar, intercropping, crop rotation, implementation of the zig-zag method of ginger cultivation on sloping lands, apiculture for pollination services etc.
- Enhance and diversify skills of people, both men and women, and especially younger people, to increase employability in different sectors in Hakha and elsewhere, as some migration cannot be avoided. Vocational training is also important as levels of technical qualifications are extremely low at present.
- A few non-timber forest products, such as elephant foot yam and orchids, have great potential for income generation for the poorer sections and women of Hakha Township, provided resources are harvested sustainably and there is targeted strategy and investment to strengthen climate resilient production, product diversification, value addition, and marketing infrastructure with strengthened private sector engagement. These wild plants can be domesticated in home gardens.

- Accord priority to promoting and supporting the growth of women- and youth-led cottage industries at rural and urban levels, for instance handicraft and traditional medicine. This will require development of business services, establishment of linkages with large industries, credit guarantees, and access to micro credit facilities.
- Strengthen the socio-economic productive system by promoting farmers' associations, developing services, and increasing farmers' capacity to withstand shocks from rapid- and slow-onset disasters and recover more quickly from them.
- Increase opportunities for new small and medium enterprises and promote investment, including through loans and other incentive schemes. This is difficult to achieve without increased overall investment and focus on Hakha. It requires the involvement of national, regional, and district authorities, and development partners and must be planned carefully to be feasible.

2. It is crucial that local capacities on disaster risk reduction are enhanced. Thus, actions should be taken for:

- Climate-resilient land use planning, management and regulations.
- Investment in protective infrastructure including climate-resilient housing.
- Natural resource management to support the risk reduction function of ecosystems.
- Disaster preparedness through early warning systems, contingency planning, search and rescue, first aid, and agro-met advisories.
- Risk transfer through (micro)-insurance, community seed banks, emergency funds (monetary) or contributors (seeds, food, etc.) to restart business.
- Women and marginalized groups must be actively involved in decision making.
- Promote bioengineering measures for slope stabilization and ensure that freshwater ecosystems, particularly springs, are not impacted by infrastructure projects. Invest in a springshed management approach, which is based on a hydrogeological assessment, and not on conventional watershed management.

3. Solutions for addressing climate change vulnerabilities of Hakha's population must include strategies for addressing women's needs and empowering them. Some ways to do so are as follows:

- Support drudgery reduction interventions. These could be improved provisions of drinking water, cleaner energy options (hydropower, solar), modern agriculture and food processing equipment, and increased connectivity.
- Give women land ownership, invest in capacity building, and bring women into mainstream businesses and entrepreneurial ventures.
- Support handicrafts as an income earning opportunity through access to finance, technology upgrading, skill enhancement, and marketing interventions in this sector.
- Include women and marginalized groups in village and township decision making.

Adaptation Action Planning

Based on the broad coverage of community consultations undertaken in this study, the assessment team also conducted participatory planning exercises with communities and local authorities to identify priority outcomes, outputs and, specific actions to avoid Scenario A, and change Hakha's development trajectory towards Scenarios B and, ideally, Scenario C.

To achieve Scenario C, the following main outcomes should be achieved:

1. A healthy ecosystem is maintained and enhanced to continue protecting and providing for people
2. The socio-economic conditions of Hakha's population are improved, diversified, and made more resilient
3. Resilient infrastructure and connectivity are achieved, which protects people and enables development

These outcomes defined during the consultations are not aspirational but are backed by a series of possible expected results and actions to undertake with different degrees of investment and partnerships. These priorities will need to be implemented by the communities and the townships, and district and national authorities. The outcomes of the plan will also help to communicate priorities to development partners and the private sector. The summary of the actions prioritized are presented in following tables.

To conclude, the findings of the study strongly indicate that adopting such a plan and using it consistently to programme and budget interventions and interact with donors and development partners will be essential to mitigating current and future conditions.

Table 10: Adaptation planning for ecosystems sector

To conserve natural ecosystems in Hakha Township	Cost	Feasibility	Acceptance	Effectiveness	Benefit anyway (no regret)	Speed	Score
To get correct data on deforestation	3	5	5	4	4	3	24
Plantation activities	3	4	5	5	4	2	23
To define specific pasture area for grazing	5	3	3	5	4	4	24
To define specific shifting cultivation area	2	2	1	4	3	1	13
To change from shifting cultivation to permanent agriculture	2	2	4	5	3	2	18
To reduce forest fires	5	3	4	5	3	3	23
To check and ensure water quality for drinking and other uses	3	5	5	5	5	3	26
To have an effective water storage and distribution system	1	5	5	5	5	3	24
To protect water resources	2	4	5	5	4	3	23
To prevent forest fires	4	4	3	5	3	3	22
To check and ensure water quality for drinking and other uses	5	5	5	5	3	3	26
To improve livestock rearing (especially chicken and pigs) to reduce hunting of wildlife for meat	2	4	5	5	4	4	24
To start cultivation of forest products to reduce the extraction of forest products and replantation	1	2	3	5	3	2	16
To reduce the use of chemical fertilizers	4	3	3	5	3	3	21
To ensure effective implementation of the rules and regulations of wildlife conservation	5	3	3	4	3	3	21

Table 11: Adaptation planning for infrastructure sector

To build resilient infrastructure in Hakha Township	Cost	Feasibility	Acceptance	Effectiveness	Benefit anyway (no regret)	Speed	Score
Improve construction techniques to protect housing from floods and landslides (foundations)	4	2	2	5	2	1	16
Improve water sewage/drainage systems at households level	3	4	4	5	5	3	24
Improve water capture and storage at community level	2	1	1	3	1	1	9
Improve renewal energy sources at household level (solar, cooking stoves)	2	1	1	3	2	2	11
Improve storage to protect food, crops, and livestock	2	3	4	5	5	3	22
Improve road and urban drainage system	2	3	4	5	4	2	20
Improve telecommunication and mobile access	2	2	4	5	4	2	19
Build retaining walls to protect roads and trails from landslides	1	3	3	5	5	2	19
Improve road safety with signals and concrete fences	3	3	4	5	4	3	22
Improve quality of materials (asphalt/gravel) and maintenance of roads	2	2	4	5	5	2	20
Policy on land administration and housing planning	4	4	2	5	2	1	18
Construct shelters that can also be used as community centres	1	2	3	5	3	2	16
Improve early warning systems and emergency preparedness	4	4	4	5	4	4	25
Studies to identify risk areas (prone to landslides, floods, erosion)	3	3	4	5	4	2	21
Community control flood plans	3	3	4	5	4	3	22

Table 12: Adaptation planning for socio-economic sector

To build resilient social and economic conditions in Hakha Township	Cost	Feasibility	Acceptance	Effectiveness	Benefit anyway (No regret)	Speed	Score
Value chains of local 'niche' products using climate resilient practices and agriculture expansion	2	3	5	5	3	2	20
Vocational training	3	4	5	5	4	3	24
Small and medium entreprise development	3	3	5	5	4	3	23
Improved access to locally relevant improved crop seeds	2	4	5	5	4	4	24
Training on climate resilient agricultural and livestock practices	3	3	3	4	3	2	18
Terrace cultivation (in place of shifting cultivation)	1	2	2	4	4	2	15
Agroforestry system promoted to modify shifting cultivation	4	4	5	5	4	3	25
Recruitment of technical staff for agriculture and livestock extension services	4	4	4	5	4	3	24
Credits/loans for on-farm and off-farm activities to increase production and increase income	4	3	5	3	3	3	21
More clinics, hospitals, and nurses in rural and urban Hakha, alongwith low-cost (affordable) treatment	2	2	5	5	3	2	19
Awareness on climate change impacts among Hakha communities	5	5	5	5	5	5	30
Improved access to education at all levels with improved infrastructure and qualified teachers	2	3	5	5	4	3	22

Myanmar Climate Change Alliance

MONREC

GCCA+
THE GLOBAL CLIMATE CHANGE ALLIANCE PLUS INITIATIVE

Funded by the European Union

International Centre for Integrated Mountain Development
GPO Box 3226, Kathmandu, Nepal
Tel +977 1 5275222 **Fax** +977 1 5275238
Email info@icimod.org **Web** www.icimod.org

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