CLIMATE CHANGE VULNERABILITY ASSESSMENT

Sekong Province

Final Report 2019

ADAPTATION FUND

UN HABITAT
FOR A BETTER URBAN FUTURE

Climate Change Vulnerability Assessment – Sekong Province
Final Report 2019

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LIST OF ACRONYMS

ARCC	Adaptation and Resilience to Climate Change
BAU	Business as usual
CBDRR	Community-based Disaster Risk Reduction
CLEAR	Consolidated livelihood exercise for analyzing resilience
DPCC	Disaster Prevention and Control Committee
DRM	Disaster Risk Management
DTA	Development triangle area
GCM	Global circulation model
GDP	Gross demostic product
GIS	Geographic information system
GIZ	Gesellschaft für Internationale Zusammenarbeit
GPAR	Governance and Public Administration Reform
IPCC	Intergovernmental Panel on Climate Change
INFORM	Index for Risk Management
IRV	Intermediate Rural Villages
L-CRVA	Lao Climate Risk and Vulnerability Assessment
LRV	Local Rural Villages
MoF	Matrix of Functions
MRC	Mekong River Commission
MRV	Main Rural Villages
NGO	Non-governmental organization
PHC	Population and Housing Census
SDGs	Sustainable Development Goals
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNREDD	United Nations Programme on Reduced Emissions through Deforestation and Forest Degradation
USAID	United States Agency for International Development
UXO	Unexploded ordinance
VDPCC	Village Disaster Prevention Control Committee
VDPU	Village Disaster Prevention Units

FOREWORD

Responding Climate Change with vulnerability assessments

Climate change is one of the most pressing international issues in the world today. The Government of Lao PDR has recognised the threat that climate change presents to national development. In recent years, severe floods, storms and droughts have affected much of Lao PDR, including the three southernmost provinces of Attapeu, Sekong and Saravan. Temperatures have increased dramatically and are predicted to continue to do so. Rainfall has become more erratic and in many areas and the dry season is becoming more prolonged.

For national development to proceed in a way that meets the government's target of becoming a middle income country by 2020, adaptation to climate change is essential. Lao PDR has ratified the Paris Agreement and has launched an ambitious and fair Nationally Determined Contribution to the Paris Agreement that prioritises mitigation actions, to reduce the causes of climate change, and adaptation responses, to cope with its consequences.

However, a great deal of work will be required to meet the targets laid out in Lao PDR's NDC, and to continue to develop in line with the 8th Five-Year National Socio-Economic Development Plan. A lack of data can hamper efforts at the local and national levels to respond effectively to challenges posed by climate change, especially considering that capacity at local level is limited. This is particularly challenging, as climate change impacts are often complicated and often manifest themselves over many years.

On behalf of the Ministry of Public Works and Transport, I recognise that we all must play our part in the response to climate change. Water supplies, for example, as the vulnerability assessment shows, will be threatened by prolonged periods of drought, with the poor being most seriously affected, unless we take action to adapt our systems to climate change. The consultations held with targeted communities also highlight access to water supply as a key factor to increase resiliency of vulnerable communities. Providing access to water supply is in line with the national goal to achieve 80% coverage by 2020. The Ministry is thus enthusiastically collaborating and partnering with UN-Habitat to execute the 'Enhancing the Climate and Disaster Resilience of the Most Vulnerable Rural and Emerging Urban Human Settlements in Lao PDR' project, funded by the Adaptation Fund, between 2017 and 2021.

The provincial climate change vulnerability assessments in Attapeu, Sekong and Saravan Provinces for the first time give local and national government staff the evidence basis to plan for an effective, targeted and cost-efficient adaptation response to climate change that meets the needs of everyone, especially the poor and indigenous people. Based on this, the project will construct small-scale water infrastructure that adapts to the challenges presented by climate change and enhances community resilience. This work is also a vital contribution to giving provincial and district staff under the Ministry of Public Works and other government departments the capacity and knowledge they need to analyse and deliver services to the people of Lao PDR in the face of the challenges posed by climate change.

Finally, on behalf of the Ministry of Public Works and Transport, I would like to take this opportunity to express my sincere gratitude to all stakeholders for their support to, and cooperation with, the government of Lao PDR in developing these assessments. Specifically, I would like to thank the Adaptation Fund, for providing funding support, and UN-Habitat for its technical support to the overall implementation of the project. The Government of Lao PDR looks forward to continued support in the future, and is determined to meet its obligations in the continued response to climate change.

Dr. Bounchanh Sinthavong
Minister
Ministry of Public Works and Transport, Lao PDR

FOREWORD

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PART 1

Executive Summary

1 Executive Summary

The main objective of this assessment is to enable sub-national authorities in Lao PDR to make informed planning decisions about taking actions to adapt to climate change. More specifically, the assessment provides the evidence basis to develop climate change action plans that will guide the implementation component of the *'Enhancing the climate and disaster resilience of the most vulnerable rural and emerging urban human settlements in Lao PDR'* project. The vulnerability assessment shows how climate change will exacerbate already significant development challenges; while poverty has reduced throughout Sekong Province, people in or nearly in poverty often rely on climate-sensitive livelihoods, particularly agriculture.

The vulnerability assessment in Sekong Province was conducted in 62 villages, across two of the province's four districts; 29 villages in Kaleum District and 33 villages in Dakcheung District. These villages have a total population of 22,925; just over 20 per cent of the province's total population, and about 21.3 per cent of the total number of people covered by the project.

Lao People's Democratic Republic (PDR) is one of the world's most vulnerable countries to climate change. The Germanwatch Global Climate Risk Index ranked it the 8th most vulnerable country in the world in 2013[1], due to its high dependence on climate sensitive natural resources and low adaptive capacity. This presents a significant obstacle to achieving the Sustainable Development Goals and national economic and social development goals. The impacts of climate change are already being felt in Laos. Between 1992 and 2009 the total area affected by flooding grew exponentially from around 1,000 square kilometres to about 25,000 square kilometres. On average, floods and storms have killed around 40 people and affected around 200,000 people annually in the same period. 14 of Lao PDRs' 17 provinces, including Sekong, have experienced flooding at least once since 1995[2].

Annual average rainfall is about 1,535 millimetres per year in Sekong Town, almost 90 per cent of which falls in the rainy season from May to October. Between 1995 and 2016, rainfall declined in total by about 130 millimetres, a decrease of about 8.5 per cent. The two highest and three lowest annual rainfall amounts have were recorded in the last ten years, indicating greater variability. There were 146 rainy days per year on average between 1995 and 1999, while the number of rainy days from 2012 to 2016 declined to only 112, meaning that Sekong Town is now expected to have 34 fewer rainy days per year than it did in 1995, a 23 per cent decline.

The average maximum temperature increased by 0.63°C between 1995 and 2016. Sekong had never experienced a temperature over 34°C, until a temperature of 36.7°C was recorded in 2016, indicating both averages and extremes are increasing. Almost all communities surveyed in Kaleum and Dakcheung Districts reported that the temperature increased throughout their lives, with many ratings defining the increase as 'significant'.

Sekong province faces multiple hazards, as shown in the table below:

Hazard	No. of Villages in Dakcheung affected (out of 33)	No. of Villages in Kaleum affected (out of 29)	Details
Floods	21	17	Primary effects are on houses and small-scale infrastructure
Storms	33	18	Most frequently affect income and damage infrastructure. Houses also affected in some cases
Landslides	14	12	Infrastructure mainly affected – especially roads and bridges
Drought	23	20	Affects income

1 The Climate Risk Index for 2013: the 10 most affected countries. The Global Climate Risk Index 2015 online: https://germanwatch.org/de/download/10333.pdf.
2 Laos Intended Nationally Determined Contribution to the UNFCCC (2015), p.5.

Climate change projections show that temperatures are forecast to increase by up to 2.5°C by 2050. Rainfall change models indicate that there will be a slight increase in rainfall over a shorter rainy season. It is not possible to infer changes in severe storms, but the changing rainy season means that more extreme rainfall events are more likely.

Deforestation has been proven to be a significant problem in the target area, with some forests degraded, resulting in reduced ecosystem services available to people in affected areas. The target districts in Sekong have not seen hydropower development in the way some other areas have but mining development has taken plance. There is very limited groundwater in Kaleum and Dakcheung Districts, and its use is uncommon. People mainly rely on surface water for domestic consumption.

Infrastructure is very limited in the target districts. Only three per cent of target villages in Kaleum District and six per cent in Dakcheung District have access to a paved road. Only 31 per cent of households in target villages in Kaleum District and 28 per cent in Dakcheung have access to on-grid electricity, with 49 and 34 per cent respectively having no electricity. 68 per cent and 73 per cent of households in Kaleum and Dakcheung Districts depend on surface water sources, leaving people vulnerable to evaporation in a longer, hotter dry season. Furthermore, access to health and education facilities is also very limited. 60 per cent and 40 per cent of villages in Kaleum and Dakcheung District respectively do not have access to a complete primary school.

Sekong has a very high level of absolute poverty and greater 'depth' of poverty than any other province in the country. This makes people in Sekong more likely to be vulnerable to climate change because they are less likely to have savings, or to be able to invest in alternative livelihoods or improved facilities. Agriculture and livestock are common sources of income throughout both districts. These industries are highly climate-dependent and people working in them are highly vulnerable highly vulnerable in the absence of adaptation measures. There is very little evidence of service industry sector employment, which is less climate-dependent, in Kaleum and Dakcheung Districts.

Adult literacy rates are among the lowest in the country at 61.9 per cent in Kaleum District and 72.2 per cent in Dakcheung District. Low literacy rates make it very difficult for people to move to non-climate dependent livelihoods and thus become more resilient. Low literacy rates are very likely to be related to low school enrolment rates, which are as low as 4.1 per cent of youth enrolled in the upper secondary in Kaleum District. Low high school enrolment begins a cycle that limits people to low- wage, climate dependent labour.

Overall, villages in Kaleum District have lower levels of infrastructure and socio-economic development than villages in Dakcheung District. 70 per cent of villages in Kaleum were classified by the assessment as 'local rural villages' meaning they have the lowest level of socio-economic development, compared to 35 per cent of villages in Dakcheung. This is mainly because of slightly better transport and connectivity in Dakcheung District. In both districts, economic development primarily occurs in a single small cluster of villages.

The vulnerability index prepared by the project shows very high levels of vulnerability across the two districts, with 19 of the 20 most vulnerable villages in the entire project area in Sekong Province.

The assessment defines three adaptation scenarios; business as usual, resilience built to maintain current living standards, and resilience built to enhance socio-economic development. The second of these is the bare minimum required to cope with the anticipated effects of climate change, without allowing these effects to compromise people's living standards.

Finally, the assessment highlights some possible climate change impacts under the business-as-usual scenario if no actions are taken. These show that the capacity of people to access water will significantly decline, access to transportation services will become far more difficult and that, as a result of human factors, forest coverage will continue to decrease.

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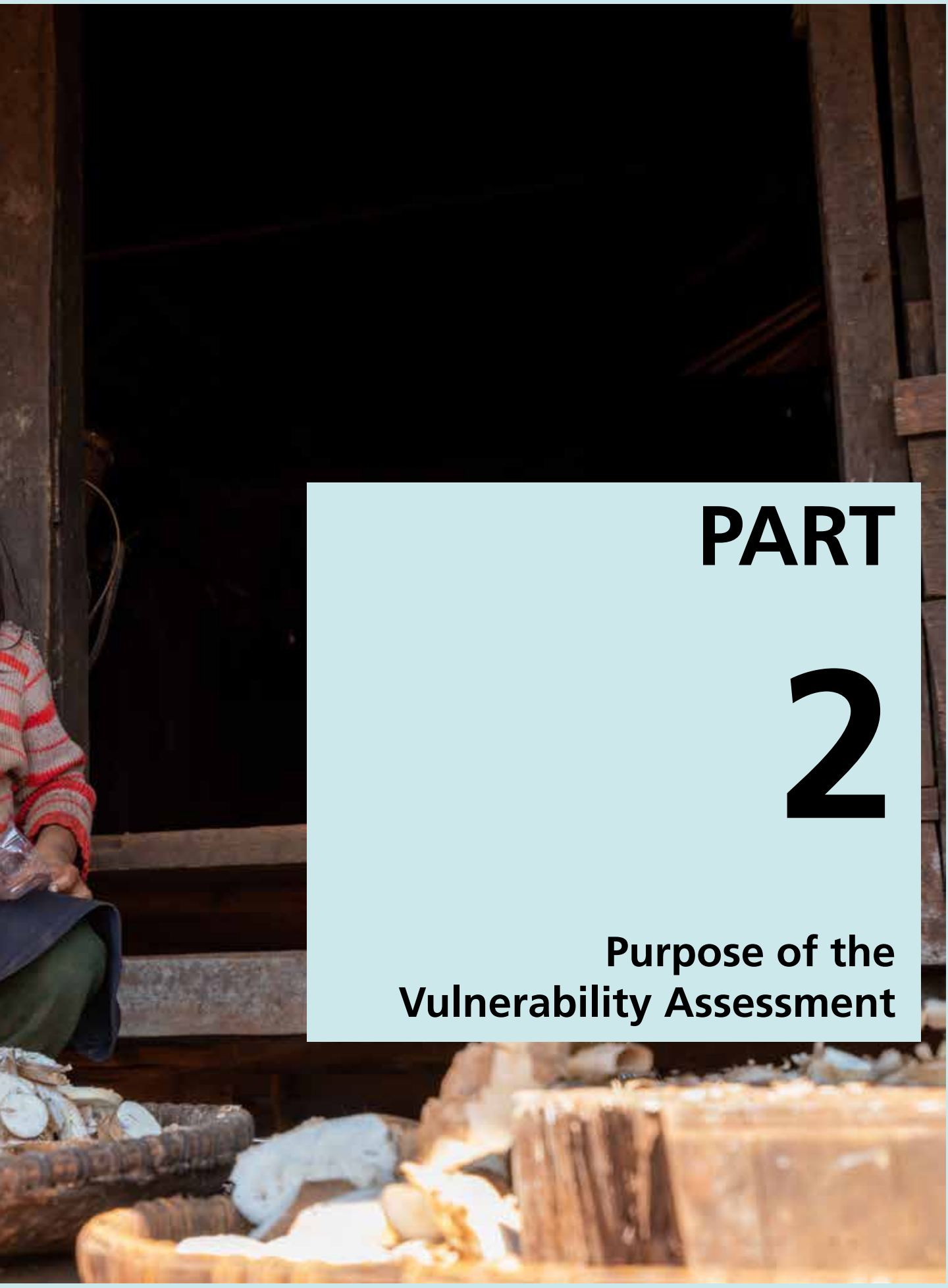

PART 2

Purpose of the Vulnerability Assessment

2 Purpose of the Vulnerability Assessment

2.1 Background

Lao People's Democratic Republic is one of the world's most vulnerable countries to climate change. The Germanwatch Global Climate Risk Index ranked it the 8th most vulnerable country in the world in 2013[3], due to its high dependence on climate sensitive natural resources and low adaptive capacity. Laos also faces a significant lack of coping capacity, which will likely lead to significant challenges in reducing negative consequences in the aftermath of a hazard[4]. Storms, floods, and droughts have increasingly affected Laos in recent years, by causing, *inter alia*, landslides, fires, disease outbreaks, loss of life, and damage to infrastructure and livelihoods. Climate change will cause the dry season to be longer and hotter, and the rainy season to be shorter and wetter, and hazards to become more intense.

This presents a significant obstacle to achieving Sustainable Development Goals and national economic and social development goals. The overall objective of Lao PDR's 8th Five Year Socio-economic Plan is to significantly reduce poverty in all areas and 'graduate' from Least Developed Country status by 2020. As the Plan notes, this requires 'effective management and efficient utilization of natural resources'. This will be achieved through three approaches: 1) Sustained, inclusive economic growth with economic vulnerability reduced to levels required for growth support (discussed further in the economic context section, below), 2) Human resources are developed and the capacities of the public and private sectors is upgraded; poverty in all ethnic groups is reduced, all ethnic groups and both genders have access to quality education and health services; the unique culture of the nation is protected and consolidated; political stability, social peace and order, justice and transparency are maintained, and finally 3) Natural resources and the environment are effectively protected and utilized according to green-growth and sustainable principles; there is readiness to cope with natural disasters and the effects of climate change and for reconstruction following natural disasters[5].

Lao PDR's economy is one of the fastest growing in the world, with GDP growth averaging just under 8 per cent per year over the last decade[6]. Supported by this growth, poverty rates nationwide fell from 27.6 per cent in 2008 to 23.2 per cent in 2013[7] [8]. While the contribution of agriculture to overall GDP has declined slightly in recent years, it comprises 24.8 per cent of the economy. The remaining share is divided between industry (27.5 per cent) and services (47.7 per cent)[9]. However, in 2015, agriculture still employed 65 per cent of the labour force, which, though a decrease from 71.3 per cent in 2010[10], is still a high figure, and indicates low incomes in the agriculture sector.

The impacts of climate change are already being felt in Laos. The land area and number of people exposed to flooding has increased 25 times, while storms and floods typically affect about 200,000 people per year throughout the country. Total economic losses resulting from Typhoon Ketsana in 2009 totalled 1.1 per cent of GDP[11]. 14 of Laos' 17 provinces, including Sekong, have experienced flooding at least once since 1995[12]. Similarly, drought has affected six provinces over the same time period[13], and projections show that Sekong, along with the other provinces targeted under this project, Attapeu and Saravan, are likely to be the most seriously affected areas in Laos[14].

3 The Climate Risk Index for 2013: the 10 most affected countries. The Global Climate Risk Index 2015 online: https://germanwatch.org/de/download/10333.pdf.
4 World Risk Report 2016, p.65.
5 Ministry of Planning and Investment, (2016) 8th Five-year National Socio-economic Development Plan, p.87-89.
6 According to World Bank data - http://www.worldbank.org/en/country/lao - accessed 17/8/2017.
7 Ministry of Planning and Investment, (2016), 8th Five-year National Socio-economic Development Plan, p.3.
8 The World Bank quotes a slightly higher national poverty headcount figure of 24.8 per cent for 2015.
9 Ibid, p.5.
10 Ibid, p.11.
11 Laos Second National Communication to the UNFCCC (2013) p.56
12 Laos Intended Nationally Determined Contribution to the UNFCCC (2015), p.5.
13 Ibid.
14 UNDP-ICEM (2017) L-CRVA Summary Report, p.31.

2.2 Enhancing the Climate and Disaster Resilience of the Most Vulnerable Rural and Emerging Urban Human Settlements in Lao PDR

To support Lao PDR in addressing these issues, the Adaptation Fund financed the 'Enhancing the Climate and Disaster Resilience of the Most Vulnerable Rural and Emerging Urban Human Settlements in Lao PDR' project beginning in 2017 for four years. The project is being implemented by UN-Habitat and executed by the Ministry of Public Works and Transport.

The project's main objective is to enhance the climate and disaster resilience of the most vulnerable rural and emerging urban human settlements in Southern Lao PDR by increasing sustainable access to basic infrastructure systems and services, emphasizing resilience to storms, floods, droughts, landslides and disease outbreaks.

To achieve this, the project has ***four*** components:

1. Institutional strengthening to reduce vulnerability in human settlements.

2. Building capacity at the community and human settlement level for climate resilience

3. Enhance climate and disaster resilient infrastructure systems in human settlements

4. Knowledge management, advocacy and monitoring

The total budget for the project is US$4.5 million. The project works in 189 villages and spread across eight districts; Samuoi and Ta Oy in Saravan Province, Kaleum and Dakcheung in Sekong Province, and Phouvong, Sanxai, Xaisettha and Samakhixay Districts in Attapeu Province.

Component 1 involves conducting province and district-level climate change vulnerability assessments. It is followed by the development of action plans, which will decide the nature of investments under Component 3. Under Component 3, US$2.8 million will be invested in small-scale infrastructure to adapt to climate change. Component 2 will build the requisite capacity at village level to construct and maintain the infrastructure, and Component 4 will facilitate replication and upscaling of the project.

2.3 Climate Change Vulnerability Assessment

The vulnerability assessment shows how climate change will exacerbate already significant development challenges. While the target districts, and Sekong Province more generally, have made progress – to varying degrees – in reducing poverty, these reductions need to be sustained and continued in the face of climate change[15]. Moreover, people in or nearly in poverty often rely on climate-sensitive livelihoods, particularly agriculture.

Moreover, the area faces unique and complex environmental challenges due to its rapid development. Hydropower is a major part of Laos's economic development strategy, with over 70 hydropower projects currently under development nationwide[16].

While extensive hydropower development has seen the country's electrification rate increased from 15 per cent in 1990 to over 90 per cent in 2015[17], Laos will more than double its current power generation capacity when all hydropower projects that are currently planned or under construction come on-grid.

Much of this additional electricity capacity will be exported; primarily to Thailand and Vietnam. Ten hydropower plants are under construction or are being built in southern Lao PDR.

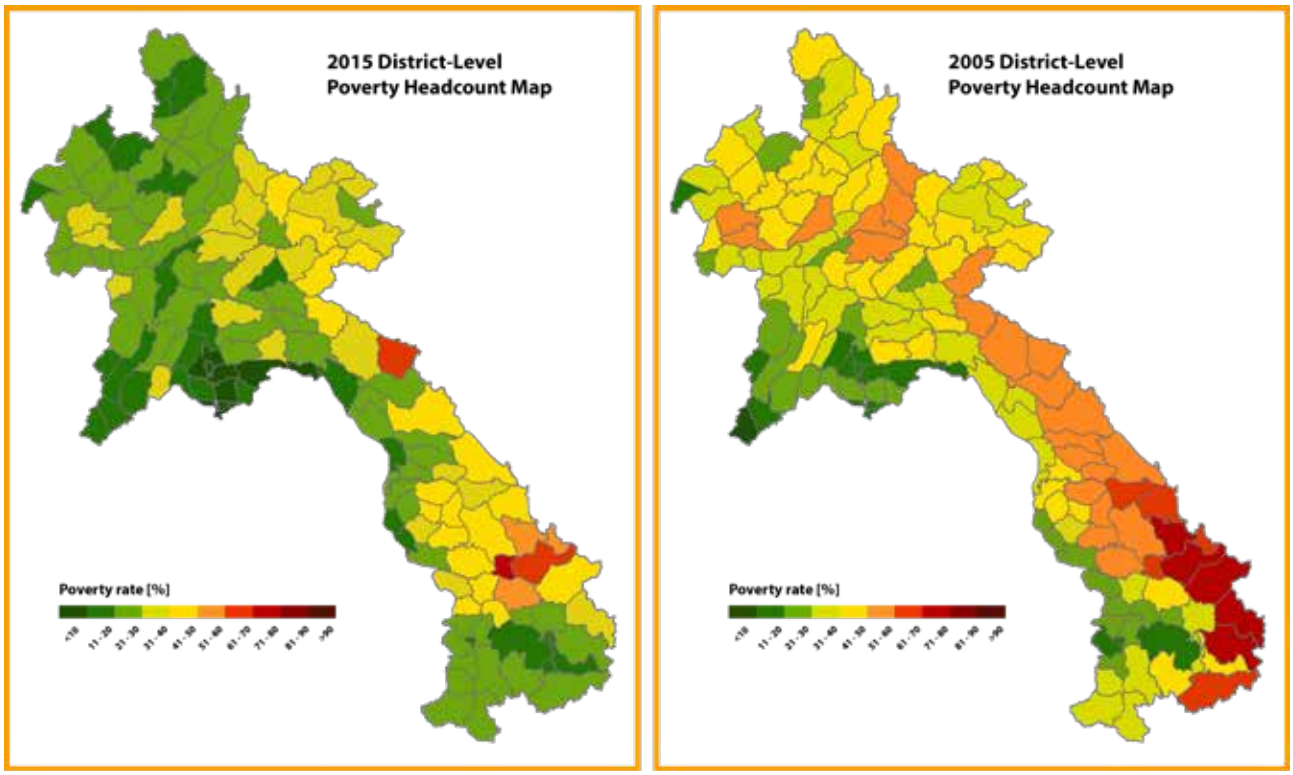

Figure 1 - Change in the district-level poverty headcount between 2005 (right) and 2015 (left)

15 LSB/World Bank (2016), Where are the Poor? Lao PDR 2015 Census-Based Poverty Map: Province and District Level Results, p.15.

16 http://www.poweringprogress.org/new/2-uncategorised/3-hydropower-in-lao-pdr, accessed 22/8/17.

17 Phomsoupha (2016) – Concession Agreements of Independent Power Producers from the Lao Government's Perspective. PowerPoint Presentation, NCC, Vientiane from 1st to 3rd March, 2016.

a. Main Objectives

The main objective of this assessment is to enable sub-national authorities in Lao PDR to make informed planning decisions about taking actions to adapt to climate change. More specifically, the assessment will also be the evidence basis to develop climate change action plans that will guide the implementation component of the 'Enhancing the Climate and Disaster Resilience of the Most Vulnerable Rural and Emerging Urban Human Settlements in Lao PDR' project.

The assessment also aims to achieve the following co-benefits and sub-objectives:

- Increasing awareness levels of national and subnational decision makers, as well as practitioners in the development partner and NGO community, particularly through the following:
  - Understanding which of the 189 villages is particularly vulnerable to climate changes;
  - Knowledge of how infrastructure, ecological and socio-economic systems interact with, and contribute to, vulnerability;
  - Enhanced awareness of the spatial interaction of settlements in the target area, how this contributes to vulnerability, and how interventions can be sited effectively to benefit multiple villages;
  - Scenarios defined that help to identify a more resilient development pathway;
  - Based on the above, increased capacity to plan and implement adaptive pathways for the province and district, that are spatially relevant, and guide the correct replication of the assessment's methodology.
- The assessment contributes significantly to strategic action plans at the province and district levels that will support adaptation to climate change through more targeted investments at the village level.

b. Methodology

The methodology is designed to support provincial and district governments to identify current and future drivers of the vulnerability in Sekong Province, by considering the current conditions and the projected climate changes. The presentation of findings is intended to inform policymakers on priority investments and actions to adapt to climate change, in a way that supports more balanced territorial development, economic growth and more equal prosperity.

The methodology of the assessment works as follows:

1) It analyses through a mix of techniques, described below, critical systems in the target districts in Sekong; infrastructure, socio-economic and ecosystems. It then ties this analysis together with a spatial analysis and a vulnerability index, thus identifying the most vulnerable villages and their locations in the province.

2) It uses projections of climate change already in existence in Laos and overlays these onto the current situation in the three critical systems to give a projection of possible future conditions if no actions are taken.

3) It defines future scenarios for action, based on business as usual; taking no action to adapt to climate change, a minimum adaptation scenario to maintain current development and a resilient and sustainable development scenario.

Data collection methods and spatial analysis tools

The assessment used a mix of data gathering methods and spatial analysis tools to ensure the findings are as relevant as possible to the local context, which will increase the usefulness of the assessment for local and national decision-makers (see Figure 2).

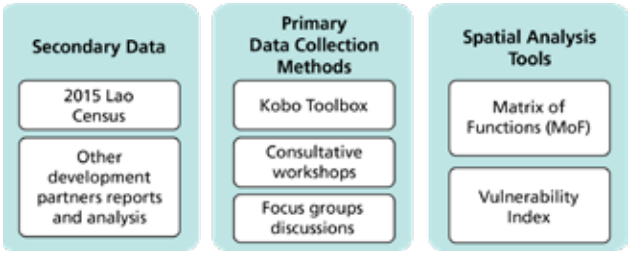

Figure 2 - Data collection methods and spatial analysis tools

The Vulnerability Assessment Report is based on data from the Laos National Census 2015 and used freely available data whenever possible to ease replication. The report also makes use of the significant work already done by other international organisations, such as UNDP's Lao Climate Risk and Vulnerability Assessment (L-CRVA), which covered a similar geographic area, and the World Food Programme's Consolidated Livelihood Exercise for Analysing Resilience (CLEAR). The assessment team also undertook several missions to the field sites to gather information from the provincial and district-level stakeholders, which inform the report.

The most innovative aspect of the data collection was the tablet-based surveys in the target villages. Because

the project covers 189 target villages, including 62 in Sekong Province that are spread across a large area with challenging terrain, a rapid means to gather data from each village was required. To do this, the assessment purchased ten low-cost tablet computers, created a survey through Kobo Toolbox, a free surveying and data gathering application, and trained enumerators in each district on how to use it. The tablets have 3G sim cards to synchronize the surveys to a central database upon completion. Once in the database, a html-based infographic was then automatically populated. These infographics are available online.

Spatial Analysis Using Matrix of Functions

The spatial and territorial analysis uses the matrix of functions (MoF) to provide national, district and local officials with the evidence to design actions that address specific areas of heightened vulnerability to climate change.

The matrix identifies which key eco-system, infrastructure and socio-economic services are available in each village, and describes how balanced the spatial development of the province and district is. Applied to climate change, it increases understanding of how the current spatial structure of the region enables or inhibits adaptation actions in the area to changes in the climate. The Matrix of Functions is developed by using data collected from the tablet-based survey to determine where services are available. Key functions were listed, analyzed and mapped through GIS, and are presented in Sections 3.5 – 3.7 of the report.

Vulnerability Index

The Vulnerability Index provides an overview of the most vulnerable locations to current natural hazards and climatic conditions. Since there is no single way to establish comprehensive indices of vulnerability, this tool is used in connection with other approaches to ensure in-depth analysis. The assessment defines vulnerability as a function of exposure, sensitivity, and adaptive capacity.

Current Drivers of Climate Vulnerability

The assessment built a picture of underlying vulnerability under three categories; environmental conditions, socio-economic conditions and infrastructure conditions. Climate-related hazards, both historical and current impacts and potential future change, were then overlaid to give a comprehensive picture of current and potential future climate change vulnerability.

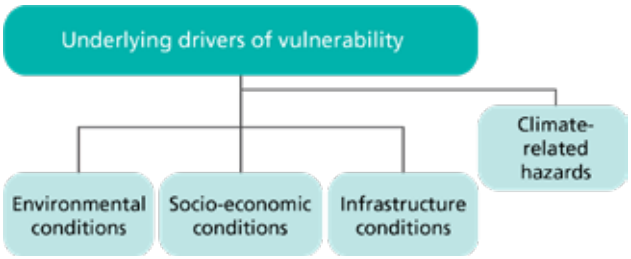

Figure 3 - Determination of current drivers of climate vulnerability

Environment and Ecosystem Conditions

This assessment analyzed the ecosystem services in the two districts and the dependence of people on the benefits ecosystems provided. Through the vulnerability assessment survey and secondary analysis, the assessment determined which services were used most frequently by communities and how climate change and other man-made factors are affecting the quality and availability of these services.

Socio-Economic Conditions

The analysis revealed the main sources of livelihoods and social conditions enabling development, such as the education level and productive sectors, which are also essential for climate change adaptation. The analysis utilized quantitative data, including data from the census and economic information from provincial level government departments. The analysis also included primary data gathered from the tablet-based survey, which allowed the assessment team to understand that poverty, livelihoods and ethnic minority issues are critical in Sekong Province.

Infrastructure Conditions

This analysis focused on the conditions of the built environment and its spatial distribution, to understand the connectivity to climate and other natural hazards. The analysis provides a description of transportation infrastructure, predominant construction techniques and materials, the spatial distribution of public facilities, 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, storms, and floods. Data was collected through a mix of the tablet-based surveys, the census, and analysis of datasets in a GIS environment.

Future Vulnerability Scenarios

The projected changes in the climate were then overlaid onto current conditions, assuming no adaptation actions are taken. This provides planners with a future scenario of forests, freshwater availability and agriculture without any adaptation actions. This analysis helps planners to prioritise and choose the most appropriate actions to adapt to climate change in the future.

Spatially based coefficients[18] of projected climate change were assigned and then multiplied against a given service, such as water availability. The multiplied effect of the increased temperature was then mapped in a GIS environment. It is important to note that these are scenarios rather than forecasts, showing what the future could be like.

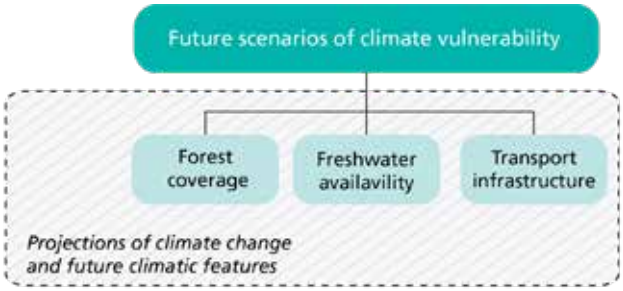

Figure 4 - Determination of future climate vulnerability

Building for Adaptation

Finally, strategic actions plans were created at the province and district level, based on both the governments' capacities and communities' main concerns. These action plans will inform adaptation and resilience planning at the village level.

c. Key Principles

Simplicity and Ease of Replication

The Vulnerability Assessment Report uses 'plain English' where possible. This aids translation into the Lao Language and makes the report's findings easier to communicate.

Secondly, the assessment used open source software and accessible data wherever possible. The assessment relied heavily on data from the census 2015, which is available from the Lao Statistics Bureau upon request, and from the survey conducted by the assessment with the use of Kobo Toolbox, an open source software. The tablets used were low-cost, at around US$130 each. The Vulnerability Assessment didn't pay for satellite imagery or use advanced high-cost GIS software as this would limit the ability of stakeholders in Laos to replicate it.

Thirdly, to facilitate the replication of the assessment, the assessment's methodology was presented to stakeholders from all provinces at a workshop in Attapeu in August 2017, and training was provided to the enumerators, who executed the survey. 32 enumerators were trained by the project, and subsequently went to all 189 villages to gather data. The enumerators were mostly district-level government staff from the 8 target districts, including two in Sekong Province.

This makes the assessment part of a broader effort to increase capacity at the subnational and national levels.

Participatory Approach

In developing the assessment, the enumerator teams visited all 189 villages and interviewed village chiefs and groups of villagers. While there is only 1 survey per village, the questionnaires were answered by consensus, meaning that villagers throughout the entire project area have been canvassed. The vulnerability assessment report's drafting team of the assessment report visited all eight districts targeted by the project, including the two in Sekong Province.

National Ownership

The findings of the assessment are 'owned' by the government of Laos, and this report is designed to influence and improve decision making in Sekong Province regarding climate change. As climate change is a strategic, long term challenge, it requires complex information to support decision making. This report aims to improve this decision making, first and foremost.

Building on Existing Work

Extensive work has already been conducted in Laos on climate change and other issues of relevance to this assessment, such as environmental protection, disaster risk reduction and infrastructure development. This assessment seeks not to duplicate this extensive work, but to be informed by it and add value to it by taking it to a new audience (especially at the sub-national level). An example of this is the climate change projections – extensive work has been done to prepare climate change projections for Laos. Rather than prepare new projections, the report builds its future climate change scenario on secondary data, using the excellent projections already in existence.

18 Defined in this case as a multiplier

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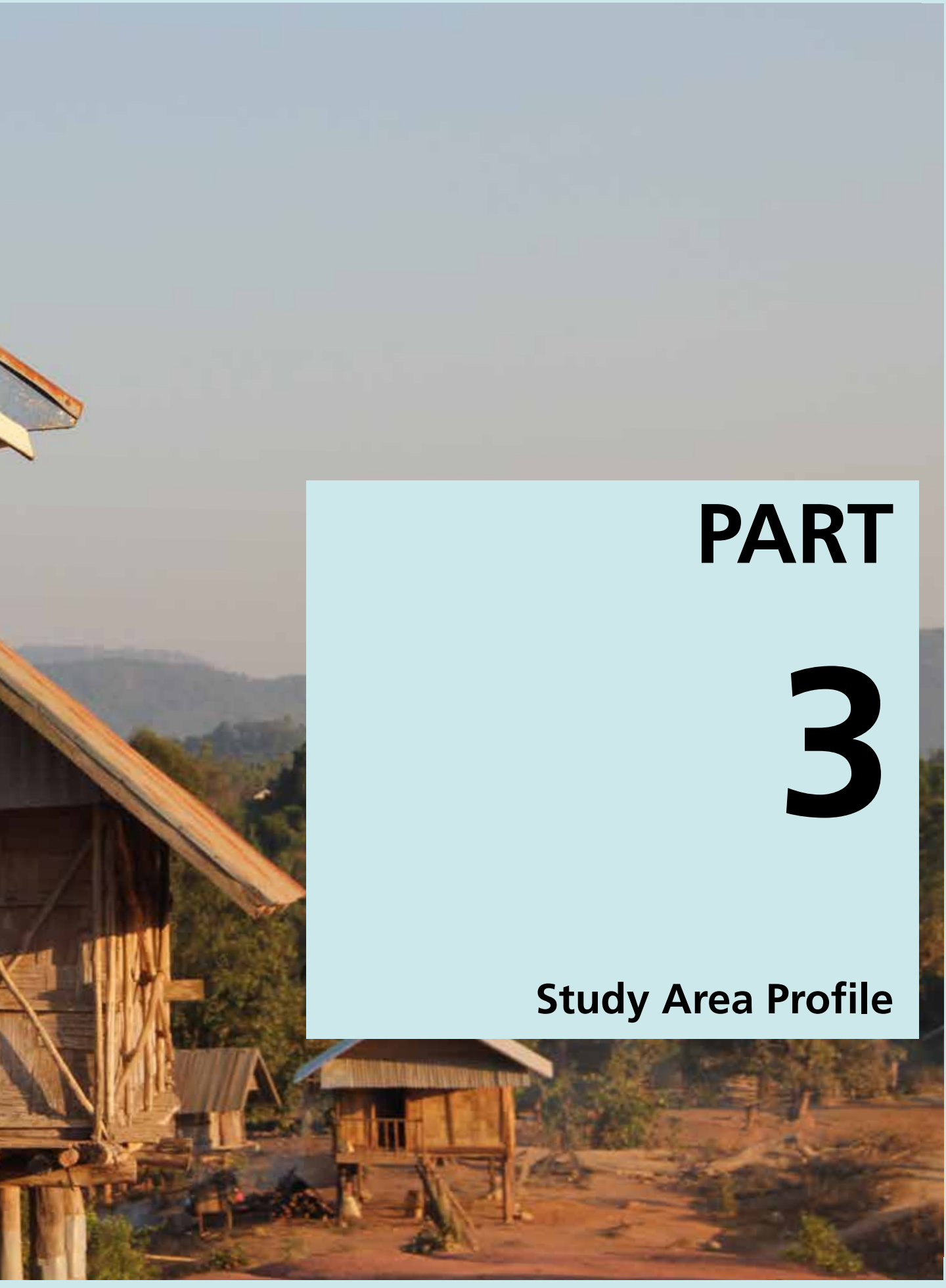


PART 3

Study Area Profile

3 Study Area Profile

3.1 Location and Physical Details

Sekong Province is at the south-eastern tip of Lao PDR, sharing a 235-kilometre-long border with Vietnam to the east[19]. Sekong Province is strategically located in the Development Triangle Area (DTA)[20], an area covering the border area between Southern Laos, Northern Cambodia and Central Highlands of Vietnam. Sekong's domestic borders are shared with the neighbouring provinces Saravan in the north, Champasak in the southwest and Attapeu in the south. Sekong Province covers an area of 7,665 square kilometres[21], is divided into four districts (Lamam, Kaleum, Dakcheung, Thateng), and has 201 villages[22]. The provincial capital Sekong, sometimes also called Lamam, is located in the western part of the province, close to the Bolaven Plateau, on the banks on the Xe Kong river.

Kaleum and Dakcheung Districts are targeted by the project and are located in the eastern part of the province. Both are mountainous and almost all villages surveyed in the assessment are upland. In eastern parts of both districts, there are mountain peaks of over 1800 metres above sea-level.

The Xe Kong river traverses Sekong from north to southwest, close to the Bolvean Plateau and passing through the provincial capital Sekong Town. Originating in Vietnam and crossing three provinces in Laos, the Xe Kong flows into the Mekong river in Cambodia, making it an important trans-boundary tributary and one of Laos' major water bodies. In fact, it has the largest catchment area of all 12 main river basins in Laos, covering 28,815 square kilometres[23]. Including the Sesan and Sre Pok river basins, bordering south of the Xe Kong basin, as shown in Figure 5, these basins are the largest and most important trans-boundary watershed of the Mekong River, contributing 20 per cent of the Mekong's annual discharge and 15 per cent of its sediment[24].

Figure 5 - Location of the Xe Kong and its neighbouring basins

19 Lao PDR Investment Promotion Department (2017): Attapeu. General Profile. Retrieved from: http://www.investlaos.gov.la/index.php/where-to-invest/provinces/audtapue (last accessed on 24/8/2017).

20 Lao PDR Department of Planning and Investment in Attapeu (2015): Infrastructure and Transportation. Retrieved from: http://www.dpia.gov.la/en/component/content/article/3/52.html (last accessed on 24/8/2017).

21 2015 Census, p.105.

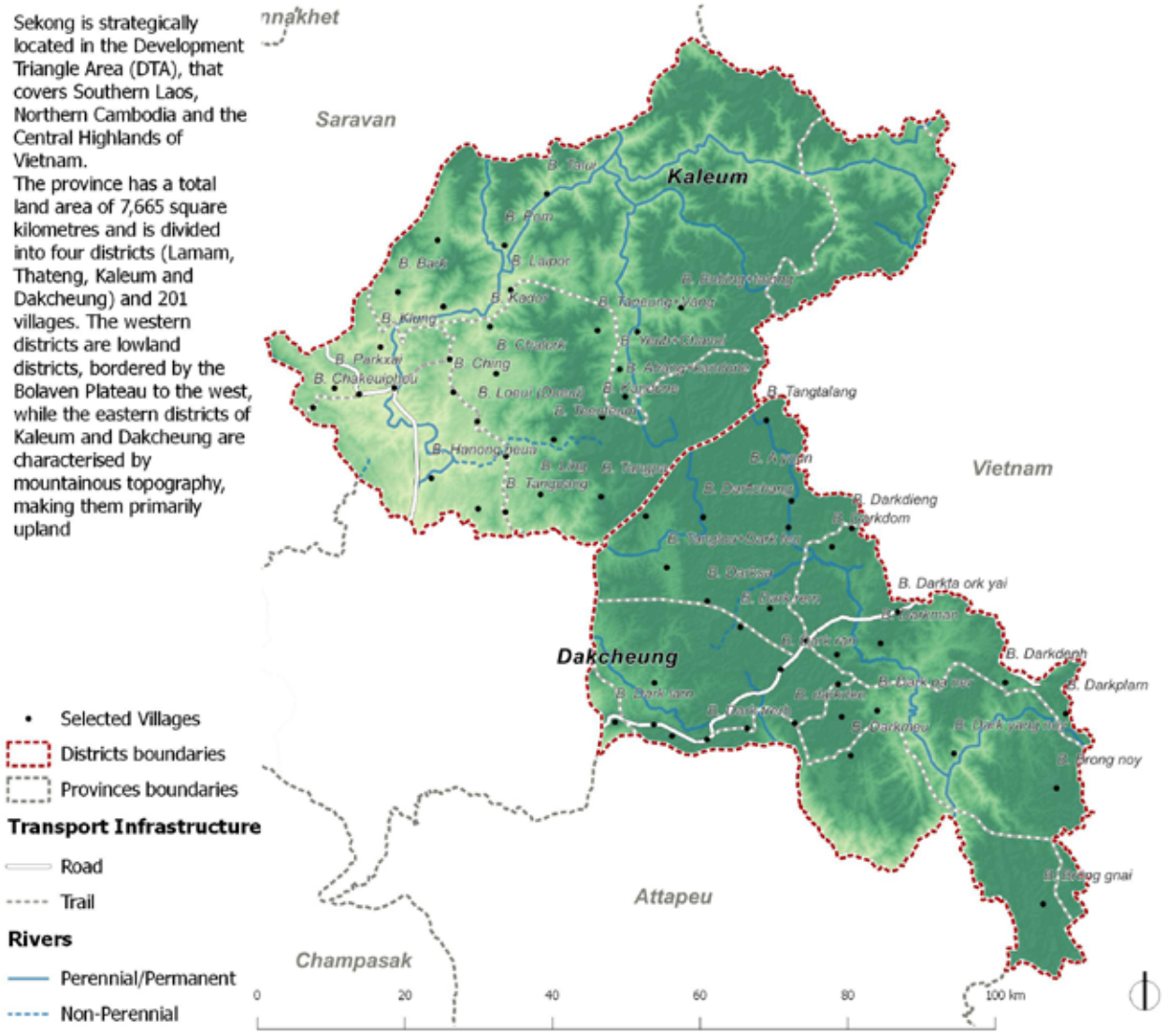
22 Lao PDR Ministry of Planning and Investment (2015): Lao Population and Housing Census 2015. Provisional Report, p.21.

23 Risk Assessment Report Vol I, p.25.

24 http://www.waterandnature.org /sites/default/files/sekong_basin_fact_sheet.pdf.

PHYSICAL DETAILS AND LOCATION OF SELECTED VILLAGES

Sekong is strategically located in the Development Triangle Area (DTA), that covers Southern Laos, Northern Cambodia and the Central Highlands of Vietnam.
The province has a total land area of 7,665 square kilometres and is divided into four districts (Lamam, Thateng, Kaleum and Dakcheung) and 201 villages. The western districts are lowland districts, bordered by the Bolaven Plateau to the west, while the eastern districts of Kaleum and Dakcheung are characterised by mountainous topography, making them primarily upland



Data Sources: Lao Decide (www.decide.la), Population and Housing Census (2015)
Disclaimer: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Concerning the legal status of any country,territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

3.2 Transportation Infrastructure

Sekong Province is accessible by National Road 11, connecting Pakse with Sekong Town and National Road 16, which connects Sekong with Attapeu and the Vietnamese border. The road between Pakse and Attapeu was recently upgraded with the support of the Asian Development Bank and is fully paved and in good condition. There is also a provincial road from Sekong Town that connects Dakcheung District and a border crossing with Vietnam, from where it ultimately connects to Da Nang.

Sekong Province has one of the lowest paved road densities in Laos, with only 0.13 to 0.16 kilometres of road per square kilometre[25]. Consequently, many areas, particularly in the uplands of Kaleum and Dakcheung Districts, can only be reached by unpaved roads or tracks which makes them very difficult to access. Some villages in Kaleum and Dakcheung districts are as much as 125 kilometres away from the nearest paved road, requiring a walk of 6-9 days to reach them[26].

Since there is no railway system in Laos, roads have an important role in Laos's transportation requirements. As much as 81 per cent of passenger traffic and 88 per cent of freight traffic are moved by road26. As outlined above, this traffic is restricted to only a small number of roads in Sekong, which underlines the importance of and reliance on Sekong's existing roads. There are 25 bridges in Sekong Province, which are vital for connecting remote villages. However, these bridges can be affected by storms, flooding and landslides[27].

Public land transportation in Sekong Province is limited to buses. There are several daily regional services from the bus station in Sekong, connecting the provincial capital with neighbouring provinces. Destinations include the provincial capitals Attapeu, Saravan and Pakse and some other towns such as Paksong. Air transportation only plays a minor role in Laos, making up 10 per cent of the total passenger traffic and only one per cent of total freight traffic[28]. Sekong Province has no airport, relying on the airport in Pakse Airport, which has flights to Vientiane, Luang Prabang, Savannakhet, Ho Chi Minh City, Bangkok, Siem Reap[29].

Access to electricity, water and other infrastructure is analyzed further in Section 4.

3.3 Socio-Economic Issues

Agriculture is the main source of livelihood for the households of Sekong province, with around 85 per cent of households engaged in agricultural practices[30]. With less than 0.32 hectares of agricultural land per person, farmers in Sekong possess less land than the national average[31], indicating that the province is dominated by small-scale agricultural practices. Rice is the province's main crop, with 91.1 per cent of households involved in rice production[32]. Highland rice paddies are mixed with cash crops in the south eastern part of the province. The predominant cash crop in Sekong is cassava, which is cultivated by around one fifth (19 per cent) of farm households, which is the country's second highest share[33].

Farm households in Sekong are also engaged in small-scale livestock activities, which this report will analyze further in Section 3. Livelihood diversification is very low in Sekong and is classified as non-diversified in the north-eastern part of the province[34].

In 2014, agriculture made up 39 per cent of the province's GDP, while the service and industrial sectors represented 40 and 21 per cent respectively[35]. However, agriculture and forestry constitute a decreasing share of the economy, giving way to industry and services, indicating that the economy of Sekong is becoming more industrialized[36].

In the southern provinces, the government of Laos seeks to industrialize by prioritizing and developing hydropower generation, agro-industry and mineral exploitation[37]. These developments are to be supported

25 Developing a National Risk Profile, p. 35.
26 Based on interviews with District officials, Kaleum District, September 2017.
27 Risk Assessment Vol I, p.68.
28 Developing a National Risk Profile, p. 34.
29 Lao Airlines (website). Summer timetable 2017. Retrieved from: http://www.laoairlines.com/image/modBannerAds/file_9348_Timetable%20S%2017%20(%20Revise%2001%20)pdf.pdf (last accessed on 28/9/2017).
30 Lao PDR Agricultural Census Office (2012): Lao census of agriculture 2010/11, p.2.
31 Ibid., p.2.
32 Ministry of Agriculture and Forestry, Government of Lao PDR, FAO (2013). Lao PDR, Risk and Vulnerability Survey 2012/2013, Analysis Report. p.88.
33 Ibid., p.88.
34 L-CLEAR, p.10.
35 Lao News Agency (website). Saravane collects revenue exceeding target set (2014). Retrieved from: http://kpl.gov.la/En/Detail.aspx?id=201 (last accessed on 28/9/2017).
36 Poverty-Environment Initiative of Lao PDR (2011): Assessment of Economic, Social and Environmental Costs and Benefits of Investment in Saravan Province Final Report, p.24.
37 IMF, p.183.

by domestic and foreign investment to attract more capital to the area, which in turn should also finance the development of economic and social infrastructure, such as roads and schools[38]. As a result of this economic development in Sekong, the provincial GDP per capita has increased from US$ 388 in 2004-2005 to US$ 710 in 2009-2010[39].

These figures are well below the national average GDP per capita of US$ 1,217 for the fiscal year of 2010-2011[40]. Consequently, Sekong is one of the poorest provinces in Laos. In fact, Sekong has the fourth highest poverty headcount rate in the country with 31.4 per cent, meaning almost one third of the province's population live below the poverty line[41]. Kaleum and Dakcheung have an even higher rate, with a poverty incidence of 46.4 per cent in Kaleum and 35.4 per cent in Dakcheung[42].

3.4 Demographic Trends

With a population of around 113,048 according to the 2015 census, Sekong is the least populated province in Laos, accounting for only 1.7 per cent of the country's total population[43]. With an area of around 7,665 square kilometres, Sekong is the third least densely populated province in Laos, with an average of 15 people per square kilometre[44]. However, the average household size is the country's highest with an average of 6.1 people[45]. Despite this, Sekong is the third most urbanized province in the country, with more than 35 per cent of its population living in urban areas[46]. At 4.13 per cent per year, Laos's urbanization rate is one of the highest in Asia, and twice the global average[47]. Despite its rapid urbanization, almost two thirds of the population live in rural areas, depending primarily on livestock herding and subsistence agriculture for their livelihoods.

Just over 40 per cent of Sekong's population is aged 15 or below – a comparatively high rate. At 2.9 per cent, Sekong has the highest population growth rate of any province in Laos[48]. Literacy rates vary greatly across the province, from 93 per cent among urban males to as low as 58 per cent among females in some rural areas[49] [50]. The relatively low literacy rates can mainly be explained by the low level of education, prevalent throughout the province, but especially in the target districts of Kaleum and Dakcheung. In Sekong Province, more than half of the population (53.2 per cent) has not completed any formal basic education, and 19.7 per cent have not had any education at all[51]. Literacy rates are analyzed further in Section 4.4.

Lao PDR is a very diverse country that is home to many ethnic groups; more than 50 according to the 2015 census[52]. The south-eastern provinces, including all three target provinces and respective districts targeted by the project are dominated by the Austroasiatic Group, which is the most diverse of all four ethnolinguistic groups in Laos, with more than 30 sub-groups. In Kaleum and Dakcheung Districts, there are 8 ethnic groups in the villages surveyed: Cha Tong, Katu, Ngkrieng, Nge, Oy, Tariang, Ye Jeh and Lao Lum.

3.5 Governance Structure

The governance structure of Laos is mainly concentrated at the central level through the President of the Republic and the Government. The local administrative structure in Lao PDR is organized into three levels: i) provincial governments, which serve as strategic development units; ii) district governments, as budgetary and planning units; and iii) village councils, which are considered as implementing units[53]. Lao PDR is divided into 17 provinces, 148 districts, and 8,507 villages[54] [55].

Since the early 1990s, Laos has engaged in public administration reforms. In 1996, the Government of Laos and UNDP developed the Governance and Public Administration Reform (GPAR) project, which "provided strategic funding for fiscal devolution and decentralised

38 Ibid., p.22.
39 Lao PDR Ministry of Planning & Investment (2015): Five-year national socio-economic development plan VIII (2016-2020).
40 Ibid, p.4.
41 World Bank, CDE & LSB (2016): Where are the poor? Lao PDR 2015 census-based poverty map: Province and District Level Results, p. 98..
42 ibid.
43 Provisional Census, p.16. Provided that Xaysomboon is not officially considered as an independent province.
44 Lao PDR Ministry of Planning and Investment (2015): Lao Population and Housing Census 2015, p.105.
45 Provisional Census, p.17.
46 ibid., p.103.
47 CIA (https://www.cia.gov/library/publications/the-world-factbook/fields/2212.html).
48 Census, p.25.
49 Lao PDR Ministry of Planning and Investment (2015): Lao Population and Housing Census 2015, p.105, 154.
50 Census 2015, p.154.
51 Ibid., p.178.
52 Ibid., p.122.
53 ADB (2012): Lao PDR Urban Development Sector Assessment, Strategy, and Road Map, p.4.
54 Results of Population and Housing Census, Lao Statistics Bureau, 2015.
55 Correct at the time of writing, however there are frequent changes to the demarcations of villages, meaning that this number is constantly changing.

planning and expenditure management at district level"[56]. This project was one of the first steps for a process of de-concentration engaged in the 2000s in the country. This decentralization process was initiated with the Prime Minister's Instruction 01/PM of 11th of March 2000, which formally regulated the decentralization of government functions[57]. It was followed by the Law on Local Administration, which passed in 2003 and states the principles concerning the organization and functions of the three local levels.

The "Sam Sang" (three-build) policy, established in 2012, went further to strengthen local capacity. The overall goal is to devolve responsibilities to lower levels: the provinces, defined as "strategic units" allocate resource priorities, the districts, defined as "comprehensively strong units" ensure the coordination between sector agencies to safeguard effective and efficient delivery in villages, and the villages, defined as "development units", deliver development outputs[58].

3.6 Target Villages

Population Distribution and Densities

The vulnerability assessment in Sekong Province was conducted in 62 villages, which are distributed across two of the province's four districts, 29 villages in Kaleum District and 33 villages in Dakcheung District. A full list of villages is provided in Annex 1. These villages have a total population of 22,925; just over 20 per cent of the province's total population, and about 21.3 per cent of the total number of people covered by the project.

Almost all the villages in Kaleum and Dakcheung Districts are upland, with only a few in Dakcheung considered plateau villages. Since the vulnerability assessment outlined in this report focuses on rural and emerging urban settlements, the target villages have been selected in rural and semi-urban areas. As shown in the table below, the selected villages have a very low population density of just under 7.5 inhabitants per square kilometre on average in the target districts.

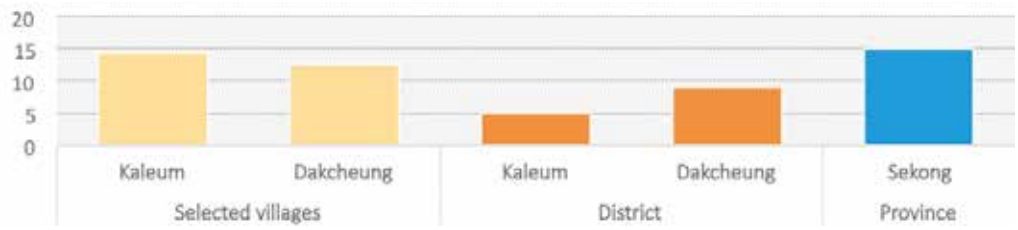


Figure 6 - Overview of population densities (hab/km2) in target villages[59]

56 Trends in the Governance Sector of the Lao PDR, Swiss Agency for Development and Cooperation, 2012.
57 ADB (2012): Lao PDR Urban Development Sector Assessment, Strategy, and Road Map, p.4
58 Sam Sang in practice: early lessons from pilot implementation, Australian Aid, 2015.
59 Housing and population Census 2015

POPULATION SIZES IN SELECTED VILLAGES

With a population of around 113,048 according to the 2015 census, Sekong is the least populated province in Lao PDR, accounting for only 1.7 per cent of the country's total population and has the lowest population density, with an average of 15 people per sauqer kilometer. The 62 selected villages have a total population of 22,925 people, of which 10,397 are in Kaleum and 12,528 are in Kaleum. This represents 20.5 per cent of the province's total population

Num. Inhabitants (2015)

- < 250
- 250 - 500
- 500 - 750
- 750 - 1000
- > 1000

Transport Infrastructure

- Road
- Trail

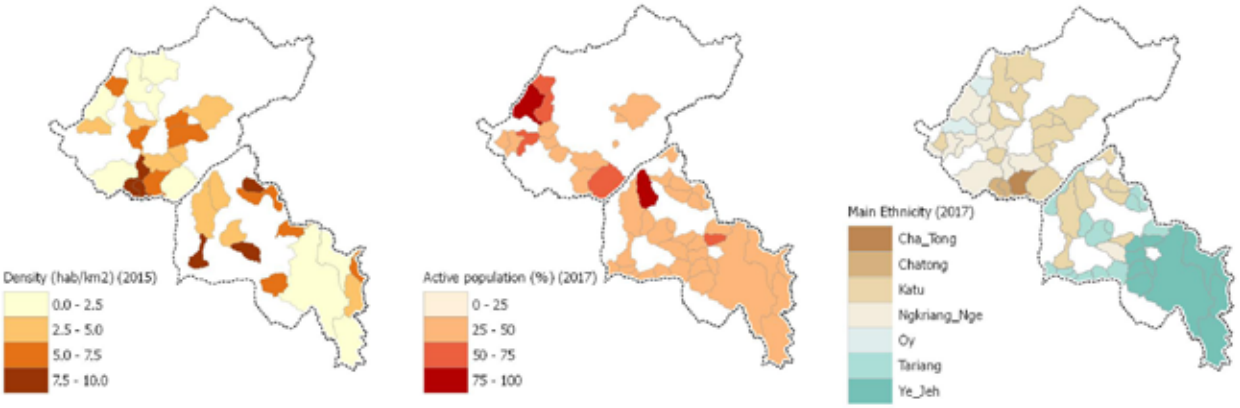
Rivers

- Perennial/Permanent
- Non-Perennial

Selected Villages

- Districts boundaries
- Provinces boundaries

POPULATION DENSITY, ACTIVE POPULATION AND ETHNICITY IN SELECTED VILLAGES



Data Sources: Lao Decide (www.decide.la), Population and Housing Census 2015, Lao Census of Agriculture 2010/2012, UN Habitat

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PART 4

Vulnerability Analysis

4 Vulnerability Analysis

4.1 Defining Vulnerability in the Context of Lao PDR, and Sekong Province

As outlined in Section 2, the project aims to strengthen the resilience of the most vulnerable settlements in the target villages in southern Laos. This report, therefore, aims to identify the most vulnerable settlements. The conceptual framework for this assessment, shown in Figure 7[60], is based on the IPCC 4th Assessment Report framework, which the report has chosen for simplicity and to align with the framework used in other vulnerability assessment work conducted previously in Laos.

Vulnerability is defined as the degree to which a system is susceptible to and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of exposure, sensitivity and adaptive capacity[61]. Exposure is defined as the presence of people and systems, such as infrastructure and livelihoods, in places and settings that could be adversely affected[62]. Sensitivity is defined as the degree to which people or systems are affected, either directly or indirectly, by climate variability or change. Adaptive capacity describes the ability of people and systems to adjust to potential impacts and consequences triggered by climate change and thereby taking advantage of opportunities that are linked to the changes[63].

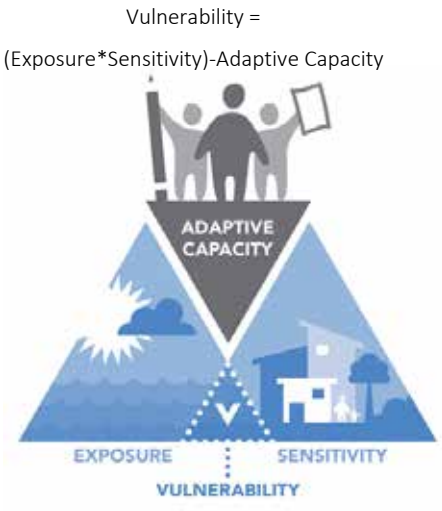


Figure 7 - Vulnerability Framework

In simple terms, vulnerability is heightened by increases in exposure and/or sensitivity, and by a reduction in adaptive capacity. Consequently, reducing people's vulnerability means some combination of reducing their exposure and/or sensitivity, or increasing their adaptive capacity. This is shown in Figure 7, where the size of the exposure, sensitivity and adaptive capacity shapes determines the size of the vulnerability triangle.

Another important consideration is the progression of vulnerability, a concept that tries to understand how the vulnerability is generated and thus how it can be addressed. Vulnerability is often increased by unsafe conditions, such as unprotected buildings and infrastructure or a lack of local institutions or disaster preparedness. Although these conditions make people vulnerable, they are not the underlying reason for their vulnerability. Planners must consider the root causes of vulnerability, when responding to climate change since these typically progress to dynamic pressures that finally result in unsafe conditions, as illustrated in Figure 8[64].

As the project seeks to provide long-term solutions to address vulnerability, this report focuses on the root causes of vulnerability, as well as unsafe conditions. Therefore, the report analyses environmental, infrastructure, basic services, and socio-economic conditions drive risks and heightened exposure and sensitivity in the target villages. These factors are analyzed in section 4.4.

60 UN-Habitat (2014), Planning for Climate Change: A Strategic, Values-based Approach, p.46.
61 IPCC AR4, p.89.
62 IPCC AR5, p.1758.
63 Ibid., p.1765.
64 Wisner et al. (2003): At Risk: Natural hazards, people's vulnerability and disasters.

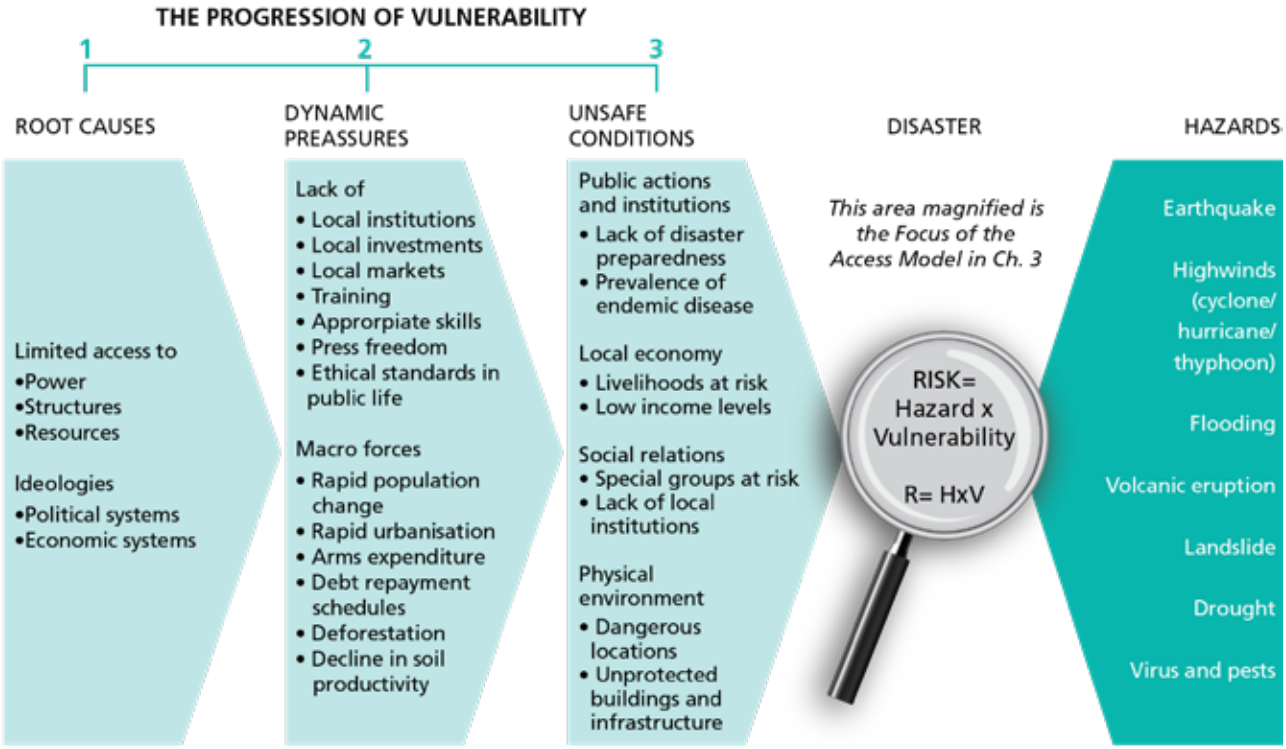


Figure 8 - The Progression of Vulnerability

4.2 Historical Trends in Climate, Hazards and Exposure

a. Climate

Lao PDR has a tropical, diurnal climate in which the weather is heavily influenced by the monsoons, with a rainy season between May and October and a dry season between November and April[65].

Rainfall

The mean average rainfall between 1995 and 2016 was 1534.5 millimetres in Sekong Town, with monthly rainfall of over 400 millimetres possible during the rainy season. About 89.5 per cent of the province's yearly rainfall takes place between May and October[66]. July and August typically have the highest number of both rainfall and rainy days, averaging 327 and 283 millimetres per month, which are distributed across 21 and 22 rainy days in those months, respectively, observed over the last 22 years. On average, Sekong has 122 rainy days per year, 84 per cent of which occur in the rainy season. This is shown in Figure 9.

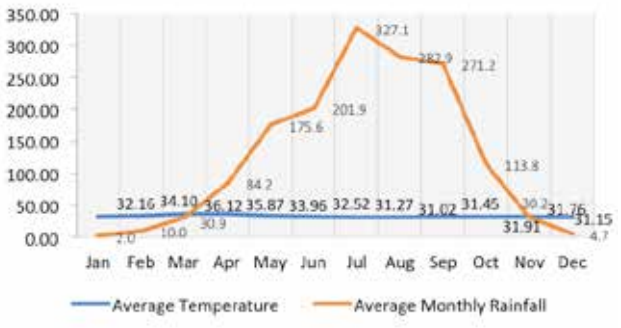


Figure 9 - Average monthly temperature and rainfall in Sekong Town (1995-2016) [67]

65 Developing a National Risk Profile for Lao PDR, p.25.
66 https://en.climate-data.org/location/1362/#climate-graph.
67 Author's work, based on data from the Department of Meteorology, Ministry of Natural Resources and Environment, Vientiane.

According to data gathered from the provincial weather station in Sekong Town, there has been a significant decrease in rainfall in Sekong in the recorded period, from 1995-2016. The average annual rainfall is now 130 millimetres less than in 1995. Besides, the three lowest annual rainfall amounts have been recorded within the last 7 years. The relative decrease in rainfall was observed more clearly during the dry season, while the relative decrease in the rainy season is lower. This is shown in Figure 10.

There was also a high variation in the amount of rainfall received. According to the dataset, as shown in Figure 8, the lowest amount of rainfall received in a calendar year was 1,075 millimetres, while the highest was 2,272, giving a high standard deviation from the mean of 279 millimetres, meaning that planners and people in Sekong can only have 68 per cent confidence of receiving between 1,255 and 1,814 millimetres of rainfall in any given year. The two extreme values were recorded in two consecutive years, in 2009 and 2010. Moreover, the second highest rainfall was observed in 2007, so that the two highest rainfall amounts and the three lowest amounts were recorded within the last 10 years, indicating that not only the mean rainfall is decreasing, but also that extremes are shifting in both directions.

Figure 10 - Annual Average Rainfall, 1995-2016[68]

The change in the number of rainy days was also marked. In the last 22 years, the average number of rainy days declined significantly.

While there were 146 rainy days per year on average between 1995 and 1999, the number of rainy days from 2012 to 2016 declined to only 112, meaning that Sekong town now expects 34 fewer rainy days per year than it did in 1995, as shown in Figure 11. Since the decrease of rainy days is greater than the decrease of the rainfall, the rainfall is concentrated in fewer events, which in turn means that the intensity of rain events is increasing. In other words, it now typically rains on fewer days, but with more heavy rainfall events. While from 1995 to 1999, the average rainfall per rainy day was around 10 millimetres, it increased to 12 millimetres per rainy day in the period of 2012 to 2016, which is an increase of 20 per cent.

Figure 11 - Number of Rainy Days Per Year 1995-2016

Total rainfall in May declined about 4.5 per cent across the dataset. This is consistent with broader evidence for the Southeast Asia region that shows a later start of the rainy season. This regional trend also shows that the rainy season is withdrawing earlier. However, the data for rainfall in Sekong Province in October and November shows that the rainfall is increasing at a yearly rate of 0.7 per cent per month. This suggests that the rainy season is shifting rather than shortening; starting and ending later. The data also shows a yearly increase of around 2.4 per cent for the average amount of rain received in June. This implies heavier rain events in this month of the rainy season.

The El Niño Southern Oscillation appears to affect the amount of rainfall received in Sekong Province. In the period of the dataset, years when El Niño was in effect received on average more than 250 millimetres less rain than years when La Niña was in effect, and around 120 millimetres less than in neutral years, shown in Figure 12.

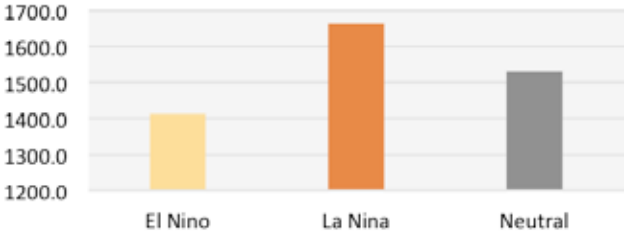


Figure 12 - Average Rainfall in El Niño, La Niña, and Neutral Years

The above analysis is all based on the weather station in Sekong Town. However, Sekong Town is around 60 kilometres from the centre of Dakcheung District and 52 kilometres from Kaleum (both straight line distance) and separated from both districts by a mountain range. We can't reliably infer that the weather patterns and climate change are the same. In 2009, a weather station was installed in Dakcheung District.

68 Author's work, based on dataset provided by the Department of Meteorology, Ministry of Natural Resources and the Environment.

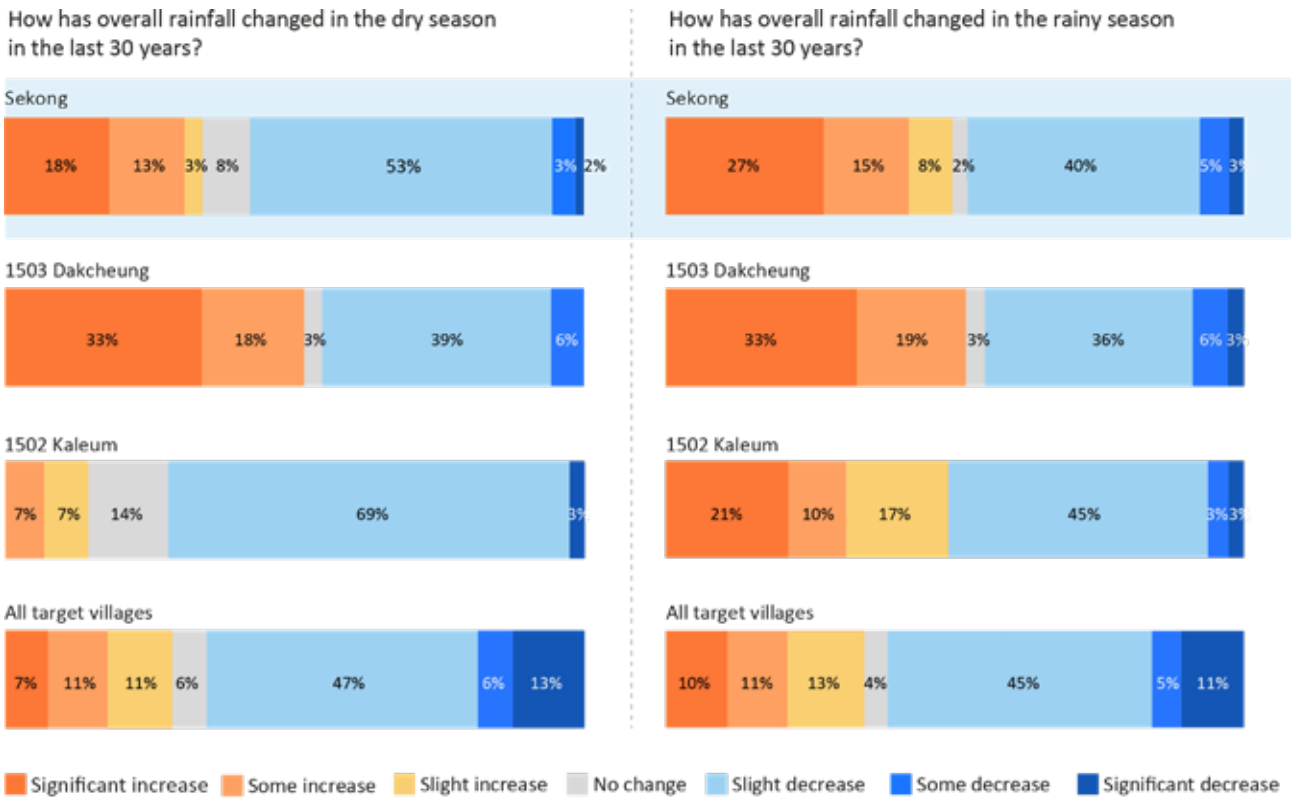


Figure 13 - Perceived changes in rainfall in selected villages

This station provides some remarkable data. In the period 2009-2015, the average annual rainfall declined by up to 900 millimetres. Similarly, there are now almost 100 fewer rainy days per year than seven years ago. If these trends continue, this would be a remarkable level of change over a short period of time. However, 7 years is not long enough to infer changes in the climate, and as such the assessment doesn't consider them further.

Evidence from communities

The assessment cross-checked data gathered from the Provincial Department of Natural Resources and Environment with the perceptions of village survey respondents. This was important because it helps to 'ground truth' the data and complement the official data from the target districts, which has only been gathered since 2009 in Dakcheung District and is not available at all in Kaleum District.

According to the respondents, rainfall change during recent decades significantly differs between the two target districts. Just over half of the villages in Dakcheung reported an increase in rainfall, with 33 per cent reporting a significant increase in both, dry and wet season, while Kaleum experienced a decrease. 69 per cent of villages indicated that there has been a slight decrease in rainfall in dry season and 45 per cent reported a slight decrease in the rainy season. Despite this, 48 per cent of Kaleum's target villages also reported an increase of rainfall during the rainy season.

Villages consistently reported that the rainy season has been starting earlier. Around 35 per cent of the target villages in Sekong Province reported that the monsoon rainfalls are always occurring earlier, while another 27 per cent indicated that they occasionally start earlier. On the contrary, only one village in Dakcheung reported that the season always starts later.

Temperature

In the early part of the dry season, from November to February, the dry northeast monsoon brings relatively dry air and lower temperatures, which then increase rapidly throughout March and April, which is the hottest month[69]. The annual average temperature in Sekong is 26°C, reaching up to an average of 32°C in the hot dry season with a maximum of 33.4°C in April[70]. The coldest temperatures are recorded in January, with an average minimum temperature of 16.8°C.

69 Lao PDR Disaster Management Reference Handbook, p.20.
70 https://en.climate-data.org/location/1362/#climate-graph.

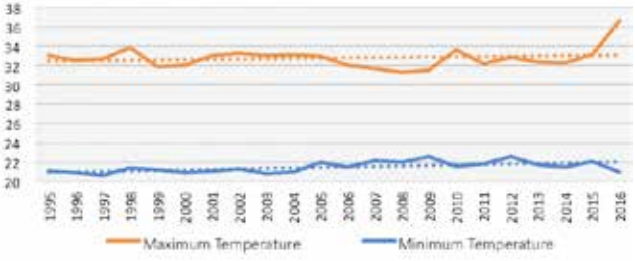


Figure 14 - Annual Average Minimum and Maximum Temperatures

According to the Provincial Department of Natural Resources and Environment dataset, shown in Figure 15, temperature increase has been significant. Analysis of the minimum and maximum recorded temperatures shows a substantial increase. Between 1995 and 1999, the average maximum temperature[71], was 32.8°C, while from 2012 to 2016 it was 33.5°C. Before 2016, Sekong had never experienced a temperature over 34°C, until a temperature of 36.7°C was recorded. The increase of maximum temperatures was primarily observed during the rainy season, with less change observed during the dry season.

The analysis showed an increase in average minimum temperatures. While the average minimum temperature from 1995 to 1999 was 21°C, the average between 2012 and 2016 was 21.8°C. Unlike maximum temperatures, the minimum temperature is increasing more rapidly in the dry season. Despite this trend, the coldest temperature recorded during the last 22 years was observed in January 2016; the same year in which the hottest temperature on record was recorded. This suggests that not only the mean of the temperature is increasing, but also that extremes of heat and cold are increasing.

The data from the Dakcheung station shows a temperature increase in the target villages much greater than in the provincial capital Sekong. The maximum average temperature in Dakcheung is increasing significantly with an average increase of 1.3°C, considering the whole observed period. This increase can particularly be observed during the dry season. However, the dataset from Dakcheung is over too short a period to definitively prove a change in the climate.

Evidence from communities

According to the respondents, there was a significant temperature increase in the target villages, as shown in Figure 16. This increase was especially evident in the dry season, particularly between February and April, where 84 per cent of the villages reported some level of increase. During the rainy season, two thirds of villages reported an increase, with 18 per cent of villages experiencing a slight increase and respectively 24 per cent a significant and some decrease.

Based on the survey results, Dakcheung appears to be more affected, since the magnitude of the temperature increase was reported to be much higher. Almost all villages in Kaleum however also noted some level of temperature increase.

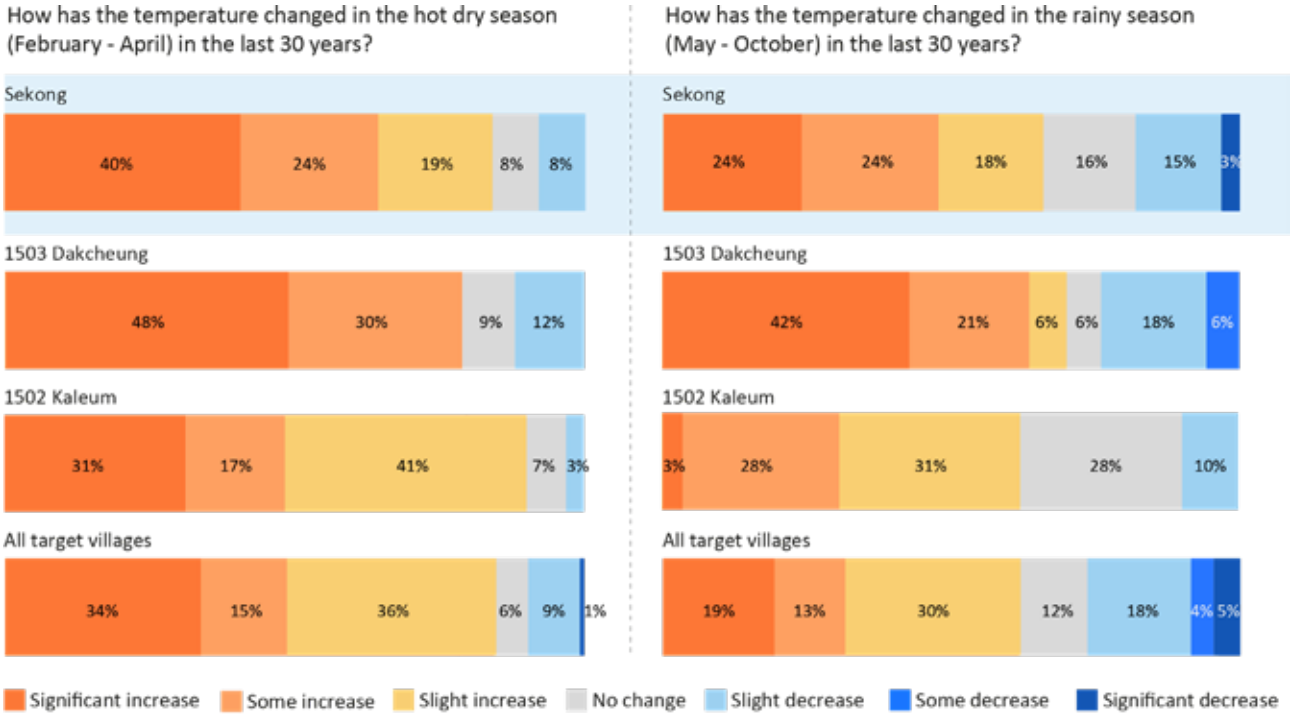


Figure 15 - Temperature Change in the Last 30 years

71 The annual average of the maximum temperature recorded in each month.

b. Overview of Hazards and Exposure

Lao PDR is exposed to multiple natural hazards, with floods and storms causing the most serious humanitarian impacts[72], followed by droughts and landslides, which also pose serious risks[73], and diseases which happen frequently throughout the country. These hazards are often interlinked since storms and typhoons often come with heavy rainfall which can trigger landslides and cause flooding which, in turn, can lead disease outbreaks. This multi-hazard environment poses a significant risk to people, livelihoods, and infrastructure in Lao PDR.

Floods

Laos was ranked has having a flood risk of 9.2 out of 10, the sixth most flood prone country in the World according to the INFORM Country Risk Profile[74]. An estimated 58 per cent of the population has been affected by flooding at some point in their life[75]. This mainly linked to the high and intense precipitation triggered by the southwest monsoon in the rainy season, particularly throughout August and September[76]. This time also coincides with the typhoon season, which peaks in August and September,[77] and significantly increases the risk of flooding since tropical cyclones also bring significant rainfall. This was last evident in 2013 when five consecutive major storms brought flooding to 12 out of Lao PDR's 17 provinces, including Sekong, and affected approximately 347,000 people nationwide while causing losses and damages worth an estimated US$219 million[78].

High flood risk is particularly evident in the southern provinces, including Sekong[79]. Sekong is traversed by the Xe Kong river, which means that the province shares a large part of the inundation area with this major river system. This can particularly be observed in the eastern area of Lamam District, where the inundation area accounts for 40 square kilometres, which is primarily exposed to flooding with a water level of 2 metres or higher[80]. Kaleum is also exposed to river flooding as it is traversed by the Xe Kong, however to a smaller degree as an upstream region with a mountainous topography, as illustrated in Figure 16.

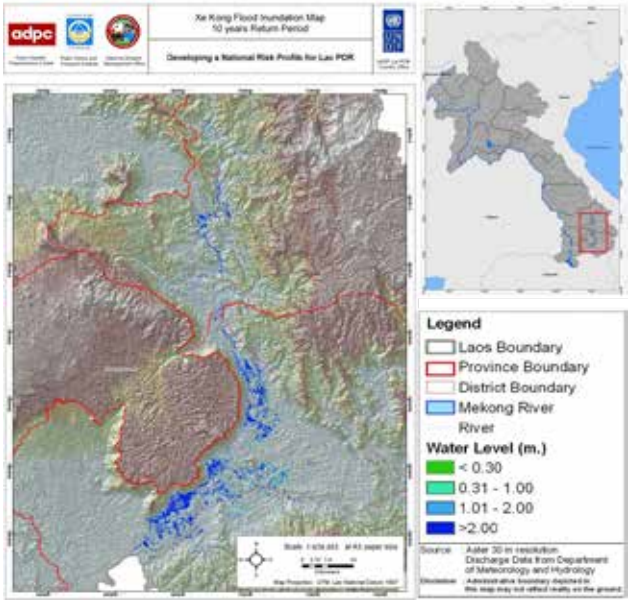


Figure 16 - Xe Kong flood inundation map for 10 years return period

Evidence from communities

Flood effects were also noted in the vulnerability assessment survey results from Kaleum District. Five of the 29 villages reported a flood impact at least once every five years, with these floods likely impacting several hundred people. A further 12 villages reported experiencing flooding at least once every 10 years, and among these, five reported that the experience larger floods that affect at least 50 households. Twelve villages reported that they do not experience floods.

Dakcheung District appears to be more severely exposed to floods; with 17 of the 33 villages there reporting at least one flood per year, which collectively impact up to 550 households – over 3,000 people. A further four villages in Dakcheung reported experiencing a severe flood at least once every five years, while 12 reported that they are not impacted by floods. This shows that flooding is a location-specific hazard in Sekong.

Storms

Tropical cyclones often cause floods. However, storms also cause serious risks due to high winds, resulting in

72 OCHA (http://reliefweb.int/sites/reliefweb.int/files/resources/CP_LaoPDR_230617.pdf).
73 Lao PDR Disaster Management Reference Handbook, p.24.
74 Ibid.
75 Developing a National Risk Profile, p.31.
76 Lao PDR Disaster Management Reference Handbook, p.24.
77 Ibid.
78 http://www.inform-index.org
79 Lao PDR Disaster Management Reference Handbook, p.24.
80 Risk Assessment Report Vol I, p.38.

significant damage to buildings and infrastructure. Storms and cyclones cause the greatest economic losses of all hazards that effect Laos, with an estimated damage of US$306 million[81] in 2014. Storms cause the greatest damage between June and December, peaking in August and September[82]. The last severe storm to impact Sekong Province was Typhoon Doksuri, in September 2017. The last severe tropical cyclones were Typhoon Wutip in October 2013, and Typhoon Ketsana, which hit Laos in September 2009[83]. The southern provinces, including Sekong, were most affected by the devastating effects of Ketsana, with almost 32,000 hectares of crops and 144 irrigation systems having been damaged, affecting more than 3,178 households[84]. Ketsana damaged 37 per cent of Sekong's road network, cutting off whole communities, in some cases for several months[85].

Evidence from communities

All villages 33 in Dakcheung reported that they are affected by storms at least once per year. Among these, 31 reported loss of income, 28 reported damage to infrastructure, 19 reported damage to homes and three reported that there had been loss of life. This means that up to 11,651 people lost income, 10,523 experienced damage infrastructure and 7,141 experienced damage to their homes.

In Kaleum District, 14 of the 29 villages are affected by at least one storm per year, with a further four affected at least once every five years. Six villages are only affected once every ten years and five villages reported that they have not been affected by storms. Considering the 24 villages that are affected by storms in Kaleum, 22 reported the damage to infrastructure, all 24 reported loss of income, 20 reported damage to homes, and five reported loss of life. This means that up to 9,055 people have been affected in Kaleum district among the surveyed villages.

Landslides

Most of Laos is in low to medium landslide susceptibility zones. Only 5.24 per cent of the country is prone to very high landslide susceptibility. However, some areas with high susceptibility are in the south-eastern and central part of Lao PDR. Rainfall is the main triggering factor for landslide occurrences, which is why their occurrence peaks during the rainy season. Apart from this hydro-meteorological factor, other principal causes of landslides include geological aspects such as slope gradient and rock condition, known as lithology, and land use, which also makes landslides a human induced hazard.

Evidence from communities

Many parts of Sekong Province are exposed to landslides. Almost one quarter (23.9 per cent) of its total area is exposed to a high landslide risk and another 57 per cent to medium landslide risk. With these figures being Lao's highest and third highest, Sekong is the country's most exposed province[86].

This was also reflected in the survey results; in Kaleum 12 of the villages reported that they have been affected by landslides, while in Dakcheung 14 of the 33 villages report being affected by landslides. In almost all villages across both districts, people report that infrastructure – primarily roads and bridges – is most greatly affected.

Droughts

Droughts affect 15 per cent of the population, which is the country's third largest share of all-natural hazards[87]. Droughts can occur in both the dry and rainy seasons. However, the late season drought, which occurs from mid-July through the southwest monsoon in September, is thought to have had the highest impact, reducing grain production, for example, by up to 30 per cent[8889]. Economic losses, resulting from droughts can therefore be quite high, which is underlined by the last severe drought, which happened in Laos' central and southern provinces in 2003 and caused estimated damage of US$ 16.5 million[90].

Evidence from communities

The country's southern provinces and particularly its upland areas of higher elevations are among the most prone to droughts[91]. Since Sekong has numerous upland areas, it is among the most exposed provinces.

81 Developing a National Risk Profile of Lao PDR, p.31.
82 Lao PDR Disaster Management Reference Handbook, p.24.
83 https://reliefweb.int/country/lao.
84 DDMCC & UNDP (2016): L-CRVA. Final Summary Report, p.6.
85 Ibid., p.6.
86 Risk Assessment Report Vol I, p.46.
87 Developing a National Risk Profile of Lao PDR, p.31.
88 Ibid., p.25.
89 Developing a National Risk Profile for Lao PDR, p.85-88.
90 Ibid., p.28.
91 Lao PDR Disaster Management Reference Handbook, p.25.

In Kaleum district, 12 villages reported experiencing at least one drought every year, with a further eight reporting droughts at least once every 10 years. Three of the twelve reported that droughts were becoming more frequent. Ten of the 20 drought-prone villages reported that they lose crops and food shortages occur as a result. Eleven of the villages reported that they face water shortages.

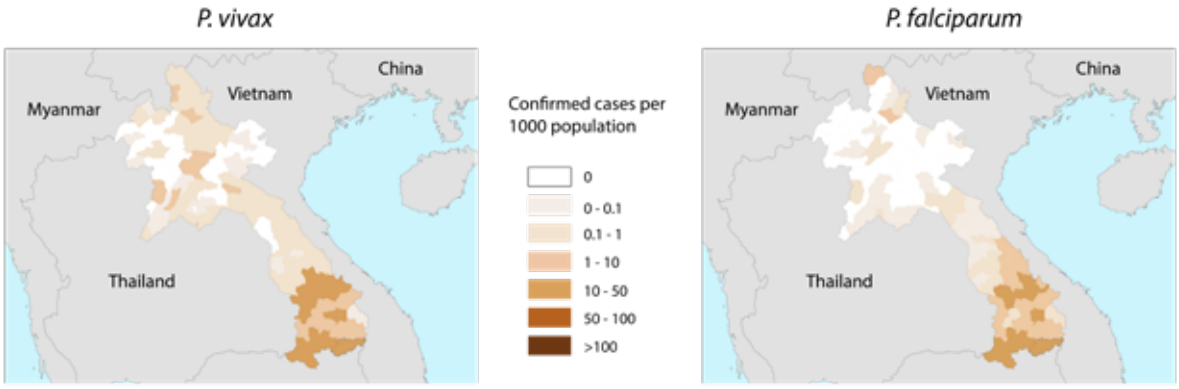
In Dakcheung, eight villages reported experiencing a drought at least once per year, and a further 15 reported experiencing at least one drought in the last 10 years. Ten villages reported that they have not experienced a drought in the last 10 years. Of the 23 villages that reported drought, only four reported that droughts are becoming more frequent, while 9 reported that they are becoming less frequent. As in Kaleum, a loss of crops leading to food shortages is a common occurrence resulting from drought in Dakcheung, with 14 of the 23 affected villages reporting crop loss. Nine of the 23 reported water shortages as a serious problem occurring from drought.

Diseases and epidemics

Diseases and epidemics are a widespread and very serious threat to people in Laos. 86 per cent of all disaster-related fatalities in the country are reported to be caused due to epidemics[92]. Most of these fatalities and of illness-cases in Laos more generally were caused by communicable diseases[93]. There are 24 epidemic diseases present in Laos, with the highest number of cases of Acute Watery Diarrhoea, with about 27,000 cases per year.

There were about 24,000 and 10,000 annual cases of Dengue Fever and Typhoid, respectively[94]. Cholera and Malaria are also recognized as a serious health issue, with only 7 per cent of Laos' population living in Malaria-free areas[95]. The last serious epidemic outbreak was a significant spread of Dengue Fever in 2013, which peaked in August with over 4,000 reported cases[96].

In Sekong Province, Malaria is among the most serious health issues, as shown in Figure 17. Although there was a nationwide decrease of reported Malaria cases in 15 out of Lao PDR's 17 provinces, Sekong (along with Attapeu) Province registered a spread of this disease and thus an increase of reported cases[97]. Consequently, Sekong faces one of Laos' highest Malaria threats, with up to 50 cases per 1000 people for both of the most common Malaria forms (Plasmodium vivid & Plasmodium falciparum)[98]. The worst affected districts in Sekong are Lamam and Thateng, with between 2-10 per cent of the population suffering one of the two forms of Malaria. These figures only count reported cases; however, and the World Health Organization estimates that the actual number of cases is likely to be double that officially been reported[99].



1. Epidemiological profile

Population (UN)	2015	%
High transmission (> 1 case per 1000 population)	2,120,000	31
Low transmission (0 - 1 cases per 1000 population)	4,170,000	61
Malaria-free (0 cases)	503,000	7
Total	6,800,000	

Parasite and vectors			
Plasmodium species:	*P. falciparum (42%), P. vivax (58%)*		
Major anopheles species:	*An. dirus, An minimus, An maculatus, An. jeyporiensis*		
Reported confirmed cases (health facility)	36,056	Estimated cases:	88,000 [68,000 ; 110,000]
Confirmed cases at community level:	9,107		
Reported deads:	2	Estimated deads:	<50

Figure 17 - Geographical distribution and statistics of (reported) Malaria cases in Lao PDR

92 Ibid., p.31.
93 Lao PDR Disaster Management Reference Handbook, p.26.
94 Developing a National Risk Profile of Lao PDR, p.65.
95 WHO (http://www.who.int/malaria/publications/country-profiles/profile_lao_en.pdf).
96 WHO (http://reliefweb.int/sites/reliefweb.int/files/resources/Dengue%2026Feb2014.pdf).
97 Developing a National Risk Profile of Lao PDR, p.71
98 WHO (http://www.who.int/malaria/publications/country-profiles/profile_lao_en.pdf)
99 ibid.

Evidence from communities

This threat is also reported in Kaleum and Dakcheung Districts, where 77 per cent of surveyed villages indicated that they have had cases of Malaria in their village, as illustrated in Figure 18. However, the most frequently experienced disease is Dengue Fever, which has occurred in 94 per cent of villages, and which is an increasingly severe problem[100]. 87 per cent of the target villages are also exposed to Encephalitis. Water-borne diseases also seriously affect people in the target villages, with diarrhoea being the frequently occurring disease, having occurred in 87 per cent of the villages.

In recent years Sekong had Laos's worst rate of acute bloody as well as acute watery diarrhoea, with an increase of up to 51 and 206 per cent in cases respectively. Skin and eye diseases have been reported by 85 and 83 per cent of all villages, while the least occurring diseases are allergies (still reported in 62 per cent of villages). This means that Sekong is highly exposed to disease, which could become worse because of climate change, considering the positive relationship between changes in the climate and water and vector-borne diseases.

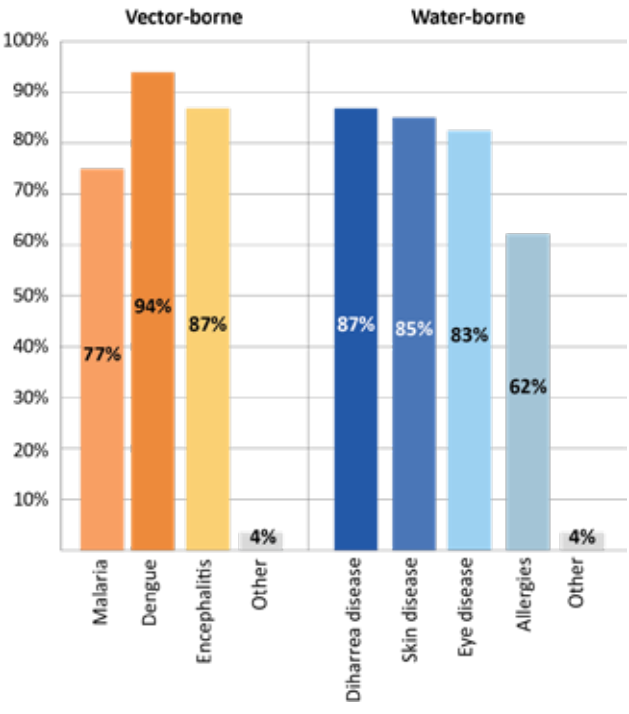


Figure 18 - Percentage of Villages that have experienced disease among the surveyed villages in Kaleum and Dakcheung

Man-made hazards: UXOs

Sekong Province also faces a large amount and wide distribution of unexploded ordinances, which are remains from the second Indochina War (1964-73)[101]. These ordinances pose a huge threat to the lives and health of many people since they can still explode because of contact, movement or heat. The avoidance of potentially exposed areas can limit the expansion of agricultural production, which, under certain circumstances, can even lead to food shortages[102]. Due to these and other serious impacts of unexploded ordinance, Lao PDR designated an 18th, country-specific Sustainable Development Goal to address this issue, aiming to ensure a safe environment through clearing the land from UXO and educating the population about risks[103]. Sekong Province has one of Lao's highest UXO densities, with as much as 0.7 to 1.2 ordinances per square kilometre in Kaleum District and is thus one of the most affected provinces, as also shown in Figure 19[104].

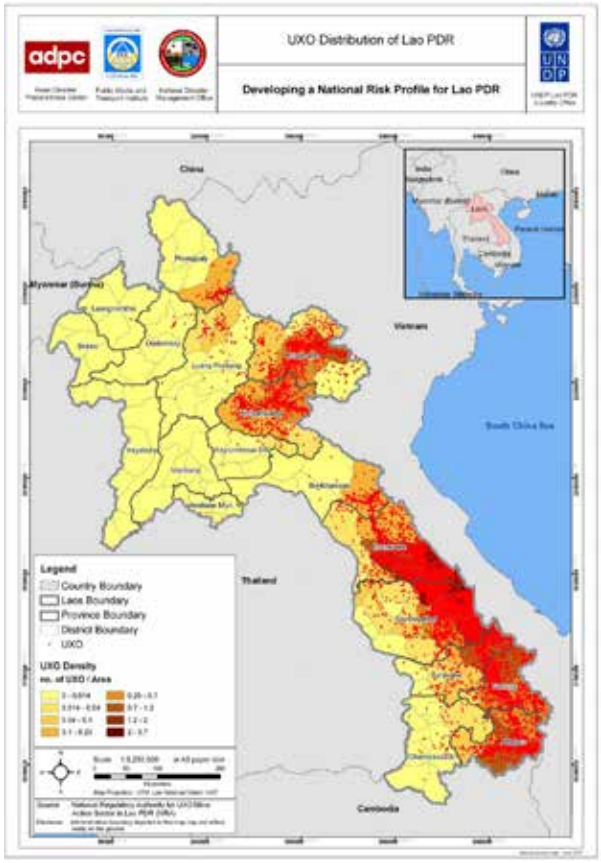


Figure 19 - Prevalence of Unexploded Ordinance

100 Developing a National Risk Profile, p. 69

101 UXO-NRA (2017): UXO Problem. Retrieved from: http://www.nra.gov.la/uxoproblem.html (last accessed on 25/8/2017)

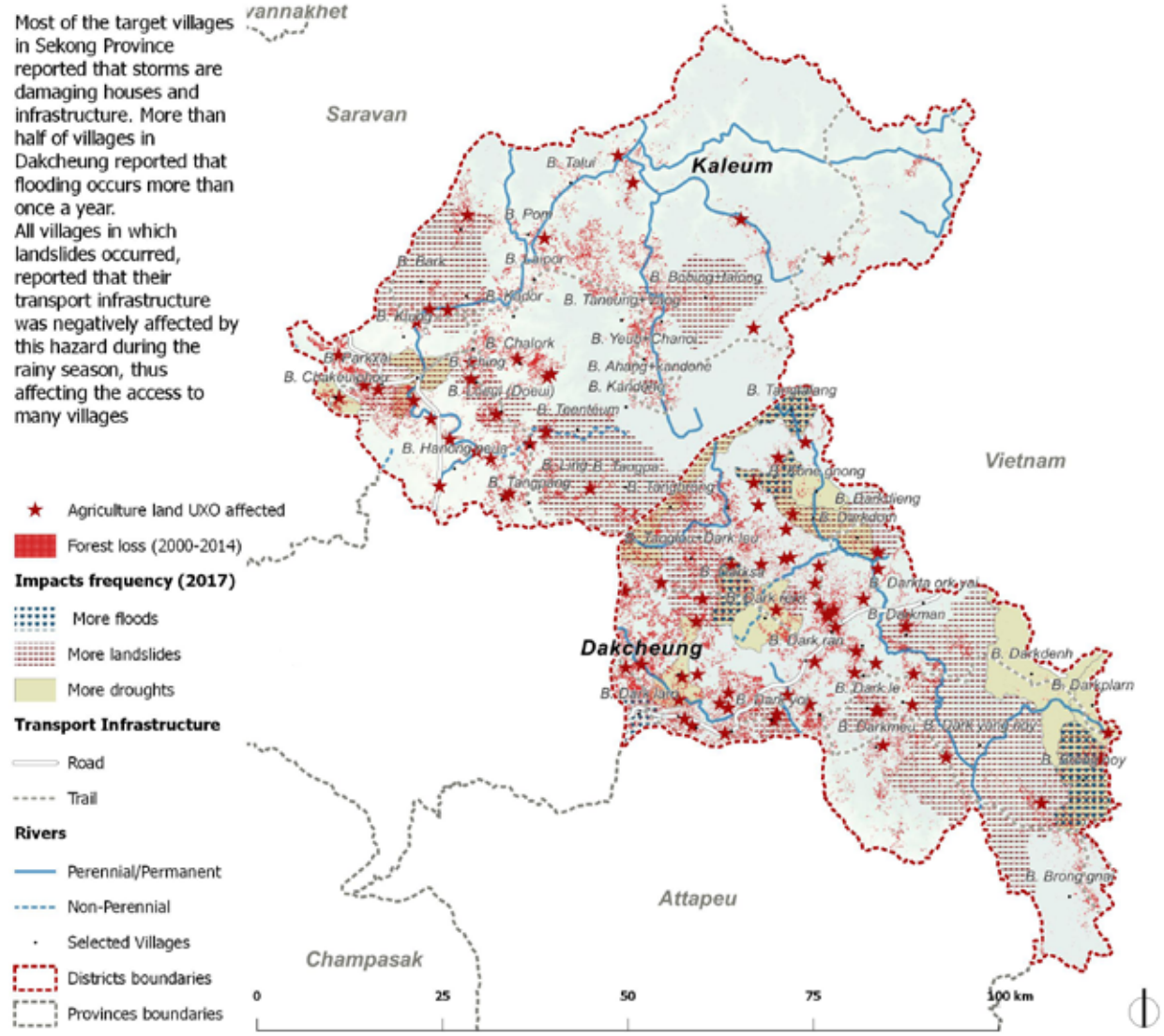
102 Lao national UXO programme (2013): UXO impact. Retrieved from: http://www.uxolao.org/index.php/en/the-uxo-problem/uxo-impact (last accessed on 25/8/2017)

103 UNDP Lao PDR (2017): Goal 18: Lives safe from UXO. Retrieved from: http://www.la.undp.org/content/lao_pdr/en/home/post-2015/sdg-overview/goal-18.html (last accessed on 25/8/2017)

104 Lao PDR National Disaster Management Committee & UNDP (2010): National Risk Profile of Lao PDR, p. 77

CLIMATIC FEATURES, NATURAL HAZARDS AND OBSERVED IMPACTS

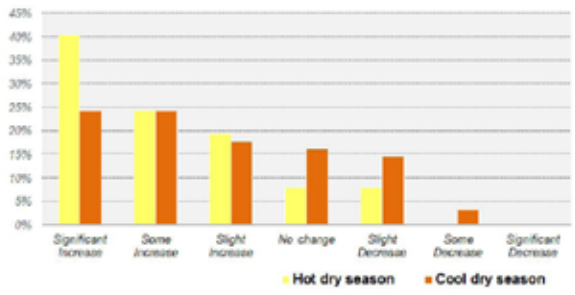
Most of the target villages in Sekong Province reported that storms are damaging houses and infrastructure. More than half of villages in Dakcheung reported that flooding occurs more than once a year.
All villages in which landslides occurred, reported that their transport infrastructure was negatively affected by this hazard during the rainy season, thus affecting the access to many villages



CHANGES IN CLIMATE OBSERVED OVER THE LAST 30 YEARS IN SELECTED VILLAGES

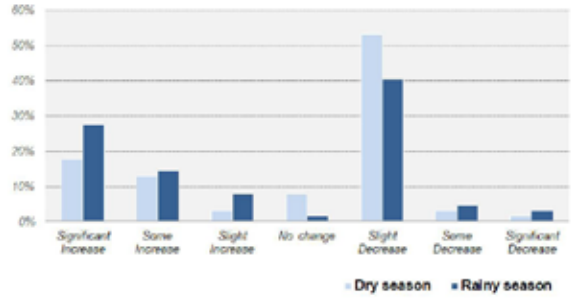
Temperature

Significant increase in temperature is perceived inboth hot season and cool season



Rainfall

Slight decrease in rainfall is perceived, both in dry and rainy season



Data Sources: Lao Decide (www.decide.la), Population and Housing Census 2015, Lao Census of Agriculture 2010/2012, UN Habitat 2017
Disclaimer: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Concerning the legal status of any country,territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

4.3 Climate Change Projections

- Temperatures are forecast to increase sharply in Sekong Province, up to 2.5°C, by 2050, relative to the baseline.
- Rainfall is harder to predict, but the indications are that there will be a slight increase in rain over a shorter rainy season.
- It is not possible to infer the change in storms, but more extreme rainfall events are highly likely.

The vulnerability assessment did not undertake its own set of climate change projections, as three sets of projections have recently been developed in Laos, for the Second National Communication to the UNFCCC (under the Ministry of Natural Resources and the Environment), by UNDP and the International Centre for Environmental Management for the Laos Community Risk and Vulnerability Assessment (L-CRVA), and by USAID under the Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin – which covers Laos. As a result, this assessment relies on the already existing set of projections. This is because the existing projections give both the team and decision makers in Laos sufficient information at present – conducting new, original projections would be time consuming and expensive and would add little value to both the assessment and decision making at the sub-national level.

The Second National Communication to the UNFCCC briefly introduces climate change projections partly based on earlier work by GIZ[105]. These were based on 14 global circulation models and three scenarios, A1B, A1 and B1 (see box text for a full explanation of climate change projections). The projections based on the average of GCM models in the GIZ report show a substantial increase in temperature in Sekong, as well as Attapeu and Saravan by 2050, compared to the 1982-2002 baseline[106].

While temperatures are projected to increase throughout the country, there are greater variations projected for rainfall. Much of southern Laos, including the target provinces, shows an increase in projected rainfall, especially in the month of October (which is in the late rainy season). Rainfall projections for May (in the early rainy season) show that there will be minimal change, though in some models an increase for April has been identified, meaning there is a greater chance of a 'false-start' to the rainy season in the future[107].

The global circulation models don't project the likelihood or magnitude of extreme weather events, including unusually heavy rains, hot spells of tropical storms, but rather tell us about the changes in averages. However, the GIZ report notes that previous trends are likely to continue, and therefore 'the incidence of extreme events, such as hotter nights and days and heavy storms, is likely to increase'[108].

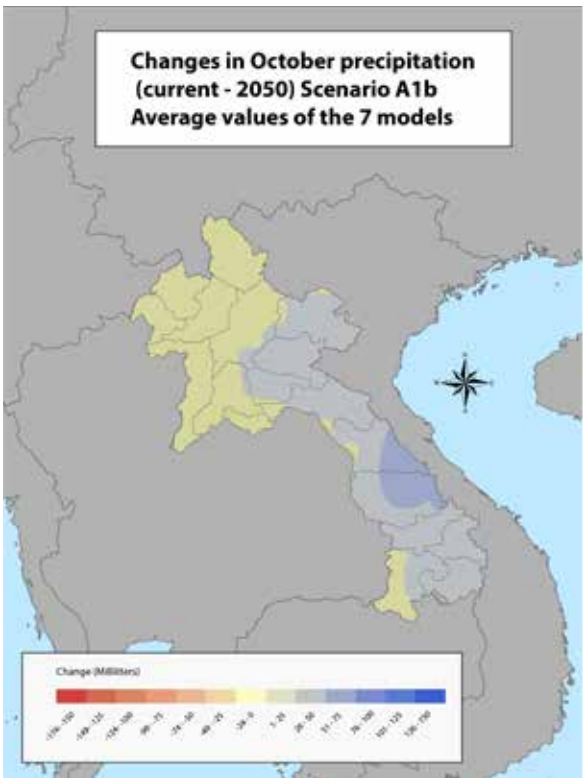


Figure 20 - Projected change in rainfall under the IPCC A1B scenario

105 Lao PDR Second National Communication to the UNFCCC, Ministry of Natural Resources and Environment p.60.
106 Lefroy, et al (2010) Study on Potential Impacts of Climate Change on Land Use in the Lao PDR, International Center for Tropical Agriculture/GTZ, p.20.
107 Ibid, p.26-27.
108 Ibid, p.27.

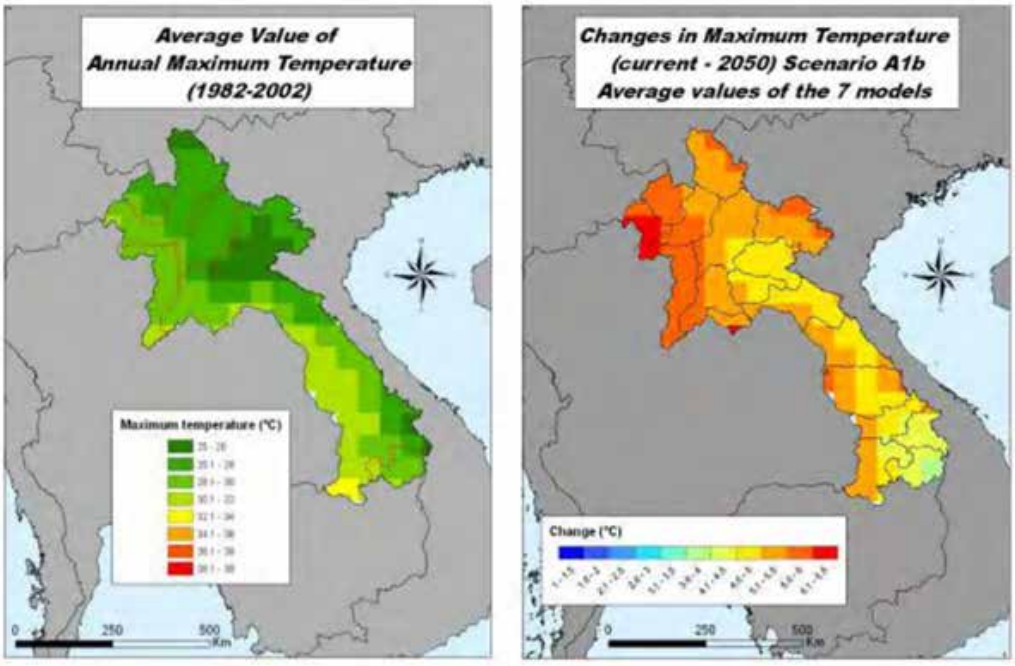


Figure 21 - Projected Change in Maximum Temperature under the IPCC A1B scenario

Lao Community Risk and Vulnerability Assessment (L-CRVA)

UNDP and the International Centre for Environmental Management also developed climate change projections as part of the Lao Community Risk and Vulnerability Assessment (L-CRVA) report, published in 2016. The L-CRVA conducted a modelling of the period 2045-2069, against a baseline of 1980-2000. Like the GIZ modelling exercise, L-CRVA used data from various weather stations in the Lower Mekong Basin, the IPCC A1B scenario and six global circulation models.

These models show an increase in temperature, rainfall and drought potential for Sekong Province (one of the target areas of the L-CRVA) [109].

The projections show that the average daily temperature during the rainy season could be at least 1.6°C higher in the period 2045-2069, compared to the baseline period, with Kaleum District experiencing the most acute changes. They show that the percentage change in average maximum rainfall during the rainy season could increase by 16 per cent, while also showing that there could be an increase in the number of drought months by up to 30 per cent. This would strongly indicate that Sekong would experience more extreme rainfall events – which would lead to more flooding and associated damage – because more rain is projected over a shorter rainy season.

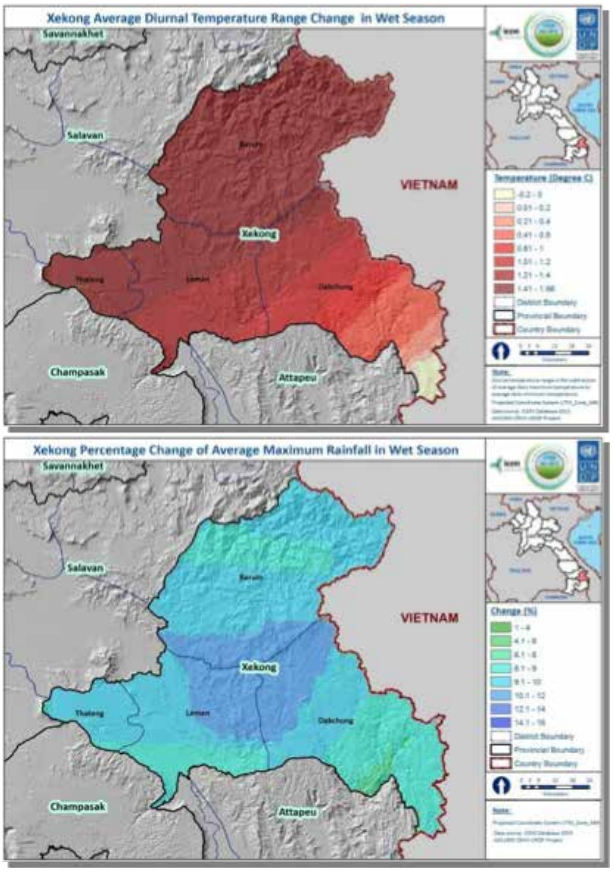


Figure 22 - Projected change in temperature and rainfall in Sekong Province

109 Ketelsen, T. et al (2016) Lao Community Risk and Vulnerability Assessment, UNDP/ICEM, p.31 (draft version).

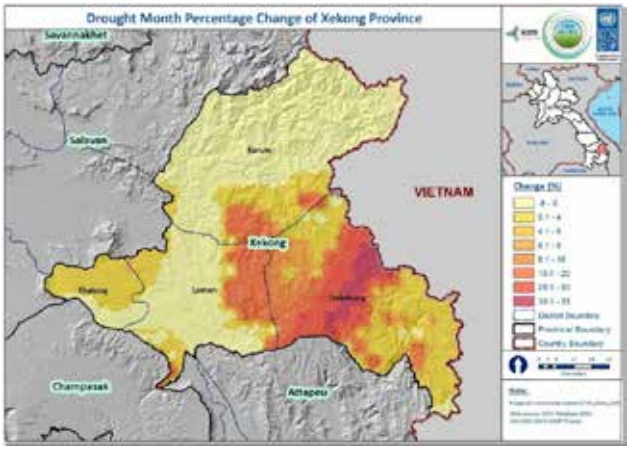


Figure 23 - Projected change in drought months in Sekong Province

The USAID Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin was published in 2013, and was based on six global circulation models like the UNDP-ICEM study and one future scenario (the IPCC A1B scenario). This was a regional study, and therefore the results are not specific to the target provinces of this assessment. However, there are projections downscaled to nearby locations that allow policy-makers to approximate changes in Sekong Province.

The temperature projections shown in Figure 24 are based on data gathered from the weather station in Mukdahan, Thailand, about 250 kilometres away from Sekong Town (straight-line distance). The average of the global circulation models shows an increase of about 2.5°C, relative to the baseline period.

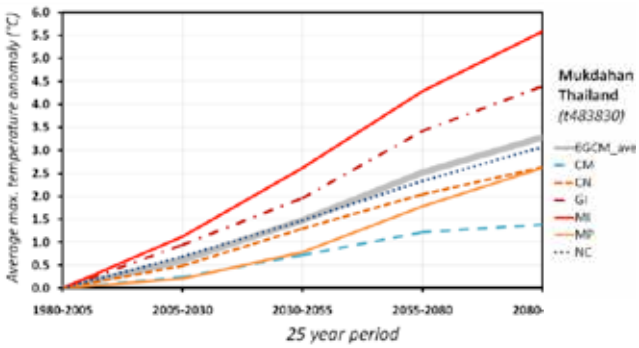


Figure 24 - Temperature projections in Southern Laos and Eastern Thailand

As with the other models, they also a trend to a slight increase in rainfall. The assessment downscaled models for rainfall in Champasack Province, which neighbours Sekong Province. The average of the six models showed a slightly greater amount of rainfall could be expected in a typical year. The average of the models showed no significant trend of late onset of early withdrawal, which has been noted in some other studies.

It should be noted that the models provide a range of projections, with the average of the six described above. In temperature, the most conservative model shows a negligible increase.

Like the other studies, these models do not provide information as to the likelihood or magnitude of extreme events. The Vulnerability Assessment Team surmises that droughts will become more frequent and more extreme, and that there will more heavy rainfall events in the rainy season. However, it is not possible to determine the frequency and magnitude of severe storms in the future.

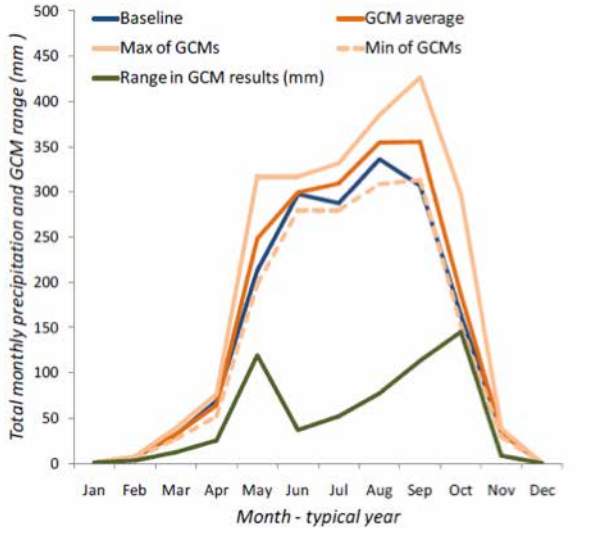


Figure 25 - Range of Precipitation Projections

Climate Change Projections

Climate change projections help us to understand what the climate will be like in the future and can be used to estimate what conditions will be like up to 100 years from now. They are not a forecast – they don't tell us exactly how the climate will be in the future or whether a given year will be hot or cold, wet or dry. Instead, they give us a broad projection of how the climate will change relative to today and the recent past. Climate change projections help policy-makers to take informed decisions when planning the construction and maintenance of infrastructure and the provision of services, because projections will tell them the likelihood of changes taking place. For example, in this assessment, we see consistent evidence that both overall annual rainfall and the number of drought months will increase. This informs decision-makers that there will be a greater need to capture and store water in the future.

The science of developing climate change models is complicated. Firstly, studies that develop climate change projections rely on emissions scenarios. The Intergovernmental Panel on Climate Change outlines various emissions scenarios in its assessment reports. In the 4th Assessment Report these were the A1FI, A1B, A1T, A2, B1, and B2 scenarios. In the IPCC Fifth Assessment Report, published in 2014, these scenarios were replaced with four scenarios known as representative concentration pathways; RCP2.4, RCP4.5, RCP 6.0 and RCP8.5. for a definition of these scenarios.

In short, however, emissions scenarios estimate the level and intensity of greenhouse gas emissions based on possible population and economic growth models, and the extent to which human beings 'de-carbonise' – reduce their dependence on fossil fuels and other activities that release greenhouse gases.

When one or more emissions scenario has been selected, assessments generally use General Circulation Models (GCMs). The science of GCMs is complex, but in simple terms, they are based on a mathematical equation that considers physics, fluid motion and atmospheric chemistry. Normally assessments will use several GCMs and base their projections on the average of these, as was the case with the USAID Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin, cited in this report.

The projections studies cited in this report use the older emissions scenarios (the USAID report is based on the A1B, for example). Studies based on the new scenarios (or representative concentration pathways, as they are now called) have not yet been conducted in Laos.

4.4 Underlying Drivers of Vulnerability

a. Environmental Conditions

- Deforestation has been prevalent in Kaleum and Dakcheung Districts and makes communities more vulnerable to floods and landslides.
- The Sekong Basin has not seen extensive hydropower dam construction. However, dam constructions have, in other areas, had negative effects on crops.
- Mining concessions have brought increased incomes but concerns about environmental impacts.
- People primarily use surface water sources. Groundwater availability in Sekong has not been well researched, and in most places is likely difficult to access.

Deforestation Trends

As shown in Figure 26, historical data shows that there have been substantial decreases in forest cover, primarily to make way for agricultural land[110].

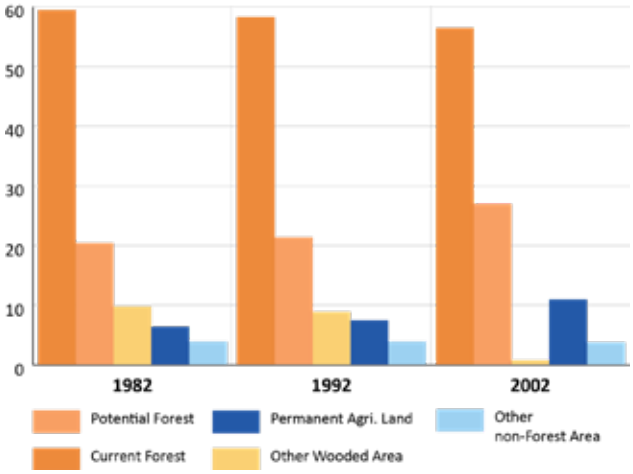


Figure 26 - Forest cover and land-use distribution in the southern region

The Mekong River Commission (MRC) developed a land use cover map for the Greater Mekong Sub-region using 2010 satellite imagery[111]. The accompanying land cover data set covered both the dry and wet seasons in 2009 and 2010 as well as a separate annual data comprising a combination of the two. In both districts, the annual map for 2010 showed that broadleaved deciduous forest was the predominant land use, followed by scrubland (see Table 1).

Table 1 - Land use cover 2010[112]

District	Land uses	%
Kalum	**Broadleaved deciduous forest**	**76.85%**
	Broadleaved evergreen forest	3.45%
	Orchard	0.4%
	Paddy field	2%
	Shrubland	**16.9%**
	Water body	0.4%
Dakcheung	Bare land	6.2%
	Broadleaved deciduous forest	**53%**
	Broadleaved evergreen forest	0.05%
	Orchard	2.45%
	Paddy field	3.45%
	Shrubland	**34.65%**
	Water body	0.2%

Source: http://portal.mrcmekong.org/tech_report

As shown in Table 2, the predominant land use, derived by automatic and regionally-tuned classification of a time series of global MERIS FR mosaics for the year 2009[113], is Closed to Open forest (>15%) covering more than 90 per cent of land in both districts.

110 Vongdeuane Vongsiharath, Department of Land Planning and Development National Land Management Authority, Lao PDR.

111 Landuse/Landcover of the Greater Mekong Subregion developed by Mekong River Commission (MRC) using 2010 satellite imagery and extensive field ground-truthing by National Government partners in Cambodia, Laos, Thailand & Vietnam. (http://portal.mrcmekong.org/tech_report).

112 http://portal.mrcmekong.org/tech_report.

113 ESA GlobCover Version 2.3 2009 300m resolution Land Cover Map.

Table 2 - Type of forest cover in 2009[114]

District	Land classification	%
Kaleum	Closed forest (>40%)	8.62%
	Closed to open forest (>15%)	**91.18%**
	Open forest (15-40%)	0.02%
Dakcheung	Closed forest (>40%)	1.24%
	Closed to open forest (>15%)	**98.58%**
	Open forest (15-40%)	0.02%

Deforestation has been a serious challenge in Laos. This has a broad range of effects but particularly makes communities more vulnerable to floods and landslides, which, as this report has shown, are highly prevalent in Kaleum and Dakcheung Districts. In addition, forests are the source of timber and non-timber products that are critical income and livelihood resources for rural communities.

Natural forest cover dropped from over 70 per cent in the 1940s to 41.5 per cent in 2002. The UN-REDD program estimates that, if the current reduction rate continues, the forest area will decrease to 7.4 million ha (31.3 per cent of the total land) in the next five years [115].

Not only has forest cover in the target area been decreasing, but the quality of forest has also declined. In addition to deforestation, many natural forests with lower productivity and impaired environmental functions suffered intensive degradation. The exploitation of natural forests during recent decades has arguably not benefitted the rural poor and instead contributed to the degradation of the natural resource base upon which most of the population depends for their livelihood[116].

Forest loss during the period 2000–2014, defined as a stand-replacement disturbance, or a change from a forest to non-forest state[117], was of 170km2 in Kaleum, and 240km2 in Dakcheung, mainly observed close to mining concessions and along road infrastructure developments (See map SEK 04).

However, road and other infrastructure development is probably not the main cause of deforestation in and of itself. Rather, the main drivers of deforestation and forest degradation in Laos are natural and human-induced fires, timber extraction due to commercial and illegal logging and for household consumption, shifting cultivation, agricultural expansion, forestry plantations, mining, hydropower, infrastructure development, and urban expansion[118]. Many of these drivers are facilitated by road infrastructure development but are not directly caused by it.

Table 3 - Forest Loss From 2000 to 2014[119]

District	Total area of forest loss between 2000-2014 (km2)
Kaleum	170
Dakchung	240
Total	**410**

Timber Extraction for Household Consumption

As shown above, small-scale timber extraction is a major concern for the villages surveyed in Kaleum and Dakcheung Districts. Broader pressures from small-scale cutting have been extensively noted in Laos. According to World Bank, timber harvesting for household consumption is assumed to have increased in line with population growth from 630,000 cubic metres per year in 1992-2002 to 770,000 cubic metres per year in 2002-2009. Total domestic timber demand was recently estimated at 1.57 million cubic metres per year. 10 Families are normally entitled to cut up to 5 cubic metres of timber per year from village utilization forests for their own use. In theory, an application to the village authorities may also be required, which will be review and approved by the Village Head or the Village Development Committee[120].

Forests are under high pressure and are largely in a degraded state due to human activities. The 2015 Census shows that firewood is by far the main source of cooking fuel (used by more than 95 per cent of households in both districts), while less than 3 per cent of the population use electricity. In addition, more than 95 per cent of the housing units' walls and floors are built from forestry sources materials[121]. The lack of alternative building materials shows that people are contributing to deforestation through necessity. This creates a

114 ESA GlobCover Version 2.3 2009 300m resolution Land Cover Map.
115 USAID Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin: Main Report.
116 USAID Lowering Emissions in Asia's Forests (USAID LEAF). Drivers of Forest Change in the Greater Mekong, Subregion Lao PDR Country Report., Ian Lloyd Thomas September 2015.
117 Global forest cover loss 2000–2015: V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53.
118 http://theredddesk.org/countries/laos.
119 Hansen/UMD/Google/USGS/NASA.
120 (USAID Lowering Emissions in Asia's Forests (USAID LEAF). Drivers of Forest Change in the Greater Mekong, Subregion Lao PDR Country Report., Ian Lloyd Thomas September 2015).
121 According to Census 2015's classes, forestry sources materials are considered: wood, bamboo and grass.

paradox, where the only building materials accessible to people in villages in Dakcheung and Kaleum Districts is inherently unsustainable and increases the vulnerability to climate change and other environmental problems.

Table 4 - Percentage of Households Relying on Forestry Sources

District	Housing materials			Cooking Fuel
	Roof	Wall	Floor	
Kaleum	45.28	96.35	98.84	96.09
Dakcheung	20.79	98.31	99.2	96.26

Source: Housing Population Census 2015

Hydropower Production

Hydropower is a central pillar of Laos's approach to development and a major driver of the high rates of GDP growth in recent years. However, Hydropower development contributes to deforestation directly because of clearance of inundation areas and indirectly because such clearance is often associated with illegal logging in adjacent forests. In addition, villages have to be resettled creating pressure on forests in new locations. New hydropower plants also require the construction of roads and high voltage power lines with attendant direct and indirect impacts on forests" [122].

Hydropower also brings further potential knock-on effects. It can impact flood regimes, which in turn negative affect traditional cropping systems that are based on sediment disposition. The changed fertilization that results could combine with the impacts of climate change – particularly changing rains and frequency of droughts – to reduce yields. While hydropower offers potential to offset this by providing additional water for irrigation, most hydropower developments in Laos have not been planned with multiple use benefits in mind[123]. The Sekong basin has not seen extensive hydropower dam construction as in the Sesan or Sre Pok. Currently, the basin has only three large hydropower dams. However, five more are under construction and another 16 under consideration[124].

In 2012, there was one dam under construction in the target districts (in Dakcheung) and four were planned, one in Kaleum and a further three in Dakcheung[125] (see map SEK 04).

Mining Concessions

Mining contributes directly to deforestation because forests have to be cleared, but also indirectly as it creates needs for additional infrastructure development, such as access roads, that themselves facilitate deforestation. The main forest loss concern is in relation to a few mega projects currently under consideration, particularly related to Bauxite mining in Southern Laos. The tens of thousands of small artisanal mining operations probably have a bigger total impact on forest resources than current large-scale mining operations. (USAID Lowering Emissions in Asia's Forests[126].

In recent years, the increase in mining concessions has provided some communities with alternative sources of income. While communities benefit from a predictable and stable source of income, especially during the dry season, there are concerns about possible environmental impacts which may affect land productivity for surrounding communities[127].

Table 5 - Mining Concessions in 2010

District	Mining concessions (km²)
Kaleum	20
Dakcheung	326
Total	**346**

According to the village survey conducted by the assessment, deforestation has affected 27 of 29 villages in Kaleum District and all villages in Dakcheung District. In almost all villages, the respondents said that small-scale cutting for agricultural expansion or timber was the primary driver of deforestation. No villages reported any impacts from mining.

Water Resources

According to the survey conducted for this assessment, very few villages have access to reliable and protected water sources. In Kaleum District, eleven of the 29 villages had no water supply system, and a further 12 relied on gravity-fed systems, whereby local people tap water flowing down from the mountains. In Kaleum, these are ad-hoc, unplanned systems, usually constructed by the villagers themselves, putting them beyond the reach of technical maintenance capability.

122 (USAID LEAF). Drivers of Forest Change in the Greater Mekong, Subregion Lao PDR Country Report., Ian Lloyd Thomas September 2015)
123 USAID Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin: Main Report
124 Reference needed here
125 Understanding New Threats and Challenges from Hydropower Development to Biodiversity and Community Rights in the 3S River Basin. Mark Grimsditch, 2012. 3S Rivers Protec on Network and International Rivers.
126 (USAID LEAF). Drivers of Forest Change in the Greater Mekong, Subregion Lao PDR Country Report., Ian Lloyd Thomas September 2015.
127 CLEAR WFP, 2015.

The picture is similar in Dakcheung District; 15 of the 33 villages rely on similar community constructed gravity fed systems. A further five villages have a public gravity fed system (which was either built by the government or with government support). Of the other villages surveyed in Dakcheung, only one has access to the public, piped water system, while another has partial access. However, only one village reported having no access to water.

Mining activities and hydropower generation are the major sources of pollution in the Xe Done and Xe Banghiang River Basins, especially through sediment deposits. However, waste-water and run-off from agricultural activities are also sources of both nutrients and chemicals, where agriculture is dependent on non-organic fertilizers. To this end, there has been some evidence of arsenic contamination in Sekong Province[128], though arsenic contamination was not highlighted during the surveys conducted by this assessment, or in any consultation with the local or national government.

Groundwater information including resource potential, uses and quality is very limited in the country. Since surface water is abundant for supply, groundwater is regarded as a viable water source only when and where surface water is not available[129]. The expansion of rubber plantations has resulted in land cover change across extensive areas of the Xe Kong basin. Expansion of other agricultural crops has added to this conversion and is thought to be depleting groundwater resources as well as affecting surface water quality by increasing erosion[130].

While irrigation systems are becoming more widespread in Sekong, and Laos more generally, only four of the surveyed villages – all of which are in Dakcheung District – have access to irrigation, a reflection of both the underdevelopment of the target districts and the challenges associated with providing irrigation to remote, difficult to access villages.

Depletion and Pollution of Groundwater Resources

Information about groundwater, including resource potential, uses and quality is very limited in Laos. Most people depend on surface water as their primary water source, and only use ground water when surface water is unavailable. However, this makes people highly vulnerable to any reduction in water availability that may occur as a result of climate change.[131]. It was beyond the capacity of this assessment to undertake detailed surveys of groundwater quality and availability. Deepwater wells, with pumps for extraction, was only a means to access water in two of the surveyed villages in Sekong, one each in Kaleum and Dakcheung.

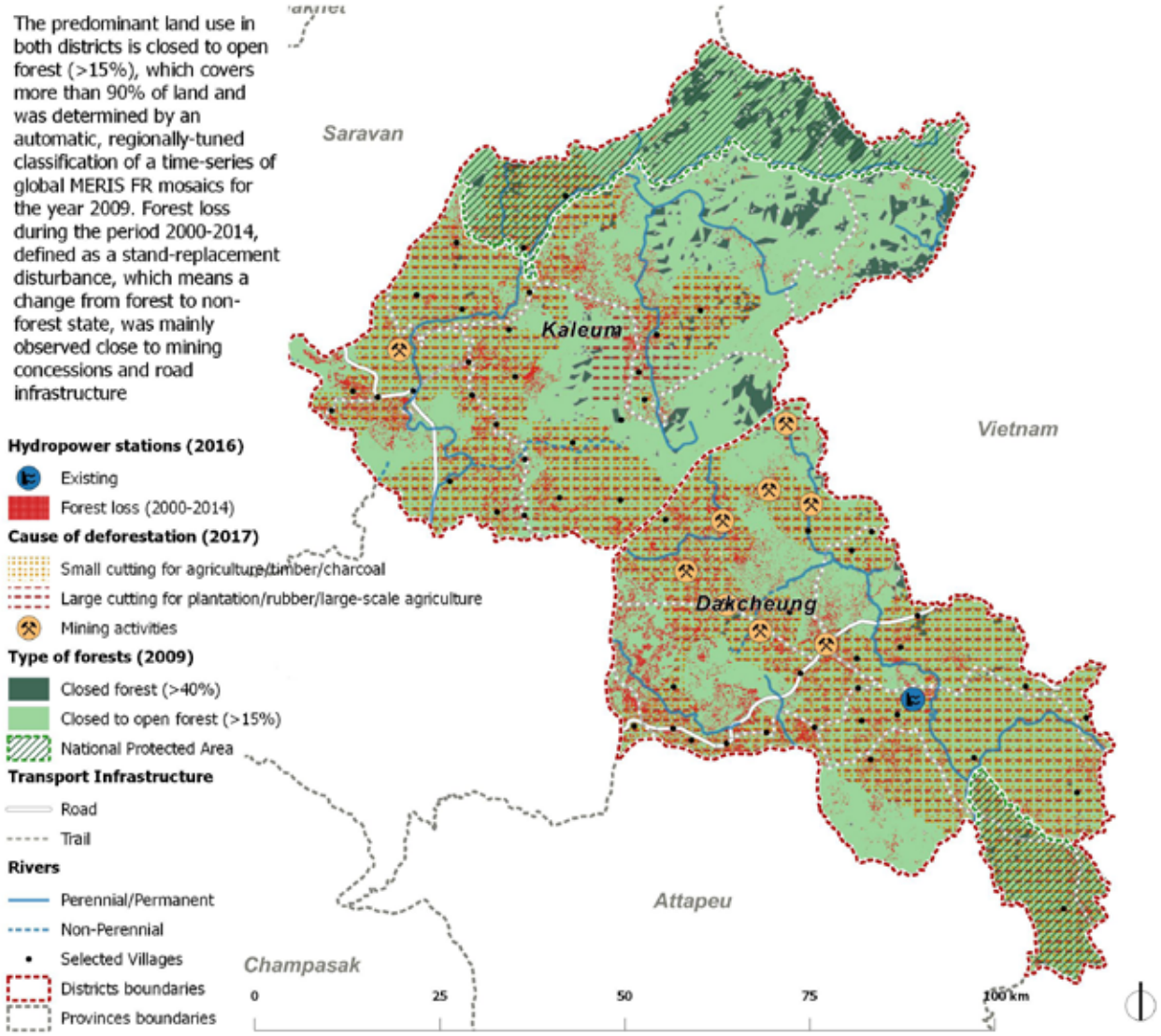
Mining activities and hydropower generation are the major sources of water quality degradation, especially through sedimentation. Wastewater or water run-off from agricultural activities are also potential sources of high nutrients and toxic chemicals originated from fertilizer and pesticide use[132].

The expansion of rubber plantations has resulted in land cover change across extensive areas of the Sekong Basin. Expansion of other agricultural crops has added to this conversion, and these too are thought to be depleting groundwater resources as well as affecting surface water quality by increasing erosion [133].

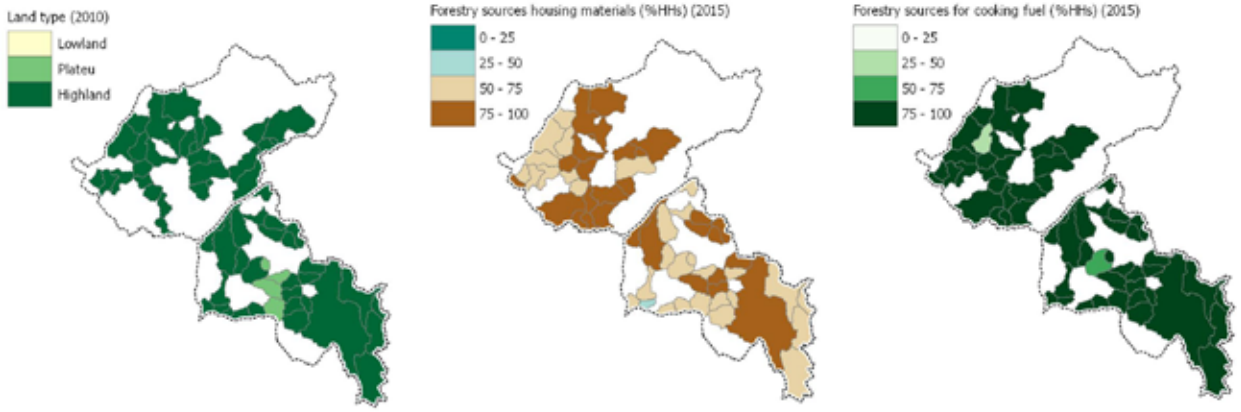
128 Ministry of Environment, Japan (2015), State of Water Resources, Outlook on Water Environmental Management in Asia 2015, p.62.
129 Ibid, p.62
130 http://www.waterandnature.org/sites/default/files/sekong_basin_fact_sheet.pdf
131 State of Water Resources, Outlook on Water Environmental Management in Asia 2015, Ministry of the Environment, Japan.
132 MRC 2010.
133 http://www.waterandnature.org/sites/default/files/sekong_basin_fact_sheet.pdf

LAND COVER AND MAIN ENVIRONMENT ISSUES

The predominant land use in both districts is closed to open forest (>15%), which covers more than 90% of land and was determined by an automatic, regionally-tuned classification of a time-series of global MERIS FR mosaics for the year 2009. Forest loss during the period 2000-2014, defined as a stand-replacement disturbance, which means a change from forest to non-forest state, was mainly observed close to mining concessions and road infrastructure



TYPE OF LAND AND FORESTRY SOURCES FOR HOUSING MATERIALS AND COOKING FUEL



Data Sources: Lao Decide (www.decide.la), Population and Housing Census (2015), Lao Census of Agriculture (2010/2012), Lao Energy and Mines, 3S Rivers Protection Network (2012), Hansen/UMD/Google/USGS/NASA (2014) C-ADAPT World Food Program (2015), UN Habitat (2017)

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b. Infrastructure and Basic Services Conditions

- The current transport infrastructure is highly vulnerable to hazards, reducing people's mobility in both districts
- There is very limited mobile communication and electricity access in Kaleum and Dakcheung Districts, reducing communities' disaster management capacity
- Availability of fresh water mainly relies on surface water sources, which are highly prone to contamination
- Basic health and primary education and disaster and security coverage is still very limited across the target villages, reducing communities' resilience to climate hazards

Transportation Infrastructure

The transport infrastructure across the country relies primarily on road transport and, to a much lesser extent, on the river and air transport. Only 14 per cent of the current road network is paved, while gravel and earth roads account for 34 per cent and 52 per cent of roads respectively[134].

The current transport infrastructure connecting rural settlements across Sekong Province is sparse and poorly maintained, relying on a network of unpaved roads and trails, where seasonal closures are frequent. In addition, many of the mountain areas have rugged terrain and a small population, meaning they are not prioritized for investment[135]. In general, roads have been constructed with poor quality materials which exacerbate the damage during extreme events. Communities themselves have a poor capacity for maintenance both in terms of skills and expertise and also in terms of access to materials and tools which typically need to be sourced from distant locations.

Many of the selected villages in Sekong province are very remote in terms of access by land. There is no "formal" collective transportation such as bus services in any of the two targeted districts, which is a major constraint towards accessing markets and basic services coverage.

As shown in Figure 27, very few of the selected villages – 3 per cent in Kaleum District and 6 per cent in Dakcheung District– have access to paved roads. Around 70 per cent of the selected villages in Kaleum are accessible only by trails and tracks, while in Dakcheung villages are mainly accessed by unpaved gravel roads.

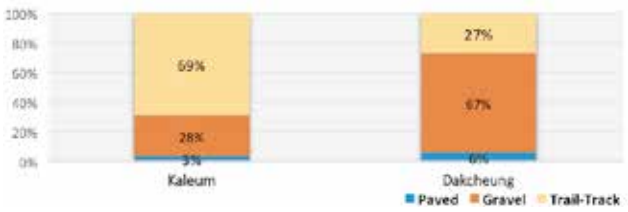


Figure 27 - Proportion of selected villages by type of road access and by district.

Source: 4th Population and Housing Census (PHC) 2015

The villages surveyed report important storm and flood related impacts on infrastructure. Indeed, 81 per cent and 50 per cent of the selected villages in Dakcheung and Kaleum Districts respectively, reported damage to infrastructure due to storms and floods, respectively. As highlighted above, most villages in Dakcheung are affected by at least one storm per year.

None of the selected villages from the assessment have storm water drainage systems. This increases these communities' vulnerability to flash floods across Dakcheung and Kaleum Districts.

The projected stronger storms and unusually heavy rainfall will inevitably reduce people's mobility; especially in those villages only accessible by unpaved trails and tracks on sloping land, which will be more exposed to landslides as well as flash flood events, isolating villagers from markets, medical facilities, schools, and other basic community services.

134 Lao People's Democratic Republic transport sector assessment, strategy, and road map. Mandaluyong City, Philippines: Asian Development Bank, 2011.

135 ICEM. 2016. Lao Climate change risk and vulnerability assessment for small scale rural infrastructure: Final Summary Report. ICEM, Hanoi Viet Nam, 30th May 2016.

Electricity Access

The Government of Laos is focusing on expanding the electricity network into rural areas to encourage development and poverty reduction among ethnic groups and the rural population[136]. Access to electricity has improved considerably over the last decade, from 57 per cent of households nationwide in 2005 to 84 percent of the households in 2015.[137]

The proportion of households in both targeted districts with electricity access is very limited, at about 30 per cent having grid connectivity. As shown in Figure 28, half of the households in Kaleum District (mainly from central areas of the district) and 34 per cent of Dakcheung's households do not have any source of power, while 36 per cent of households in Dakcheung and 17 per cent in Kaleum rely on their own sources of energy, through generators and batteries. The need for a generator increases household dependence on external supplies (and therefore requires road accessibility) and varying costs, which may represent an extra burden on already low and fragile household incomes. However, the use of batteries associated with solar power systems is a good opportunity to reduce costs, while also being more climate resilient.

Figure 28 - Proportion of households by type of electricity in targeted districts

Source: 4th Population and Housing Census (PHC) 2015

The mobile repeater and communication network is particularly weak in the southern areas of Dakcheung and northern areas of Kaleum (see map SEK5a). According to the 2015 Census, in both target districts around 65 per cent of households have cell phones, well below the national average of 86 per cent[138].

Figure 29 - Proportion of households having cell phones in targeted districts

Source: 4th Population and Housing Census (PHC) 2015

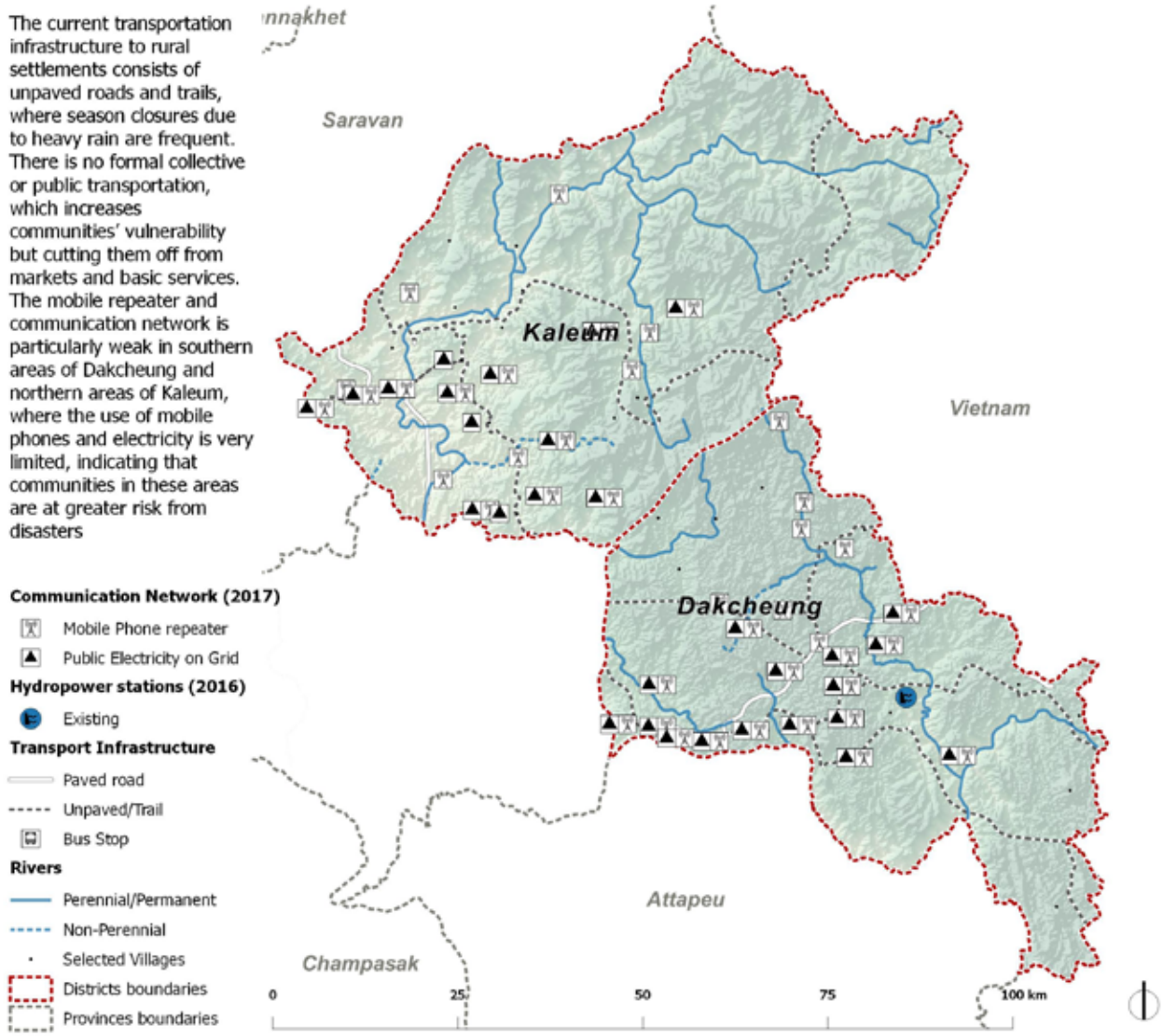
Villages in the northern and central area of Kaleum and the southern area of Dakcheung Districts are less access to transportation, electricity and communication infrastructure, making them more sensitive to climate hazards.

These constraints already jeopardize rural livelihoods and will worsen in emergency situations that will occur as a result of projected extreme weather events.

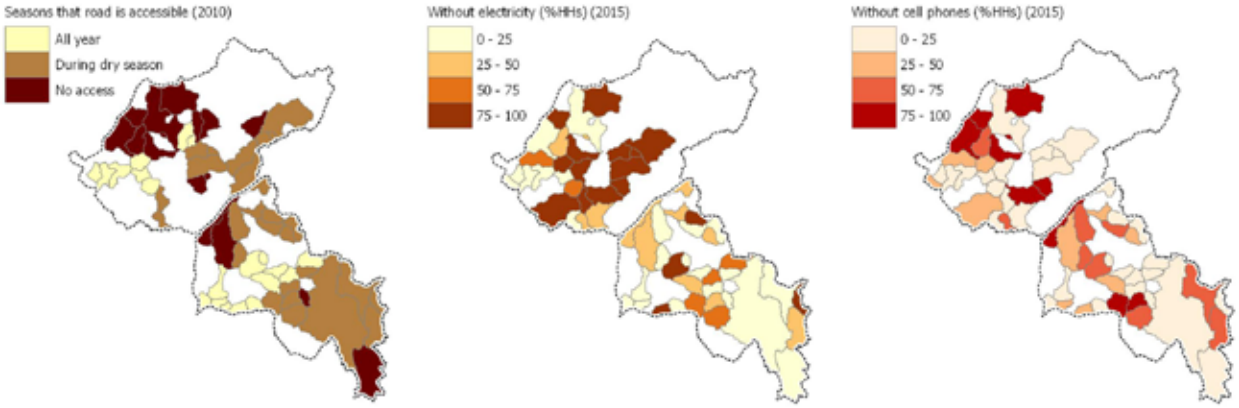
136 http://news.xinhuanet.com/english/2017-01/09/c_135967940.htm.
137 The 4th Population and Housing Census (PHC) 2015. Lao Statistics Bureau.
138 The 4th Population and Housing Census (PHC) 2015.

SPATIAL DISTRIBUTION OF MAIN TRANSPORT AND COMMUNICATION INFRASTRUCTURE

The current transportation infrastructure to rural settlements consists of unpaved roads and trails, where season closures due to heavy rain are frequent. There is no formal collective or public transportation, which increases communities' vulnerability but cutting them off from markets and basic services. The mobile repeater and communication network is particularly weak in southern areas of Dakcheung and northern areas of Kaleum, where the use of mobile phones and electricity is very limited, indicating that communities in these areas are at greater risk from disasters



ACCESS TO ROADS, ELECTRICITY AND CELL PHONES IN SELECTED VILLAGES



Data Sources: Lao Decide (www.decide.la), Population and Housing Census (2015), Lao Census of Agriculture (2010/2012), Lao Energy and Mines, Global Energy Network Institute, 3S Rivers Protection Network (2012), UN Habitat (2017)

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Water Supply

The Law on Water Resources from 2013 defines water sources as "places where natural water temporarily or permanently gathers, reside, rest or move. Water source exists on the ground surface and underground. Surface water source is a source on the ground surfaces such as rivers, streams, reservoirs, lakes, ponds, wetlands, spring; groundwater is water source underground being layered, or mixing with soil."[139]

According to the 2015 Census, around 60 per cent of households across Sekong Province depend on underground sources for drinking water[140]. However, in the target districts, the situation is quite the opposite. In fact, most of the villages in both targeted districts (around 70 per cent) depend on surface water sources.[141][142] This is due to the upland nature of the target districts and the complexity of accessing underground water in upland areas.

Figure 30 - Proportion of households by main natural source of drinking water in targeted districts

Source: 4th Population and Housing Census (PHC) 2015

In both districts, most of the surface water (streams and mountain sources) is distributed through a gravity-feed system (76 per cent and 59 per cent of the targeted villages in Dakcheung and Kaleum Districts respectively), which means that most villages are autonomous in terms of managing their water supply. However, the reliance on spring sources typically means that water sources are located at a significant distance from the village centre; which can be a challenge for water distribution and exposes the system to a greater likelihood of damage as piped- networks traverse flood and landslide risk landscapes. Moreover, most villagers have limited technical or financial capacity to expand service delivery in response to rising demand, coupled with the difficulty to bring construction equipment onto the remote, mountainous sites represents a great challenge in providing water to people.[143]

According to the assessment, 38 per cent of the selected villages in Kaleum District don't have any water supply system, which indicates they rely on water collected on a daily basis, a task done mainly by women from seasonal streams.

14 per cent and 24 per cent of villages in Kaleum and Dakcheung Districts respectively, reported having irrigation systems, mainly due to their location close to rivers, however, the projected stronger rains and river flooding would damage facilities for longer periods.

Table 6 - Proportion of selected villages by type of water supply and distribution systems by district[144]

	Gravity System	Deep well	Rain harvesting	Small water system	Tank+ Well	Rand pump	Water network	Irrigation	None
Kaleum	59%	3%	3%	0%	3%	3%	0%	14%	38%
Dakcheung	76%	0%	0%	3%	0%	3%	21%	24%	6%

Source: Vulnerability Assessment Survey

Villages across the two targeted districts rely on unprotected[145] water supply and distribution system (72% in Kaleum and 86% in Dakcheung) which exposes people to greater contamination risks, that arise from floods and storms (as well as non-climate factors).[146]

The high proportion of households exposed to unprotected water supply and distribution systems

139 Law on Water Resources, 2013. http://www.monre.gov.la/dwr/index.php?option=com_content&view=category&id=108&layout=blog&Itemid=182&lang=en

140 According to Census 2015 categories, underground water sources are wells; boreholes; piped and bottled.

141 According to Census 2015 categories, surface water sources are river, stream, dam, mountain, rain.

142 The 4th Population and Housing Census (PHC) 2015

143 ICEM. 2016. Lao Climate change risk and vulnerability assessment for small scale rural infrastructure: Final Summary Report. ICEM, Hanoi Viet Nam, 30th May 2016.

144 Vulnerability Assessment Survey

145 According to Census 2015, unprotected water supply and distribution systems are: unprotected borehole /well; river/stream/dam; mpountain sources; others. While protected water supply and distribution systems are: piped water; protected borehole/well; rain water; bottled water

146 Source: The 4th Population and Housing Census (PHC) 2015.

coupled with projected changes in precipitation patterns and an increase in mean temperatures can lead to higher risks of water borne diseases, especially considering that increased drought risk will reduce the quantity of water available.[147]

Figure 31 - Proportion of households by water supply and distribution system in targeted districts

Source: 4th Population and Housing Census (PHC) 2015

61 per cent of villages across the two target districts reported suffering a lack of water due to temperature variations. In fact, this high dependence on surface sources exposes people to higher vulnerability as higher rates of evaporation and longer drought periods are projected in the coming years. Moreover, in the midterm groundwater sources will also be affected as aquifers will take longer to recharge leading to the need for further investments in water infrastructure, including storage capacity and deeper boreholes.

In addition, data indicate very limited sanitation coverage across households in the province. According to the 2015 Census, 65 per cent and 42 per cent of households in Kaleum and Dakcheung respectively report the use of other unimproved sanitation facilities highly vulnerable to the risk of water sources contamination leading to water borne and vector diseases[148].

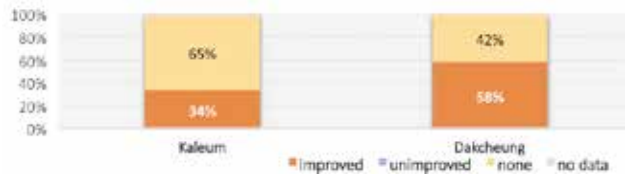


Figure 32 - Proportion of households by type of toilet in targeted districts

Source: 4th Population and Housing Census (PHC) 2015

As shown in Map SEK05b, central villages of Kaleum District and northern and southern areas of Dakcheung District show the highest levels of unreliable and unsafe drinking water sources and very limited access to sanitation facilities.

Health and Education Coverage

The network of health services in Lao PDR is structured in four levels: (i) Primary health-care services; (ii) Intermediate level health-care services; (iii) High-level health-care services; and (iv) Advanced healthcare services[149].

Primary healthcare services are the medical treatments provided at community and sub-district level: Village drug kits provide essential drugs and health care at the village level, to people in remote areas inhabited by ethnic minorities, and in geographic locations where there are no health centres. Health staff consist of village assistant physicians or village public-health volunteers and traditional birth attendants and have basic medical instruments. They provide drugs and offer consultations and treatment for non-life-threatening illnesses, diarrhoea, malaria, flu and minor wounds, assist in home births and distribute medicine. Health Centre facilities have trained medical staff[150], where health care service is provided for a village or for a group of villages. Higher-level treatments than those provided by the village drug kits are provided, such as treatment for chronic diarrhoea, prolonged flu, wound suture, vaccination and assistance with childbirth.

The basic health coverage in Kaleum District is very weak. According to the survey, only a quarter of selected villages have access to village drug kits and around 20 per cent have a health centre, 17 per cent have a midwife while only 7 per cent have a physician. The coverage is even more limited Dakcheung District, where less than 10 per cent of selected villages have access to village drug kits and 15 per cent have health centres.

There is a severe lack of health professionals across the selected villages; there are no midwifes and only 6 per cent of villages have convenient access to a doctor. These very limited health services highlight a high health risk to which people are exposed. This risk is likely to worsen under the projected climate hazards; storms, floods and landslides, which may disrupt the already seasonal and unreliable road access and prevent medical supplies from reaching more remote villages.

Table 7 - Type of Basic Health Services in the Targeted Districts

	Drug / 1st Aid kits	Health Centre	Doctor	Midwife
Kaleum	24%	21%	7%	17%
Dakcheung	9%	15%	6%	0%

Source: Vulnerability Assessment, 2017

147 ICEM Database, 2014
148 The 4th Population and Housing Census (PHC) 2015.
149 Law on Health Care, No. 09/NA. 9 November 2005.
150 Physicians, assistant physicians, nurses, and midwives.

Education

Compulsory education in Laos comprises elementary, lower-secondary and upper-secondary school. Elementary school takes five years to complete and is compulsory. Lower-secondary school takes four years to complete and upper-secondary takes three years to complete, giving 12 years' basic education in total[151]. There are two types of primary school, complete and incomplete primary schools. Due to some infrastructure and staffing constraints, incomplete primary schools do not provide a complete primary education up to grade 5. Most of the incomplete primary schools are in rural and remote areas. As some students are unable to travel to school in another location, they drop out of school before their primary education is completed[152].

More than 60 per cent of surveyed villages in Kaleum District do not have access to complete primary schools, mainly located in the central and northern areas of the district, while in Dakcheung District the situation is a bit better, as the percentage of selected villages without primary schools is 40 per cent. This situation jeopardizes communities' awareness and coping capacity to deal with climate hazards and indicates lower adaptive capacity.

The National School Construction Guidelines set the minimum standards that school construction must meet, including safety key principles against natural hazards155. This provides a basic level of resilience for schools against climate hazards and natural disasters.

The Prime Minister's Decree No. 220/PM[153] establishes Disaster Prevention and Control Committees (DPCCs) at national, provincial, district and villages to take the lead on Disaster Risk Management (DRM) issues in Lao PDR. At the community level, the Village Disaster Prevention Units (VDPU)/Village Disaster Prevention and Control Committee (VDPCC), are responsible for the implementation of a village's Community-Based Disaster Risk Reduction (CBDRR) planning and trains communities on what to do before, during and after disaster events.[154]

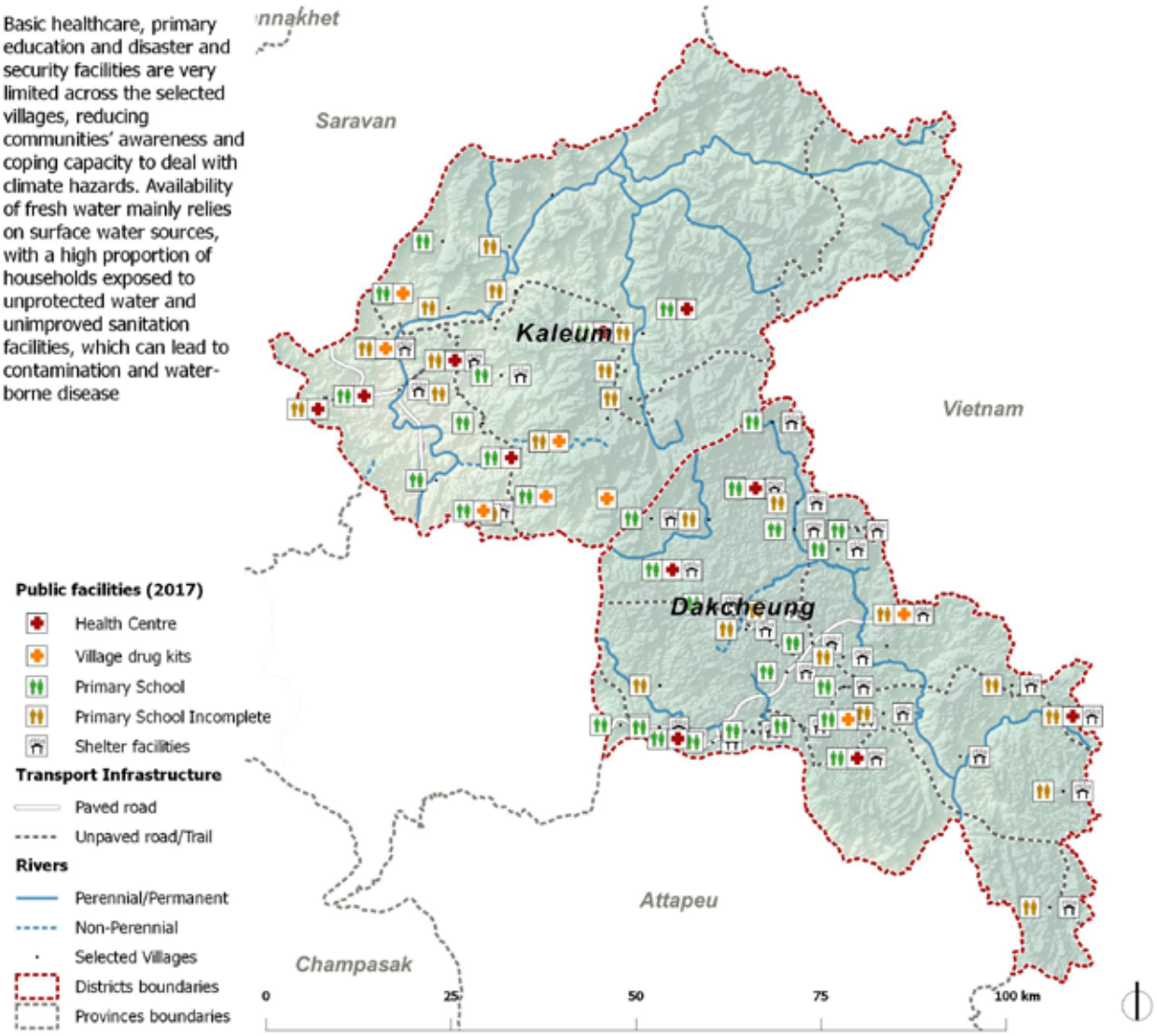
While in theory all villages should have a disaster management committee, in Kaleum District less than half of the surveyed villages have a functioning committee while in Dakcheung District none of the villages do. However, in Dakcheung around 90 per cent of the selected villages have disaster facilities while in Kaleum only 17 per cent do.

The projected stronger rains and potential for more frequent and/or intense cyclones may increase communities' vulnerability, especially in villages where there is a lack of community shelters providing critical emergency shelter or public buildings (such as health centres and schools) are not disaster resilient and therefore cannot be used as shelters in the case of storms and floods.

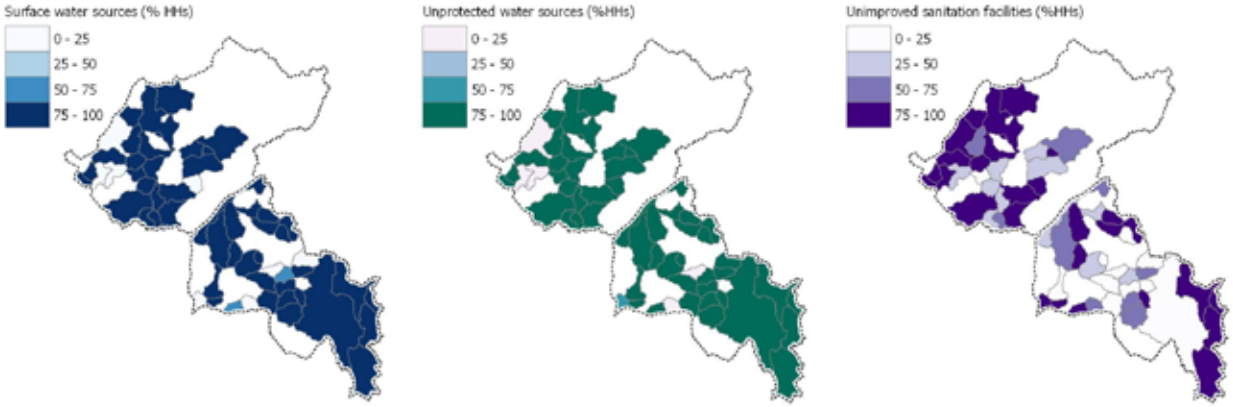
151 Law on Education No. 149/PDR Vientiane Capital City dated 17/07/2007.
152 Education for All 2015 National Review. National EFA 2015 Review Report, Lao PDR August 2014.
153 28 August 2013.
154 Community-Based Disaster Risk Reduction (CBDRR) Manual in Lao PDR, MoNROE.

SPATIAL DISTRIBUTION OF MAIN PUBLIC FACILITIES AND BASIC SERVICES

Basic healthcare, primary education and disaster and security facilities are very limited across the selected villages, reducing communities' awareness and coping capacity to deal with climate hazards. Availability of fresh water mainly relies on surface water sources, with a high proportion of households exposed to unprotected water and unimproved sanitation facilities, which can lead to contamination and water-borne disease



ACCESS TO FRESHWATER SOURCES AND SANITATION FACILITIES IN SELECTED VILLAGES



Data Sources: Lao Decide (www.decide.la), Population and Housing Census 2015, Lao Census of Agriculture 2010/2012, UN Habitat
Disclaimer: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Concerning the legal status of any country,territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

c. Socio Economic Conditions

- Sekong has a very high level of absolute poverty and greater 'depth' of poverty. This makes people in Sekong more likely to be vulnerable to climate change because they are less likely to have savings, or to be able to invest in alternative livelihoods or improved facilities.

- Agriculture and livestock are common sources of income throughout both districts and these are highly climate dependent. There is very little evidence of industry of service sector employment in Kaleum and Dakcheung.

- Literacy rates are among the lowest in the country. Low literacy rates make it very difficult for people to move to non-climate dependent livelihoods and thus become more resilient.

- School enrolment rates are as low as 4.1 per cent of youth enrolled in upper secondary in Kaleum. Low high school enrolment begins a cycle that leads to people being limited to low-wage, climate-dependent jobs.

Poverty is a severe challenge for Sekong Province. At 31.4 per cent, Sekong's poverty rate is the fourth highest in the country. However, Kaleum and DakcheungDistricts, with poverty rates of 46.4 and 35.4 per cent respectively, have much higher poverty levels even when compared to the rest of Sekong province[155]. The national poverty rate is 24.8 per cent[156]. The poverty gap[157] index, which measures the 'depth' of poverty (i.e. how much individuals would, on average, need to increase their income to no longer be considered poor), also shows Sekong somewhat lower than the national average, at 9 per cent compared to 6 per cent nationally. Kaleum and Dakcheung show a much higher poverty gap index, of 14.8 per cent and 11.9 per cent, respectively.

The assessment was not able to conduct a local income survey, due to the time and complexity of conducting such an exercise. However, the assessment did analyze the main types of livelihoods. Casual labour was the most common form of livelihood, with 47 of the 62 villages reporting dependence on it. Livestock herding (39 villages) and agriculture (32 villages) were the next most common types. No villages reported industry as a source of livelihood, despite some industrial development taking place in Sekong Province. Casual labour and livestock herding were particularly common in Dakcheung District as sources of livelihood, as 32 and 29 of the 33 villages reported dependence on them, respectively. In Kaleum District, the picture was slightly more scattered as 15 villages reported dependence on casual labour, 14 on agriculture and 10 on livestock[158].

The assessment assumes that having multiple sources of livelihood makes a village more resilient. If people are flexible to move between agriculture, livestock and manual labour, as climate and non-climate conditions dictate, they are less likely to be seriously affected by climate related hazards or disasters. Dependence on one livelihood, however, indicates increased vulnerability. If, for example, a household (or an entire village) is dependent on agriculture, and a flood damages crops, those villagers would not have other income sources to fall back on.

The assessment surveyed the presence of seven different types of livelihood. Figures 33 and 34 show the number of villages in Dakcheung and Kaleum Districts respectively that reported dependence on the seven different types of livelihood surveyed. Villages could select more than one livelihood source per village. From this simple analysis, we see that Dakcheung District has a greater number of livelihood sources available than Kaleum District. Almost all villages in Dakcheung District noted at least two different livelihood sources, while 19 villages in Kaleum reported that the entire village depends on only one source of income.

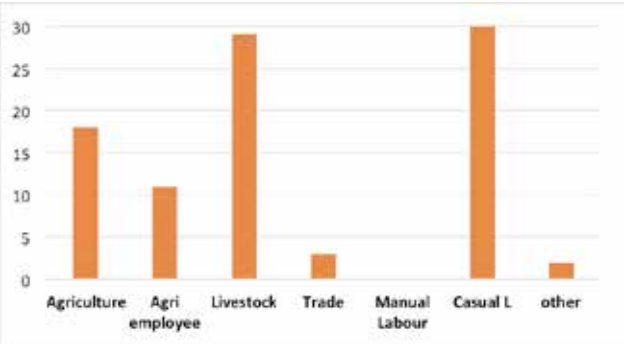


Figure 33 - Livelihood Sources by Village – Dakcheung District

155 Coulombe et al (2016) Where are the Poor? Lao PDR Census-based Poverty Map: Province and District level Results, Lao Statistics Bureau, the World Bank, p.91-99.
156 Ibid, p.21.
157 The poverty gap ratio is defined as the gap between the average income of those below the poverty line, and the poverty line itself. It is expressed as a percentage. For example, in Kaleum district, the average person below the poverty line earns 14.8 per cent below the poverty line.
158 Villages could choose multiple sources of livelihood.

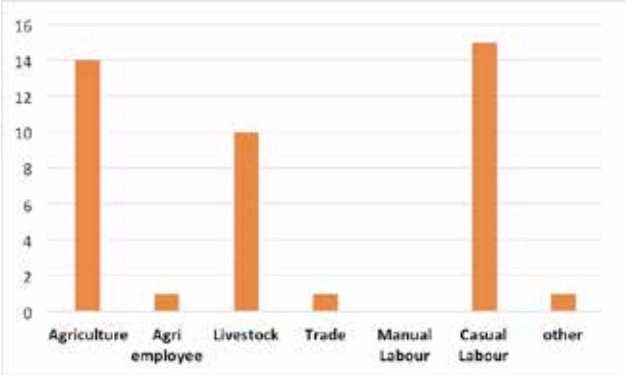


Figure 34 - Livelihood Sources by Village – Kaleum District

Unemployment is very low in the target districts, at 0.2 per cent and 0.9 per cent respectively in Kaleum and Dakcheung Districts. However, this figure is probably misleading, as those without work are unlikely to be counted as seeking work (which is implied in the definition of unemployed). This is supported to some extent by the dependency ratio, which is 51.5 per cent and 50.7 per cent in Kaleum and Dakcheung Districts respectively. This is far higher than in Lamam and Thateng Districts, the remaining districts in Sekong Province, where dependency is 41.4 and 43.8 per cent, respectively. This suggests higher sensitivity, because more than 50 per cent of people in both provinces at working age – between 18 and 64 – are not involved in wage labour and are not seeking work (and, implicitly, are doing only informal, unpaid work) [159].

The data on dependency is not gender disaggregated. However, evidence from Laos and elsewhere suggests that high levels of economic inactivity generally correlate with high numbers of women outside the formal economy. If we assume that those outside the formal economy (i.e. without their own source of livelihood) are more vulnerable to climate change, this suggests that women's vulnerability is increased. This assumption is supported by the figure for the number of women in non-agricultural employment, which is 19 per cent in Kaleum District and 27 per cent in Dakcheung; lower than the figures for Lamam and Thateng Districts, 33 per cent and 32 per cent respectively and much lower than the national average[160].

The literacy rate in Sekong for 15-64-year olds was 72.3 per cent in 2015. This compares unfavourably to the national average for the same age group which is 79.4 per cent. The rate is even lower in Kaleum and Dakcheung Districts, as shown in Table 8, below[161]:

Table 8 – Literacy Rates in Kaleum and Dakcheung Districts

District	Literacy Rate – 15-25 year olds (%)	Literacy Rate – 15-64-year olds (%)
Kaleum	83.5	61.9
Dakcheung	92.6	72.2
Sekong Average	90.9	72.3
National Average	92.0	82.5

Net school enrolment rates remain very low in Sekong, Province, particularly in Kaleum District. The national average school enrolment rates for primary, lower secondary and upper secondary were 75.5 per cent, 41 per cent and 21.7 per cent, respectively, with virtually no gender disparity[162]. The corresponding rates for Sekong are 71.3 per cent, 31.4 per cent and 15.9 per cent for primary, lower secondary and upper secondary. The figures for the target districts in Sekong Province are shown below. As shown in the Table, access to secondary schools, particularly upper secondary schools, is still virtually non-existent outside the main district towns in Kaleum and Dakcheung.

Table 9 - School Enrolment Rates[163]

District	Primary enrolment (%)	Lower secondary enrolment (%)	Upper secondary enrolment (%)
Kaleum	66.8	8.1	4.1
Dakcheung	69.2	22.1	10.9
Sekong Average	71.3	31.4	15.9

These enrolment rates are critically low – especially the secondary school rates (and especially in Kaleum District). This can partly be explained by access; only 8 of the 62 villages surveyed – about 12.7 per cent – have access to a high school of any type. Of these, three are in Kaleum, five in Dakcheung. All 8 villages with a school had some form of road, making them at least accessible for part of the year. This lack of access makes it very challenging for children to attend school. Informally the assessment found that parents are unwilling to allow their children to travel long distances to attend school and can't afford to pay for dormitories or other accommodation for their children where the school is.

159 Coulombe et al (2016) Where are the Poor? Lao PDR Census-based Poverty Map: Province and District level Results, Lao Statistics Bureau, the World Bank, p.114.
160 Ibid, p.91-99.
161 Ibid, p.106.
162 Ibid, p.21.
163 Ibid, p.106.

4.5 Adaptive Capacity: Spatial Structure of the Province

• Villages in Kaleum District have lower levels of infrastructure and socio-economic development than villages in Dakcheung District. Around 70 per cent of the villages in Kaleum are categorized as Local Rural Villages (LRV), meaning they have the lowest level of socio-economic and infrastructure development.

• Better transportation infrastructure across selected villages in Dakcheung District means they have relatively greater access to socio-economic services than in villages in Kaleum District.

• The territorial and socio-economic development of Kaleum District is mainly centred on the southern set of villages of Kaengkhouy, Thongkai and Songkhone, representing the central market of the region, while the northern areas of the district have the lowest levels of socio-economic and infrastructure development.

• In Dakcheung District, the cluster of settlements around Darkbon, Dark Rern, Tongxieng and Dark Ran villages is the most developed area of the region, while villages located in southern areas of the district, where road accessibility is limited, have a lower level of socio-economic and infrastructure development.

The overall aim of this chapter is to present a comprehensive spatial analysis of the current development situation in the province, focusing on the two target districts. This will guide socio-economic and infrastructure development in the districts in the short and medium- term and influence planners at the district and provincial level, who will be able to use the findings to make more informed, strategic planning decisions in the long-term. In the longer term, understanding of the spatial and territorial linkages provides a good basis for analysis of the linkages at district and provincial level.

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

• Determine a functional hierarchy of human settlements among the selected villages, based upon the current availability of critical infrastructure and socio-economic services

• Visualize how balanced the infrastructure and socio-economic development of the region is and most importantly identify the degree of territorial linkages between settlements

• Support national, regional, and local government decision-making to focus and prioritize strategic interventions towards more balanced territorial development patterns.

Functional Hierarchy of Human Settlements

The analysis is based on the data collected in the selected 189 villages and inventories the presence of 86 functions with an economic, administrative, social, or cultural function. The complete list of inventoried functions is presented in Annex A1.

The data collected was fed into an unordered Matrix of Functions spreadsheet, where columns show functions and rows are villages. Sorting by *function weight*[164] and *centrality score*[165] the "ordered matrix" was 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.[166]

The Matrix of Functions and the centrality index show that basic, intermediate, and central villages are identified by establishing one or more levels of differentiation whenever an important gap appears between two successive values of the index. For further information, refer to Annex A1 –Matrix of Ordered Functions. The functions were then analyzed to define a profile for each category based on the combination and diversity of specific provisioning eco-system services, physical infrastructure, social and economic activities.

Of the 86 functions inventoried; only 63 functions are present in the selected villages, mainly covering eco-system provisioning services and basic infrastructure and public services. All settlements show weak economic

164 It is obtained by adding up the number of times a function occurs, which is the function frequency, divided by 100 to obtain the function weight.
165 The "centrality score" is calculated by adding up the weights of all functions present in each administrative unit,
166 Refer to Annex MoF for a complete explanation of the methodology and detailed matrix of ordered functions.

development mainly relying on agriculture and livestock for income, while a few villages have mining operations and hydropower production.

Unlike exposure and sensitivity, adaptive capacity can't be measured directly. Therefore, this assessment takes the number of services available in the target villages as a proxy indicator for the level of adaptive capacity. In Kaleum and Dakcheung Districts, 31 of the 62 villages have only the most basic level of functions and services (at level 1 and 2 in the hierarchy) allowing us to surmise that they have very limited adaptive capacity. Only 1 village in Dakcheung and none in Kaleum District has the highest score in the level of hierarchy, further evidencing low adaptive capacity throughout the two districts because people can't even travel to nearby locations for functions and services.

Table 10 - Type of human settlements identified

Type	Local Rural Villages (LRV)					
Centrality Score	3.10- 63.80	Level of hierarchy	1	2		
Main characteristics	This type of village has the lowest level of socio-economic and infrastructure development. Transportation infrastructure is limited to tracks and trails and gravel roads, mobile repeaters are accessible in some locations, while electricity on the grid is available in some villages. Water is mainly distributed by gravity feed systems from spring water sources and seasonal streams. Only primary education is provided, while health facilities are not available. Agriculture (rice and coffee) and livestock are the main economic activities, together with some casual labour work.					
Functions	15 functions					
Villages	31 Villages (50%)					
Type	Intermediate Rural Villages (IRV)					
Centrality Score	67.80 - 209.90	Level of hierarchy	3	4	5	6
Level of Development	These villages have greater access to basic health facilities (drug kits and health centres with midwifes) and higher education levels (high schools) than local rural villages, while basic needs are provided through small groceries and street sellers. Access to rivers and water sources allow some irrigation systems and more agriculture crops (sugar cane and vegetables). The presence of business and industrial opportunities (hydroelectric power production and mining exploitation) constitutes a good opportunity to increase the range of private professionals.					
Functions	38 functions (15 from the previous category)					
Villages	30 villages (48%)					
Type	Main Rural Villages (MRV)					
Centrality Score	1,756.00	Level of hierarchy	10			
Level of Development	This type of village represents the highest level of socio-economic and infrastructure development. Access to paved roads allows better transportation facilities (such as a petrol station and bus stop) and the presence of markets and commercial establishments (restaurants, construction material shop, furniture shop, banks/western union). In addition, this category provides more security services (police check point and police station) and better health services (doctors and pharmacy).					
Functions	63 functions (38 from the previous category)					
Villages	1 village					

Territorial Linkages and Infrastructure and Socio Economic Development

As shown in map SEK06, the analysis of the spatial distribution of type of settlements and the cartographic representation of levels of hierarchy as based on isopleths[167] allows planners to make assumptions on how balanced the spatial development of the region is, and the degree of territorial influence (if any) of each settlement over neighbouring settlements:

The territorial and socio-economic development of selected villages in Kaleum District is lower and appears to be more unbalanced than in selected villages in Dakcheung District

Around 70 per cent of the selected villages in Kaleum District are categorized as Local Rural Villages, meaning they have the lowest level of socio-economic and infrastructure development, compared with 35 per cent of villages in Dakcheung District.

The territorial and socio-economic development of Kaleum District is mainly centred on the southern tri-polar cluster of villages of Kaengkhouy, Thongkai and Songkhone, while the northern areas of the district, have the lowest levels of socio-economic and infrastructure development. Kaengkhouy and Thongkai Villages, strategically located at the junction of the main roads to Saravan Province and to the northern areas of Kaleum District, provide the highest levels of health facilities, security services and has the main market for the neighbouring rural communities. The lack of adequate transportation infrastructure coupled with access to only basic education seems to be the main constraint for the socio-economic development in northern areas, where population mainly relies on subsistence agriculture, often in the form of shifting cultivation and livestock.

In Dakcheung, the Darkbon, Dark Rern, Tongxieng and Dark Ran cluster of settlements located at the junction of the main east-west road, which extends from Champasak Province through Sekong Province toward Vietnam with the north-south provincial road. This road is the most productive area of the region, where all the hydroelectric power and mining operations, as well as large-scale rice and coffee plantations are located. Villages in southern areas of the district have inferior road accessibility, resulting in their lower levels of socio-economic and infrastructure development.

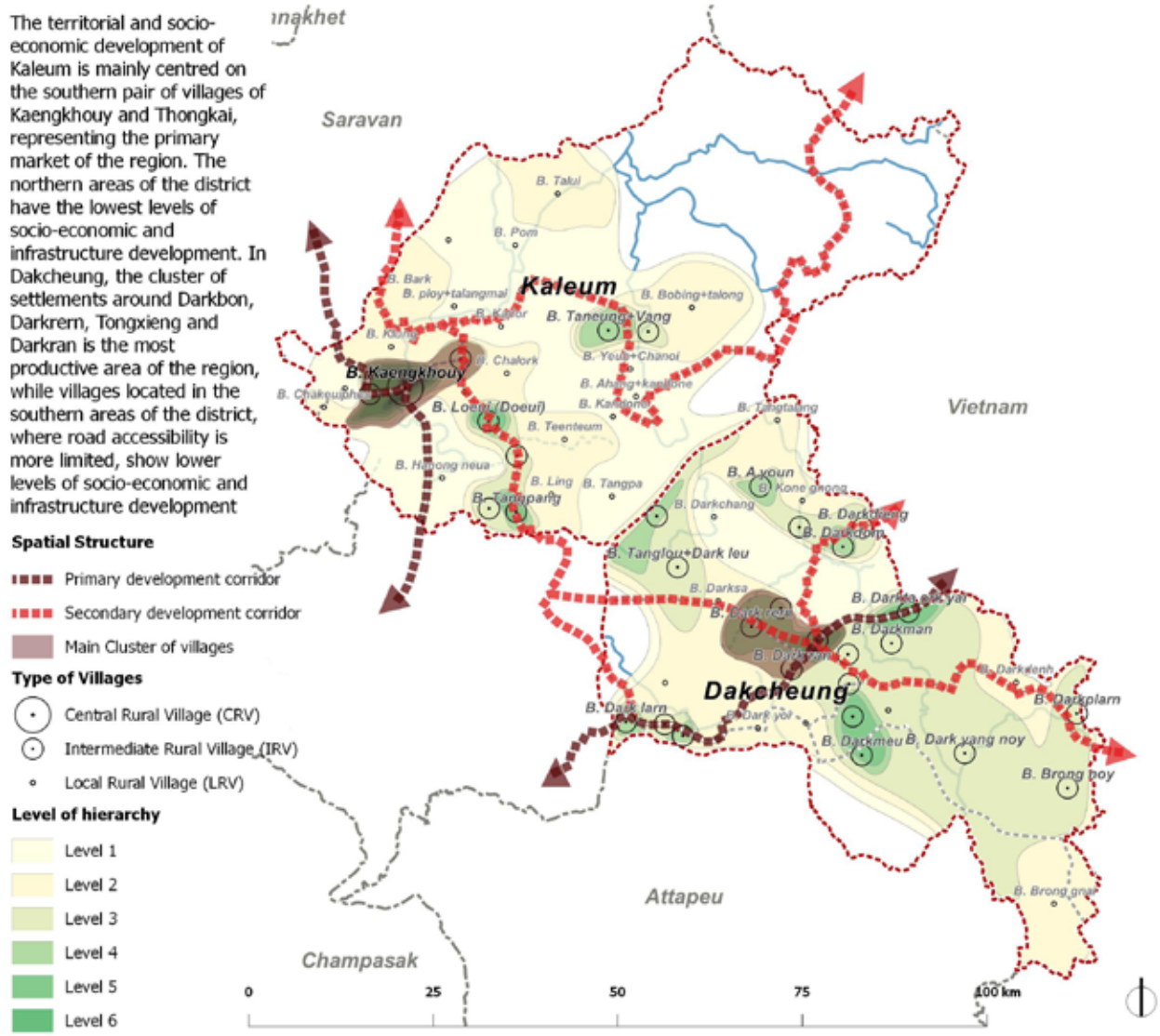
Better transportation infrastructure across villages in Dakcheung district enables better access to socio-economic services than in villages in Kaleum

The target villages where accessibility is better (due to superior road infrastructure and more means of transportation) have better coverage of public services and more economic activities and opportunities.
Most of the intermediate rural villages are located at the junctions of national or provincial roads, which enables better health and education services and more economic activities, compared with more isolated settlements, where only basic education facilities and some other basic needs services are provided.

167 NB: In meteorology, an isopleth indicates a geographical line connecting points showing an equal level of incidence of a specific meteorological feature. In the case of the MoF, the term is used to indicate a geographical line representing a specific aggregate ranking.

TERRITORIAL LINKAGES AND SPATIAL STRUCTURE

The territorial and socio-economic development of Kaleum is mainly centred on the southern pair of villages of Kaengkhouy and Thongkai, representing the primary market of the region. The northern areas of the district have the lowest levels of socio-economic and infrastructure development. In Dakcheung, the cluster of settlements around Darkbon, Darkrern, Tongxieng and Darkran is the most productive area of the region, while villages located in the southern areas of the district, where road accessibility is more limited, show lower levels of socio-economic and infrastructure development



Spatial Structure
- Primary development corridor
- Secondary development corridor
- Main Cluster of villages

Type of Villages
- Central Rural Village (CRV)
- Intermediate Rural Village (IRV)
- Local Rural Village (LRV)

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

Transport Infrastructure
- Road
- Trail

Rivers
- Perennial/Permanent
- Non-Perennial
- Selected Villages
- Districts boundaries
- Provinces boundaries

SPATIAL DISTRIBUTION OF THE TYPE OF VILLAGES

Villages in Kaleum show lower levels of infrastructure and socio-economic development than villages in Dakcheung. Around 70% of the selected villages in Kaleum are categorised as Local Rural Villages (LRV), considered the lowest level of socio-economic and infrastructure development, against the 35% of villages in Dakcheung

Type of Villages
- Central Rural Village (CRV)
- Intermediate Rural Village (IRV)
- Local Rural Village (LRV)

Data Sources: Lao Decide (www.decide.la), Population and Housing Census 2015, Lao Census of Agriculture 2010/2012, UN Habitat
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4.6 Impact Index

To understand and visualize villages' vulnerability, the assessment prepared impact and vulnerability indices. A more detailed methodological note on these tools is provided in Annex 3.

The impact index was calculated using the indicators shown in Figure 35. The index attempts to find which villages have experienced the greatest impacts, based on data from the census and the vulnerability assessment survey.

When the calculations from the index are mapped (shown in Map SEK 07a, below), we see that villages throughout Kaleum and Dakcheung Districts face severe impacts. However, villages in Dakcheung are especially impacted, and, critically, that there are clusters of villages that have faced impacts. This is very problematic because where an isolated village is impacted, people may still be able to access markets and services in neighbouring villages, whereas when clusters of villages are affected it affects not only a greater number of people, but means people are unlikely to be able to access markets and services nearby. This means that where there are clusters of impacted villages, the effects are greater and the capacity of people to recover is reduced.

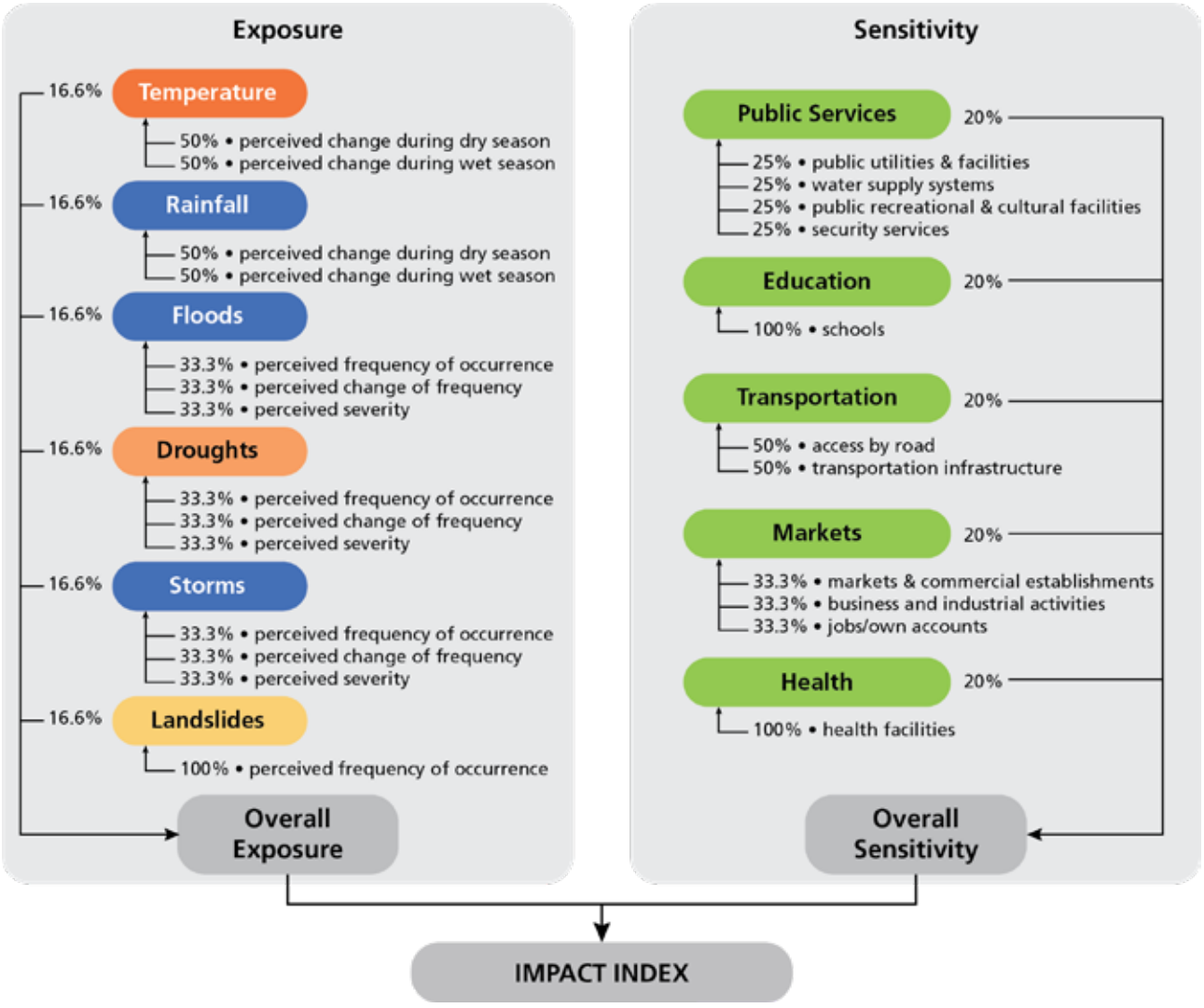
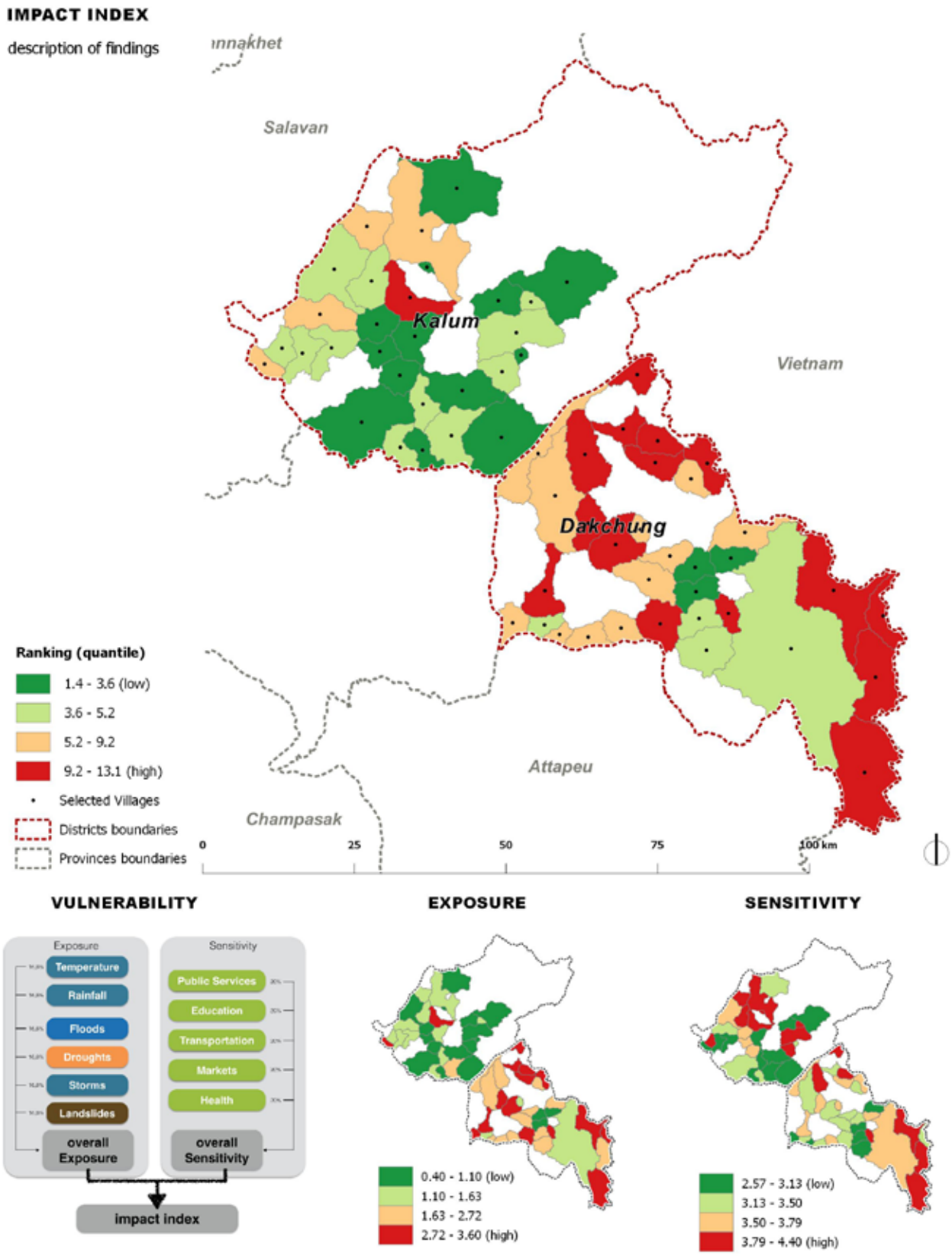


Figure 35 - Method for calculating the Impact Index



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Climate Change Vulnerability Assessment of Dakcheung and Kaleum Districts in Sekong Province **SEK07a**

4.7 Vulnerability Index

The impact index does not, however, reveal villages' and people's capacity to respond to climate change impacts. As outlined in Section 3, vulnerability is composed of three elements: exposure, sensitivity and adaptive capacity. To gain a more complete picture of vulnerability, and thereby inform resilience building activities, the assessment team also developed a vulnerability index for the target villages, shown in Figure 36. Exposure was calculated in the same way, but sensitivity was expanded, and the equation then considered adaptive capacity. The difference in the methodology is also explained in Annex 3.

The vulnerability index shows much higher levels in Kaleum District compared to the impact index, because people in Kaleum District have very little capacity to respond to climate change=related impacts, if they are impacted in the future. This is an important consideration for decision makers; though Kaleum has not been severely impacted in the past, there is every chance it will be in the future, and if it is hit by major flooding or a tropical cyclone, capacity to respond there is very low. Dakcheung District remains vulnerable, because although capacity is slightly higher there, it is still low overall, compared to other districts in the project area, and it has experienced more frequent impacts in the past.

According to the vulnerability index, Kaleum and Dakcheung Districts face the highest vulnerability of the eight districts targeted by the project. 19 of the 20 most vulnerable villages in the project are in Kaleum and Dakcheung Districts. The Province's mean vulnerability score in the index is 7.32 (with 10 being the highest), is higher than the averages for Saravan Province, at 6.09, and 5.75 in Attapeu Province. The most vulnerable villages are in the northern and southern parts of both Kaleum and Dakcheung, while the least vulnerable ones can be found in the central parts of the districts. Across the two districts, 34 villages are in the highly vulnerable category, and 44 have a vulnerability index score greater than the average for the project area. Only nine villages are in the least vulnerable category; six in Kaleum District and three in Dakcheung.

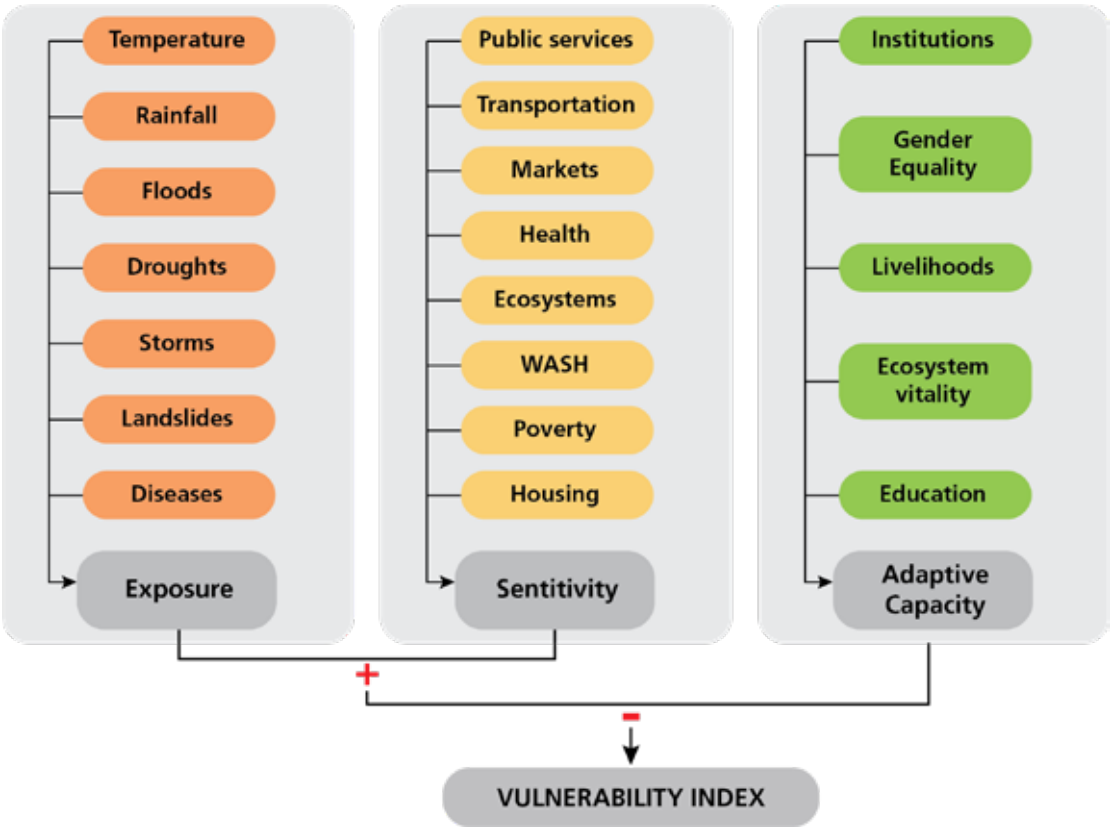
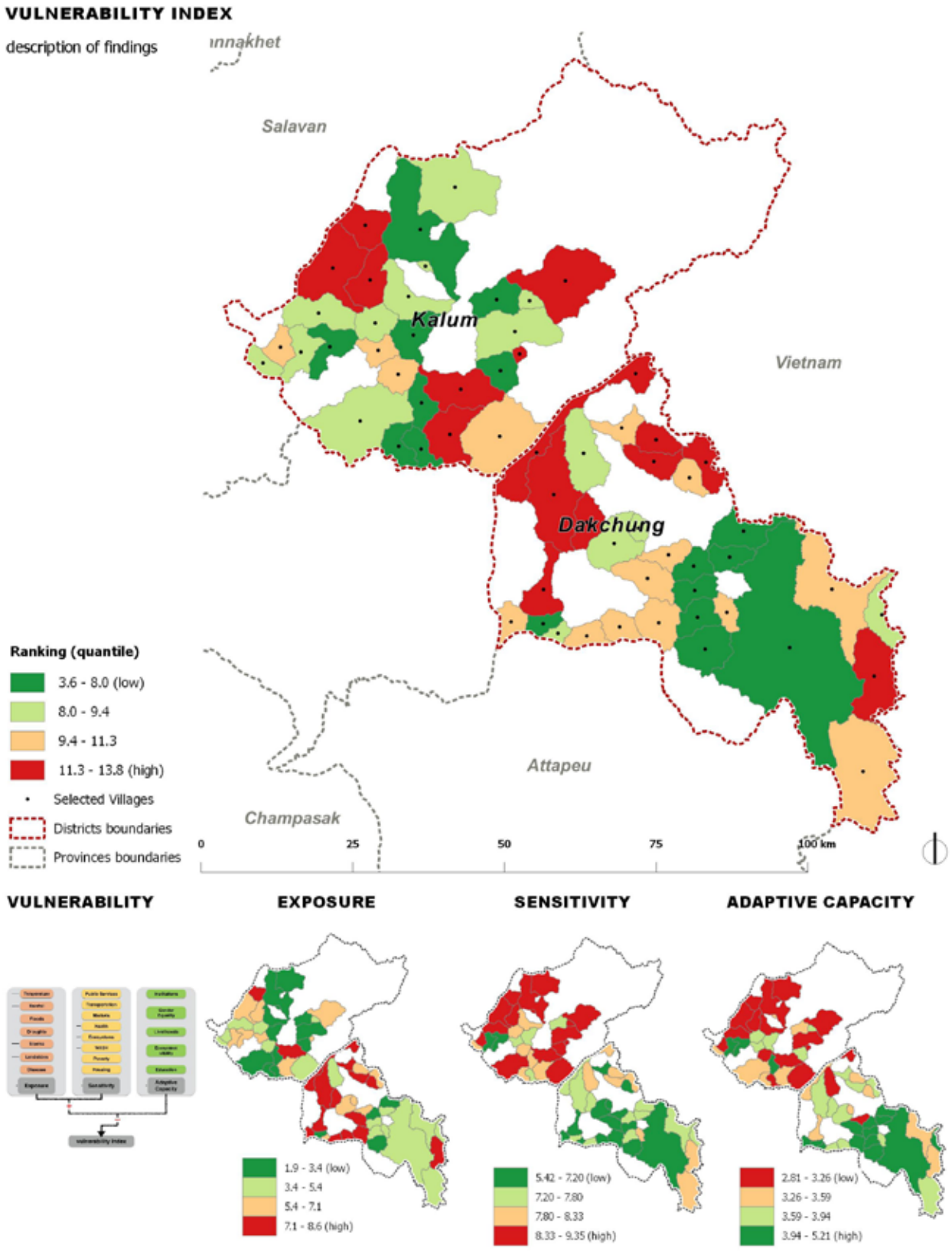


Figure 36 - Calculating the Vulnerability Index



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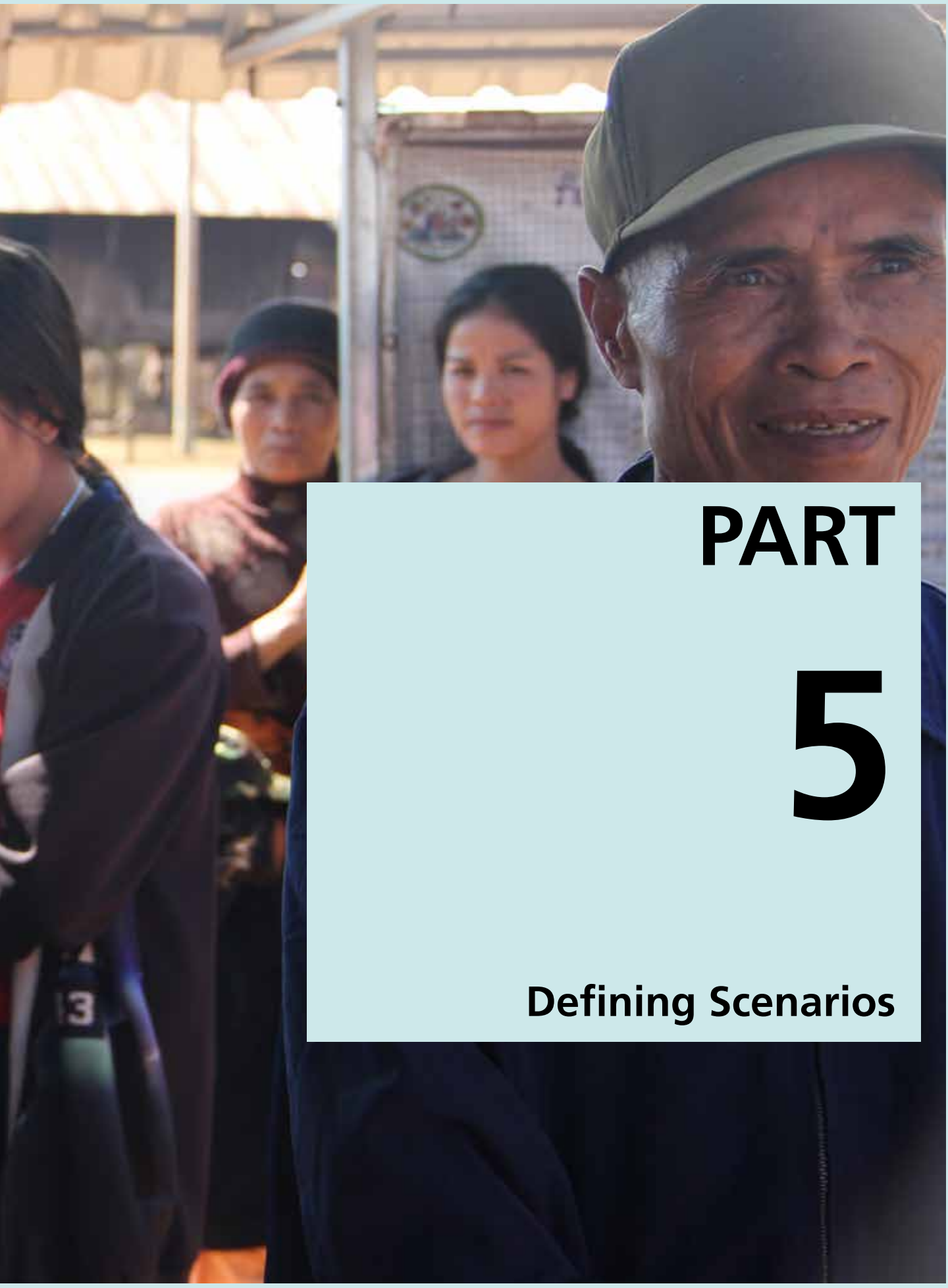


PART 5

Defining Scenarios

5 Defining Scenarios

Scenario	Required response and impact
A: Business as Usual	**Situation:** The authorities and communities don't recognize the urgent need to address current and future climate change impacts and vulnerabilities, and no additional action, beyond existing government programmes and initiatives is taken. **Impact:** Climate change will increasingly affect people's life, livelihoods, health and safety until 2050 and beyond; current socio-economic and environmental vulnerabilities will aggravate; development will be impeded.
B: Resilience is built to maintain current living standards by 2050	**Situation**: The authorities and communities recognize the urgent need to address current and future climate change impacts and vulnerabilities. However, there are limited financial, technical and human resource capacities capacities for large-scale investments and climate change adaptation responses. Under this scenario, local adaptation plans can focus on: • Improved environmental management, sustainable natural resources utilization and land-use planning, ecosystems restoration and conservation, introduction of climate-smart agricultural practices • Limited investment in infrastructure but sufficient to ensure that functionality is maintained to present levels, through improving transport infrastructure and networks, and access to public services, particularly water; and diversification of water and energy sources at a community or household level. • Small-scale socio-economic measures such as agricultural production diversification, and improved access to loans or microfinance. **Impact**: While climate change will affect people's lives, livelihoods, health and safety until 2050, provinces and districts can maintain current living standards. However, climate change would continue to be a challenge to social development and economic growth.
C: Resilience is built that enables economic and social development at least in line with national priorities and SDG targets, despite changes in climate, by 2050	**Situation**: The authorities and communities recognize the urgent need to address current and future climate change impacts and vulnerabilities and are committed to implement a wide range of low- and high-cost climate change adaptation measures. Provinces and Districts have the support of national authorities and international partners to achieve environmental, infrastructural and socio-economic objectives. These could be: 1) Healthy ecosystem that sustains life; 2) Resilient infrastructure that protects people and promotes development; 3) Diversified economy that supports sustainable and resilient economic and social development. 4) An educational system that provides people with skills to adapt to economic change. **Impact**: Climate change will affect people's life, livelihoods, health and safety until 2050, and beyond; however, provinces and districts will be able to maintain current living standards and to achieve Laos's national development priorities and the Sustainable Development Goals.

5.1 Future Impacts and Vulnerabilities Under a Business as Usual Scenario

a. Potential Impact Pathways graph

By analyzing the surveys and secondary data generated by the assessment, a pathway to impact graphic was created, shown below in Figure 37. This shows the primary and secondary impacts of climate change that can reasonably be expected in Sekong by 2050, assuming no actions are taken to adapt. In many cases, we see a worsening of existing conditions. The path to impact graphic also shows the complex interrelationship between hazards and impacts, including how a given primary impact can cause multiple secondary impacts.

The left-hand column shows the full range of projected changes in the climate as discussed in Section 3 of this report. The 2nd column shows four major hazards that already affect Sekong Province and are likely to become more severe in the future because of projected climate change.

The primary impacts that result from these hazards are listed in the next column. Understanding the relationship between change by 2050, hazards and impacts, planners can enhance their understanding of which people are more likely to be vulnerable to which impact. Secondary impacts consider the broader, knock-on effects in the target districts. For example, crop failures arising from storms or flooding could contribute to worsening nutritional outcomes (especially when failures occur over consecutive years). However, they also cause other issues, such as increasing the potential for mass migration – which has not yet been seen in Kaleum and Dakcheung Districts. Primary and secondary impacts can worsen the cycle of poverty. For example, crop failure and a lack of water can reduce productivity, raise food prices and worsen people's health. This can cause either migration or borrowing to cover basic expenses, which are required to avoid malnutrition. The cycle can be repeated or exacerbated by severe climate related hazards.

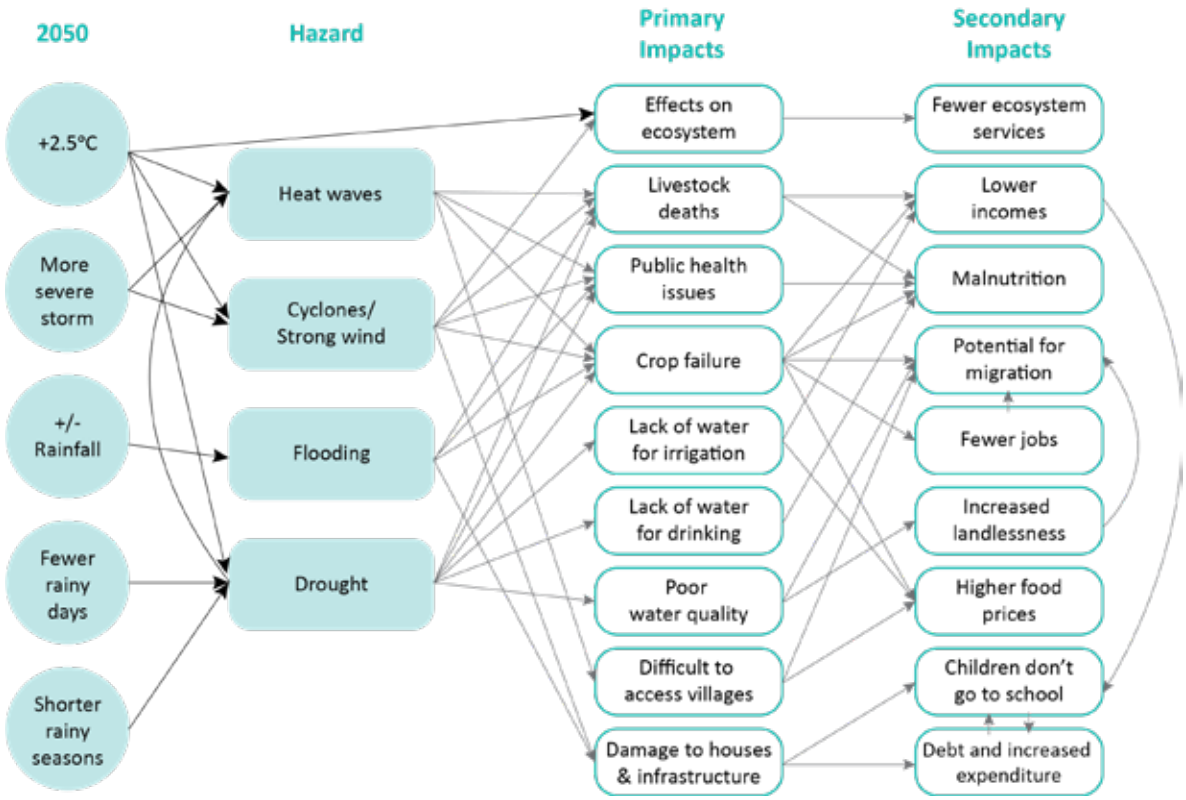


Figure 37 - Pathway to Impact Graphic

b. Future Impacts under BAU

The assessment developed coefficients of change, based on current trends, to show the worst-case scenarios for 2050 if no adaptation actions are implemented. As such, the results are the "estimated reduction" compared to the 2017 baseline given the projected climate changes in temperature and rainfall.

The future vulnerabilities were determined by applying coefficients of change to the current capacities of the people of selected villages to benefit from the main eco-system provisioning and infrastructure services identified; forestry sources, water sources and transport services.

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

National forest cover is reported to have declined dramatically between 1992 and 2002, at an average rate of 134,000 hectares per year (equivalent to 1.3 per cent per year). This decade also saw widespread deterioration in forest quality, with dense forest declining from 29 per cent to 8.2 per cent between 1992 and 2002, and open forest increasing from 16 per cent to 24.5 per cent. The UN REDD program estimates that, if the current reduction rate continues, the forest area will decrease to 7.4 million hectares (31.3 per cent of the total land) by 2020[168].

	Hazard	Eco-system service	Main projected impacts
+ 2.5°C warmer	Higher average temperatures	*Vegetation cover*	The increase in temperatures might enhance the frequency of forest fires and the pest and disease infestations in forests.
+ / - Rainfall	There will be more intense rainfall events, and more frequent and severe floods	*Soils*	The increase in magnitude and frequency of extreme events such as flooding is expected to cause soil erosion, degradation of watershed, and massive landslides.
		Vegetation cover	Changes in precipitation patterns might affect the survival of seedlings and saplings.

- If no adaptation measures are implemented, the current deforestation trends would increase forest degradation in highland areas, reducing the numerous basic ecosystems services they provide that support climate resilience – erosion control, defences against severe storms and natural habitats- may also be lost.

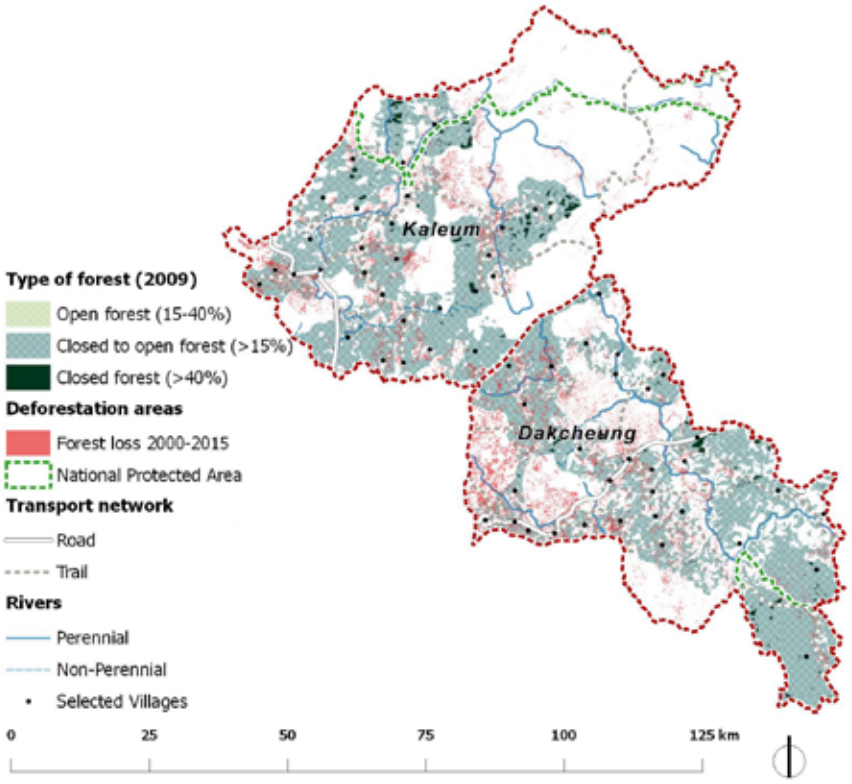
- This continuing deforestation, both low land areas and upstream, will make communities close to rivers highly vulnerable to more frequent and severe intense rainfall events.

- 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 further to gather essential materials like firewood and materials for their homes.

168 USAID Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin: Main Report.

FOREST COVERAGE IN SELECTED VILLAGES IN 2017

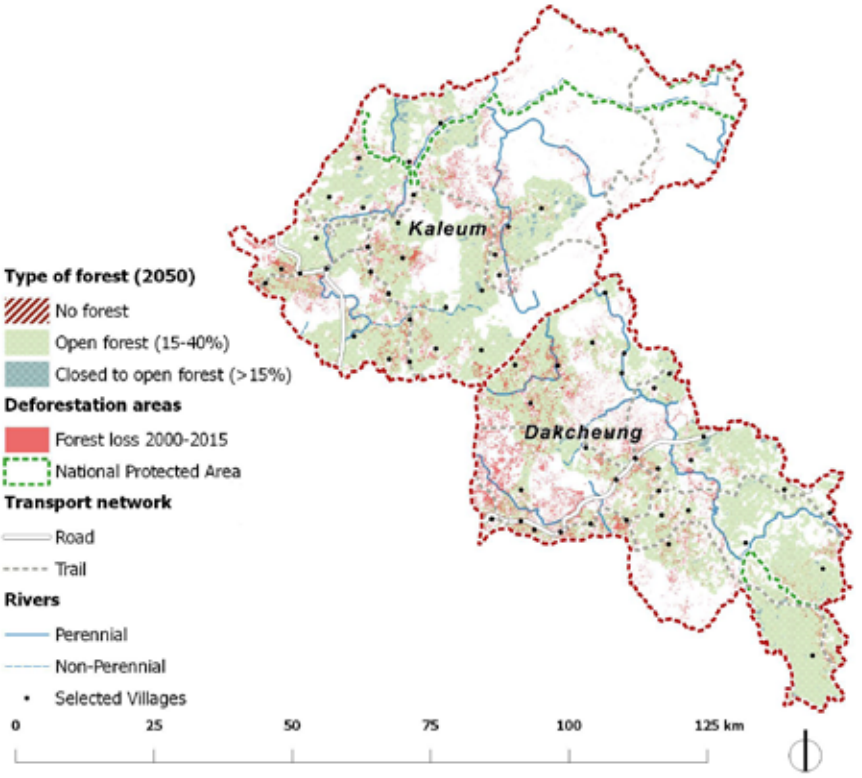
Forests are the source of timber and non-timber products that are critical income sources for rural communities. National forest cover is reported to have declined by 134,000 hectares (about 1.2%) per year between 1992 and 2002. The main drivers of forest and habitat loss are shifting cultivation, legal and illegal logging land conversion for agriculture and plantations and infrastructure development.
In the absence of more updated data, the forest coverage for 2017 has been calculated based on the GlobCover land-cover map for 2009



ESTIMATED FOREST COVERAGE IN SELECTED VILLAGES IN 2050

+ 2ºC warmer | +/- Rainfall | + drought

If no adaptation measures are implemented, the current deforestation trends would increase forest degradation in highland areas, reducing the numerous ecosystem services that contribute to climate resilience, such as erosion control, defence against severe storms, and natural habitats. Continued deforestation in upstream areas will increase exposure to flooding in the plains along the Sekong River, which is already highly prone to flooding



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Two key areas of the rural infrastructure sector are identified as highly vulnerable to climate change: roads and water supply infrastructure. The most prominent climate threats to rural infrastructure are flooding, including flash flooding, and landslides.

Access to Freshwater for Drinking Water Uses by 2050

As highlighted in Section 4, availability of fresh water mainly relies on surface water sources, with a high proportion of households exposed to unprotected water sources, which can lead to water source contamination, increasing water and vector-borne diseases.

Most of the selected villages depend on surface water sources,[169] mainly distributed through gravity systems, allowing communities an important degree of autonomy in terms of operation and maintenance. Communities reported suffering a lack of water due to temperature variations. This high dependence on surface sources exposes the villages to higher vulnerability as higher rates of evaporation and more drought months are projected in the coming years. Moreover, in the medium-term groundwater sources will also be affected as aquifers will take longer to recharge, leading to the need for further infrastructure improvement investments in the form of storage capacity and borehole depth, for example.

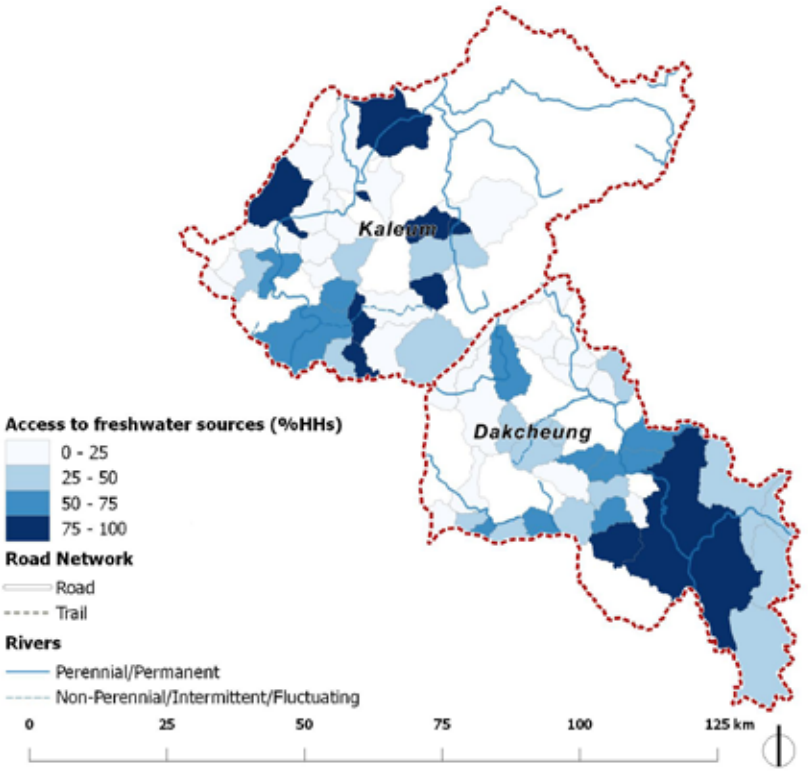
The capacity of the population to have access to surface freshwater for drinking use relies mainly on three eco-system services (surface freshwater, geology and vegetation cover) that will be highly impacted by the projected climate change:

	Hazard	Eco-system service	Main projected impacts
+ 2.5°C warmer	Higher average temperatures	*Type of vegetation*	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 rainy days and a 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 toward the end of the dry season.
+ / - Rainfall	More heavy rain, less useful and more damaging	*Type of vegetation*	Loss of vegetation cover, increased runoff rate, and soil erosion, damaging water storage facilities.
		Groundwater sources	Decreased sub-surface flow and recharge as most flows run-off 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.

169 According to Census 2015 categories, surface water sources are river, stream, dam, mountain, rain.

CAPACITY OF THE POPULATION TO ACCESS FRESHWATER FOR DRINKING WATER USES IN 2015

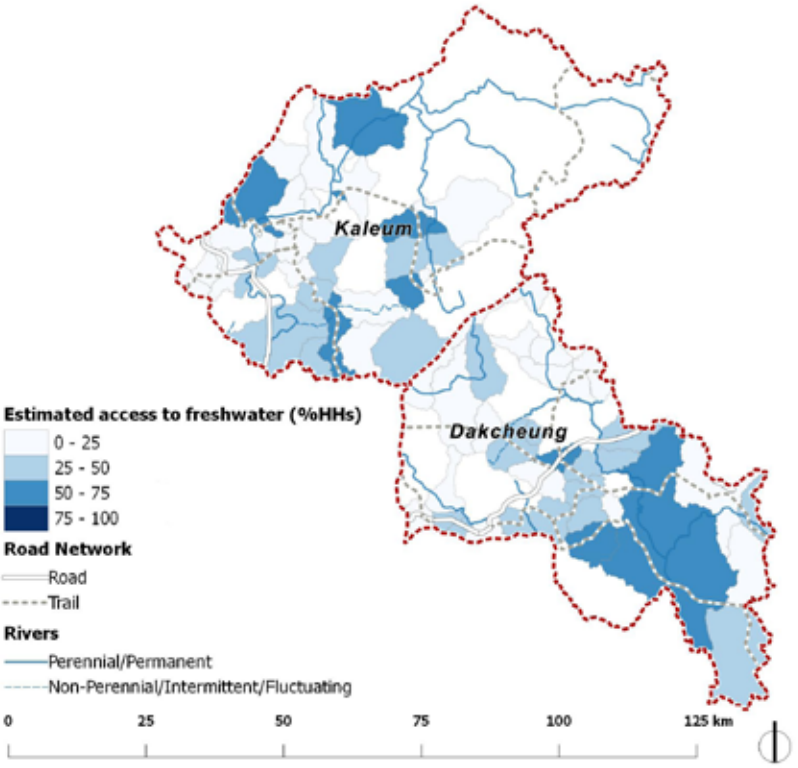
Around 70% of villages depend on surface water sources. This is primarily because of the upland nature of the districts; most of the surface water (from streams and mountain sources) is distributed through gravity fed systems (76% in Kaleum and 59% in Dakcheung), which can allow the population, with the right support, to have reliable, year-round access to water.
The percentage of households having access to freshwater was calculated by applying a coefficient of change based on current impacts to the 2015 census data



CAPACITY OF THE POPULATION TO ACCESS FRESHWATER FOR DRINKING WATER USES IN 2050

+ 2°C warmer | +/- Rainfall | + drought

Access to freshwater for drinking use in 2050, if no adaptation measures are implemented, is calculated by applying coefficients of impact on 2017 baseline by type of water sources and infrastruture used, given the projected changes in temperature and rainfall, which will result in a longer and more frequent and severe droughts, increased evaporation and more intense rainfall events, leading to severe floods damaging water facilities for longer periods.



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Access to the transportation network will be highly reduced in highland areas by 2050

In Kaleum and Dakcheung Districts' highland areas, mobility is a significant constraint for the socio-economic and livelihood development of rural communities. Currently, rural transport mainly relies on a network of secondary and tertiary unpaved roads and trails, which make these rural communities highly vulnerable to strong storms and unusually heavy rainfall. These mobility constraints already jeopardize rural livelihoods but will worsen in emergency situations following the projected extreme weather events.

Frequent landslides, flash floods, and hillslope isolate mountain villages from markets, medical facilities, schools, and other core community services.

Rural road networks are critical infrastructure highly exposed to climate change, as they mainly depend on the interaction of two main eco-system services (types of vegetation and soil):

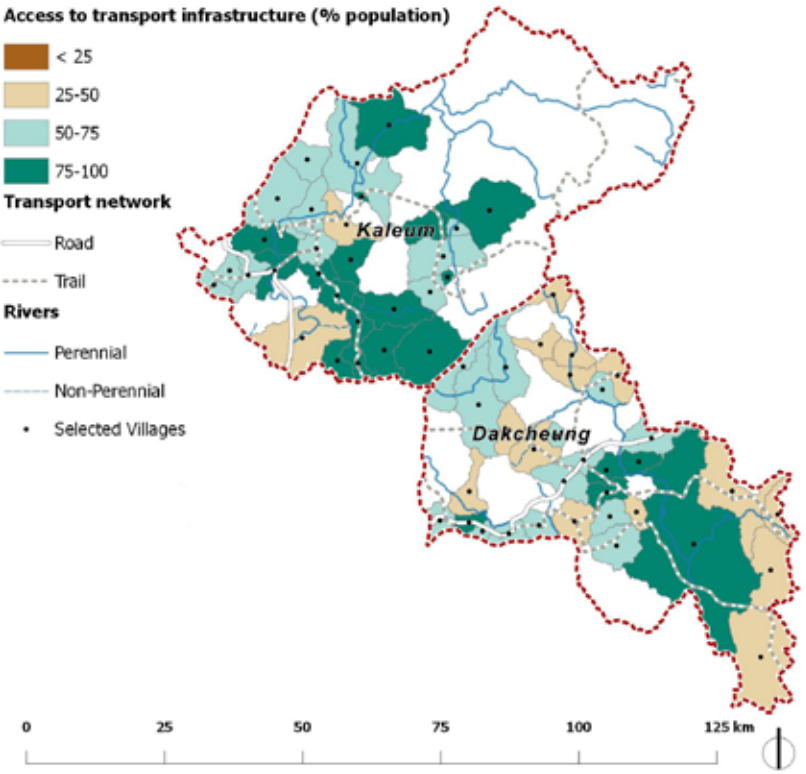
	Hazard	Eco-system service	Main projected impacts
+ 2°C warmer	Higher average temperatures	*Soils*	Higher temperatures will increase the rates of evapotranspiration and reduce the moisture content of the soil making it vulnerable to erosion in areas where there are unpaved roads
+ / - Rainfall	There will 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
		Vegetation cover	Deforestation increases exposure to erosion and slope instability Landslides in riverbank areas damage vegetation cover and destroy roads and bridges

- If no adaptation measures are implemented, the lack of capacity to mitigate erosion through formal infrastructure coupled with weak transport and communication will make communities highly vulnerable to more floods and inundation.
- In villages located in remote highland areas, where the transport communication mainly relies on a network of rural unpaved roads on steep slopes, more intense rainfall events will increase road degradation and damage to bridges from landslides and flash floods.

ACCESS TO TRANSPORT NETWORK IN SELECTED VILLAGES IN 2017

In Kaleum and Dakcheung the current rural transport network mainly consists or secondary and tertiary unpaved roads and trails, which make these rural communities highly vulnerable to strong storms and unusually heavy rainfall. Communities in the selected villages reported frequent damage to infrastructure due to storms and floods, isolating mountain villages from markets, medical facilities, schools and other community services.

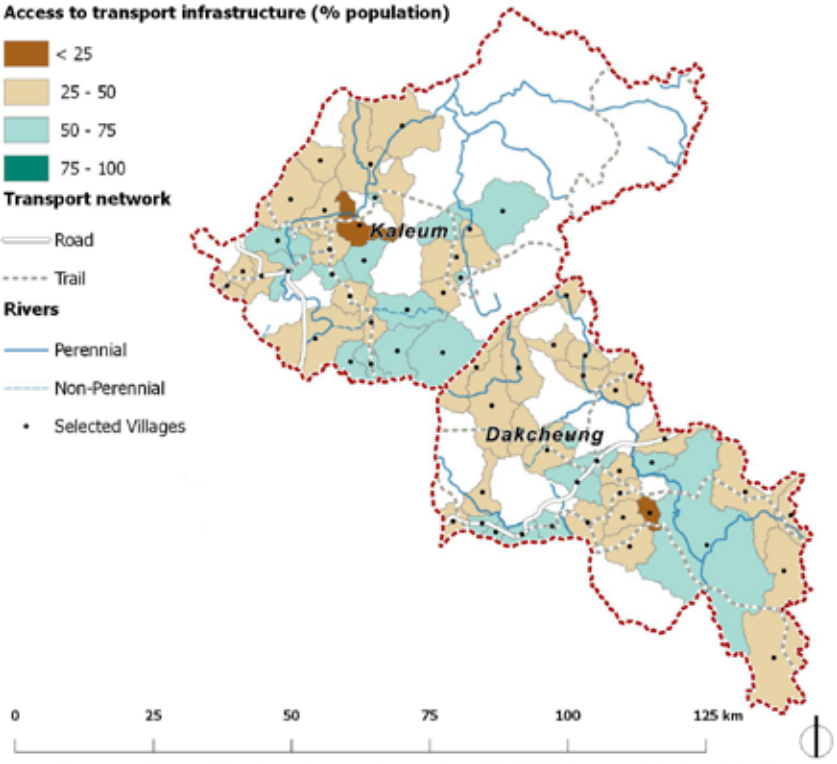
The percentage of the population that has access to the transportation network in 2017 was calculated by combining the type of roads each village has access to, the type of transportation services available in each village with landslides, and the landslides and floods impact on infrastructure reported in the selected villages.



ESTIMATED ACCESS TO TRANSPORT NETWORK IN SELECTED VILLAGES IN 2050

+ 2°C warmer | +/- Rainfall | + drought

If no adaptation measures are implemented, the lack of capacity to prevent erosion through infrastructure, coupled with weak transport communication, will lead to communities being highly vulnerable to more floods and inundation. Remote villages in highland areas, where transport mainly relies on unpaved trails on sloping land will be more affected by intense rainfall events, which will in-turn degrade roads and damage bridges



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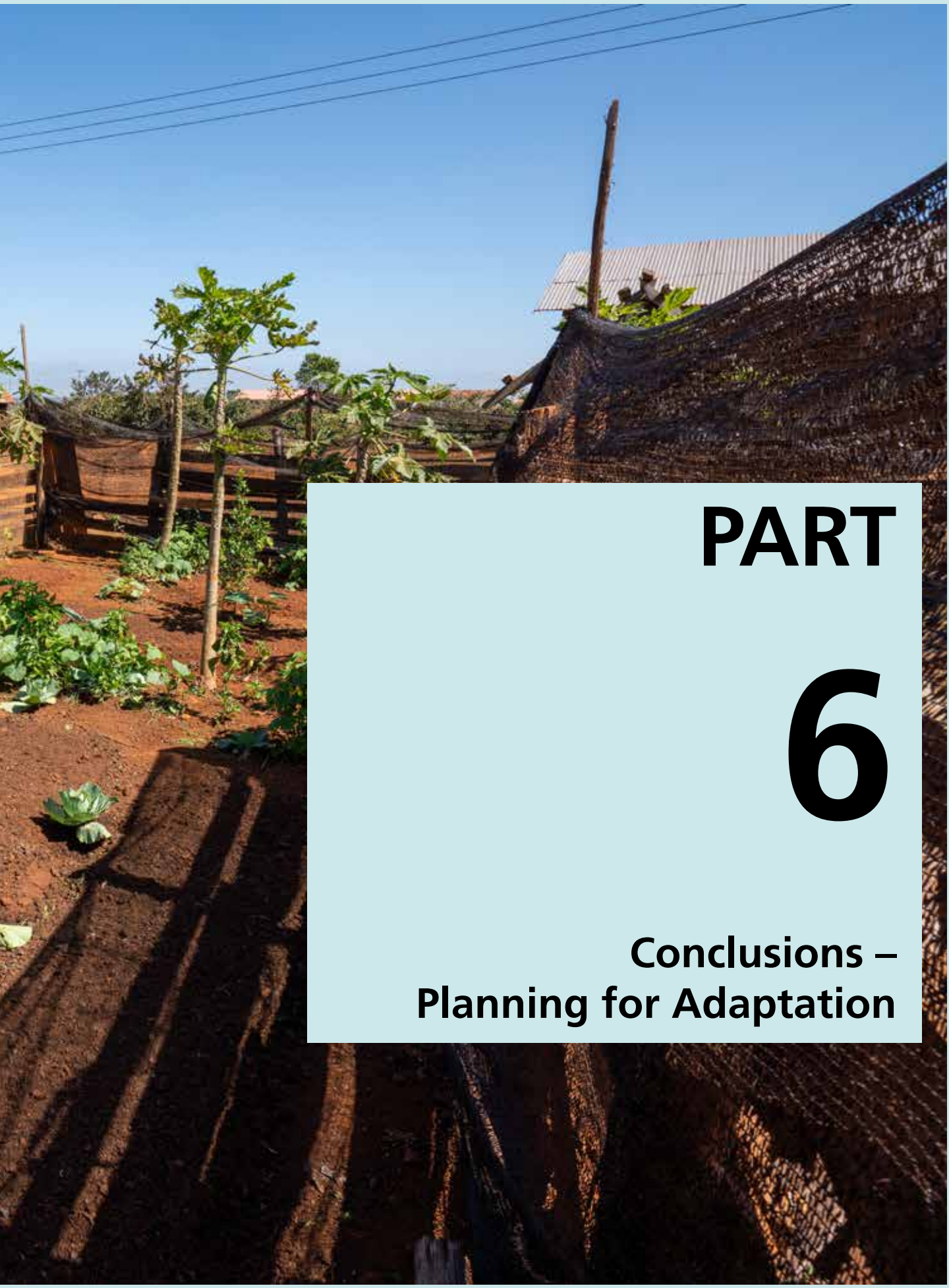


PART 6

Conclusions – Planning for Adaptation

6 Conclusions – Planning for Adaptation

6.1 Towards Action Planning

The target villages in Sekong Provinces have attributes that make them highly vulnerable considering already observed and projected future climate change.
As explained in previous chapters, the projected change in climate will have a great impact unless adaptation actions are prioritised and implemented over time.

Few livelihood options, underdeveloped infrastructure, and long-term deforestation create a very vulnerable context, which will be exacerbated by future climate change, bringing higher temperatures, changing rainfall patterns and more extreme weather.

- **Deforestation trends will make communities highly vulnerable to more frequent and severe intense rainfall events**

The exploitation of natural forests during recent decades has contributed to the degradation of the natural resource base upon which most of the population depend, directly or indirectly, for their livelihoods. Forests are under pressure from the expansion of agricultural activities, rubber plantations, industrial development and illegal cutting at the individual and household scale. With current deforestation trends, forest degradation will reduce the numerous basic ecosystems services forests provide that support climate resilience, such as erosion control, defences against landslides and natural habitats, and most importantly, forestry sources to build houses and for fuel wood.

- **Freshwater availability will decline**

The projected changes in precipitation patterns and an increase in mean temperature will lead to higher rates of evaporation and longer months of drought. In addition, stronger storms and unusually heavy rainfall will inevitably damage water infrastructure. Without any measures to improve water storage infrastructure and distribution management, the amount of water available to communities will decrease, especially during the dry season.

- **Landslides and floods will become more frequent, more severe, and last for longer isolating communities for longer periods**

The lack of capacity to prevent erosion through formal infrastructure coupled with weak transport and communication infrastructure will make communities highly vulnerable to more floods and inundation. Landslides and floods will be more frequent, damaging roads and bridges, and, in the worst cases, isolating communities for longer periods following the projected extreme weather events.

- **Stronger climate hazards will jeopardize communities' coping capacities to deal with them**

The lack of functioning Disaster Management Committees and disaster facilities in many villages, which are crucial for planning and training communities on what to do before, during and after disaster events, will increase communities' vulnerability. In addition, weak access to mobile repeater and communication networks, which can be a key tool used in disaster preparation, early warning and communication during and after the emergency, will lead communities highly exposed to stronger climate hazards and risks.

Under these circumstances, building resilient villages to climate change is a great and urgent challenge, on which the life and welfare of thousands of people depend.

a. Strategic adaptation measures

The assumption in this assessment is that those human settlements where fewer functions are present are more sensitive, have a lower adaptive capacity, and that they would become more resilient if the services that are largely missing could be provided.

However, under a regional planning perspective, where a region is not only a system of functionally diversified settlements but also a network of social, economic, and physical interactions, larger villages' vulnerabilities are also felt in smaller villages. This means that strategic investments in the main villages, where vulnerability is very high, will help to build resilience in both main and local settlements, as they are strongly interconnected.

The territorial and socio-economic development of Kaleum District is mainly centred on Kaengkhouy, Thongkai and Songkhone Villages, which are the main trading area of the district, while the northern areas of the district show the lowest levels of socio-economic and infrastructure development. In Dakcheung, the cluster of settlements around Darkbon, Dark Rern, Tongxieng and Dark Ran Villages are the most productive area of the region, while villages located in southern areas of the district, where road accessibility is seasonal

or absent completely, have lower levels of socio-economic and infrastructure development. If we overlay vulnerability to climate change – as identified through the vulnerability index exercise – these main villages show high levels of vulnerability (orange to red colours in SEK11 map).

This leads to some strategic adaptation measures at the provincial and district level:

- **Improve water storage infrastructure and distribution management** by diversifying freshwater sources and water facilities in all target villages.

- **Enhance road infrastructure and transport services to/from main villages to surrounding rural villages in the district and beyond**, to improve connectivity and allow better access to markets.

- **Create and enhance Vocational Training Centres in main villages** to provide the skilled people needed in the agro-industries and enhance agricultural practices at the household level.

- **Improve access to electricity and other renewal sources of energy** to reduce deforestation.

- **Enhance coverage of disaster facilities and services in each village** to reinforce communities' awareness and coping capacity to deal with climate hazards.

Beyond these actions, Figure 38 highlights functions that would be needed in the target villages to reduce the overall vulnerability of the district and work toward the sustainable and resilient development scenario. Providing these functions in the longer term would be synonymous with climate change adaptation actions.

b. Action Planning in Kaleum and Dakcheung Districts

This section very briefly describes the adaptation action planning process that could be implemented in Sekong Province to help to achieve the sustainable and resilient development scenario, outlined above.

Long-list of actions tagged by village

• A long-list of potential actions, based on the findings of this assessment, will be developed by provincial and district level officials. Following the guidance material referenced above, the long list will gather together all the possible adaptation activities that could be implemented in the target villages.

Objectives set and prioritized, each with a set of supporting actions

• The critical issues identified as a result of the assessment and a set of objectives will be defined. There will most likely be three main objectives in each plan, which will support work across multiple sectors (for example, improve ecosystems, provide climate resilient basic services, reduce risks to livelihoods).

• Then indicators will be developed that will measure the achievement of objectives.

• Once indicators are decided, prioritise the objectives that the plan should achieve which will inform the areas the project will work on (and, by extension, which areas will be broader priorities, for implementation under national government finance or support from other donors).

• Once this is complete, the objectives should be aligned with the long-list of potential actions. This will begin the process of shortlisting the actions; by filtering out actions that do not meet the objectives, that are not likely to be effective, or that are clearly not feasible.

Village acceptance of actions gained, with environmental and social risks initially screened

• A village-level questionnaire about the long-listed actions is necessary . This is developed and delivered under a similar methodology to the questionnaire used during the assessment. The questionnaire would be necessary to gain the inputs from and consent of villagers spread across the project's large area.

• An initial safeguards screening at the village level is also necessary. This can be incorporated into the aforementioned village survey.

Prioritized actions in each village

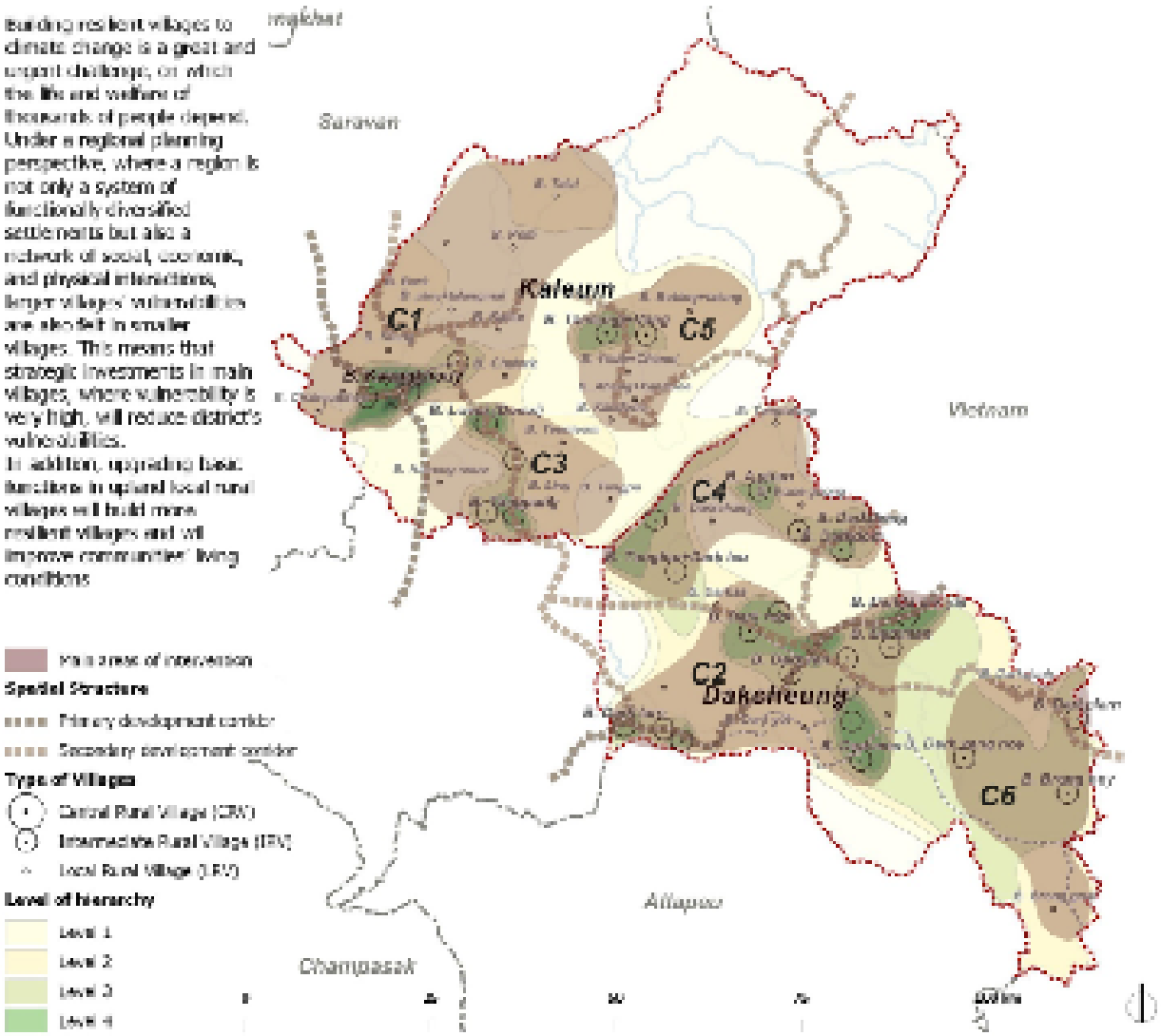
• A Multicriteria analysis (the procedure for which is outlined in UN-Habitat's Planning for Climate Change) would help to prioritize actions in the plan.

Further screening, including by engineers and other technical experts, would likely be required to meet international-standard environmental and social safeguard procedures.

• Finally, a cost-benefit analysis (CBA) exercise would analyze short-listed actions to ensure that they are cost-effective for the benefits gained. CBA is an important tool for decision makers to support cost-effective decision making as well as to support pitching projects to other donor.

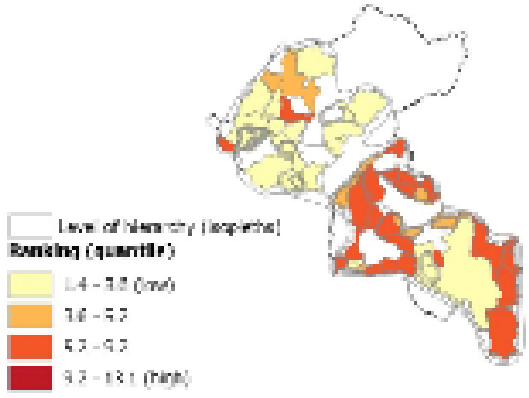
PLANNING FOR ADAPTATION AND BUILDING RESILIENCE: STRATEGIC AREAS OF INTERVENTION

Building resilient villages to climate change is a great and urgent challenge, on which the life and welfare of thousands of people depend. Under a regional planning perspective, where a region is not only a system of functionally diversified settlements but also a network of social, economic, and physical interactions, larger villages' vulnerabilities are also felt in smaller villages. This means that strategic investments in main villages, where vulnerability is very high, will reduce district's vulnerabilities.
In addition, upgrading basic functions in upland local rural villages will build more resilient villages and will improve communities' living conditions



IMPACT INDEX AND SPATIAL STRUCTURE

By overlaying the proposed spatial structure and the vulnerability ranking to climate change – as identified through a vulnerability index exercise by combining exposure and sensitivity –, suggests "priority areas of intervention" where building infrastructure will reduce district's vulnerabilities



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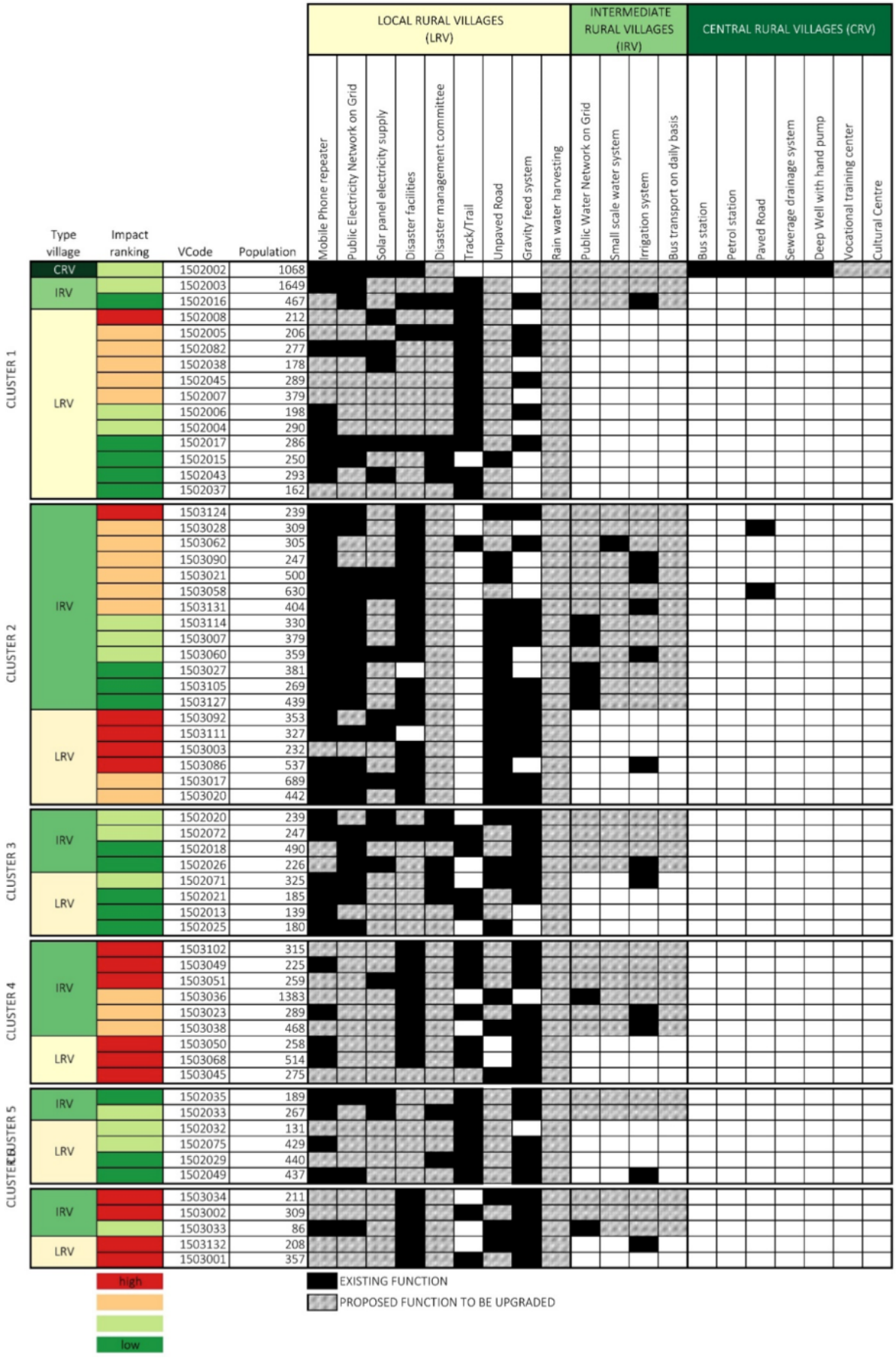

Figure 38 - Priority functions to be added in selected villages

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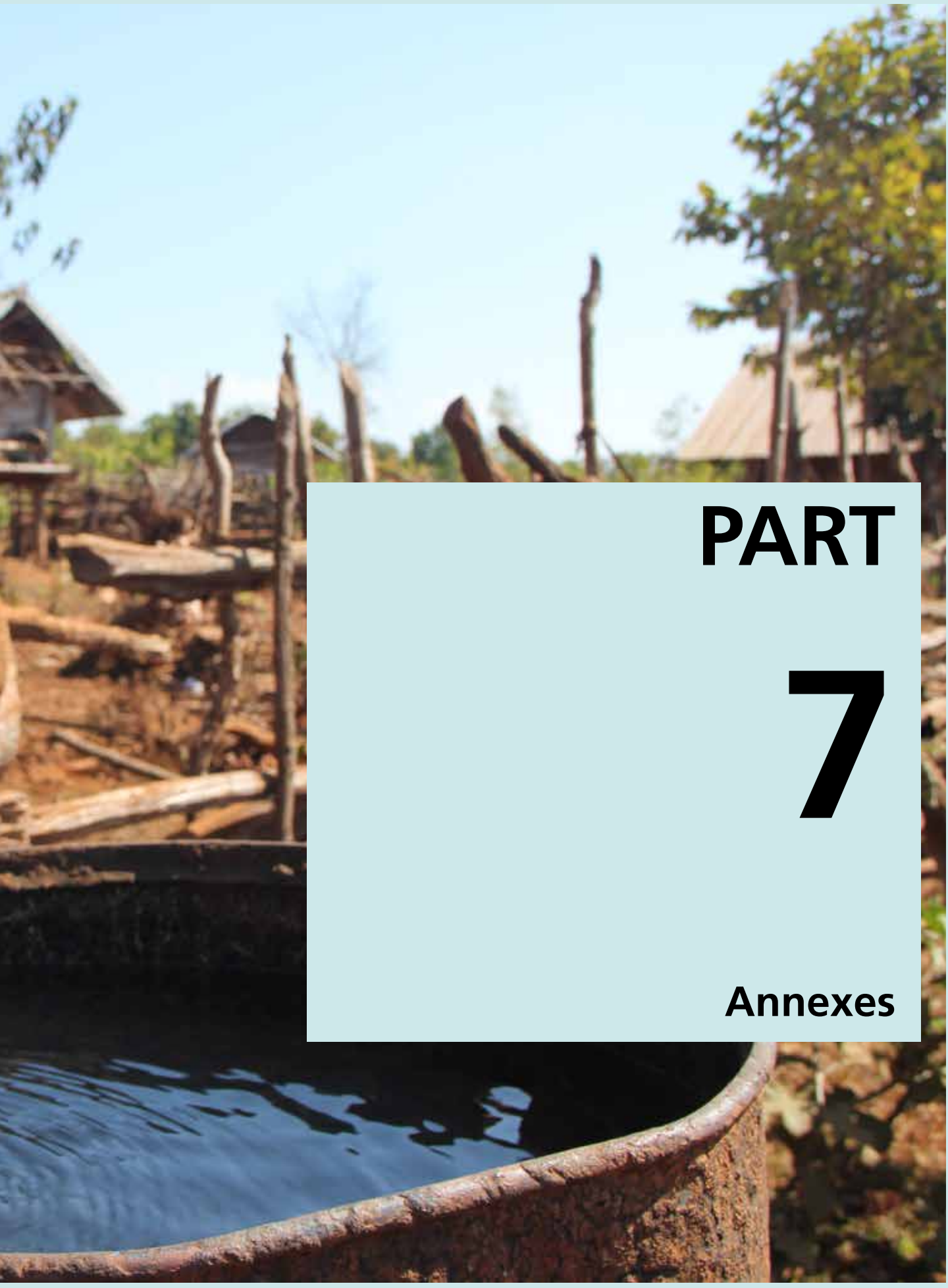


PART 7

Annexes

Annex 1 List of target villages by district

District	Village Code	Village Name	Population (2015)
KALEUM	1502002	B. Kaengkhouy	1,068
	1502003	B. Thongkai	1,649
	1502004	B. Parkxai	290
	1502005	B. Klung	206
	1502006	B. Bark	198
	1502007	B. ploy+talangmai	648
	1502008	B. Kador	212
	1502013	B. Hanong neua	139
	1502015	B. Ching	250
	1502016	B. Songkhone	467
	1502017	B. Chalork	286
	1502018	B. Loeui	490
	1502020	B. Chale	239
	1502021	B. Teenteum	185
	1502025	B. Tangpa	180
	1502026	B. Tangpang	226
	1502029	B. Ahang+kandone	440
	1502032	B. Kandone	131
	1502033	B. Tamor	267
	1502035	B. Taneung+Vang	189
	1502037	B. Laipor	162
	1502038	B. Pom	178
	1502043	B. Talui	293
	1502045	B. Po+Lam+Sa ang	289
	1502049	B. Bobing+talong	437
	1502071	B. Ling	325
	1502072	B. Tangkard	247
	1502075	B. Yeub+Chanoi	429
	1502082	B. Chakeuiphou	277
	Total	29 Villages	10,392

District	Village Code	Village Name	Population
	1503001	B. Brong gnai	357
	1503002	B. Brong noy	309
	1503003	B. Dark pa ner	232
	1503007	B. Darkmeu	379
	1503017	B. Dark trerb	689
	1503020	B. Dark yoi	442
	1503021	B. Lienglouang	500
	1503023	B. Darkdom	289
	1503027	B. Darkman	381
	1503028	B. Darkta ork yai	309
	1503033	B. Dark yang noy	86
	1503034	B. Darkplarn	211
	1503036	B. Tangbrong	1,383
	1503038	B. Tanglou+Dark leu	468
	1503045	B. Darkchang	275
	1503049	B. Tangmii	225
DAKCHEUNG	1503050	B. Kone gnong	258
	1503051	B. Darkdieng	259
	1503058	B. Dark larn	630
	1503060	B. Darkxeng	359
	1503062	B. Darkbong	305
	1503068	B. Tangtalang	514
	1503086	B. darkden	537
	1503090	B. Tongxieng	247
	1503092	B. Darksa	353
	1503102	B. A youn	315
	1503105	B. Dakouang	269
	1503111	B. Darkdoung	327
	1503114	B. Dark le	330
	1503124	B. Dark rern	239
	1503127	B. Darkwor+Dark ark	439
	1503131	B. Dark ran	404
	1503132	B. Darkdenh	208
	Total	33 Villages	12,528

Annex 2 Methodology of the Matrix of Functions (MoF)

The Matrix of Function (MoF) is used to strategically categorise the existing human settlements based on the mere availability, or non-availability, of key functions170 and to identify economic development areas ("clusters" of human settlements strategically interconnected) within a given region. It was developed from the Sc-alogram method (Rondinelli, 1985) and renamed to MoF by Giovanni Spaliviero in regional development projects in West and North Africa in the 1980s (Spaliviero, 2015, Unité de Réalisation des Projets Pilotes, 1992, Unité Technique de Planification, 1986). The purpose is to empirically derive the hierarchy of settlements to ensure guidance of realistic planning and implementation.

The assumption in this proposed assessment method is that those human settlements where fewer functions are present are more sensitive, and their sensitivity would be reduced by providing the services that are largely missing. This method allows visualising the linkages between villages such as the degree of dependency in terms of health or education services.

The analysis is based on the data collected through a simple questionnaire filled by local government or community representatives at the basic administrative unit of reference that identifies a human settlement (villages), to check whether services/functions are available. (i.e. primary school, police station, pharmacy, or lawyer across 10 to 15 functional categories, such as education and health facilities, transport services, law and security, financial services, or private professionals).

The team establishes a list as comprehensive and exhaustive as possible of services and facilities which is further revised by relevant stakeholders and government authorities to ensure complete adaption to the context of the region.

Data collected is then fed into an unordered MoF (spreadsheet), where:

- **1st column**: shows the name/code of selected Villages
- **2nd columns**: shows the "functions"(as many columns as functions are inventoried)
- I**n the table (or matrix) itself**, a black cell indicates the presence of the function (NB: not how many times the function is present, just if it is present or not – this is a normalised method), while a white cell indicates its absence in the Village concerned

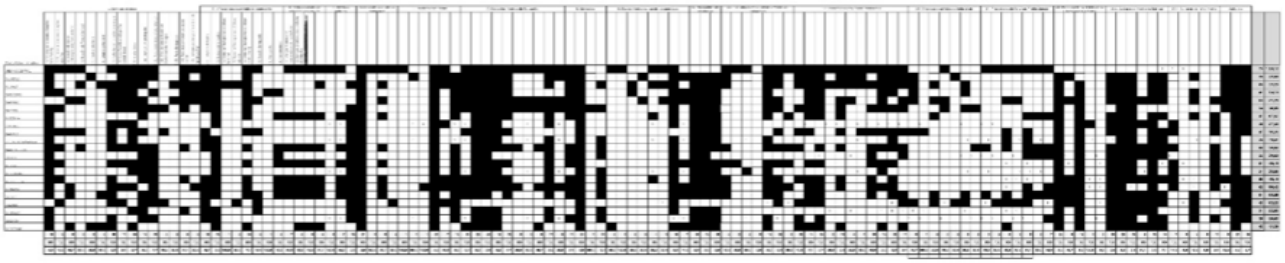


Figure 39 - Matrix of Ordered Functions (MoF) spreadsheet

Then by summing the number of times a function occurs, which is the function frequency, and by convention divides by 100 a function weight is obtained. Hence basic functions which occur often, obtain a low weight and rare central functions obtain a high weight. Therefore, each black square represents a present function and has an associated weight. When the weights of all functions present in each administrative unit are summed, the "centrality score" emerges for each settlement. Then, after sorting by function weight and centrality score the "ordered matrix" is established (see figure 40).

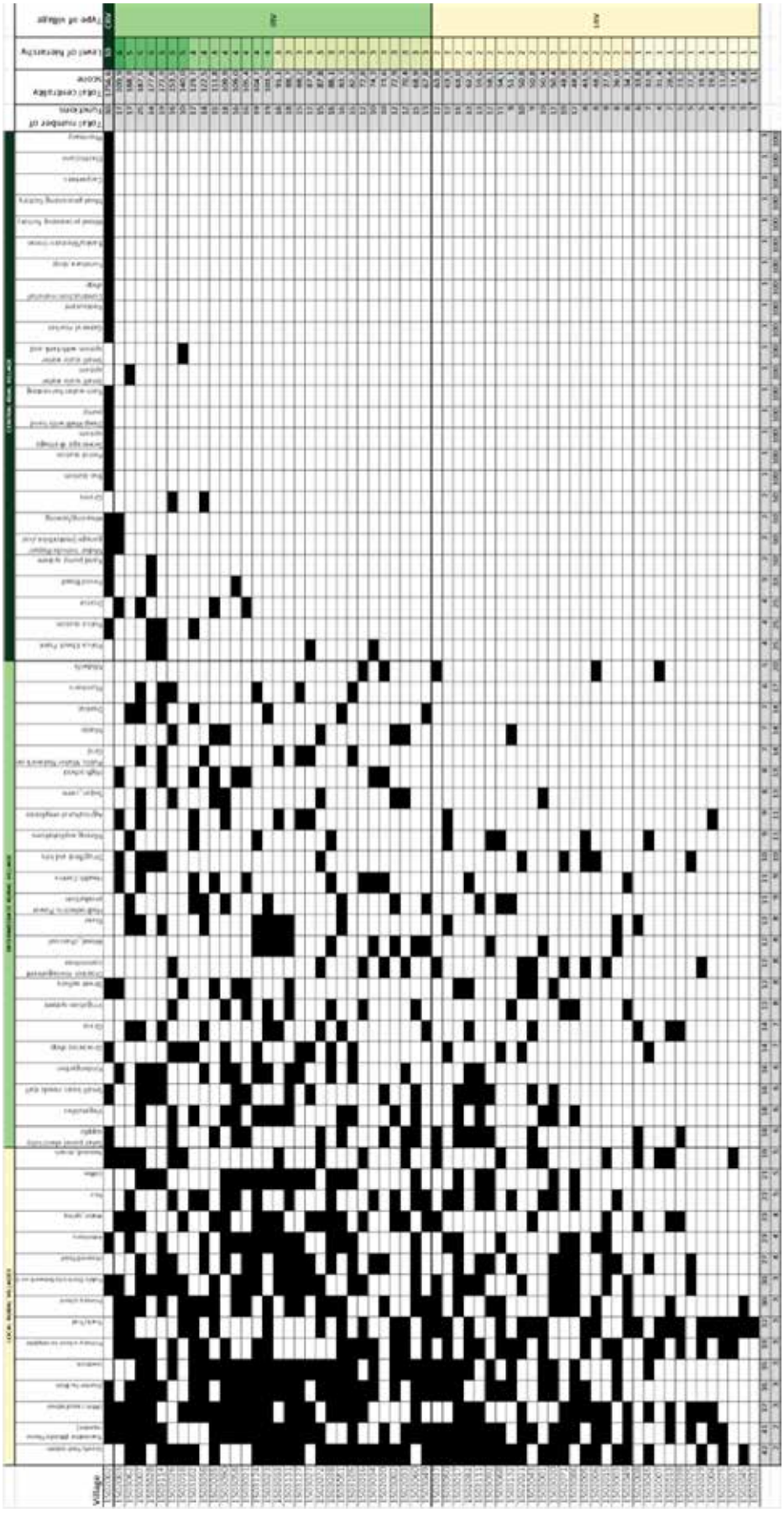
- **Functions** are sorted according to their frequency, basic functions on the left side of the matrix
- **Villages** are sorted according to their centrality score, higher values on the top of the matrix

170 NB: A "function" we define as every service, equipment, activity and facility which has an economic, administrative, social or cultural function in a given human settlement.

Table 11 - List of functions used to build the Matrix of Function

Category	Function
Transportation Infrastructure	Paved road, Gravel road, Trail/Track, Bus transport on a daily basis, Bus Station, Bus stop, Petrol Supply Station,
Public Utilities and Facilities	Telecommunication Transmitter (Mobile Phone repeater), Solar panel electricity supply, Public Electricity Network on Grid, Sewerage drainage system, Storm water drainage system
Water supply systems	Gravity feed system, Deep Well with hand pump, Rain water harvesting (on ground/underground), Small scale water system, Small scales water system with tank and well, Rand pump system, Public Water Network on Grid (piped water), Irrigation system
Markets and Commercial Establishments	General market, Livestock market, Small basic needs stall (i.e a stall selling basic items (fruits, veg, soaps, drinks, mobile phone cards), Groceries shop, Supermarket, Restaurant, Hotel, Bicycle Repair garage, Motor Vehicle Repair garage (motorbike /car), Construction material shop, Furniture shop, Banks/Western Union, ATM
Business and industrial activities	Hydroelectric Power production, Mining exploitations, Wood processing factory, Meat processing factory, Feed (e.g. for animals) Processing Factory
Jobs/own account workers	Street sellers, Weaving/sewing, Carpenters, Veterinary, Electricians, Lawyers, Plumbers, Agriculture (small-holder/self-sufficient), Agricultural employee, Employment in industry/manufacturing, Other casual labour
Community Organizations and NGOs	Farmers cooperatives, Non-Profit Associations (NPAs), International/National Non-Government Organizations (I/NGOs)
Provisioning eco-systems services	Rice, Coffee, Tea, Sugar cane, Maize, Grains, Vegetables, Livestock, Wood for charcoal, Roof/wall material (Grass), River, Seasonal stream, Water spring
Health facilities and services	Health Centre, Drug/first aid kits, Doctor, Midwife, Dentist, Pharmacy
Educational institutions	Vocational training center, High school, Primary school, Primary school but with incomplete classes (i.e. not enough teachers/ space), Kindergarten
Public recreational and Cultural Facilities	Monastery, Library, Cultural Centre, Museum, Playground
DRR and Security Services	Disaster management committee, Disaster facilities (i.e. Shelter), Police Check Point, Police station, Fire Station

Figure 40 - Matrix of Ordered Functions (MoF)



The ordered matrix is then interpreted to group basic, intermediate, and central settlements and determine a "set of functions" that should be covered considering the highest presence of a function for each category in the context of the region. Considering local rural villages as the lowest level, an implicit assumption is that in a "regular/standard distribution" any higher hierarchical level should contain the number of functions of the precedent level(s) plus their own specific functions, hence the matrix allows to identifying settlements where functions are "missing" and whether functions of higher levels are present.

Table 12 - Functions that should be covered in each type of village

Functions		Local Rural Village (LRV)	Intermediate Rural Village (IRV)	Central Rural Village (CRV))
INFRASTRUCTURE	**Transportation Infrastructure**	Track/Trail Unpaved Road		Paved Road Bus station Petrol station
	Public Utilities and Facilities	Mobile Phone repeater Public Electricity Network on Grid	Solar panel electricity supply	Sewerage drainage system
	Water supply systems	Gravity feed system	Irrigation system Public Water Network on Grid	Deep Well with a hand pump Rain water harvesting Small scale water system
SOCIO-ECONOMIC SERVICES	**Health facilities and services**		Drug/first aid kits Health Centre Dentist Midwife	Doctor Pharmacy
	Educational institutions	Primary school incomplete Primary school	Kindergarten High school	
	DRR and Security Services	Disaster facilities	Disaster management committee	Police Check Point Police station
	Markets and Commercial Establishments		Small basic needs stall Groceries shop	Motor Vehicle Repair garage (motorbike /car General market Restaurant Construction material shop Furniture shop Banks/Western Union
	Business and industrial activities		Hydroelectric Power production Mining exploitations	Wood processing factory Meat processing factory
	Jobs/own account workers	Other casual labour Veterinary	Street sellers Agricultural employee Plumbers	Weaving/sewing Carpenters Electricians
ECO-SYSTEM SERVICES	**Provisioning services**	Livestock Rice Coffee Seasonal stream Water spring	Vegetables Sugar cane Maize Grass Wood charcoal River	
Total		**16**	**22**	**21**

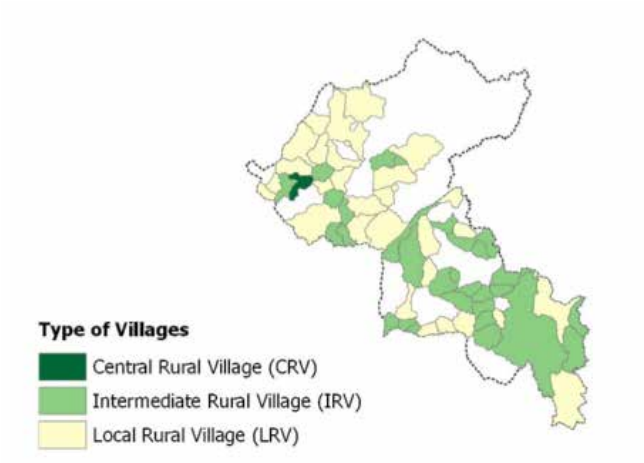


Figure 41 - Spatial distribution of the type of villages

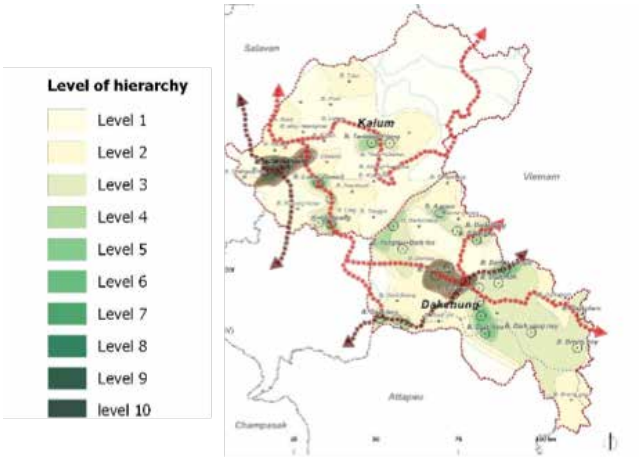


Figure 42 - Territorial linkages ans spatial structure

In addition, mapping the different typologies of settlements through geographic information system (GIS) helps visualising how balanced the spatial development of the region is, which, from the perspective of improving the human settlements gives already some clear indications, in terms of prioritisation, for preliminary needed investments in each settlement:

• Villages in Kaleum show lower levels of infrastructure and socio-economic development than villages in Dakcheung. Around 70% of the selected villages in Kaleum are categorised as Local Rural Villages (LRV), considered the lowest level of socio-economic and infrastructure development, against the 35% of villages in Dakcheung.

• Better transportation infrastructure across selected villages in Dakcheung district enables better access to socio-economic services than in villages in Kaleum.

The spatial analysis is then complemented with an isopleth map showing the levels of centrality of each settlement. The map can be drawn by hand or mapped in a geographic information system (figure 42). From the isopleth map the spatial structure emerges. It visualises the "territorial linkages" of each settlement and identifies "clusters" of settlements (or areas of concentration of urban settlements) which are strongly interconnected and work cooperatively in terms of socio-economic activities.

• The territorial and socio-economic development of Kaleum is mainly centred on the southern tri-polar set of villages of Kaengkhouy, Thongkai, and Songkhone representing the central market of the region, while the northern areas, show the lowest levels of socio-economic and infrastructure development.

• In Dakcheung, the "cluster" of settlements (Darkbon, Dark Rern, Tongxieng and Dark Ran) represents the most productive area of the region, while Villages located in southern areas of the district, where road accessibility is weaker, show a lower level of socio-economic and infrastructure development.

Under the strategy of socio-economic complementarity, the analysis of the existing and missing functions in the settlements within these "clusters", helps to define priority investments for clustering services and facilities, considering the proposed regional settlement system, the distribution of functions among settlements and the settlement hierarchy

• The bi-polar set of settlements in Kaleum district centred in the village of Kaengkhouy and Thongkai strategically is located at cross-junction of the main north-south axe of transportation (Salavan- Xekong-Attapeu) with the provincial road to the northern areas of the district.

Kaengkhouy is the only Central Rural Village (CRV) of the region (level of hierarchy 10). Its "territorial influence" is mainly observed over the neighbouring village of Thongkai (level of hierarchy 6). These two settlements provide the highest levels of health, education and infrastructure services and represent the main market to the surrounding rural population living in northern central areas of Kaleum district.

	Name	Level	Type of village
Villages	Kaengkhouy (1502002)	10	Central Rural Village (CRV)
	Thongkai (1502003)	6	Intermediate Rural Villages (IRV)
Main services provided	Infrastructure services	Bus station and Petrol Station, Mobile Phone repeater, Public Electricity Network on Grid, Gravity feed system, Deep Well with hand pump	
	Socio-economic services	Kindergarten, Primary school, High School, Health Centres (Doctor and Midwife)	
	Eco-system Provisioning services	Water spring, seasonal streams	
Main sources of income	General Market, Agricultural employee, Other casual labour, Wood processing factory		
Main recommendations	Enhance road infrastructure and transport services to/from northern areas of the district		

- **The main cluster of settlements in Dakcheung district is centred in the village of Darkbong, strategically is located at cross-junction of the main west-east axe of transportation (Champasak - Sekong - Vietnam) with the north-south provincial road crossing the district**

Well-balanced "cluster" of settlements as all four villages, Darkbon, Dark rern, Tongxieng and Dark ran, are categorised as Intermediate Rural Villages (IRV). Access to the primary road infrastructure has enabled intermediate levels of infrastructure and public services in all four settlements. It represents the productive area of the region, based on Hydroelectric Power and Mining exploitations, as well as Rice and Coffee plantations

	Name	Level	Type of village
Villages	Darkbong (1503062)	5	Intermediate Rural Villages (IRV)
	Dark rern (1503124)	4	Intermediate Rural Villages (IRV)
	Tongxieng (1503090)	4	Intermediate Rural Villages (IRV)
	Dark ran (1503131)	3	Intermediate Rural Villages (IRV)
Main infrastructure and public services provided	Infrastructure service	Water gravity feed systems, Irrigation system, Mobile Phone repeater, Public Electricity Network	
	Socio-economic services	Kindergarten, Primary school, High school	
	Eco-system Provisioning services	Livestock, Rice, Coffee, vegetables, water springs, rivers	
Main sources of income	Hydroelectric Power production, Mining exploitations, Other Casual labour		
Main recommendations	Efforts should be made to create Vocational Training Centres to provide skilled people needed in the agro-industries and enhance agricultural practices at household levels		

Annex 3 Developing the vulnerability index

The vulnerability index was calculated based on the three vulnerability elements; exposure, sensitivity and adaptive capacity, which in this assessment were determined by a total of 40 indicators, categorized into 20 indicator groups. The general structure of the index was based on the calculation of the world risk index[171] and adjusted to fit the context of the vulnerability assessment in Saravan, Sekong, and Attapeu and to utilise the data available.

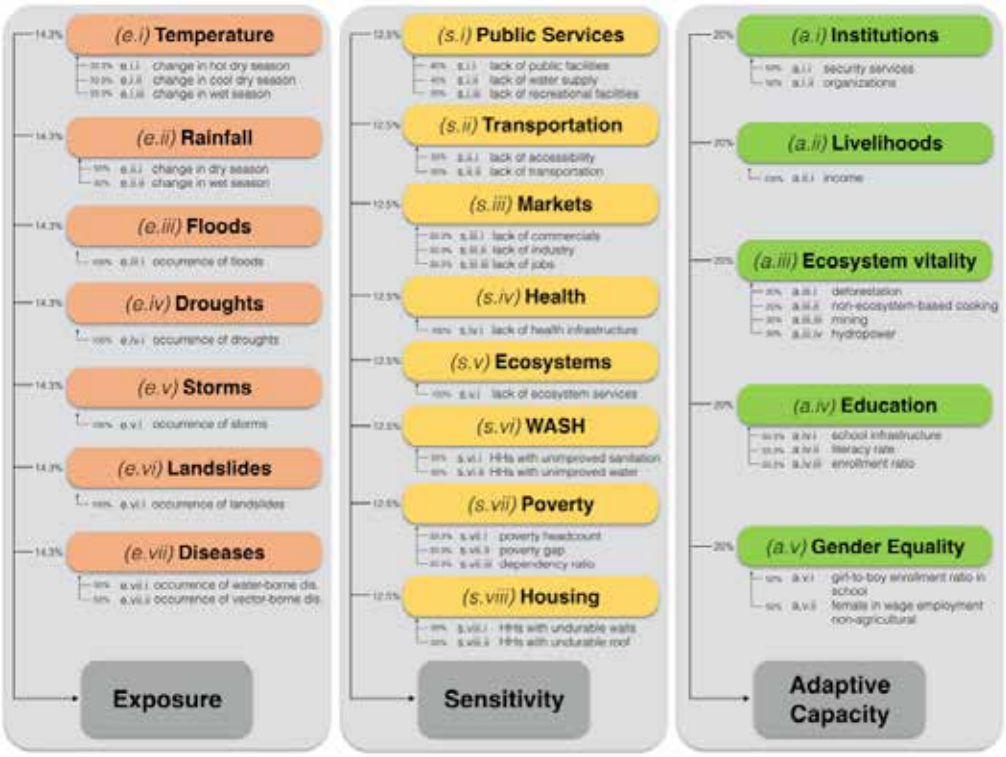


Figure 43 - an overview of vulnerability index indicators, including weight for Exposure calculation

Exposure

The vulnerability index considers of the exposure to 7 different hazards. These are: (e.i) temperature, (e.ii) rainfall, (e.iii) floods, (e.iv) droughts, (e.v) storms, (e.vi) landslides, and (e.vii) diseases. Based on the results of these indicator groups, the overall exposure was calculated as the mean value of these 7 groups, hence every indicator group has an equal weight of 14.3 per cent to the overall exposure. The indicator groups for exposure are expressed in a value between 0 and 10, where 0 is the lowest exposure and 10 is the highest.

These 7 indicator groups are composed of 11 individual indicators. The indicators are arranged as follows:

- **Temperature**
  - Change in the hot dry season (February to April)
  - Change in the cool dry season (November to January)
  - Change in the wet season (May to October)
- **Rainfall**
  - Perceived change in the dry season (November to April)
  - Perceived change in the rainy season (May to October)
  - Floods – Occurrence of floods
- **Droughts** – Occurrence of droughts
- **Storms** – Occurrence of storms
- **Landslides** – Occurrence of landslides
- **Disease**
  - Occurrence of water-borne disease
  - Occurrence of vector-borne disease

171 http://weltrisikobericht.de/wp-content/uploads/2017/11/Indicators-WorldRiskIndex.pdf.

element	indicator group	group weight for element (%)	indicator	indicator weight in group (%)	data source	N° of options	type of option	options/answers	weighting	possible score (multiple-choice only)	conversion scheme	conversion
Exposure	(e.i) Temperature	14,3%	(e.i.i) perceived change of Temperature_hot dry season	33,3%	survey	7	single choice	significant_increase, some_increase, slight_increase, no_change, slight_decrease, some_decrease, significant_decrease	n/a	n/a	10, 8.4, 6.7, 5, 3.4, 1.7, 0	significant_increase=10, some_increase=8.4, slight_increase=6.7, no_change=5, slight_decrease=3.4, some_decrease=1.7, significant_decrease=0
			(e.i.ii) change of Temperature_cool dry season	33,3%	survey	7	single choice	significant_increase, some_increase, slight_increase, no_change, slight_decrease, some_decrease, significant_decrease	n/a	n/a	10, 8.4, 6.7, 5, 3.4, 1.7, 0	significant_increase=10, some_increase=8.4, slight_increase=6.7, no_change=5, slight_decrease=3.4, some_decrease=1.7, significant_decrease=0
			(e.i.iii) change of Temperature_rainy season	33,3%	survey	7	single choice	significant_increase, some_increase, slight_increase, no_change, slight_decrease, some_decrease, significant_decrease	n/a	n/a	10, 8.4, 6.7, 5, 3.4, 1.7, 0	significant_increase=10, some_increase=8.4, slight_increase=6.7, no_change=5, slight_decrease=3.4, some_decrease=1.7, significant_decrease=0
	(e.ii) Rainfall	14,3%	(e.ii.i) change of Rain_dry season	50,0%	survey	7	single choice	significant_increase, some_increase, slight_increase, no_change, slight_decrease, some_decrease, significant_decrease	n/a	n/a	10, 8.4, 6.7, 5, 3.4, 1.7, 0	significant_increase=0, some_increase=1.7, slight_increase=3.4, no_change=5, slight_decrease=6.7, some_decrease=8.4, significant_decrease=10
			(e.ii.ii) change of Rain_rainy season	50,0%	survey	7	single choice	significant_increase, some_increase, slight_increase, no_change, slight_decrease, some_decrease, significant_decrease	n/a	n/a	10, 8.4, 6.7, 5, 3.4, 1.7, 0	significant_increase=0, some_increase=1.7, slight_increase=3.4, no_change=5, slight_decrease=6.7, some_decrease=8.4, significant_decrease=10
	(e.iii) Floods	14,3%	(e.iii.i) occurrence of Flood	100,0%	survey	5	single choice	more_1_year, 1_year, 1_every_3_5_years, 1_every_10_years, no_floods	n/a	n/a	10, 7.5, 5, 2.5, 0	more_1_year=10, 1_year=7.5, 1_every_3_5_years=5, 1_every_10_years=2.5, no_floods=0
	(e.iv) Droughts	14,3%	(e.iv.i) occurrence of Drought	100,0%	survey	5	single choice	more_1_year, 1_year, 1_every_3_5_years, 1_every_10_years, no_droughts	n/a	n/a	10, 7.5, 5, 2.5, 0	more_1_year=10, 1_year=7.5, 1_every_3_5_years=5, 1_every_10_years=2.5, no_droughts=0
	(e.v) Storms	14,3%	(e.v.i) occurrence of Storms	100,0%	survey	5	single choice	more_1_year, 1_year, 1_every_3_5_years, 1_every_10_years, never	n/a	n/a	10, 7.5, 5, 2.5, 0	more_1_year=10, 1_year=7.5, 1_every_3_5_years=5, 1_every_10_years=2.5, never=0
	(e.vi) Landslides	14,3%	(e.vi.i) occurrence of Landslides	100,0%	survey	2	single choice	yes, no	n/a	n/a	10, 0	yes=10, no=0
	(e.vii) Diseases	14,3%	(e.vii.i) occurrence of Water_disease	50,0%	survey	6	multiple choice	Diarrhea_disease, Skin_disease, Eye_disease, Allergies, Other, No_problems	n/a	5 (highest) to 0 (lowest); intervall: 1	10, 8, 6, 4, 2, 0	score_5=10, score_4=8, score_3=6, score_2=4, score_1=2, score_0=0
			(e.vii.ii) occurrence of Vector_disease	50,0%	survey	5	multiple choice	Malaria, Dengue, Encephalitis, Other, None	n/a	4 (highest) to 0 (lowest); intervall: 1	10, 7.5, 5, 2.5, 0	score_4=10, score_3=7.5, score_2=5,
count	7	100,0%	11	EXPOSURE		0-10	0-lowest, 10-highest					

Figure 44 - an overview of the determination of exposure and its indicators

Where there is more than one indicator per indicator group, the individual indicators contribute equally. For example, the indicator for disease is the average of the two sub-indicators; water-borne disease and vector-borne disease. All 11 indicators were taken from the vulnerability assessment survey and consider a period of the last 30 years for the perceived/reported hazards.

In some cases, the raw data, especially from the survey, was not expressed as a numerical value, and therefore had to be converted for use in the index. For example, the occurrence of floods, droughts, storms, and landslides was a multiple-choice question in the survey; respondents could choose from five pre-determined answers; more than one event per year, one event per year, one event every 3 to 5 years, one event every 10 years, never. More than one event per year indicates the greatest level of exposure, which means that it was assigned a value of 10. Never indicates the lowest exposure, so a value of 0 was assigned to it. The remaining answers were assigned values with equal distance between them, meaning once per year = 7.5, once every 3-5 years = 5 and once every 10 years = 2.5.

More than one indicator could be chosen for both disease sub-indicators (water and vector-borne) because more than one disease can occur in a given village. The survey respondents could choose up to four vector-borne diseases, or none (a total of five options). Therefore, four diseases in a given village were assigned a value of 10. Three was assigned 7.5, two was assigned 5, one was assigned 2.5 and none was assigned 0.

The same conversion concept was also applied for the other exposure indicators that are characterized by single-choice options.

Sensitivity

Sensitivity is calculated using eight different indicators and 17 sub-indicators, shown below. Each indicator has an equal weight of 12.5 per cent of overall sensitivity. Overall sensitivity (and each individual indicator) were expresses as a value between 0 and 10, with 10 being the highest level of sensitivity.

Of the 17 sub-indicators, 10 were taken from the survey and 7 from the census and/or secondary analysis of census data. The weight of each sub-indicator is shown in parenthesis below. The sub-indicators were also expressed as a value between 0 and 10, where 0 indicates the lowest level of sensitivity and 10 indicates the highest:

- **Public services**
  - Lack of public facilities (40 per cent)
  - Lack of water supply infrastructure (40 per cent)
  - Lack of recreational facilities (20 per cent)
- **Transportation**
  - Lack of accessibility (50 per cent)
  - Transportation infrastructure (50 per cent)
- **Markets**
  - Lack of commercial activity (33 per cent)
  - Lack of industry (33 per cent)
  - Lack of markets (33 per cent)
- **Health**
  - Lack of health infrastructure (100 per cent)
- **Ecosystems**
  - Lack of ecosystems (100 per cent)
- **WASH**
  - Percentage of households with unimproved sanitation (50 per cent)
  - Percentage of households relying on unprotected water (50 per cent)
- **Poverty**
  - Absolute poverty rate (33 per cent)
  - Poverty gap index (33 per cent)
  - Dependency ratio (33 per cent)
- **Housing**
  - Percentage of houses with non-durable roof materials (50 per cent)
  - Percentage of houses with non-durable wall materials (50 per cent)

element	indicator group	group weight for element (%)	indicator	indicator weight in group (%)	data source	N° of options	type of option	options/answers	weighting	possible score (quantity only)	conversion sheme	conversion
	(s.i) Public Service	12,5%	(s.i.i) Lack of Public_facility	40,0%	survey	6	multiple choice	Telecomunications, solar_panel, public_electricity, sewerage_drainage, storm_drainage, none	n/a	5 (lowest) to 0 (highest); interval: 1	10, 8, 6, 4, 2, 0	score_5=0, score_4=2, score_3=4, score_2=6, score_1=8, score_0=10
			(s.i.ii) Lack of Water_suply	40,0%	survey	9	multiple choice	Gravity, deep_well, rain_harvesting, small_water_system, tank_well, rand_pump, public_network, irrigation, none	n/a	8 (lowest) to 0 (highest); interval: 1	10, 8.75, 7.5, 6.25, 5, 3.75, 2.5, 1.25, 0	score_8=0, score_7=1.25, score_6=2.5, score_5=3.75, score_4=5, score_3=6.25, score_2=7.5, score_1=8.75, score_0=10
			(s.i.iii) Lack of Recreational facilities	20,0%	survey	6	multiple choice	monastery, library, cultural_centre, museum, playground, none	n/a	5 (lowest) to 0 (highest); interval: 1	10, 8, 6, 4, 2, 0	score_5=0, score_4=2, score_3=4, score_2=6, score_1=8, score_0=10
	(s.ii) Transportation	12,5%	(s.ii.i) Lack of Accessibility	50%	survey	4	single choice	paved, gravel, unmade, no	n/a		10, 6.7, 3.3, 0	paved=0, gravel=3.3, unmade=6.7, no=10
			(s.ii.ii) Lack of Transportation	50%	survey	5	multiple choice	bus, bus_station, bus_stop, petrol, none	bus=1, bus_station=1, bus_stop=0.5, petrol=1	3.5 (lowest) to 0 (highest); interval: 0.5	10, 8.58, 7.15, 5.72, 4.29, 2.86, 1.43, 0	score_3.5=0, score_3=1.43, score_2.5=2.86, score_2=4.29, score_1.5=5.72, score_1= 7.15, score_0.5=8.58, score_0=10
	(s.iii) Markets	12,5%	(s.iii.i) Lack of Comercials	33,3%	survey	14	multiple choice	general_market, livestock_market, basic, groceries, supermarket, restaurant, hotel, bicycle_repair, motor_repair, construction_shop, furniture_shop, bank, ATM, none	n/a	13 (lowest) - 1 (highest); interval: 1	10, 9.24, 8.47, 7.7, 6.93, 6.16, 5.39, 4.62, 3.85, 3.08, 2.31, 1.54, 0.77, 0	score_13=0, score_12=0.77, score_11=1.54, score_10=2.31, score_9=3.08, score_8=3.85, score_7=4.62, score_6=5.39, score_5=6.16, score_4=6.93, score_3=7.7, score_2=8.47, score_1=9.24, score_0=10
			(s.iii.ii) Lack of Industry	33,3%	survey	6	multiple choice	hydroelectric, mining, wood, meat, feed_animals, none	n/a	5 (lowest) to 0 (highest); interval: 1	10, 8, 6, 4, 2, 0	score_5=0, score_4=2, score_3=4, score_2=6, score_1=8, score_0=10

Figure 45 - an overview of the determination of sensitivity and its indicators (part 1)

As with exposure, values had to be converted to a value between 0-10. For example, poverty headcount was expressed as a value between 0 and 100, so to convert the value to the index it was divided by 10. In the case of the poverty gap, where the values were between 0 and 22, the value was divided by 0.455. Meanwhile, some non-numerical values were converted in the same way as for exposure, outline above, by placing them on a scale with equal spacing. For example, in the case of 'lack of accessibility', a paved road was assigned 0, while gravel was assigned 3.3, unmade 6.7 and no road was 10.

However, in some cases, options are not considered to be of equal value. To address this, the team developed a weighting system to reflect this.

Sensitivity												
			(s.iii.iii) Lack of Jobs	33,3%	survey	12	multiple choice	street_sellers, weaving_sewing, carpenters, veterinary, electricians, lawyers, plumbers, agriculture_small, agricultural_employee, employment_industry, casual, none	n/a	11 (lowest) to 0 (highest); intervall: 1	10, 9.1, 8.19, 7.28, 6.37, 5.46, 4.55, 3.64, 2.73, 1.82, 0.91, 0	score_11=0, score_10=0.91, score_9=1.82, score_8=2.73, score_7=3.64, score_6=4.55, score_5=5.46, score_4=6.37, score_3=7.28, score_2=8.19, score_1=9.1, score_0=10
	(s.iv) Health	12,5%	(s.iv.i) lack of health_infrastructure	100%	survey	7	multiple choice	health_centre, drug, doctor, midwife, dentist, pharmacy, none	health_centre=1.5, drug=0.5, doctor=2, midwife=1, dentist=1, pharmacy=1	7 (lowest) to 0 (highest); intervall: 0.5	10, 9.23, 8.52, 7.81, 7.1, 6.39, 5.68, 4.97, 4.26, 3.55, 2.84, 2.31, 1.42, 0.71, 0	score_7=0, score_6.5=0.71, score_6=1.42, score_5.5=2.31, score_5=2.84, score_4.5=3.55, score_4=4.26, score_3.5=4.97, score_3=5.68, score_2.5=6.39, score_2=7.1, score_1.5=7.81, score_1=8.52, score_0.5=9.23, score_0=10
	(s.v) Ecosystems	12,5%	(s.v.i) Lack of eco_systems_services	100%	survey	15	multiple choice	rice, coffee, tea, sugar_cane, maize, grains, vegetables, livestock, wood_charcoal, grass, river, seasonal_stream, water_spring, other, none	n/a	14 (lowest) to 0 (highest); intervall: 1	10, 9.23, 8.52, 7.81, 7.1, 6.39, 5.68, 4.97, 4.26, 3.55, 2.84, 2.31, 1.42, 0.71, 0	score_14=0, score_13=0.71, score_12=1.42, score_11=2.31, score_10=2.84, score_9=3.55, score_8=4.26, score_7=4.97, score_6=5.68, score_5=6.39, score_4=7.1, score_3=7.81, score_2=8.52, score_1=9.23, score_0=10
	(s.vi) WASH	12,5%	(s.vi.i) HH (%) with unimproved access to sanitation	50%	census	0-100	single choice	0-100	n/a		%/10	
			(s.vi.i) HH (%) with unimproved drinking water facility	50%	census	0-100	single choice	0-100	n/a		%/10	
	(s.vii) Poverty	12,5%	(s.vii.i) poverty headcount (%)	33,3%	census based poverty map	0-100	single choice	0-100	n/a		%/10	
			(s.vii.ii) poverty gap (%)	33,3%	census based poverty map	0-22	single choice	0-22	n/a		x*0,457	
			(s.vii.iii) dependency ratio (%)	33,3%	census based poverty map	0-100	single choice	0-100	n/a		%/10	
	(s.viii) Housing	12,5%	(s.viii.i) HH (%) with undurable wall material	50%	census	0-100	single choice	0-100	n/a		%/10	
			(s.viii.ii) HH (%) with undurable roof material	50%	census	0-100	single choice	0-100	n/a		%/10	
count	8	100,0%	17	SENSITIVITY		0-10		0-lowest, 10-highest				

Figure 46 - an overview on the determination of sensitivity and its indicators (part 2)

Taking the lack of health infrastructure sub-indicator as an example, a health centre and a doctor have greater influence on reducing sensitivity than a village drug kit, which provides on very basic medicines. Reflecting this, the team determined higher weights for the presence of a doctor (2) and a health centre (1.5) than for a village drug kit (0.5). The options of dentist, midwife or pharmacy were all given a weight of 1. Consequently, if a village would have each of these options, their score for this indicator would be 7 (1.5+2+0.5+1+1+1=7). If it only had a doctor and a midwife, the score would be 3 (2+1=3) and if the village had none of these options, it would be 0.

If a village had all the above health care professionals and facilities, it would be given an indicator of 7. If it had a doctor and a midwife, it would get 3 (2 for doctor + 1 for midwife). Some villages had none of the above, and therefore score 0. As with the other indicators, these were then converted to a value between 0 and 10. So, continuing the above example, the village with all facilities and professionals would be given a value of 10, while the village with a doctor and a midwife only would be given a score of 4.29

Consequently, if a village would have each of these options, their score for this indicator would be 7 (1.5+2+0.5+1+1+1=7). If it only had a doctor and a midwife, the score would be 3 (2+1=3) and if the village had none of these options, it would consequently be 0. The range of this indicator is 7 to 0, however 7 is considered as low lack while 0 expresses a high lack. The interval is 0.5, which means that it is possible to score values with the difference of 0.5 (7, 6.5, 6, 5.5 ...) which finally amounts for 14 scores. Just like the other multiple-choice indicators, these scores are equally transferred to a range of 0 (lowest) to 10 (highest). So taking up the above outlined examples of the scores 7, 3 and 0; these would be transferred to 0, 5.68 and 10. Therefore, having all health facilities in place will result in a minimum lack of health infrastructures, contributing to a low sensitivity, while having none of these options will result in a high lack and thus also contributes to a high sensitivity.

Adaptive Capacity

The adaptive capacity element of the vulnerability index was calculated using 5 different indicator groups, and 12 sub-indicators. The weight of the sub-indicators is shown in parenthesis below:

- **Institutions**
  - Existence of security services (50 per cent)
  - Existence of NGOs/CBOs and other external organisations (50 per cent)
- **Livelihoods**
  - Number of income sources (100 per cent)
- **Ecosystem vitality**
  - Occurrence of deforestation (20 per cent)
  - Use of forest-based cooking fuels (20 per cent)
  - Occurrence of mining (30 per cent)
  - Occurrence of hydropower (30 per cent)
- **Education**
  - Presence of schools (33 per cent)
  - Literacy rate (33 per cent)
  - School enrolment rate (33 per cent)
- **Gender equality**
  - Female to male school enrolment rate (50 per cent)
  - Percentage of female in non-agriculture wage employment (50 per cent)

The overall adaptive capacity was calculated as the mean value of these 5 groups, hence every indicator group was given an equal weight of 20 per cent. Both adaptive capacity and the 5 indicator groups are expressed in a value between 0 and 10, where 0 is the lowest adaptive capacity and 10 respectively the highest.

The respective indicators are expressed as a value between 0 and 10, where 0 indicates the lowest adaptive capacity of a given indicator and 10 respectively the highest. So a value of 0 for the school infrastructure (a.iv.i) for example shows a lack of education and hence indicates a minimum adaptive capacity, whereas a value of 10 shows the best education, suggesting that this will increase people's adaptive capacity. The calculation of the indicator groups and the respective transformation of options to the range of 0 to 10 was done as outlined above for exposure and sensitivity.

element	indicator group	group weight for element (%)	indicator	indicator weight in group (%)	data source	N° of options	type of option	options/answers	weighting	possible score (multiple-choice only)	conversion scheme	conversion
Adaptive Capacity	(a.i) Institutions	20%	(a.i.i) Security Services	50%	survey	6	multiple choice	disaster_committee, disaster_facilities, police_check_point, police_station, fire_station, none	n/a	5 (highest) to 0 (lowest); intervall: 1	10, 8, 6, 4, 2, 0	score_5=10, score_4=8, score_3=6, score_2=4, score_1=2, score_0=0
			(a.i.ii) Organizations	50%	survey	4	multiple choice	Cooperatives, NPAS, NGO, none	n/a	3 (highest) to 0 (lowest); intervall: 1	10, 6.7, 3.3, 0	score_3=10, score_2=6.7, score_1=3.3, score_0=0
	(a.ii) Livelihoods	20%	(a.ii.i) income	100%	survey	7	multiple choice	Agriculture, Agricultural_employee, Livestock, Trade, Industry_manufacturing, casual_labour, other	n/a	6 (highest) to 0 (lowest); intervall: 1	10, 8.33, 6.67, 5, 3.33, 1.67, 0	score_6=10, score_5=8.33, score_4=6.67, score_3=5, score_2= 3,33, score_1=1,67, score_0=0
	(a.iii) Ecosystem vitality	20%	(a.iii.i) Deforestation	20%	survey	2	single choice	yes, no	n/a	n/a	10, 0	yes=0, no=10
			(a.iii.ii) non-ecosystem-based cooking	20%	census	0-100	single choice	0-100	n/a	n/a	%/10	
			(a.iii.iii) Mining	30%	survey	2	single choice	yes, no	n/a	n/a	10, 0	yes=0, no=10
			(a.iii.iv) Hydropower	30%	survey	2	single choice	yes, no	n/a	n/a	10, 0	yes=0, no=10
	(a.iv) Education	20%	(a.iv.i) school infrastructure	33,33%	survey	6	multiple choice	vocational, high_school, primary_school, primary_school_incompl ete, kindergarten, none	vocational=2, high_school=2, primary_school=1, primary_school_inc omplete=0.5, kindergarten=0.5	6 (highest) to 0 (lowest); intervall: 0.5	10, 9.16, 8.33, 7.5, 6.66, 5.83, 5, 4.17, 3.33, 2.5, 1.66, 0.83, 0	score_6=10, score_5.5=9.17, score_5=8.33, score_4.5=7.5, score_4=6.66, score_3.5=5.83, score_3=5, score_2.5=4.17, score_2=3.33, score_1.5=2.5, score_1=1.66, score_0.5=0.83, score_0=0
			(a.iv.ii) literacy rate	33,33%	census	0-100	single choice	0-100	n/a	n/a	%/10	
			(a.iv.iii) enrollment ratio	33,33%	census	0-100	single choice	0-100	n/a	n/a	%/10	
	(a.v) Gender Equality	20%	(a.v.i) girl-to-boy enrolment rate in school	50%	census based poverty map	0-1	single choice	0-1	n/a	n/a	x*10	
			(a.v.ii) female in wage employment non-agriculture	50%	census based poverty map	0-100	single choice	0-100	n/a	n/a	%/10	
count	5	100,0%	12 ADAPTIVE CAP.			0-10	0-lowest, 10-highest					

Figure 47 - an overview of the determination of adaptive capacity and its indicators

Vulnerability

After the calculation of the above outlined elements, the overall vulnerability was calculated for every village. This was done by adding exposure and sensitivity and then subtracting the adaptive capacity. Because each element has a value between 0 and 10, the minimum vulnerability is therefore -10, while the maximum is 20, expressing a very high vulnerability.

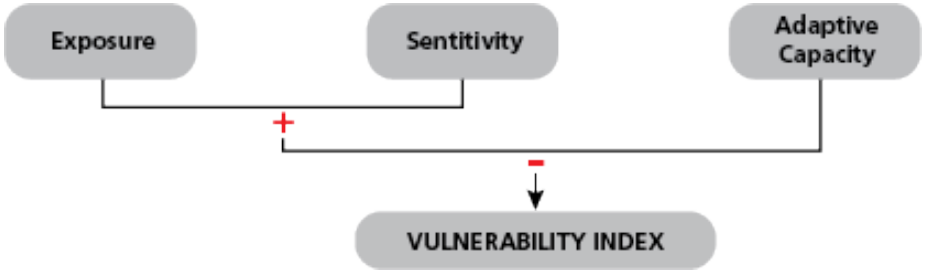


Figure 48 - an overview of vulnerability calculation based on the afore determined elements

Annex 4 Determination of coefficients of change under 'business-as-usual' (BAU) scenario

The coefficients of change are based on the current trends and have been defined to show the worst future scenario in 2050, 'business-as-usual' (BAU), that assumes no adaptation actions are taken. As such, they should be considered as the "estimated reduction" to 2017's baseline given the projected climate changes in temperature and rainfall.

These coefficients are spatially based considering the observed impacts and trends to identify the most vulnerable villages to maintain and support current living standards assessed in 2017.

Deforestation trends

National forests cover has declined dramatically between 1992 and 2002, at an average rate of 134,000 hectares per year (equivalent to 1.2 -1.3%). This decade also saw widespread deterioration in forest quality, with dense forest declining from 29% to 8.2% from 1992 to 2002, and open forest increasing from 16% to 24.5%. The UN REDD program estimates that, if the current reduction rate continues, the forest area will decrease to 7.4 million ha (31.3% of the total land) by 2020.

The quality of forest coverage in 2050, if no adaptive measure is considered, assumes the quality of the forest in 2009 will worsen, given the observed deforestation trends.

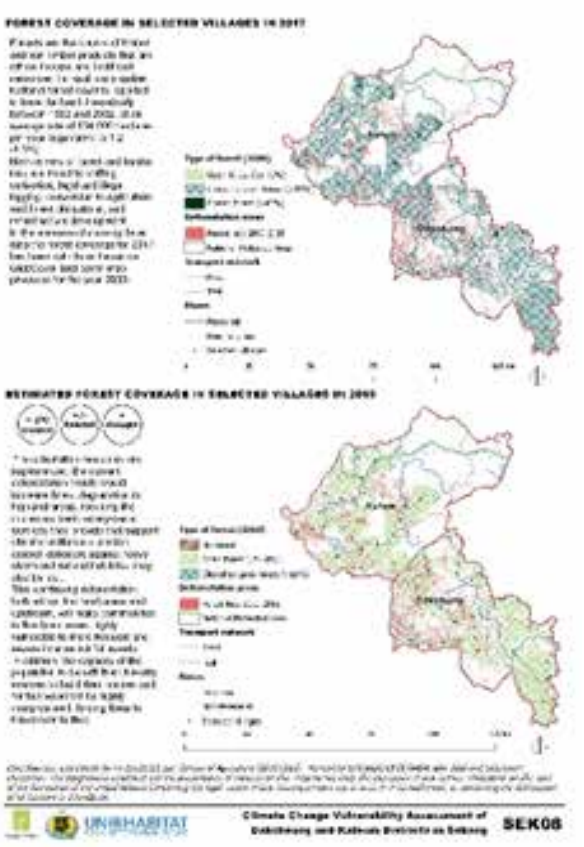
Assumptions

It is assumed that human activities such as wood harvesting, shifting cultivation, legal and illegal logging, conversion to agriculture and forest plantations, and infrastructure development will continue leading to:

"Closed forest" areas in 2009[172] (2017) will be "closed to open forest" areas in 2050.

"Closed to open forest" areas in 2009 (2017) will be "open forest areas" in 2050.

"Open forest" areas in 2009 (2017) will disappear by 2050.



172 In the absence of more updated data the forest coverage for 2017 has been calculated from Glove cover map from 2009.

Calculations

District	VCODE	Estimated type of forest 2050	Area (Ha)
Kaleum	1502002	Closed to open forest (>15%)	15,00
	1502002	Open forest (15-40%)	3.048,00
	1502002	No forest	11,00
	1502003	Open forest (15-40%)	2.780,00
	1502004	Open forest (15-40%)	1.948,00
	1502005	Closed to open forest (>15%)	6,00
	1502005	Open forest (15-40%)	3.691,00
	1502006	Closed to open forest (>15%)	25,00
	1502006	Open forest (15-40%)	6.315,00
	1502007	Closed to open forest (>15%)	103,00
	1502007	Open forest (15-40%)	2.602,00
	1502008	Closed to open forest (>15%)	103,00
	1502008	Open forest (15-40%)	3.490,00
	1502013	Closed to open forest (>15%)	67,00
	1502013	Open forest (15-40%)	10.201,00
	1502013	No forest	40,00
	1502015	Open forest (15-40%)	1.759,00
	1502016	Open forest (15-40%)	1.677,00
	1502017	Open forest (15-40%)	3.293,00
	1502018	Open forest (15-40%)	2.084,00
	1502020	Open forest (15-40%)	1.726,00
	1502021	Closed to open forest (>15%)	46,00
	1502021	Open forest (15-40%)	5.129,00
	1502025	Closed to open forest (>15%)	62,00
	1502025	Open forest (15-40%)	7.998,00
	1502026	Open forest (15-40%)	1.593,00
	1502029	Open forest (15-40%)	143,00
	1502032	Closed to open forest (>15%)	184,00
	1502032	Open forest (15-40%)	2.738,00
	1502033	Closed to open forest (>15%)	29,00
	1502033	Open forest (15-40%)	565,00
	1502035	Closed to open forest (>15%)	95,00
	1502035	Open forest (15-40%)	2.682,00
	1502037	Open forest (15-40%)	168,00
	1502038	Closed to open forest (>15%)	566,00
	1502038	Open forest (15-40%)	9.306,00
	1502043	Closed to open forest (>15%)	935,00
	1502043	Open forest (15-40%)	7.689,00
	1502045	Closed to open forest (>15%)	160,00
	1502045	Open forest (15-40%)	3.056,00
	1502049	Closed to open forest (>15%)	1.073,00
	1502049	Open forest (15-40%)	8.956,00
	1502071	Open forest (15-40%)	3.966,00

	1502072	Open forest (15-40%)	2.215,00
	1502075	Closed to open forest (>15%)	145,00
	1502075	Open forest (15-40%)	7.244,00
	1502082	Open forest (15-40%)	1.909,00
Dakcheung	1503001	Closed to open forest (>15%)	180,00
	1503001	Open forest (15-40%)	15.461,00
	1503002	Closed to open forest (>15%)	184,00
	1503002	Open forest (15-40%)	6.148,00
	1503003	Open forest (15-40%)	889,00
	1503007	Open forest (15-40%)	4.214,00
	1503017	Open forest (15-40%)	1.308,00
	1503020	Open forest (15-40%)	1.364,00
	1503021	Open forest (15-40%)	689,00
	1503023	Closed to open forest (>15%)	21,00
	1503023	Open forest (15-40%)	1.216,00
	1503027	Closed to open forest (>15%)	14,00
	1503027	Open forest (15-40%)	794,00
	1503028	Closed to open forest (>15%)	553,00
	1503028	Open forest (15-40%)	3.244,00
	1503033	Closed to open forest (>15%)	671,00
	1503033	Open forest (15-40%)	29.423,00
	1503034	Closed to open forest (>15%)	26,00
	1503034	Open forest (15-40%)	1.101,00
	1503036	Open forest (15-40%)	5.083,00
	1503038	Closed to open forest (>15%)	12,00
	1503038	Open forest (15-40%)	9.548,00
	1503038	No forest	15,00
	1503045	Open forest (15-40%)	5.408,00
	1503045	No forest	37,00
	1503049	Open forest (15-40%)	1.155,00
	1503050	Open forest (15-40%)	1.775,00
	1503051	Closed to open forest (>15%)	126,00
	1503051	Open forest (15-40%)	2.973,00
	1503058	Closed to open forest (>15%)	9,00
	1503058	Open forest (15-40%)	1.464,00
	1503060	Open forest (15-40%)	1.015,00
	1503062	Closed to open forest (>15%)	68,00
	1503062	Open forest (15-40%)	1.623,00
	1503068	Closed to open forest (>15%)	37,00
	1503068	Open forest (15-40%)	1.848,00
	1503086	Open forest (15-40%)	3.143,00
	1503090	Open forest (15-40%)	484,00
	1503092	Closed to open forest (>15%)	191,00
	1503092	Open forest (15-40%)	2.157,00
	1503102	Open forest (15-40%)	1.450,00
	1503105	Open forest (15-40%)	1.875,00

	1503111	Closed to open forest (>15%)	15,00
	1503111	Open forest (15-40%)	2.742,00
	1503114	Open forest (15-40%)	1.848,00
	1503124	Closed to open forest (>15%)	3,00
	1503124	Open forest (15-40%)	2.720,00
	1503127	Open forest (15-40%)	1.761,00
	1503131	Closed to open forest (>15%)	7,00
	1503131	Open forest (15-40%)	2.659,00
	1503132	Closed to open forest (>15%)	360,00
	1503132	Open forest (15-40%)	7.660,00

Access to freshwater for drinking use by 2050

Most of the villages in both targeted districts (around 70%) depend on surface sources. Probably, this is related to the dominant upland geography of these districts. In fact, in both districts, most of the surface water (streams and mountain sources) is distributed through a gravity system (76% and 59% of the targeted villages in Dakcheung and Kaleum) allowing the population, if adequately addressed, an important degree of autonomy in terms of operation and maintenance

The projected changes in precipitation patterns and an increase in mean temperature can easily lead to higher rates of evaporation and longer months of drought. Moreover, in the midterm groundwater sources will also be affected as aquifers will take longer to recharge leading to the need for further investments on infrastructure's improvement (tanks capacity, boreholes depth, etc.). In addition, stronger storms and unusually heavy rainfall will inevitably damage water infrastructure

Assumptions

It is assumed, that under a BAU scenario, communities' freshwater sources and current water supply and systems are highly exposed to climate change. The projected climate changes in temperatures and rainfall will lead to more frequent drought periods and more damaging storms.

- The observed drought, storms and floods impacts will worsen in all surveyed communities
- No adaptive measure is considered

Calculations

(i) Percentage of Households having access to freshwater sources in 2015 = percentage of households in each village having access to freshwater according to Census 2015

(ii) Coefficient impacts observed = is applied to selected villages where impacts where reported by type of water system used: being a) 0.9 piped water; b) 0.8 protected well/borehole; c) 0.7 unprotected borehole; d) 0.6 river/stream/dam; e) 0.7 mountain water. f) 0.5 Rain water; g) 0.9 Bottled/Canned : h) 0.80 Tank
Percentage of the Households having access to freshwater sources in 2017 = (i)*(ii)

(iii) Climate change Coefficient = is applied to all selected villages due to the projected climate changes on stronger storms and unusually heavy rainfall by type of water system used: being 0.9 piped water; 0.8 protected well/borehole; 0.7 unprotected borehole; 0.6 river/stream/dam; 0.7 mountain water. 0.5 Rain water; 0.9 Bottled/Canned

(iv) Percentage of the Households having access to freshwater sources in 2050 = (iii)*(iv)

DISTRICT	VCODE	CENSUS 2050								(iii)	(v)
		a	b	c	d	e	f	g	h		
Kaleum	1502002	64	16	4	0	0	0	16	0	53,36	46,74
	1502003	0	76	24	0	0	0	0	0	30,14	23,39
	1502004	0	0	0	0	100	0	0	0	14,85	10,40
	1502005	0	0	0	100	0	0	0	0	19,80	11,88
	1502006	0	0	0	0	0	0	100	0	81,00	72,90
	1502007	0	0	0	0	100	0	0	0	14,85	10,40
	1502008	0	0	0	100	0	0	0	0	19,80	11,88
	1502013	0	0	0	100	0	0	0	0	60,00	36,00
	1502015	0	0	0	0	100	0	0	0	14,85	10,40
	1502016	0	0	0	0	100	0	0	0	16,50	11,55
	1502017	0	0	0	0	100	0	0	0	50,00	35,00
	1502018	0	0	0	25	75	0	0	0	52,50	35,44
	1502020	0	0	0	0	100	0	0	0	100,00	70,00
	1502021	0	0	0	0	100	0	0	0	14,85	10,40
	1502025	0	0	0	0	100	0	0	0	50,00	35,00
	1502026	0	0	0	0	100	0	0	0	100,00	70,00
	1502029	0	0	0	100	0	0	0	0	6,53	3,92
	1502032	0	0	100	0	0	0	0	0	100,00	70,00
	1502033	0	0	0	0	100	0	0	0	100,00	70,00
	1502035	0	0	0	0	100	0	0	0	100,00	70,00
	1502037	0	0	0	0	100	0	0	0	100,00	70,00
	1502038	0	0	0	0	100	0	0	0	14,85	10,40
	1502043	0	0	0	100	0	0	0	0	100,00	60,00
	1502045	0	0	0	20	80	0	0	0	13,19	8,97
	1502049	0	0	0	40	60	0	0	0	11,52	7,61
	1502071	0	0	0	0	100	0	0	0	14,85	10,40
	1502072	0	0	0	0	100	0	0	0	50,00	35,00
	1502075	0	0	0	0	100	0	0	0	50,00	35,00
	1502082	0	0	0	0	100	0	0	0	14,85	10,40
Dakcheung	1503001	0	0	0	0	100	0	0	0	45,00	31,50
	1503002	0	0	0	60	40	0	0	0	29,88	19,12
	1503003	0	0	0	0	100	0	0	0	14,85	10,40
	1503007	0	0	0	40	60	0	0	0	100,00	66,00
	1503017	0	0	36	64	0	0	0	0	29,40	18,71
	1503020	0	100	0	0	0	0	0	0	52,80	42,24
	1503021	0	0	0	40	60	0	0	0	67,20	44,35
	1503023	0	0	0	0	100	0	0	0	14,85	10,40
	1503027	0	0	0	100	0	0	0	0	60,00	36,00
	1503028	0	0	100	0	0	0	0	0	70,00	49,00
	1503033	0	0	0	0	100	0	0	0	100,00	70,00
	1503034	0	0	0	0	100	0	0	0	45,00	31,50
	1503036	0	0	0	23	77	0	0	0	12,93	8,75
	1503038	0	0	0	0	100	0	0	0	14,85	10,40

	1503045	0	0	20	0	80	0	0	0	54,00	37,80
	1503049	0	0	0	25	75	0	0	0	17,33	11,69
	1503050	0	0	0	33	67	0	0	0	17,60	11,73
	1503051	0	0	0	0	100	0	0	0	33,00	23,10
	1503058	0	33	44	22	0	0	0	0	19,84	14,11
	1503060	0	0	0	0	100	0	0	0	50,00	35,00
	1503062	75	0	20	5	0	0	0	0	64,35	54,38
	1503068	0	0	0	0	100	0	0	0	14,85	10,40
	1503086	0	0	0	0	100	0	0	0	45,00	31,50
	1503090	0	0	0	0	100	0	0	0	50,00	35,00
	1503092	0	0	0	33	67	0	0	0	36,60	24,40
	1503102	0	0	0	0	100	0	0	0	14,85	10,40
	1503105	0	0	43	0	57	0	0	0	58,57	41,00
	1503111	0	0	0	25	75	0	0	0	12,77	8,62
	1503114	0	0	0	17	83	0	0	0	51,67	35,31
	1503124	0	0	0	0	100	0	0	0	50,00	35,00
	1503127	0	0	0	0	100	0	0	0	50,00	35,00
	1503131	0	0	0	67	33	0	0	0	9,31	5,89
	1503132	0	0	0	33	67	0	0	0	36,60	24,40

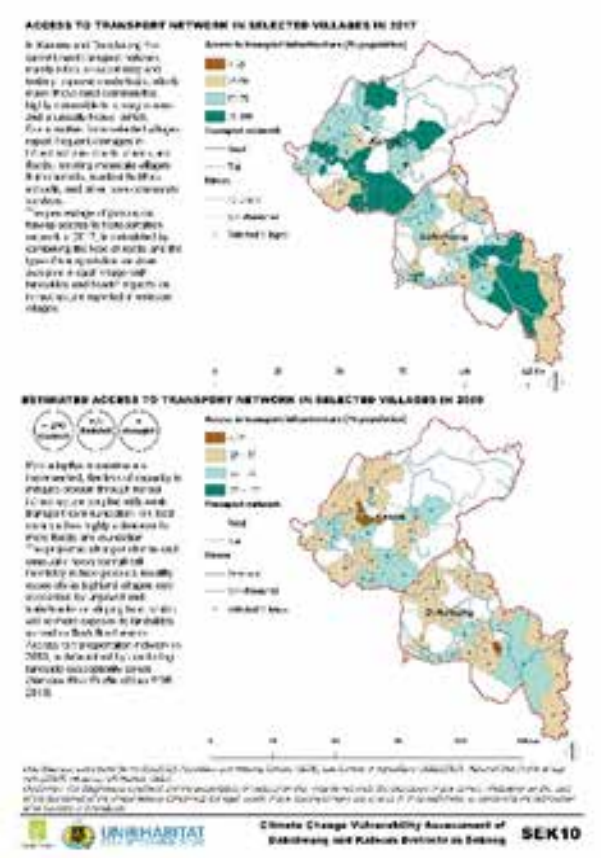
Water sources and systems: a) piped water; b) protected well/borehole; c) unprotected borehole; d) river/stream/dam; e) mountain water. f) Rain water; g) Bottled/Canned; h) Tank

Access to transportation services by 2050

In Kaleum and Dakcheung districts' highland areas, mobility seems to be the main constraint for the socio-economic and livelihood development of rural communities. Currently, the rural transport network mainly relies on a network of secondary and tertiary unpaved roads/trails, which make these rural communities highly vulnerable to strong storms and unusually heavy rainfall. These mobility constraints already jeopardize rural livelihoods but will worsen in emergency situations following the projected extreme weather events.

Most of the selected villages in Kaleum are accessible only by trails/tracks (around 70%) while in Dakcheung accessibility is mainly by unpaved gravel roads (67%). While only 3% in Kaleum and and 6% Dakcheung, have access to paved roads.

Communities report important storm and flood's impacts on infrastructure. Indeed, 81% and 50% of the selected villages pointed damages in the community's infrastructures due to storms and floods, respectively. Moreover, the population in Dakcheung considers storms are particularly frequent (more than one per year).



Assumptions

It is assumed, that under a BAU scenario, the current rural road networks is a critical infrastructure highly exposed to climate change. The projected climate changes in temperatures and rainfall will lead to frequent landslides, flash floods and hillslope isolate mountain villages from markets, medical facilities, schools, and other core community services.

• The observed landslides and floods impacts will worsen in landslide susceptibility and flood prone areas defined by the National Risk Profile of Lao PDR

• No adaptive measure is considered

Calculations

(i) Population in 2017 = total population in each village accruing to Census 2015

(ii) Coefficient of impacts perceived 2017 = is defined by combining the type of transport infrastructure and services available in each village with the hazards and impacts reported, being 0.5 high, 0.75 medium and 0.9 low

(iii) Percentage of the population having access to transportation network in 2017 = [(i)*(ii)]/(i)*100

(iv) Coefficient of landslides risk = is applied to landslide's susceptibility areas defined by the National Risk Profile of Lao PDR, being 0.5 high, 0.75 medium and 0.9 low

(v) Coefficient of flood risk = is applied to flood prone areas defined by the National Risk Profile of Lao PDR, being 0.5 high and 0.9 low

(vi) Coefficient of storms = is applied to all villages due to the projected climate changes on stronger storms and unusually heavy rainfall, being 0.5 high and 0.9 low

(vii) Percentage of the population having access to transportation network in 2050 = [(iv)*(v)*(vi)*(i)]/(i)*100

DISTRICT	VCODE	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Kaleum	1502002	1068	0,9	90	0,75	0,90	0,90	55
	1502003	1649	0,75	75	0,75	0,90	0,90	46
	1502004	290	0,75	75	0,75	0,90	0,90	46
	1502005	206	0,9	90	0,75	0,90	0,90	55
	1502006	198	0,75	75	0,50	0,90	0,90	30
	1502007	648	0,75	75	0,50	0,90	0,90	30
	1502008	212	0,5	50	0,50	0,90	0,90	20
	1502013	139	0,5	50	0,75	0,90	0,90	30
	1502015	250	0,9	90	0,75	0,90	0,90	55
	1502016	467	0,75	75	0,75	0,90	0,90	46
	1502017	286	0,9	90	0,75	0,90	0,90	55
	1502018	490	0,9	90	0,50	0,90	0,90	36
	1502020	239	0,9	90	0,50	0,90	0,90	36
	1502021	185	0,9	90	0,75	0,90	0,90	55
	1502025	180	0,9	90	0,75	0,90	0,90	55
	1502026	226	0,9	90	0,75	0,90	0,90	55
	1502029	440	0,9	90	0,75	0,90	0,90	55
	1502032	131	0,75	75	0,75	0,90	0,90	46
	1502033	267	0,75	75	0,75	0,90	0,90	46
	1502035	189	0,9	90	0,75	0,90	0,90	55
	1502037	162	0,9	90	0,75	0,90	0,90	55

	1502038	178	0,75	75	0,50	0,90	0,90	30
	1502043	293	0,9	90	0,50	0,90	0,90	36
	1502045	289	0,75	75	0,50	0,90	0,90	30
	1502049	437	0,9	90	0,75	0,90	0,90	55
	1502071	325	0,9	90	0,75	0,90	0,90	55
	1502072	247	0,9	90	0,75	0,90	0,90	55
	1502075	429	0,75	75	0,75	0,90	0,90	46
	1502082	277	0,75	75	0,75	0,90	0,90	46
	1503001	357	0,5	50	0,75	0,90	0,90	30
	1503002	309	0,5	50	0,90	0,90	0,90	36
	1503003	232	0,5	50	0,50	0,90	0,90	20
	1503007	379	0,75	75	0,75	0,90	0,90	46
	1503017	689	0,75	75	0,90	0,90	0,90	55
	1503020	442	0,75	75	0,90	0,90	0,90	55
	1503021	500	0,75	75	0,90	0,90	0,90	55
	1503023	289	0,75	75	0,75	0,90	0,90	46
	1503027	381	0,9	90	0,75	0,90	0,90	55
	1503028	309	0,75	75	0,75	0,90	0,90	46
	1503033	86	0,9	90	0,75	0,90	0,90	55
	1503034	211	0,5	50	0,75	0,90	0,90	30
	1503036	1383	0,75	75	0,75	0,90	0,90	46
	1503038	468	0,75	75	0,75	0,90	0,90	46
	1503045	275	0,75	75	0,75	0,90	0,90	46
	1503049	225	0,5	50	0,75	0,90	0,90	30
Dakcheung	1503050	258	0,5	50	0,75	0,90	0,90	30
	1503051	259	0,5	50	0,75	0,90	0,90	30
	1503058	630	0,75	75	0,75	0,90	0,90	46
	1503060	359	0,9	90	0,75	0,90	0,90	55
	1503062	305	0,75	75	0,90	0,90	0,90	55
	1503068	514	0,5	50	0,75	0,90	0,90	30
	1503086	537	0,5	50	0,90	0,90	0,90	36
	1503090	247	0,75	75	0,90	0,90	0,90	55
	1503092	353	0,5	50	0,75	0,90	0,90	30
	1503102	315	0,5	50	0,75	0,90	0,90	30
	1503105	269	0,9	90	0,50	0,90	0,90	36
	1503111	327	0,5	50	0,75	0,90	0,90	30
	1503114	330	0,75	75	0,50	0,90	0,90	30
	1503124	239	0,5	50	0,90	0,90	0,90	36
	1503127	439	0,9	90	0,50	0,90	0,90	36
	1503131	404	0,75	75	0,90	0,90	0,90	55
	1503132	208	0,5	50	0,75	0,90	0,90	30

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