CLIMATE CHANGE VULNERABILITY ASSESSMENT

Saravan Province

Final Report 2019

ADAPTATION FUND

UN HABITAT
FOR A BETTER URBAN FUTURE

Climate Change Vulnerability Assessment – Saravan 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 Saravan Province was conducted in 61 villages, in two of the province's eight districts; 31 villages in Ta Oi District and 30 villages in Samuoi District. These villages have a population of 24,307, about 52.4 per cent of the total population of the two districts

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 Saravan, have experienced flooding at least once since 1995[2].

Annual average rainfall is just over 2,000 millimetres per year in Saravan Town, about 87 per cent of which falls in the rainy season from May to October[3]. There has been a slight increase in the amount of rainfall Saravan Town receives on average since 1990 of about 4 per cent. The number of rainy days has slightly decreased however; there are now about 12 fewer rainy days per year than in 1990. There was also a substantial amount of variation experienced in rainfall, with the driest year receiving less than 1,500 millimetres of rain, and the wettest receiving just under 3,000 millimetres.

The average maximum temperature has increased by about 1.05°C since 1990 in Saravan town, while the average minimum temperature has increased by about 0.6°C. Saravan had never recorded a temperature over 40°C until 2016 when it recorded temperatures of 41.5°C and 42°C in April and May. Almost all communities surveyed in the assessment noted some level of temperature increase and rainfall decrease, though the level varied between district and season.

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

Hazard	No. of villages affected in Ta Oi	No. of villages affected in Samuoi	Details
Floods	12	13	Damages houses, infrastructure and livelihoods
Storms	18	28	Storms affected houses, infrastructure and incomes, primarily
Landslides	4	2	Damages infrastructure
Drought	12	13	Lack of water then affects crops and health

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.

3 It should be noted that Samuoi District has a slightly different monsoon pattern, with the dry season continuing through May and June and the rainy season coming in July and lasting until January

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.

In 2010, forest land made up 80 per cent of land cover in Samuoi District and 76.5 per cent in Ta Oi District. Shrubland was the next most common land use type, followed by paddy fields and agriculture land, which made up only 6-7 per cent of land cover in each district. In both districts, over 90 per cent of the forest cover was classified as 'closed to open' forest. Despite this, all 31 villages surveyed in Ta Oi District said they had been affected by deforestation, while 14 in Samuoi District also reported impacts of deforestation. Only two villages – both in Ta Oi, reported that hydropower had impacted them, while none reported any impacts from mining activities. Household-level dependence on forest resources for cooking fuel and construction material is the main driver of small-scale deforestation; 90 per cent of households in both districts rely on such material.

Only 14 per cent of roads are paved in Samuoi District, and only 27 per cent of the surveyed villages in Saravan Province have access to paved roads, resulting in transport challenges in most villages. Upland villages in Samuoi were the least accessible, with three-quarters only being accessible by a trail or track. Roughly half of the households don't have access to a telephone, and 20 per cent and 50 per cent in Ta Oi and Samuoi Districts respectively don't have electricity connections. 64 per cent and 73 per cent of households in Ta Oi and Samuoi Districts respectively depend on surface water as their primary source. Throughout the two districts, gravity- fed systems were the most common type of water supply, followed by deep wells. Virtually none of the villages have access to piped water. Over 50 per cent of households in both districts reported that increased temperatures were directly impacting their ability to access water.

Poverty continues to be a pressing challenge for Saravan Province; the overall poverty headcount for the province is 48.2 per cent, almost double the national average of 24.8 per cent[4]. Ta Oi District's poverty rate makes it the 2nd poorest district in the country. Samuoi District is the 5th poorest in the country[5].

The poverty gap index, which measures the depth of poverty (as opposed to absolute number of the poor), shows a poverty gap of 21.9 per cent for Ta Oi District and 16.5 per cent for Samuoi District. In Ta Oi, all villages reported a dependence of agriculture and livestock, while in Samuoi District, many villages also depend on casual labour for income. The literacy rates in the target districts are much lower; 45.4 per cent in Ta Oi District and 42.1 per cent in Samuoi District. High school enrolment rates are around 5 per cent in both districts, among the lowest in the country, which is partly due to the lack of high schools and difficulty for many to access them.

The assessment classes 60 per cent of the villages in Samuoi District as local rural villages, compared to 25 per cent of those in Ta Oi District. This is primarily because Ta Oi's transportation network is better, but also because there are most social and economic services in Ta Oi. Both districts are dependent on one cluster of villages to provide the majority of services, making them more vulnerable to extreme events. Informally, the assessment understands that people in Samuoi District are more likely to cross the border into Vietnam to access services.

The vulnerability index shows that vulnerable villages are located throughout Saravan Province. In particular, there are clusters of vulnerable villages in the northern part of Samuoi District and the central part of Ta Oi District. Villages with lower vulnerability tend to have more services than those with higher vulnerability, as villages are exposed to hazards throughout the two districts.

The assessment defines three adaptation scenarios; business as usual; resilience built to maintain current living standards, and resilience is built to enhance socio-economic development, and considers the second of these to be the bare minimum required to cope with the anticipated effects of climate change.

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.

4 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.97.

5 Author's analysis, based on 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, pp. 91-99

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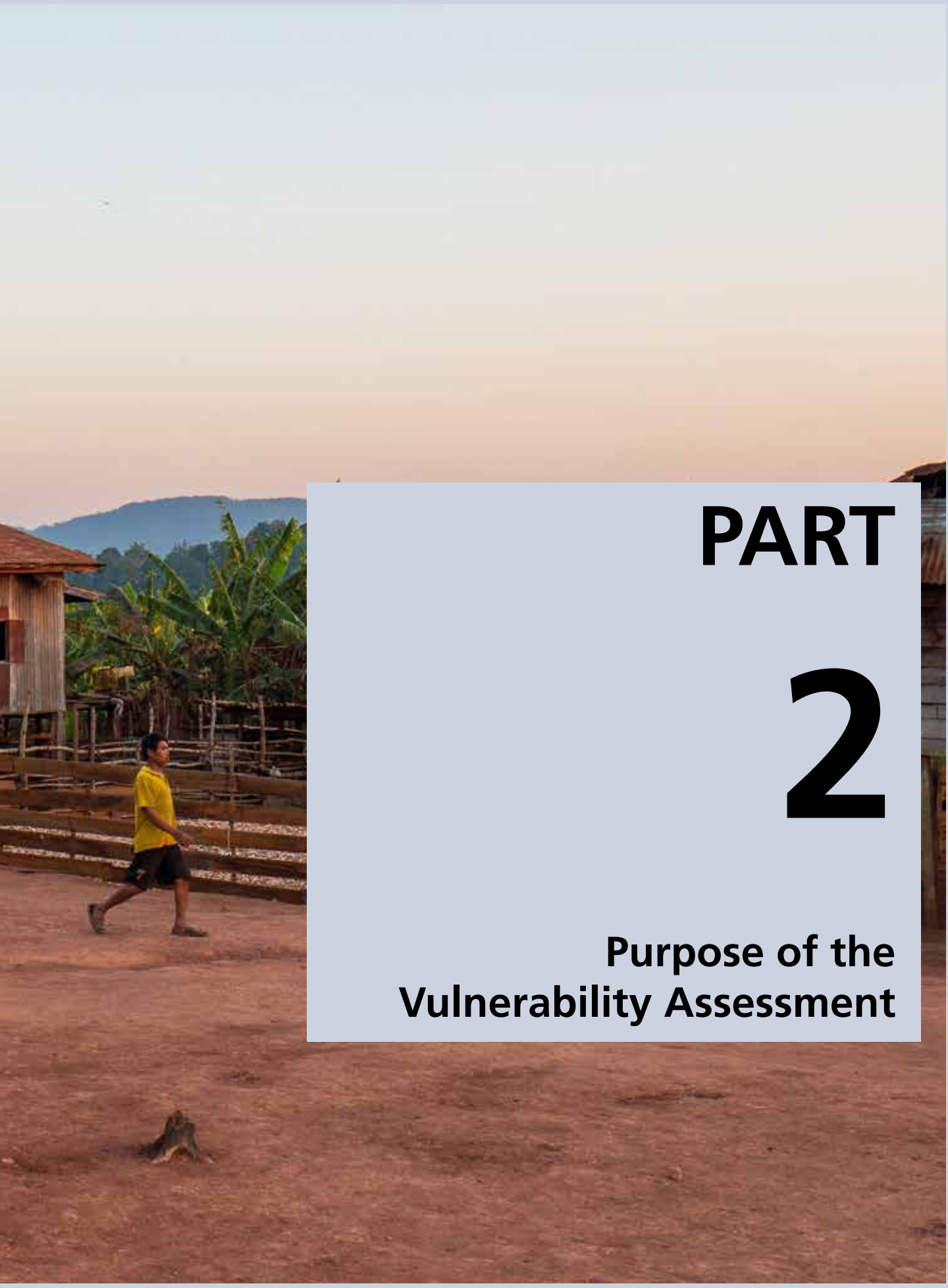

PART 2

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[6], 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[7]. 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[8].

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[9]. Supported by this growth, poverty rates nationwide fell from 27.6 per cent in 2008 to 23.2 per cent in 2013[10] [11]. 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)[12]. However, in 2015, agriculture still employed 65 per cent of the labour force, which, though a decrease from 71.3 per cent in 2010[13], 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[14]. 14 of Laos' 17 provinces, including Sekong, have experienced flooding at least once since 1995[15]. Similarly, drought has affected six provinces over the same time period[16], 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[17].

6 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.
7 World Risk Report 2016, p.65.
8 Ministry of Planning and Investment, (2016) 8th Five-year National Socio-economic Development Plan, p.87-89.
9 According to World Bank data - http://www.worldbank.org/en/country/lao - accessed 17/8/2017.
10 Ministry of Planning and Investment, (2016), 8th Five-year National Socio-economic Development Plan, p.3.
11 The World Bank quotes a slightly higher national poverty headcount figure of 24.8 per cent for 2015.
12 Ibid, p.5.
13 Ibid, p.11.
14 Laos Second National Communication to the UNFCCC (2013) p.56
15 Laos Intended Nationally Determined Contribution to the UNFCCC (2015), p.5.
16 Ibid.
17 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 Saravan 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[18]. 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[19].

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[20], Laos will more than double its current power generation capacity when all hydropower projects that are currently planned or under construction come on-grid.

Ten hydropower plants are under construction or are being built in southern Lao PDR. While none are currently being built in Saravan, it was reported by the district authorities that five hydropower dams are at the planning stage in Ta Oi District.

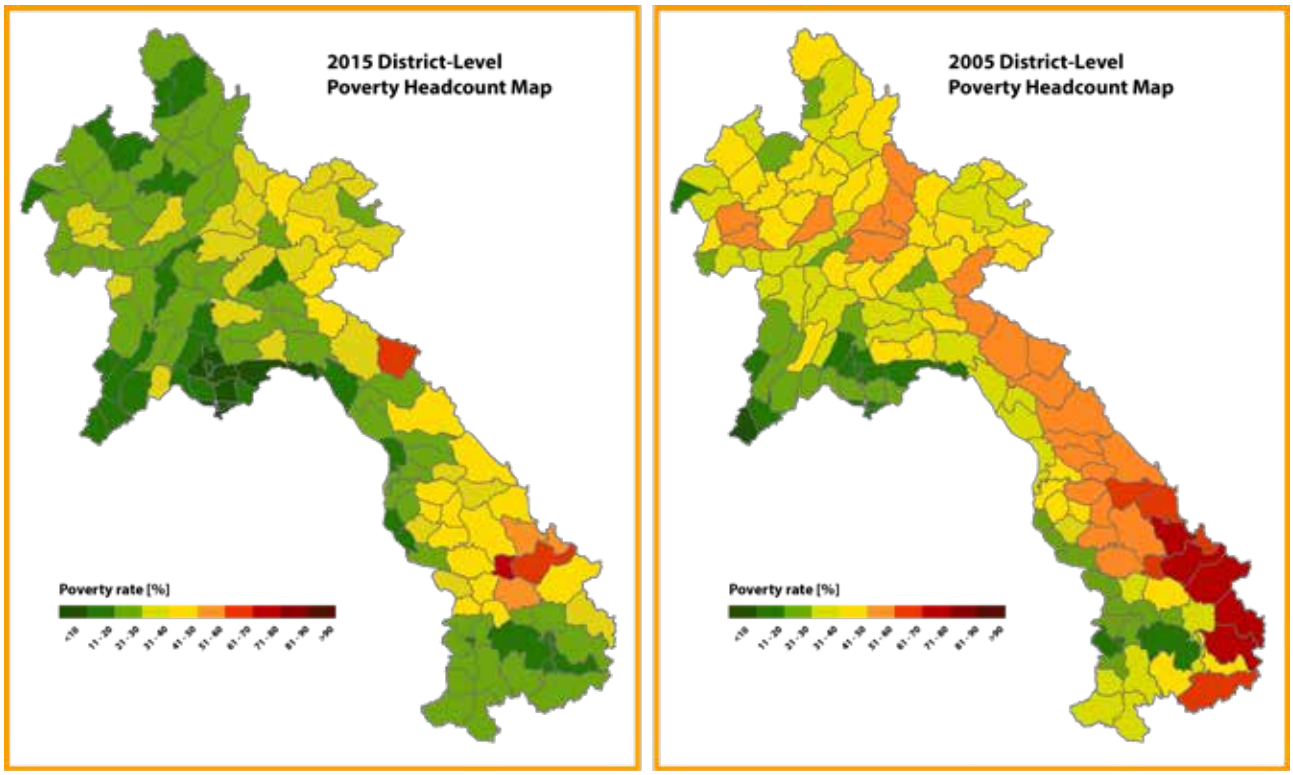

Figure 1 - Change in the district-level poverty headcount between 2005 (right) and 2015 (left)

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

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

20 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 Saravan 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 Saravan; 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).

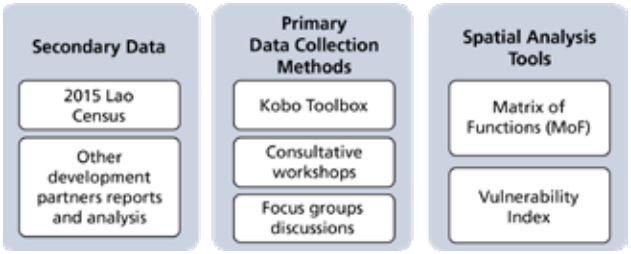

Figure 2 - Data collection methods and spatial analysis tools

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 organizations, 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 61 in Saravan Province that are spread across a large area with challenging terrain, a rapid means to gather data from each village was required. To address 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.

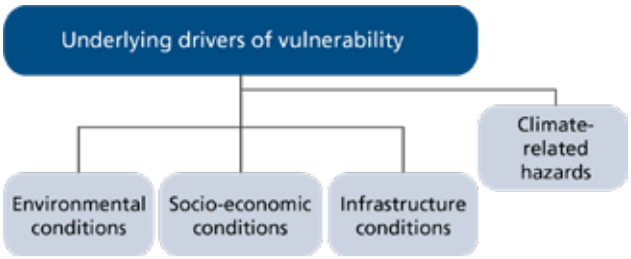

Figure 3 - Determination of current drivers of climate vulnerability

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 utilizes quantitative secondary information, such as data from the census and economic information from provincial level government departments, and primary data gathered from the tablet-based survey, which also allowed the assessment to understand poverty, livelihoods and ethnic minority issues, which are critical in Saravan 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[21] 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.

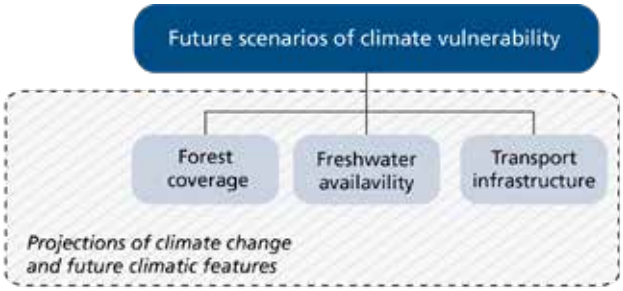

Figure 4 - Determination of future climate vulnerability

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 Saravan 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.

21 Defined in this case as a multiplier

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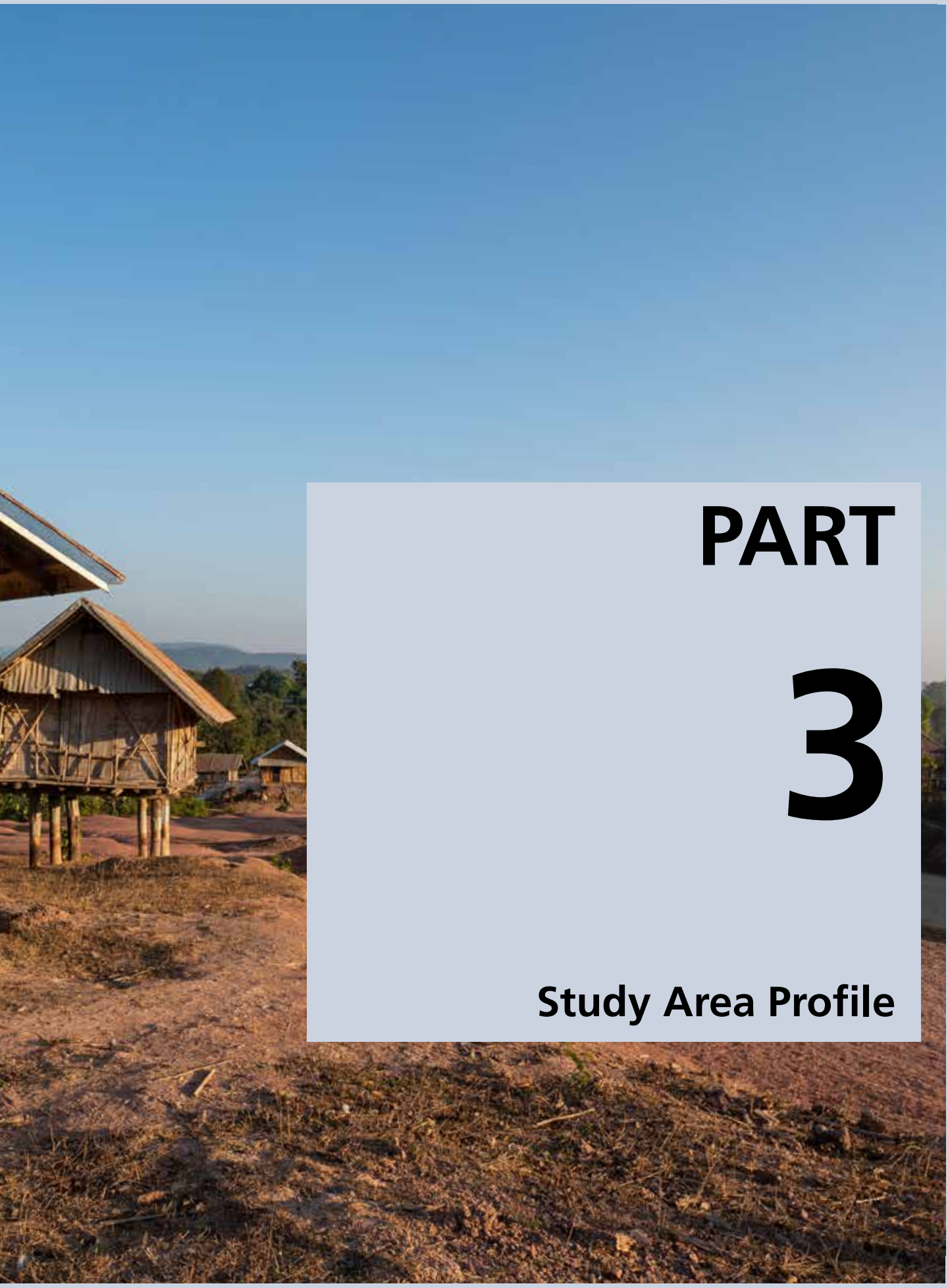


PART 3

Study Area Profile

3 Study Area Profile

3.1 Location and Physical Details

Saravan is in the southern part of Laos, sharing a border with Vietnam to the east and the Mekong River (and Thailand) to the west. Saravan Province is strategically located in the Development Triangle Area[22], an area covering the border area between Southern Laos, Northern Cambodia and Central Highlands of Vietnam. Saravan Province borders Savanakhet Province to the north And Champasack and Sekong Provinces to the South. Saravan Province has a land area of 16,389 km² and is divided into eight districts: Ta Oi, Samuoi, Saravan, Toomlarn, Lakhonepheng, Vapy, Khongsedone and Lao Ngarm and 588 villages[23]. The provincial capital is Saravan Town, located close to the foot of the Bolaven Plateau on the banks on the Xe Don river[24].

Ta Oi and Samuoi Districts are targeted by the project and are located in the eastern part of the province. Both districts have hilly topography and almost all villages surveyed in the assessment are upland (either mountainous or plateau). In Ta Oi District there are peaks of over 1500 metres, though the typical elevation of the villages is between 500 and 1000 metres.

Meanwhile, the central and western districts of Saravan Province (Lakhonepheng, Khongsedone, Vapy, Lao Ngarm, Saravan), are lowland areas, bordered by the Bolaven Plateau to the south. The province is an ancient volcanic area but rich volcanic soils still cover 40% of the province[25].

Much of Saravan Province is part of the Mekong Basin ecosystem. The Lower Mekong Basin alone provides natural resource for ecosystem-based rural livelihoods of a population of 60 million people[26].

Two major Mekong River tributaries cross Saravan Province; The Xe Don River flows through the centre of the province, including Saravan Town, while the Banghiang River passes through the east of the province. With a catchment area of almost 20,000 square kilometres, it is the third largest of Laos' 12 main river systems, while the Xe Don is the third smallest with a catchment area of around 7,230 square kilometres[27].

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

22 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)

23 Lao PDR Investment Promotion Department (2017). Saravan Province, Executive Summary. Retrieved from: http://www.investlaos.gov.la/images/Investment-Profiles/Saravan/1.Saravan_Executive_Summary.pdf (last accessed on 28/9/2017).

24 Lao tourism (http://www.laotourism.org/Saravan.htm)

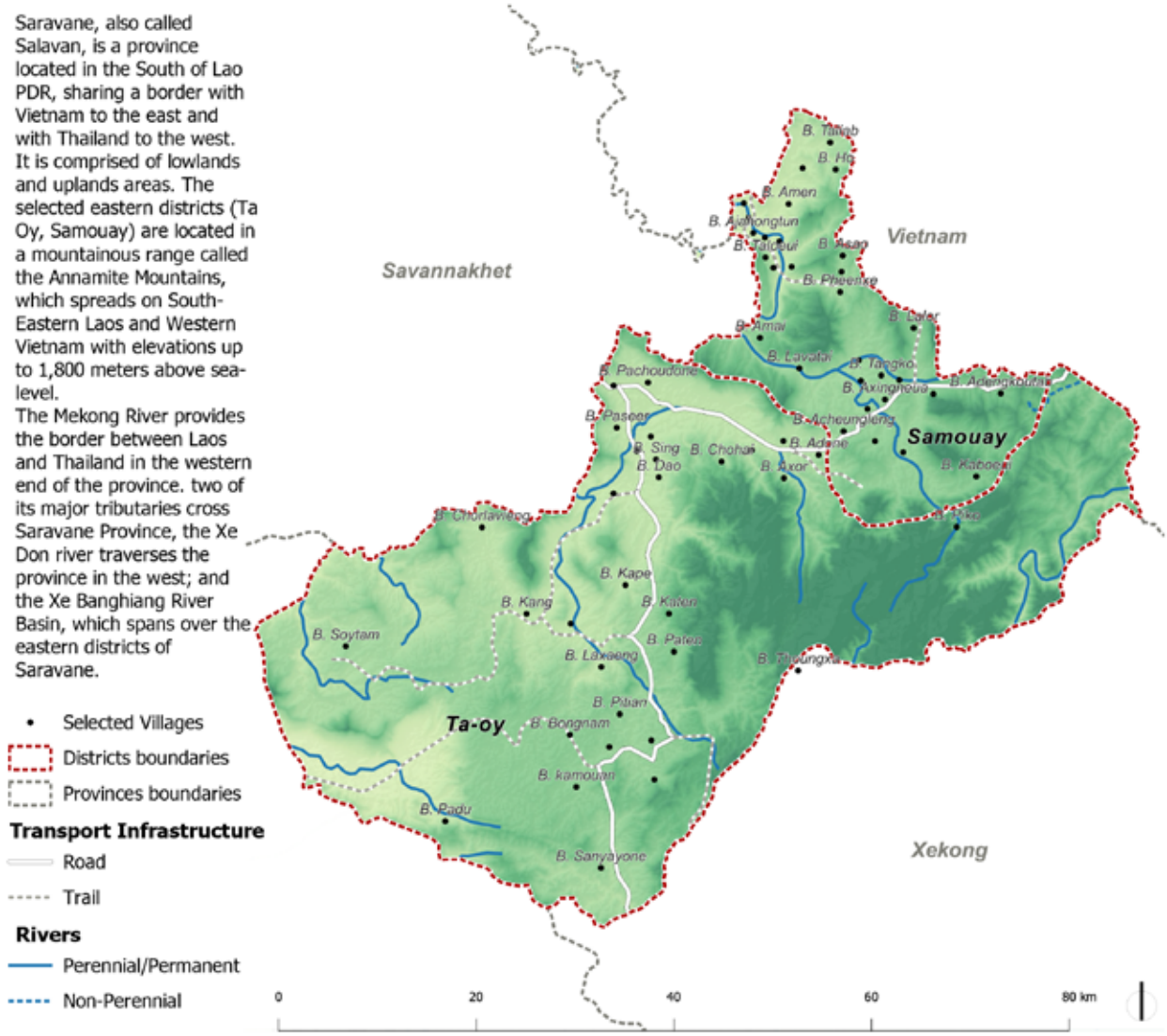
25 Saravanh Tourism Laos. Saravanh History. Retrieved from: https://Saravanhtourismlaos.wordpress.com/Saravanh-history/ (last accessed on 28/9/2017).

26 Ibid.

27 Risk Assessment Report, Vol. I, p.25.

PHYSICAL DETAILS AND LOCATION OF SELECTED VILLAGES

Saravane, also called Salavan, is a province located in the South of Lao PDR, sharing a border with Vietnam to the east and with Thailand to the west. It is comprised of lowlands and uplands areas. The selected eastern districts (Ta Oy, Samouay) are located in a mountainous range called the Annamite Mountains, which spreads on South-Eastern Laos and Western Vietnam with elevations up to 1,800 meters above sea-level.
The Mekong River provides the border between Laos and Thailand in the western end of the province. two of its major tributaries cross Saravane Province, the Xe Don river traverses the province in the west; and the Xe Banghiang River Basin, which spans over the eastern districts of Saravane.



Data Sources: Lao Decide (www.decide.la), Population and Housing Census 2015 (Lao Statistics Bureau)
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3.2 Transportation Infrastructure

Saravan has 2,144km of roads, making its road density of 0.32 kilometres of road per square kilometre higher than many other provinces in Laos[28]. National roads 15 and 20 connect Saravan Town with Savannakhet and Vientiane to the north and Pakse and the Cambodia border to the south. Saravan Town is linked through Ta Oi and Samuoi Districts by a paved road to the Vietnamese border and on to Hue, which is a vital trade connection. Public transport connections by bus are now in place between Saravan Town and the Vietnam border. These bus services also stop in Ta Oi and Samuoi Districts.

Since there is no railway system in Lao PDR, roads have an important role in Lao PDR's traffic and fulfilling transportation needs. As many as 81 per cent of passenger traffic and 88 per cent of freight traffic are moved by road transport[29]. However, and despite their importance, roads are often in poor condition. It is estimated that 194 square kilometres (9 per cent) of the roads are paved, while 1,950 square kilometres (91 per cent) are gravelled or earth roads[30]. Since virtually all of these gravelled and earth roads provincial- and local roads, the access to all the districts, particularly the eastern districts located in a mountainous area, remains difficult during the rainy season[31]. There are also as many as 181 bridges in the province – essential for crossing Saravan's numerous rivers and streams[32].

Public land transportation is restricted to buses, which connect Saravan town to the other districts of the province as well as to other cities in the country such as Vientiane, Pakse, Savannakhet or Sekong. The nearest airport is in Pakse, which has daily domestic flights to Vientiane, Luang Prabang and Savannakhet and international flights to Ho Chi Minh City, Bangkok and Siem Reap[33].

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 households in Saravan province, with around 90 per cent of households engaged in agricultural practices[34]. Farm sizes are among the largest in the country; the amount of agricultural land per person is thought to be 0.38 ha[35]. Rice is Saravan's main crop; 89.5 per cent of households are involved in rice production[36]. Saravan Province is dominated by lowland paddies, but there are also some highland and plateau paddies, especially in Ta Oi and Samuoi Districts, the location of this assessment.

Besides rice production, there are also some cash-crop and livestock herding activities. The fertile volcanic soil and the climate of the nearby Bolaven Plateau enable the production of coffee, cardamom and fruits such as rambutan[37]. In the lowland areas, farmers produce bananas, peanuts, soybeans, chilies, cassava, maize and sweet potatoes[38]. Some households herd livestock typically cattle, buffalo, pigs and poultry[39]. However, livelihood diversification remains very low in the province[40].

In 2014, agriculture accounted for 39 per cent of the province's GDP, while the service - and industrial sector represented 40 and 21 per cent respectively[41]. However, economic trends indicate that agriculture and forestry are decreasing to give way to industry and service, meaning the economy of Saravan is becoming more industrialized[42]. In the southern provinces, including Saravan, the government of Laos wants to further industrialization by prioritizing and developing the electricity industry, agro-processing and mineral exploitation[43]. The government has identified foreign direct and domestic investment as a means to develop these economic activities, as well as infrastructure.

28 Lao PDR Peace Independence Democraty Unity Prosperity, UNDP (2010). Developing a National Risk Profile. p. 35.
29 Ibid.
30 Ibid, p.29.
31 Ecotourism Laos (website). Saravan province. Retrieved from: http://ecotourismlaos.com/index.php/travel-guide/provincial-highlight/199-Saravan-province (last accessed on 28/9/2017).
32 Poverty-Environment Initiative of Lao PDR (2011): Assessment of Economic, Social and Environmental Costs and Benefits of Investment in Saravan Province. Final Report. p.30.
33 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).
34 Lao PDR Agricultural Census Office (2012): Lao census of agriculture 2010/11. p.2.
35 Ibid. p.2.
36 Ministry of Agriculture and Forestry, Government of Lao PDR, FAO (2013). Lao PDR, Risk and Vulnerability Survey 2012/2013, Analysis Report. p.88.
37 Sustainable tourism development project in Lao PDR. A guide to Saravan. Retrieved from: http://www.stdplaos.com/downloads/web-based_knowledge_center/visitor_information/provinces_in_laos/Saravanh/Saravan%20Guidebook.pdf (last accessed on 28/9/2017).
38 Ibid.
39 Ministry of Agriculture and Forestry, Government of Lao PDR, FAO (2013). Lao PDR, Risk and Vulnerability Survey 2012/2013, Analysis Report. p.88.
40 Lao PDR DDMCC & WFP (2012): Lao PDR. CLEAR: Consolidated Livelihood Exercise for Analyzing Resilience. p. 10.
41 Lao News Agency (website). Saravan collects revenue exceeding target set (2014). Retrieved from: http://kpl.gov.la/En/Detail.aspx?id=201 (last accessed on 28/9/2017).
42 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.
43 IMF, p. 183

As a result of this economic development in Saravan, the provincial GDP per capita has increased from US$ 388 in 2004-2005 to US$ 710 in 2009-2010. These figures are well below the national average of US$ 1,217 for the fiscal year of 2010-2011[44]. Consequently, Saravan is one of the poorest provinces in Lao PDR. In fact, Saravan has the highest poverty headcount rate in the country with 49.8 per cent of the population living below the poverty line[45]. The eastern districts, including Ta Oi and Samuoi are the poorest districts of the province[46]. In Ta Oi District, for example, the poverty ratio is 61 per cent, which is one of the highest poverty headcounts in Lao PDR[47].

3.4 Demographic Trends

With a population of around 397,000 according to the 2015 census, and an area of around 10,700 square kilometres, Saravan is the fourth most densely populated province in Laos, with an average of 37 people per square kilometre[48]. Despite this, Saravan is also one of the least urbanized provinces in the country, with less than 20 per cent of its population living in urban areas[49]. As people mostly live in rural settlements, people typically depend on agriculture for their income[50]. However, Laos is currently experiencing one of the fastest urbanization rates in the world at 4.9 per cent, more than twice the global average of 2 per cent[51]. This suggests that there is a growing number and share of the urban population.

Around one third (64.2 per cent) of Saravan Province's population is above the age of 15. The literacy rate of this population group is 79.3 per cent, which is below the national average of 84.7 per cent. Literacy rates also differ greatly between areas and different demographic groups. In rural areas of the province, the literacy rate is 78.9 per cent in those villages with road access but declines to 69.5 per cent. The overall literacy rate for women is 72.7 per cent, but can be as low as 60.8 per cent in some rural areas. In urban areas, however, male literacy is around 93.5 per cent, compared to 86.1 per cent for women[52].
The low level of education mostly explains the relatively low literacy rates. In Saravan Province, more than half of the population (50.9 per cent) has not completed any formal basic education and 18.5 per cent has not received any education at all. 56 per cent of women have not completed education in the province, while only 0.7 per cent of the province's population has completed a university degree, the lowest rate in Lao PDR.

Lao PDR is a very diverse country that is home to many ethnic groups; more than 50 according to the 2015 census[53]. 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 Saravan Province, the three main ethnic minority groups are Ta Oi, Katang and Pako[54].

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 implementing units[55]. Lao PDR is divided into 17 provinces, 148 districts, and 8,507 villages[56] [57].

Since the early 1990s, Laos has engaged in public administration reforms. In 1996, the Government of Lao PDR and UNDP developed the Governance and Public Administration Reform (GPAR) project, which "provided strategic funding for fiscal devolution and decentralized planning and expenditure management at district level"[58]. This project was one of the first steps in a process of decentralization that began in the 2000s. This decentralization process was initiated with the Prime Minister's Instruction 01/PM of 11th of March

44 8th 5-year Development Plan, p. 4.
45 The World Bank (2012-2013). Poverty profile in Lao PDR.
46 Poverty-Environment Initiative of Lao PDR (2011): Assessment of Economic, Social and Environmental Costs and Benefits of Investment in Saravan Province. Final Report. p.25.
47 Where are the poor? P. 15.
48 Lao PDR Ministry of Planning and Investment (2015): Lao Population and Housing Census 2015, p. 105.
49 Ibid., p.10.
50 Lao PDR Disaster Management Reference Handbook, p.10
51 CIA (https://www.cia.gov/library/publications/the-world-factbook/fields/2212.html)
52 Lao PDR Ministry of Planning and Investment (2015): Lao Population and Housing Census 2015, pp. 105 & 154.
53 ibid., p.122.
54 http://www.laotourism.org/Saravan.htm.
55 ADB (2012): Lao PDR Urban Development Sector Assessment, Strategy, and Road Map, p.4.
56 Results of Population and Housing Census, Lao Statistics Bureau, 2015.
57 Correct at the time of writing, however there are frequent changes to the demarcations of villages, meaning that this number is constantly changing.
58 Trends in the Governance Sector of the Lao PDR, Swiss Agency for Development and Cooperation, 2012.

2000, which formally regulated the decentralization of government functions[59]. 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[60].

3.6 Target Villages

Population Distribution and Densities

The vulnerability assessment in Saravan Province was conducted in 61 villages which are distributed across two of the eight districts, namely Ta Oi (30 villages) and Samuoi (31 villages). A full list of villages is presented in Annex 1. These villages have a total population of 23,845, about 6 per cent of the province's total population. The two target districts are the most sparsely populated in Saravan Province. Most of the villages in the target area have between 250 and 750 inhabitants. As outlined above, Samuoi and Ta Oi Districts have a mountainous topography and consequently the survey includes mostly upland villages. In Samoui District, most of the surveyed villages have a population of fewer than 250 inhabitants. The target area has a very low population density, averaging 3.56 inhabitants per square kilometre.

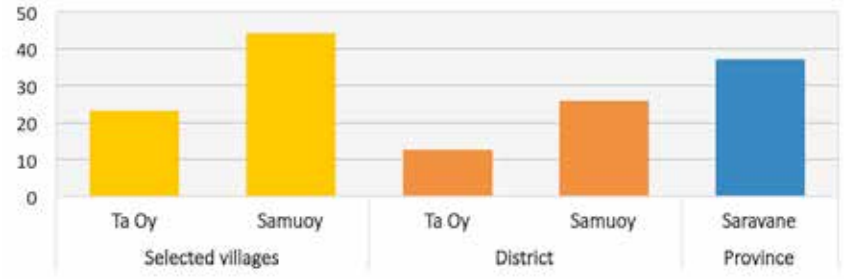
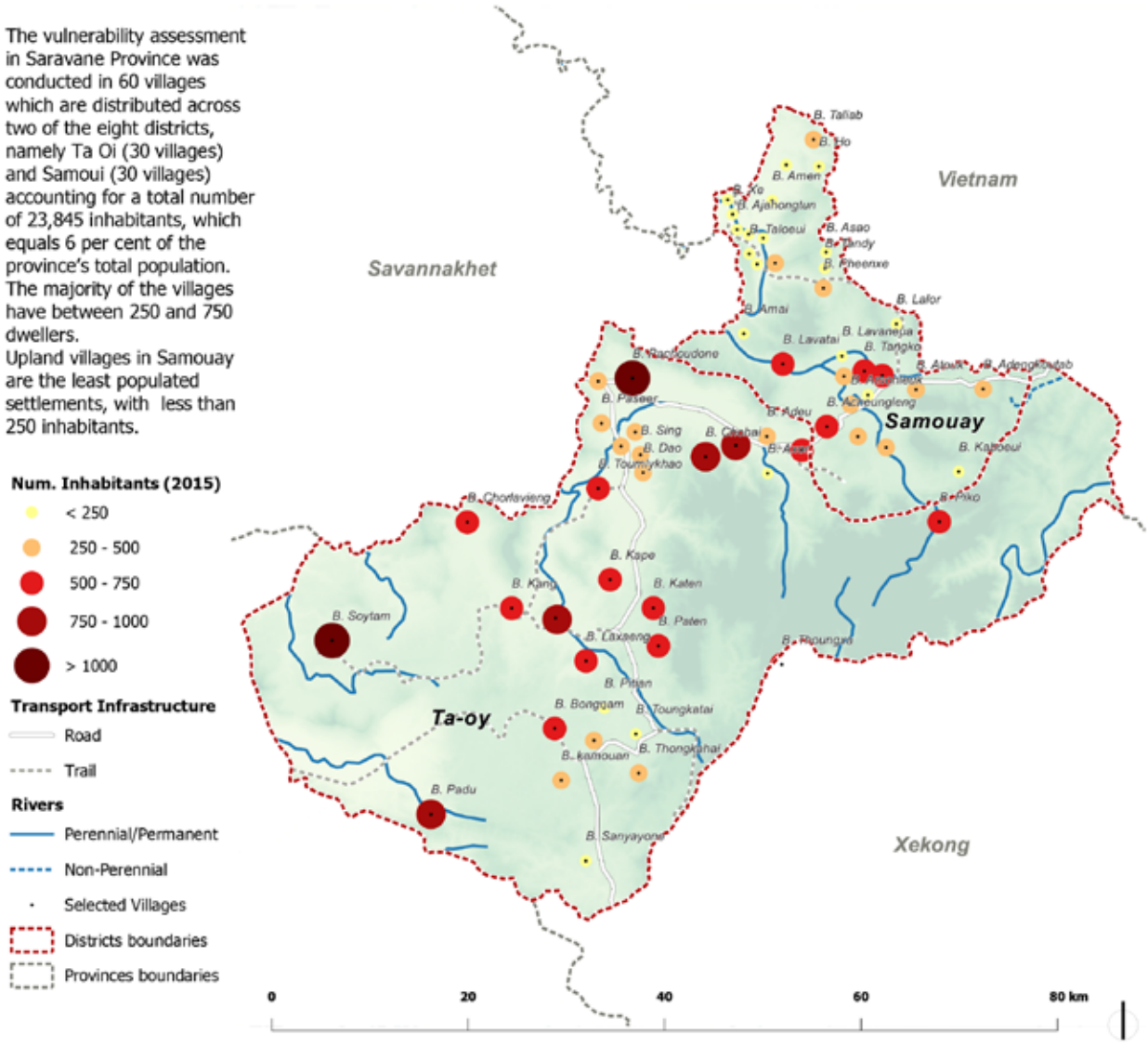


Figure 6 - Overview of population densities (hab/km2) in target villages[61]

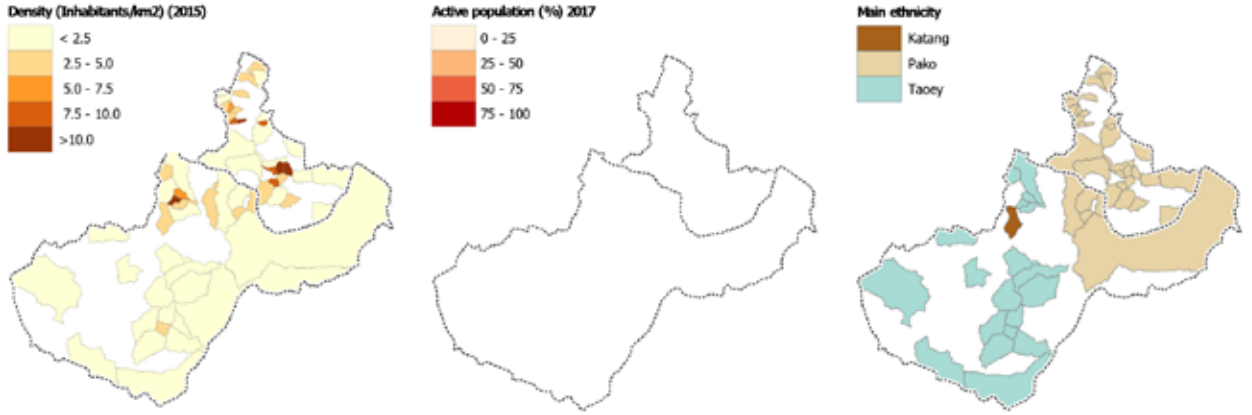
59 ADB (2012): Lao PDR Urban Development Sector Assessment, Strategy, and Road Map, p.4.
60 Sam Sang in practice: early lessons from pilot implementation, Australian Aid, 2015.
61 Housing and population Census 2015

POPULATION SIZES IN SELECTED VILLAGES

The vulnerability assessment in Saravane Province was conducted in 60 villages which are distributed across two of the eight districts, namely Ta Oi (30 villages) and Samoui (30 villages) accounting for a total number of 23,845 inhabitants, which equals 6 per cent of the province's total population. The majority of the villages have between 250 and 750 dwellers.
Upland villages in Samouay are the least populated settlements, with less than 250 inhabitants.



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[62], 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[63]. Exposure is defined as the presence of people and systems, such as infrastructure and livelihoods, in places and settings that could be adversely affected[64]. 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[65].

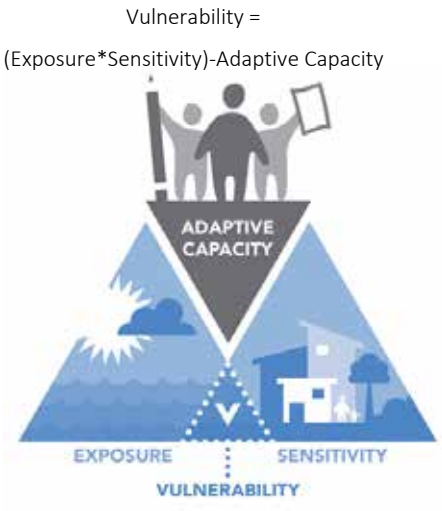


Figure 7 - Vulnerability Framework

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[66].

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.

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

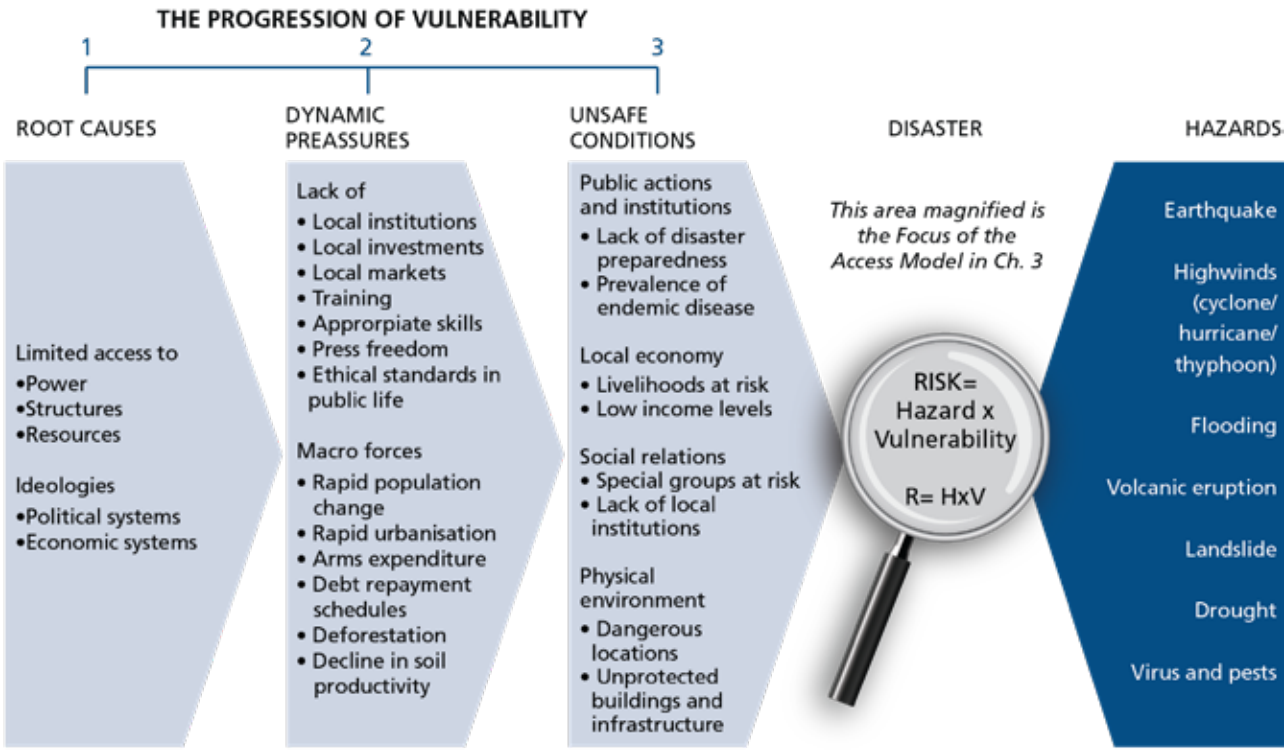


Figure 8 - The Progression of Vulnerability

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[67]. While this applies to most of the country, as this section will show, Samuoi District has a slightly different seasonal pattern

Rainfall

In Saravan Town, the mean annual average rainfall is 2,105 millimetres per year. 1,951 millimetres of rain falls in the rainy season, meaning that almost 93 per cent of rain falls during the rainy season. August is typically the wettest month, averaging 476 millimetres of rain. Typically, there are 25 rainy days in August and 128 rainy days in the entire year, 109 of which occur in the rainy season[68]. Change in rainfall is particularly marked in the month of June, which saw the greatest change of any month analyzed in the dataset, as shown in Figure 9.

Intriguingly, and in contrast to Sekong and Attapeu Provinces, whose rainfall data was also analyzed in the project, there are substantial differences in the change trends in El Niño, La Niña and neutral years. While El Niño years are drier and La Niña years are wetter, the trend is for slight reductions in rainfall in El Niño years, significant reductions in La Niña years and substantial increases in neutral years, which is an unexpected finding.

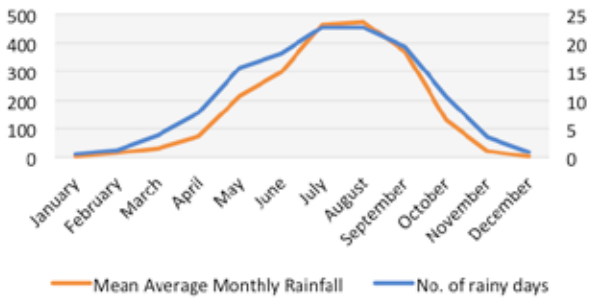


Figure 9 - Rainfall and number of rainy days

67 Developing a National Risk Profile for Lao PDR, p.25.
68 Author's work, based on data from the Department of Meteorology, Ministry of Natural Resources and Environment, Vientiane

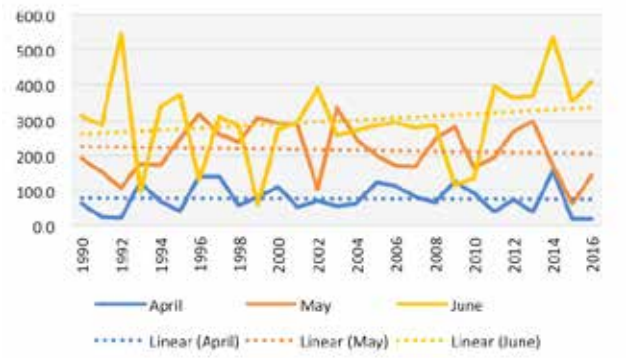


Figure 10 - Tremd in early wet season rainfall

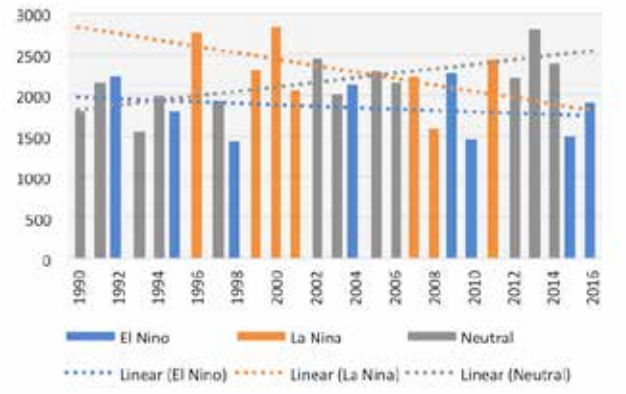


Figure 11 - Rainfall in El Niño, La Niña, and Neutral Years

According to data gathered from the provincial weather station in Saravan Town, there has been a slight increase in rainfall in the recorded period (from 1990 to 2016). The average rainfall is now 80 millimetres more than in 1990. The highest recorded rainfall in a given year was 2,813 millimetres in 2013, while the lowest was 1,444 millimetres in 1998. Two of the three lowest rainfall years were in 2010 and 2015, suggesting increased variability.

The difference between wettest and driest years points to a high variation in the amount of rainfall received. According to the dataset, and as shown in Figure 12 below, there was a high standard deviation of 391 millimetres, meaning planners in Saravan can only say with 68 per cent certainty that rainfall will be between 1,714 and 2,496 millimetres in any given year. Moreover, there is some evidence from the dataset that the variability is increasing in recent years (though a longer dataset would be needed to prove this). This points to the conclusion that both increasingly dry and increasingly wet years can be expected in the future.

There was also a marked change in the number of rainy days. Saravan Province can now expect to receive 13 fewer rainy days per year than it would have in 1990. There are 8 fewer rainy days during the rainy season on average, compared to 5 in the dry season.

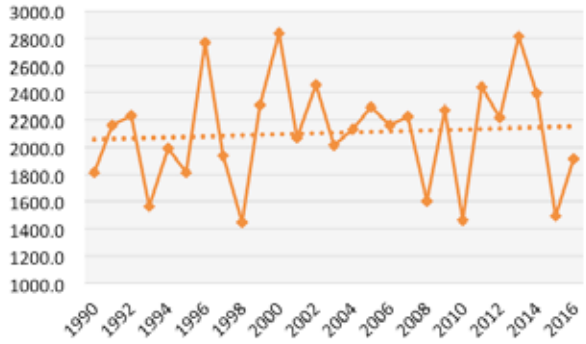


Figure 12 - Total Annual Rainfall and Variation

The rainy season has therefore seen an increase in total rain and a decrease in the number of rainy days, meaning the intensity of rainfall events has increased. At the start of the dataset there was around 16.5 millimetres of rain per rainy day, whereas by 2016 there was 19 millimetres, on average. This is an increase of 15 per cent. Allied to an increase in overall rainfall, this indicates that rain now occurs in fewer but heavier periods, increasing the possibility of localized flooding.

Evidence from communities

There is currently no weather station in Ta Oi District, and a weather station was only installed in Samuoi in 2005, meaning there is insufficient data from it to draw conclusions about changes in the climate. Because Ta Oi is around 75 kilometres from Saravan Town and Samuoi around 140 kilometres away, with hills in between, the findings gathered from the weather station at Saravan Town don't necessarily reflect the situation in Ta Oi and Samuoi Districts. Additionally, Saravan Town is only around 100 metres above sea level, whereas parts of Ta Oi and Samuoi districts have elevations of more than 1,000 metres above sea level. Because of this, it is difficult to infer any conclusions about the climate in Ta Oi or Samuoi Districts based only on the data from Saravan Town.

According to the survey respondents, rainfall decreased in many of the target villages in Saravan Province. Respondents observed a decrease in the dry and rainy seasons, but with a greater decline reported in the rainy season. Around 72 per cent of the target villages reported some level of decrease during the rainy season. However, more than half of the respondents in Samuoi District reported that rainfall is increasing There are also differences between the two districts in reporting the change in the onset of the rainy season; every target village in Ta Oi District reported the rainy season starts later, while 90 per cent of the villages in Samuoi District reported that the rainy season begins earlier.

Samuoi town is on a similar latitude to Hue, in Central Vietnam, which is only about 75 kilometres away in

terms of straight-line distance (Samuoi is around 80 kilometres straight line distance from Saravan Town). The team therefore obtained climate data from Hue. This shows that Hue receives on average 3130.6 millimetres of rain on average per year. Hue (and Central Vietnam more generally) follows a different rainy season from Southern Laos, with the onset on the monsoon coming in August and lasting through until January.

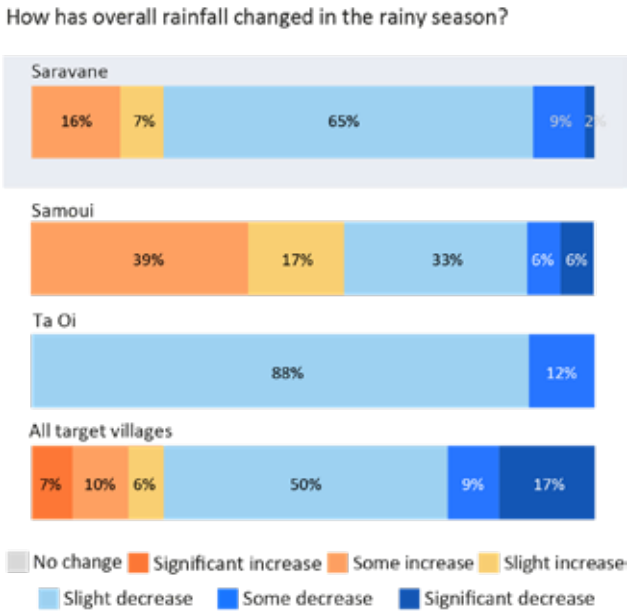


Figure 13 - Perceived changes in rainfall in target villages

Temperature

In the dry season from November to April, the dry northeast monsoon brings relatively dry air and lower temperatures in the cool dry season, through to February and causes the hottest temperatures of the year leading towards April and May[69]. The annual average temperature in Saravan is 24.3 °C, reaching up to an average of 29.2 °C in the hot dry season with a maximum of 31.7 °C in April[70].

According to the Provincial Department of Natural Resources and Environment dataset, shown in Figure 15, temperature increase has been notable. The average daily maximum temperature was 32°C. In 2016, Saravan Town experienced a maximum daily temperature of over 40°C for the first time. Overall, Saravan's average mean maximum temperature is about 1.05°C higher now than at the start of the dataset, in 1990. The greatest temperature increases were observed in April and May. The analysis also showed an increase in average minimum temperatures. The average in the first 5 years of the dataset was 21.9°C, compared to 22.4°C in the most recent 5 years in the dataset. Overall, there was an increase of 0.61°C. The increase was spread throughout the year, with February and November showing the most significant increases. Despite this, the two coldest temperatures recorded in the dataset were in 2014 and 2016, suggesting that Saravan is experiencing greater extremes of temperature.

Evidence from communities

According to the survey respondents, there has been a substantial increase in temperature in the hot season, with 88 per cent perceiving some level of temperature increase. In Samuoi District especially people noted significant or moderate increases in temperatures. This finding has been consistent across all districts surveyed in the project, but has been more empatic in other areas.

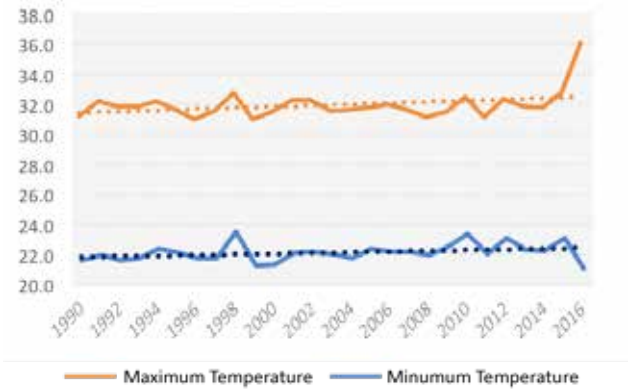


Figure 14 - Annual Average Minimum and Maximum Temperatures

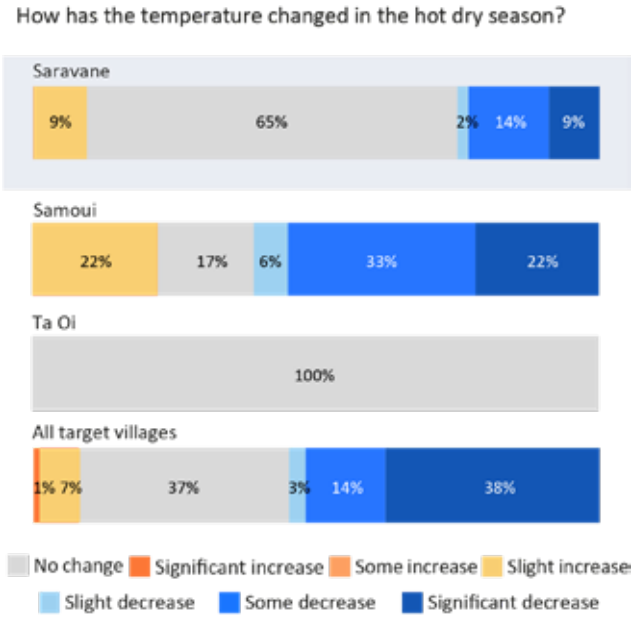


Figure 15 - Perceived changes in temperature in the hot dry season in target villages

69 Lao PDR Disaster Management Reference Handbook, p. 20.
70 https://en.climate-data.org/location/974773/#climate-graph.

b. Overview of Hazards and Exposure

Lao PDR is exposed to multiple natural hazards, with floods and storms causing the most serious humanitarian impacts[71], followed by droughts and landslides, which also pose serious risks[72], 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[73]. An estimated 58 per cent of the population has been affected by flooding at some point in their life[74]. This mainly linked to the high and intense precipitation triggered by the southwest monsoon in the rainy season, particularly throughout August and September[75]. This time also coincides with the typhoon season, which peaks in August and September,[76] 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[77].

High flood risk is particularly evident in the southern provinces, including Saravan[78]. Saravan is traversed by the Mekong and Xe Don river systems, which means that it has a large inundation area. This can particularly be observed in the western lowland districts, such as Khong Xedon, where the inundation area accounts for more than 26 square kilometres.[79] The two target districts, however, are less exposed to riparian flooding because of their mountainous topography. However, there are numerous small streams in the target districts that flood and cause damage during the rainy season.

Evidence from communities

Occasional flood affects were noted in 40 per cent of the villages in Ta Oi District and 39 per cent in Samuoi. Only two of the villages surveyed in Samuoi District reported annual floods. This finding suggests that floods are not the primary hazard that concern most people in Ta Oi and Samuoi.

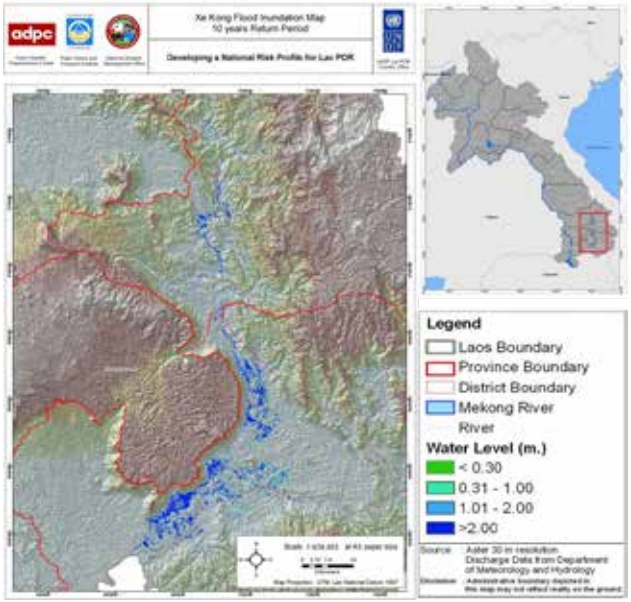


Figure 16 - Xe Kong flood inundation map for 10 years return period

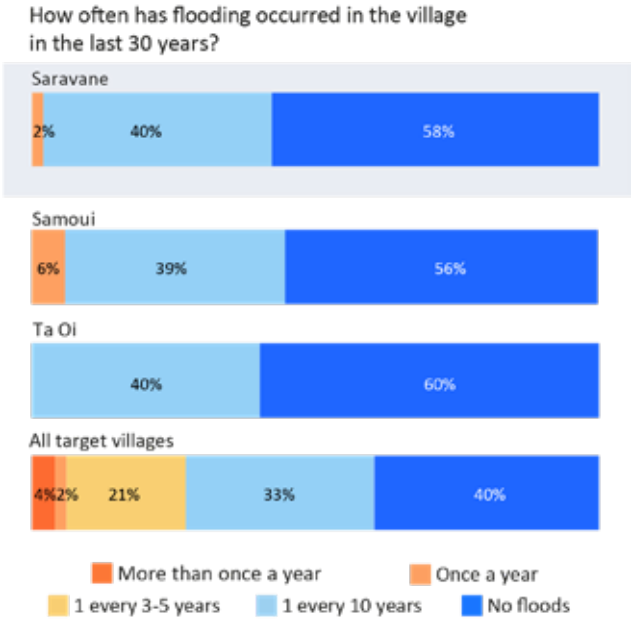


Figure 17 - Overview of perceived occurrence of flooding in the target villages

71 OCHA (http://reliefweb.int/sites/reliefweb.int/files/resources/CP_LaoPDR_230617.pdf).
72 Lao PDR Disaster Management Reference Handbook, p.24.
73 Ibid.
74 Developing a National Risk Profile, p.31.
75 Lao PDR Disaster Management Reference Handbook, p.24.
76 Ibid.
77 http://www.inform-index.org
78 Lao PDR Disaster Management Reference Handbook, p.24.
79 Risk Assessment Report Vol I, p. 39

Storms

Tropical cyclones often cause floods. However, storms also cause serious risks due to high winds, resulting in 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[80] in 2014. Storms cause the greatest damage between June and December, peaking in August and September[81]. The last severe storm to impact Saravan Province was Typhoon Doksuri, in September 2017. Prior to that, Typhoon Wutip in October 2013, and Typhoon Ketsana, which hit Laos in September 2009 caused severe damage and loss of life.[82] The southern provinces, including Saravan, 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[83]. Ketsana damaged 25 per cent of Saravan's road network was damaged during Ketsana, and dozens of villages were cut off, in a few cases for several months.[84]

Evidence from communities

41 per cent of the villages surveyed in Saravan Province report that storms have caused fatalities. 37 per cent of villages report that storms hit more than once per year. Samuoi District was particularly affected, with 19 villages reporting more than once annual storms. The figures are roughly in line with the overall average for the southern provinces, where 46 per cent of the villages surveyed are affected by more than one storm per year. Ta Oi District is less exposed, as 52 per cent of villages reported that storms don't affect them.

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 Saravan Province are exposed to landslides. About 6.5 per cent of the province's total area is characterized by a high landslide exposure while another 41.9 per cent is moderately exposed.[85] However, 12 per cent of villages across the two districts are affected by landslides, all of which are in the upland areas.

Droughts

Droughts affect 15 per cent of the population, which is the country's third largest share of all-natural hazards[86]. Droughts can occur in both the dry and rainy seasons. However, droughts occurring from mid-July until the southwest monsoon in September, are thought to have the highest impact, reducing grain production for example, by up to 30 per cent[8788]. 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[89].

The high elevation areas of Laos' southern provinces are among the most prone to droughts[90]. Saravan has been ranked as the most drought prone province in Laos in both the rainy and dry seasons[91].

Evidence from communities

Curiously, the survey reported that drought was not a serious issue for many of the communities surveyed. 58 per cent of villages reported that they had not experienced drought in recent years, while a further 37 per cent reported that they have only experienced one drought in the last ten years.

This is supported by the survey, which indicates that droughts are not a major threat – 58 per cent of villages haven't experienced a drought in the last decade, while another 37 report only one in the last 10 years. Only two villages in Samuoi District reported frequent droughts,

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

with one more reporting annual drought. These findings are below the average for the southern provinces, where 27 of all target villages report droughts at least once every five years. There are no major discrepancies between Ta Oi and Samuoi Districts, suggesting that droughts are not highly localized.

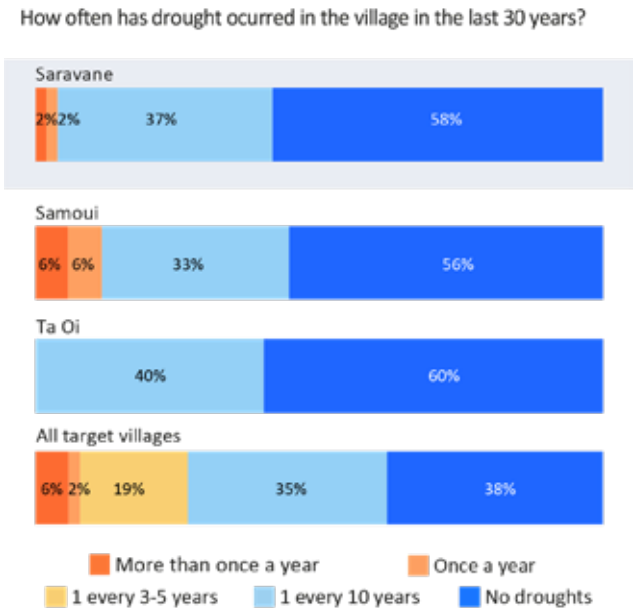


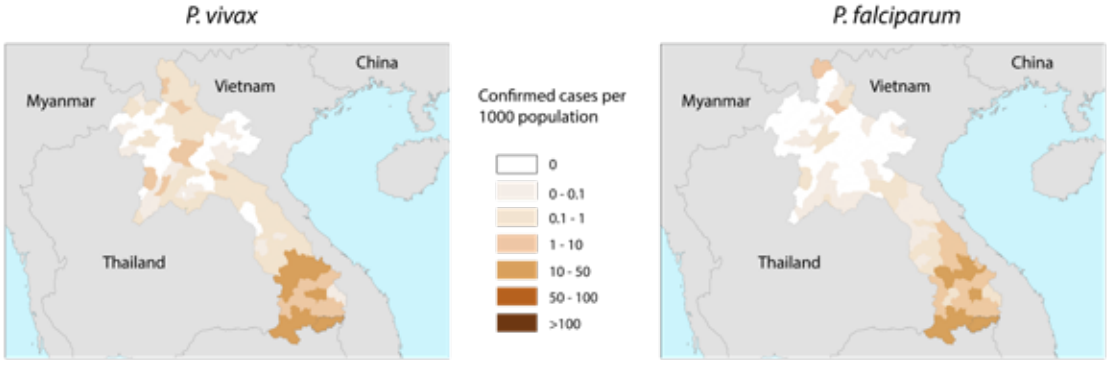
Figure 18 - Overview of perceived occurrence of droughts in the target villages

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 Saravan Province, Malaria is among the most serious health issues, as shown in Figure 19. Although there has been a widespread decrease in Malaria cases in most provinces in Laos, Saravan Province has shown an increase in recent years[97]. Consequently, Saravan 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 district in Saravan is Ta Oi with up to 5 per cent of the population suffering from Plasmodium falciparum. These figures only count reported cases; however, 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 19 - 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

These malaria trends are confirmed by the surveys conducted in Saravane's villages. As illustrated in Figure 20, 81 per cent of villages report that they have been affected by Malaria. Dengue Fever is also prevalent. Official figures show that Saravan has experienced an increased number of reported Dengue cases, which is among the worst provincial trends in Laos. Water-borne diseases also affect the target villages, with 88 per cent reporting incidence of water-borne disease, with eye and skin complaints the most common. Diarrhoea also was reported in 60 per cent of the target villages.

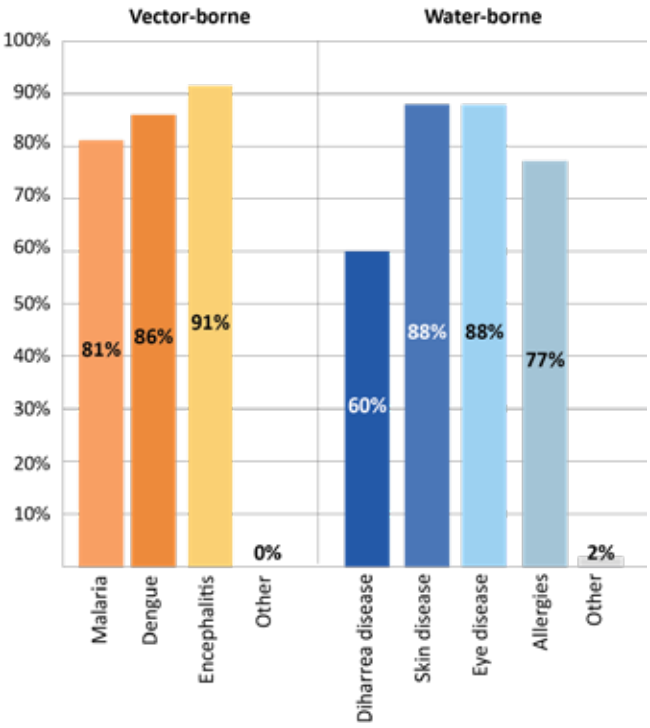


Figure 20 - Percentage of Villages that have experienced disease among the surveyed villages in Saravan

Man-made hazards: UXOs

Saravane Province also faces a large amount and wide distribution of unexploded ordinances, which are remains from the second Indochina War (1964-73)[100]. 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[101]. 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[102]. Neighbouring 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 21[103].

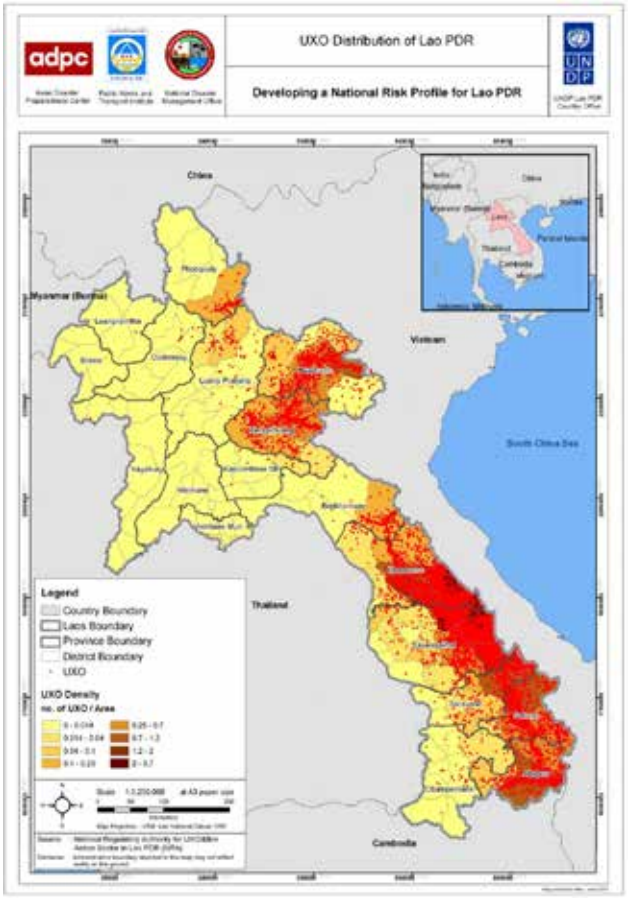


Figure 21 - Prevalence of Unexploded Ordinance

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

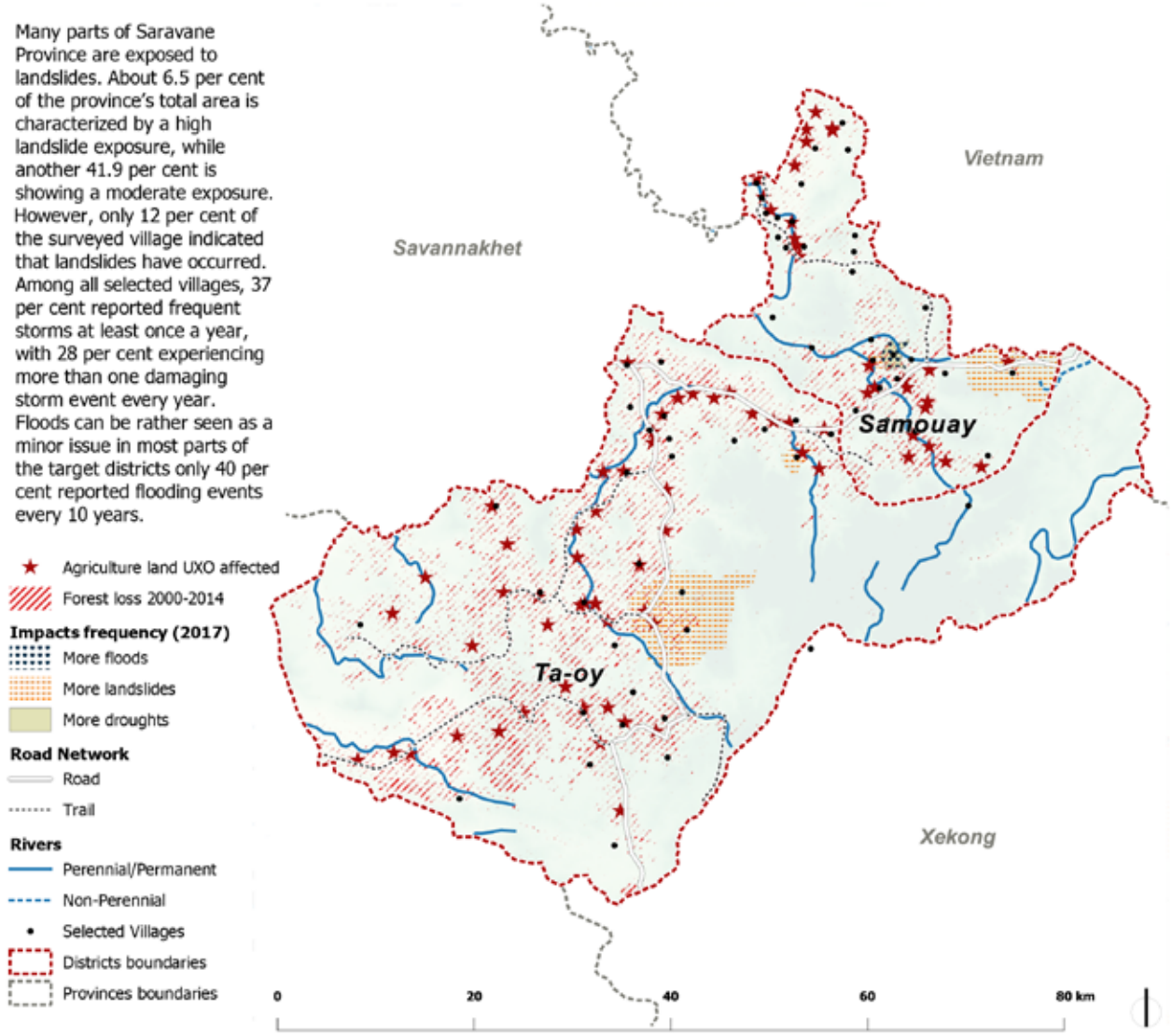
101 Lao national UXO programme (2013): UXO impact. Retrieved from: http://www.uxolao.org/index.php/en/the-uxo-problem/uxo-impact (last accessed on 25/8/2017)

102 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)

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

CLIMATIC FEATURES, NATURAL HAZARDS AND OBSERVED IMPACTS

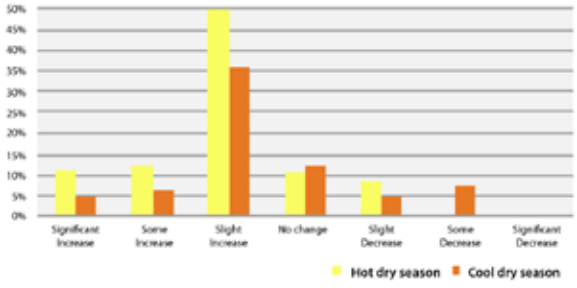
Many parts of Saravane Province are exposed to landslides. About 6.5 per cent of the province's total area is characterized by a high landslide exposure, while another 41.9 per cent is showing a moderate exposure. However, only 12 per cent of the surveyed village indicated that landslides have occurred. Among all selected villages, 37 per cent reported frequent storms at least once a year, with 28 per cent experiencing more than one damaging storm event every year. Floods can be rather seen as a minor issue in most parts of the target districts only 40 per cent reported flooding events every 10 years.



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

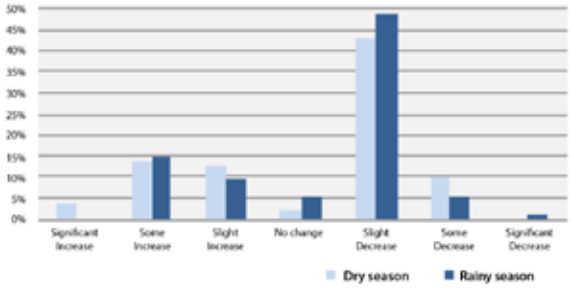
Temperature

Slight decrease in temperature is perceived in hot season, while slight increase in temperature is perceived in the 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

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 Saravan 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 didn't 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[104]. 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[105].

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[106].

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'[107].

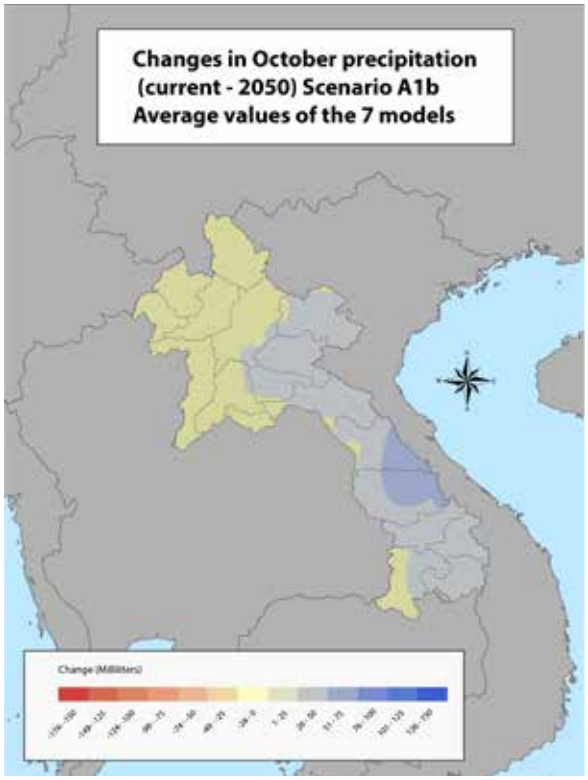


Figure 22 - Projected change in rainfall under the IPCC A1B scenario

104 Lao PDR Second National Communication to the UNFCCC, Ministry of Natural Resources and Environment p.60.
105 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.
106 Ibid, p.26-27.
107 Ibid, p.27.

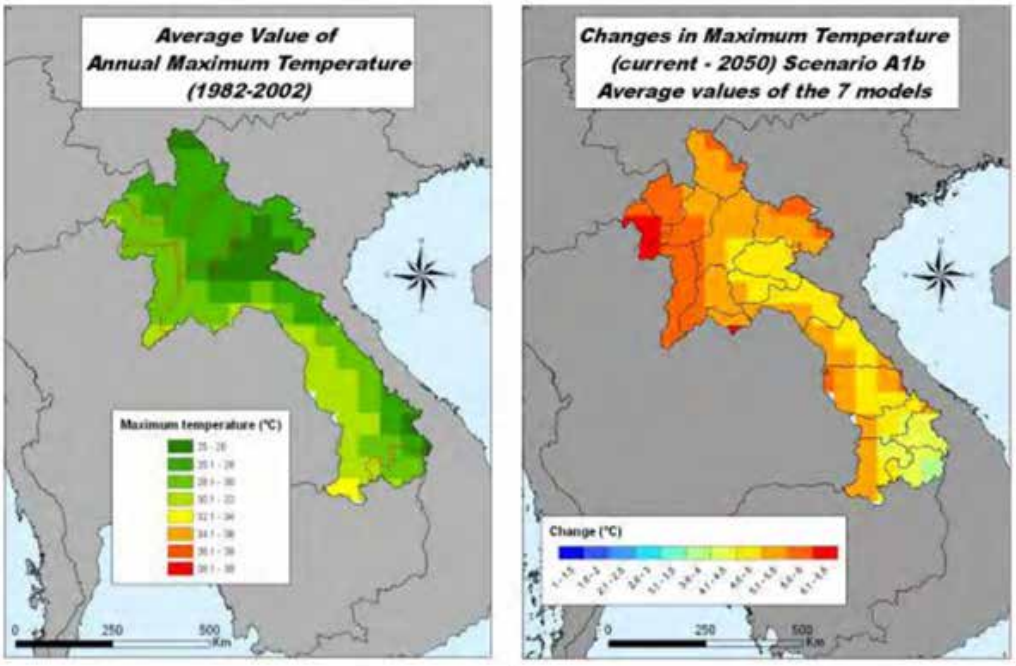


Figure 23 - Projected Change in Maximum Temperature under the IPCC A1B scenario

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) [108].

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, in neighboring Sekong Province, 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 Saravan would also experience more extreme rainfall events – which would lead to more flooding and associated damage – because more rain is projected over a shorter rainy season.

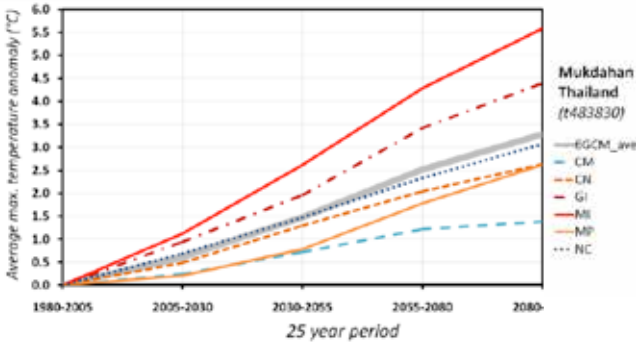


Figure 24 - Temperature projections in Southern Laos and Eastern Thailand

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

Mekong ARCC Climate Change Impact and Adaptation Study

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 Saravan Province.

The temperature projections shown in Figure 24 are based on data gathered from the weather station in Mukdahan, Thailand, about 200 kilometres away from Saravan Town (straight-line distance). The average of the global circulation models shows an increase of about 2.5°C, relative to the baseline period.

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 Saravan 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.

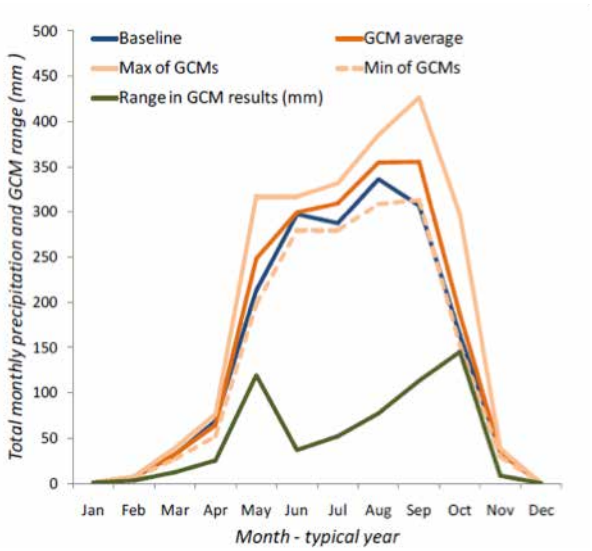


Figure 25 - Range of Precipitation Projections

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, Ecosystems and Other Drivers

- Deforestation has been a serious challenge in Laos and has been prevalent in Ta Oi and Samuoi Districts. Forest degradation is also widespread.
- Increased mining activity is providing some communities with economic benefits, concerns remain about possible negative environmental consequences
- People primary depend on unprotected surface water sources, which makes them more sensitive to floods and droughts.

Landscape and Protected Areas

The Xe Sap National Protected Area starts just to the east of Ta Oi District and expands across the border into Vietnam. It is one of the most important bird sanctuaries in Laos and home to a variety of evergreen tree species[109]. The Xe Sap covers approximately 1,335km² in Saravan and Sekong, and has been a national biodiversity conservation area since 1996[110]. The Xe Sap is part of the Annamite Range and has steep mountainous terrain with abundant streams and rivers. It has a varied topography with elevation ranging from 400 metres above sea-level to a highest peak of 2066 metres. 35 per cent of the area is above 1,000 metres and there are four peaks above 1,900 metres. Such peaks extend into Sekong Province. There is also a particularly large dense forest area as part of the Xe Sap[111][112].

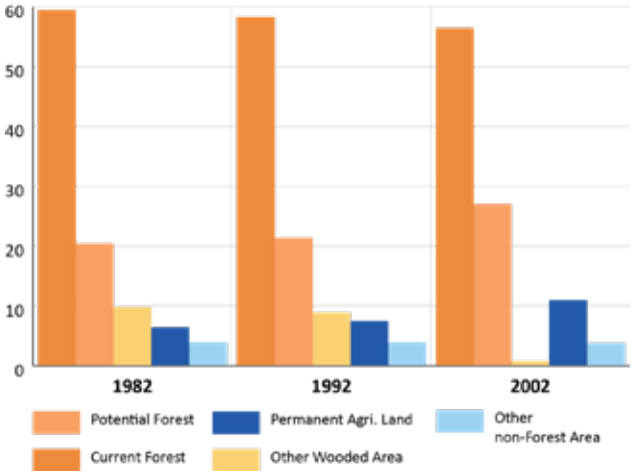


Figure 26 - Forest cover and land-use distribution in the southern region

Land Use Cover

The Mekong River Commission (MRC) developed a land use cover map for the Greater Mekong Sub-region using 2010 satellite imagery[113]. 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 clasification, followed by scrubland (see Table 1).

Table 1 - Land use cover 2010[114]

District	Land uses	%
Ta Oi	**Broadleaved deciduous forest**	**80%**
	Broadleaved evergreen forest	0.05%
	Orchard	0.15%
	Paddy field	7.45%
	Shrubland	**12.25%**
	Water body	0.9%
Samuoi	Bare land	0.02%
	Broadleaved deciduous forest	**76.5%**
	Broadleaved evergreen forest	0.05%
	Orchard	0.35%
	Paddy field	6.35%
	Shrubland	**16.15%**
	Water body	0.6%

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

109 www.investlaos.gov.la/index.php/provinces/Saravanh
110 Decree 210/96
111 Biodiversity Surveys of Xe Sap National Protected Area Lao PDR 2012, WWF Greater Mekong, Vientiane, Lao PDR, February 2013
112 National Forest Reconnaissance Survey. Vongdeuane Vongsiharath Department of Land Planning and Development National Land Management Authority, Lao PDR
113 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).
114 http://portal.mrcmekong.org/tech_report.

Forest Cover

According to the results of the last forest cover reconnaissance survey in 2002, the total land area of Lao PDR covered by natural forest (defined as having a canopy density of greater than 20 per cent and a height above 5 metres) was 9,824,700 hectares or roughly 41.5 per cent of the total land area. Dryland (lowland dry dipterocarp) forest covered approximately 1,317,200 hectares or 13.88 per cent of the total land area. Almost all of this is located in central and southern Laos[115].

As shown in below, the predominant land use, derived by an automatic and regionally-tuned classification of a time series of global MERIS FR mosaics for the year 2009[116], is Closed to Open forest (>15%) covering more than 90% of the land in both districts.

Table 2 - Type of forest cover in 2009[117]

District	Land classification	%
Ta Oi	Closed forest (>40%)	6.97%
	Closed to open forest (>15%)	**92.47%**
	Open forest (15-40%)	0.09%
Samuoi	Closed forest (>40%)	6.67%
	Closed to open forest (>15%)	**93%**

Deforestation Trends

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 Ta Oi and Samuoi 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 [118].

As USAID has recently noted; "*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*"[119].

Forest loss during the period 2000–2014, defined as a stand-replacement disturbance, or a change from a forest to non-forest state[120], was of 46km^2 in Ta Oi, and 224km^2 in Samuoi, mainly observed along road infrastructure developments. See map SAL04 for an illustration of the particularly affected locations.

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[121]. Many of these drivers are facilitated by road infrastructure development but are not directly caused by it.

Hydropower Production

Hydropower can be a direct and indirect driver of deforestation. New hydropower dams result in deforestation to facilitate construction and also in their inundation areas. Moreover, indirect deforestation occurs because illegal logging often takes place adjacent to inundation areas. Where resettlement occurs because of hydropower development, further deforestation pressure can result, as land may be cleared for new settlements, and local villagers may log illegally or practice shifting cultivation in new areas.

As the USAID study notes, "*Hydropower development and its impact on flood regimes will impact traditional systems based on fertilization through sediment deposition during the annual flood. The gap in fertilization will exacerbate the drop-in yield due to climate change*". However, well-managed hydropower developments can offset some of the impacts of climate change by expanded opportunities for irrigation, which

115 Forest cover and land-use changes in Lao PDR according to the National Forest Reconnaissance Survey. Vongdeuane Vongsiharath Department of Land Planning and Development National Land Management Authority, Lao PDR, 2002

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

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

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

119 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.

120 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.

121 http://theredddesk.org/countries/laos.

reduces vulnerability to drought[122].

A rise in dam construction along major rivers has led to more frequent village resettlements. The government has established criteria for the relocation of villages that include a population below 200, lack of access to roads or potable water, and reliance on slash and burn cultivation[123].

Forestry and Agro-Industrial Expansion

In recent years, agricultural activity has expanded. This has brought benefits in terms of increased incomes and greater levels of food security, but has also brought agricultural land into greater competition with wetlands and forests. Climate change threatens the benefits seen by agricultural communities in recent years as floods cause damage to agricultural infrastructure, disrupt planting seasons and droughts cause crop failure and increasing food insecurity[124].

In many areas dramatic increases in the extent of coffee, rubber and industrial tree plantations have resulted in the fragmentation and loss of large areas of natural forest[125].

According to the 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 cubmic metres per year. Ten families are normally entitled to cut up to 5 m3 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 checked and decided upon by the village head or the Village Development Committee[126].

Forests are also under pressure from illegal cutting at the individual and household scale. According to the 2015 census, firewood is the main source of cooking fuel in households across the two target districts, with less than 5 per cent relying on grid electricity. In addition, the buildings in Saravan Province are predominantly (95.6 per cent) non-engineered, which is the third highest share in the country.[127] This means that almost all houses consist of clay, wood, bamboo, zinc or corrugated iron with a flexible or non-permanent roof[128]. This makes them highly susceptible to various hazards, including landslides, flooding and storms in particular. Since many of these buildings were built in areas which are characterized by a high exposure to these hazards, people living in them face a significant risk of being adversely affected.

Table 3 - Use of forest products for construction materials in the two districts[129]

District	Housing materials			Cooking Fuel
	Roof	Wall	Floor	
Ta Oi	21.7	98.08	95.73	95.46
Samuoi	25.52	97.02	93.25	94.7

Mining Concessions

In recent years, the scope and scale of mining operations has been increasing in Laos, particularly in southern Laos. This provides increased incomes for some communities, and mining incomes are often more predictable and stable, giving year-round earning potential to communities that had previously been dependent on seasonal earnings from agriculture.

However, mining contributes directly to deforestation as land needs to be cleared for mining operations and indirectly as land clearance is also required for access roads and additional supportive infrastructure. There are two main types of mining operations in Southern Laos; thousands of smaller, artisan mines that may have led to larger net loss of forests, and planned mega-project Bauxite mines[130].

Water Resources

Laos has extensive water resources, including the largest amount of available freshwater in Asia[131]. However, water supply remains limited due to problems with access to water and water infrastructure. None of the surveyed villages in either district had access to public water facilities. In Ta Oi 13 villages rely on a mix of

122 USAID (2013) Mekong ARCC Climate Change Impact and Adaptation Study for the Lower Mekong Basin: Main Report, p.175
123 Lao PDR Disaster Management Reference Handbook, p.17
124 ICEM. (2016). Lao Climate change risk and vulnerability assessment for small scale rural infrastructure: Final Summary Report. ICEM, Hanoi Viet Nam, 30th May 2016
125 Thomas (2015) Drivers of Deforestation in the Greater Mekong Sub-region; Lao PDR Country Report, p.7
126 Thomas (2015) Drivers of Deforestation in the Greater Mekong Sub-region; Lao PDR Country Report, p.10
127 Risk Assessment Report, Vol. II p.116
128 Ibid.
129 Housing Population Census 2015.
130 Thomas (2015) Drivers of Deforestation in the Greater Mekong Sub-region; Lao PDR Country Report, p.8.
131 Lao PDR Disaster Management Reference Handbook, p. 54

gravity fed systems and deep wells, while a further 10 rely only on deep wells. In Samuoi there is a broad mix of means of accessing water, with the most frequent being gravity fed, present in 20 villages. Significantly, four villages responded that they have no regular water source whatsoever.

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 Saravan Province[132].

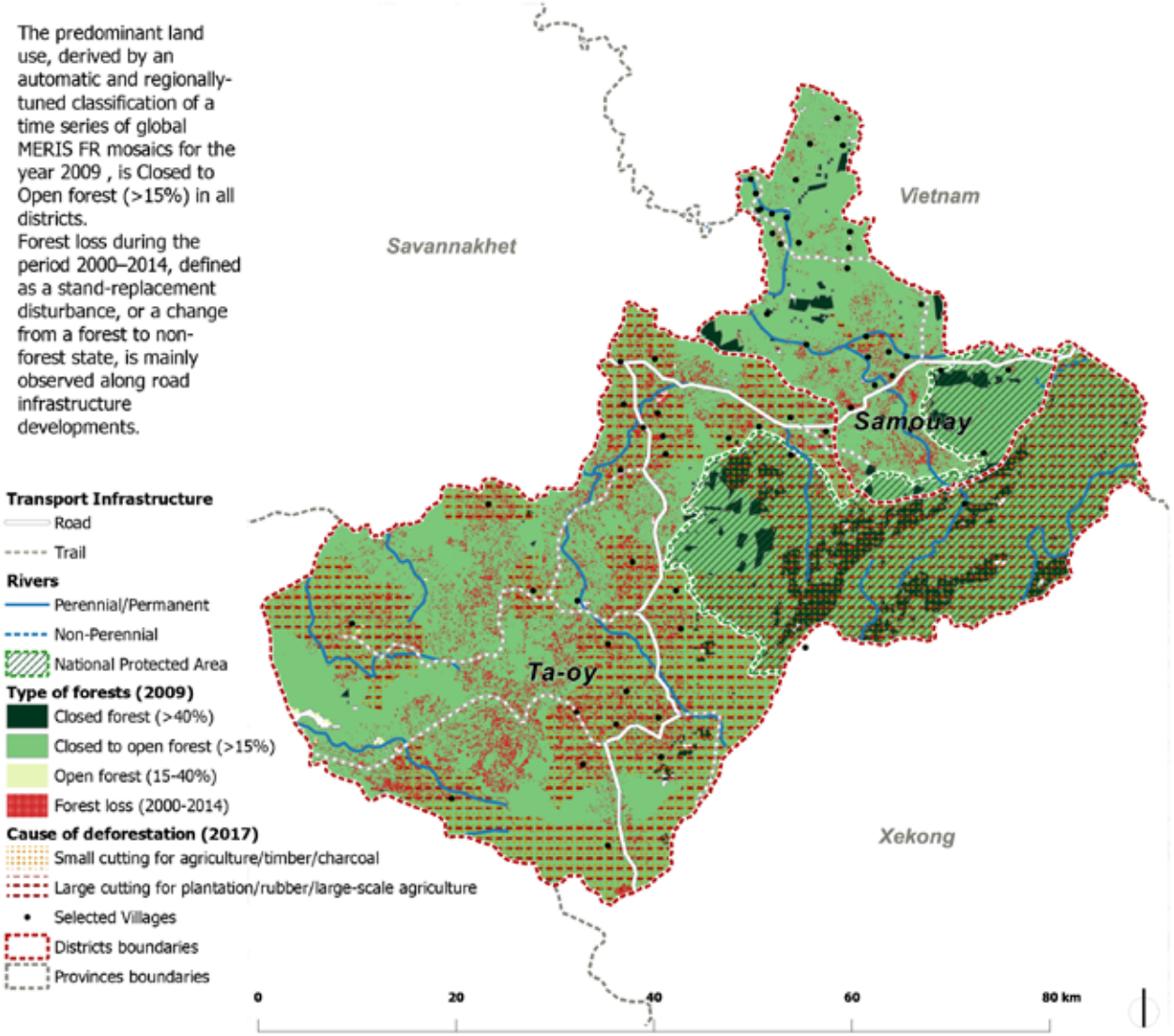
Groundwater information including resource potential, uses and quality is very limited in Laos. Since surface water is mostly abundant for supply, groundwater is used only when and where surface water is not available[133]. The expansion of rubber plantations has resulted in land cover change across 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[134].

There are a total number of 151 irrigation head works in Saravan Province[135], which provide water for a total irrigated area of 7,235 hectares[136]. Both irrigation infrastructure and irrigated land are mainly concentrated in the western districts, along the Xe Don River, where more than a quarter of land is highly exposed to flooding, with inundations of more than 2 metres common[137][138]. In the target districts, only two villages in Samuoi and five in Ta Oi reported having access to irrigation infrastructure.

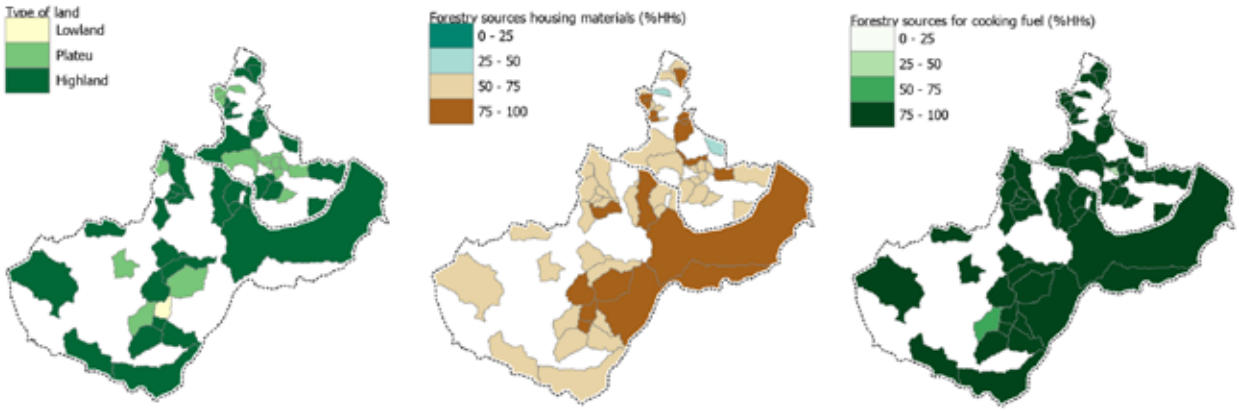
132 Ministry of Environment, Japan (2015), State of Water Resources, Outlook on Water Environmental Management in Asia 2015, p.62.
133 Ibid, p.62
134 http://www.waterandnature.org/sites/default/files/sekong_basin_fact_sheet.pdf
135 Risk Assessment Report Vol I, p.73
136 ibid, p.76
137 ibid, p.71
138 Risk Assessment Report Vol II, p.28

LAND COVER AND MAIN ENVIRONMENT ISSUES

The predominant land use, derived by an automatic and regionally-tuned classification of a time series of global MERIS FR mosaics for the year 2009 , is Closed to Open forest (>15%) in all districts.
Forest loss during the period 2000–2014, defined as a stand-replacement disturbance, or a change from a forest to non-forest state, is mainly observed along road infrastructure developments.



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), C-ADAPT World Food Program (2015), UN Habitat (2017), http://earthenginepartners.appspot.com/ science-2013-global-forest,
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.

b. Infrastructure and Basic Services Conditions

• The current transport infrastructure is highly vulnerable to hazards, reducing people's mobility, particularly in Samuoi District.

• Very limited mobile communication and electricity access in both districts, reducing communities' disaster management capacity

• • Availability of fresh water mainly relies on surface water sources, with a high proportion of households exposed to unprotected water sources and unimproved toilet facilities.

• Coverage of disaster and security services is still very limited across the province. While basic health coverage is very limited, there is a good coverage of primary school facilities.

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[139].

The existing rural road network in Saravan is sparse and poorly maintained. In addition, many of the mountain areas are rugged with sparse populations (compared with floodplain areas), meaning that they are often deprioritized for investments in the floodplain that may benefit a greater population[140]. The existing rural road infrastructure is mostly constructed with poor quality materials, which exacerbate the damage during extreme events. There is a shortage of materials and maintenance capabilities at the village and district levels, making it difficult to repair rural roads.

Overall, the selected villages in Saravan Province are very remote in terms of access by land, only 27 per cent of the villages surveyed have access to paved roads, and fewer than 10 per cent have access to public transport services (defined as a bus stop).

Differences between the two target districts are significant, however. Villages in Ta Oi District are far more accessible than in Samuoi. In fact, while 42 per cent of the selected villages in Ta Oi are accessible by paved roads, in Samuoi almost 80 per cent of villages can only be accessed by seasonal unpaved roads.

Figure 27 - Bridge in Samuoi District, UN Habitat, 2017

The difference in topography is a factor. Villages in the upland area are far more likely to be only accessible by seasonal trail or track than in the plateau area; 71 per cent compared to 42 per cent.

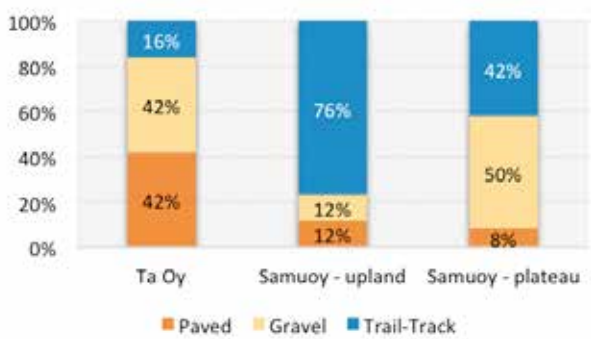


Figure 28 - Proportion of households by type of electricity in targeted districts

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

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

"Formal" collective transportation is very limited in both districts, especially in Samuoi, where none of the selected villages has access to bus nor has any other collective transport service. In Ta Oi, only selected villages along the east-west road that connects the Vietnam border with Saravan Town and Lao PDR's national road network, are served by a daily bus and have bus stops.

Communities report that storms and floods impact infrastructure. Storms are perceived as frequent, particularly in Samuoi District where 89 per cent of the selected villages report storms at least every year and more than 60 per cent of the target villages have seen their infrastructures damaged by storms. In Samuoi in particular, the selected villages also don't have storm water management systems, while in Ta Oi only 19 per cent of the selected villages have one. Overall, the near absence of this infrastructure in most of the selected villages increases communities' vulnerability to climate hazards.

Figure 29 - Floods in Samuoi district during the Vulnerability Assessment Survey. UN-Habitat, 2017

In fact, stronger storms and unusually heavy rainfall will inevitably reduce people's mobility; especially in the upland villages only accessible by unpaved roads 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 core community services.

Electricity and Telcoms

The Government of Lao PDR is focusing on expanding the electricity network into rural areas to encourage development and poverty reduction among rural people and ethnic groups[141]. 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.[142]

In Saravan Province 80 per cent of households have electricity, about in line with the national average. However, villages in both targeted districts have considerably less electricity access, with only 30 per cent of households connected to the grid. In Samuoi District, more than 50 per cent of households have no electricity from any source, while in Ta Oi almost half depend on 'own source' electricity (from generators or batteries). In this case, the use of batteries (associated with private solar power systems) is probably the most climate resilient solution for electricity supply both in terms of cost and reducing exposure to power cuts (as these systems are less exposed to hazards and thus less likely to be damaged). On the other hand, the need for a generator increases household's dependence on external variables such as road accessibility and fuel cost fluctuations, which may represent an extra burden on the household's already low and fragile income.

Figure 30 - Proportion of households in selected villages by district and by type of electricity

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

The mobile repeater and communication network in the northern areas of Samuoi District is very weak (see map SAL5a). The 2015 Census shows that around 50 per cent of households in both target districts have mobile phones, which can be a key tool used in disaster preparation, early warning and communication during and after an emergency, if there is wider network coverage.

Considering access to transport, electricity and communication infrastructure, and as shown in map (SAL05a), villages in the central area of Ta Oi District and northern and southern area of Samuoi District are more sensitive to climate hazards, and therefore likely to be more vulnerable. These conditions already jeopardize rural livelihoods and are likely to exacerbate the impact of extreme events associated with climate change.

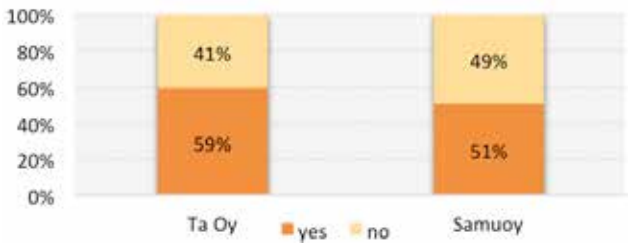


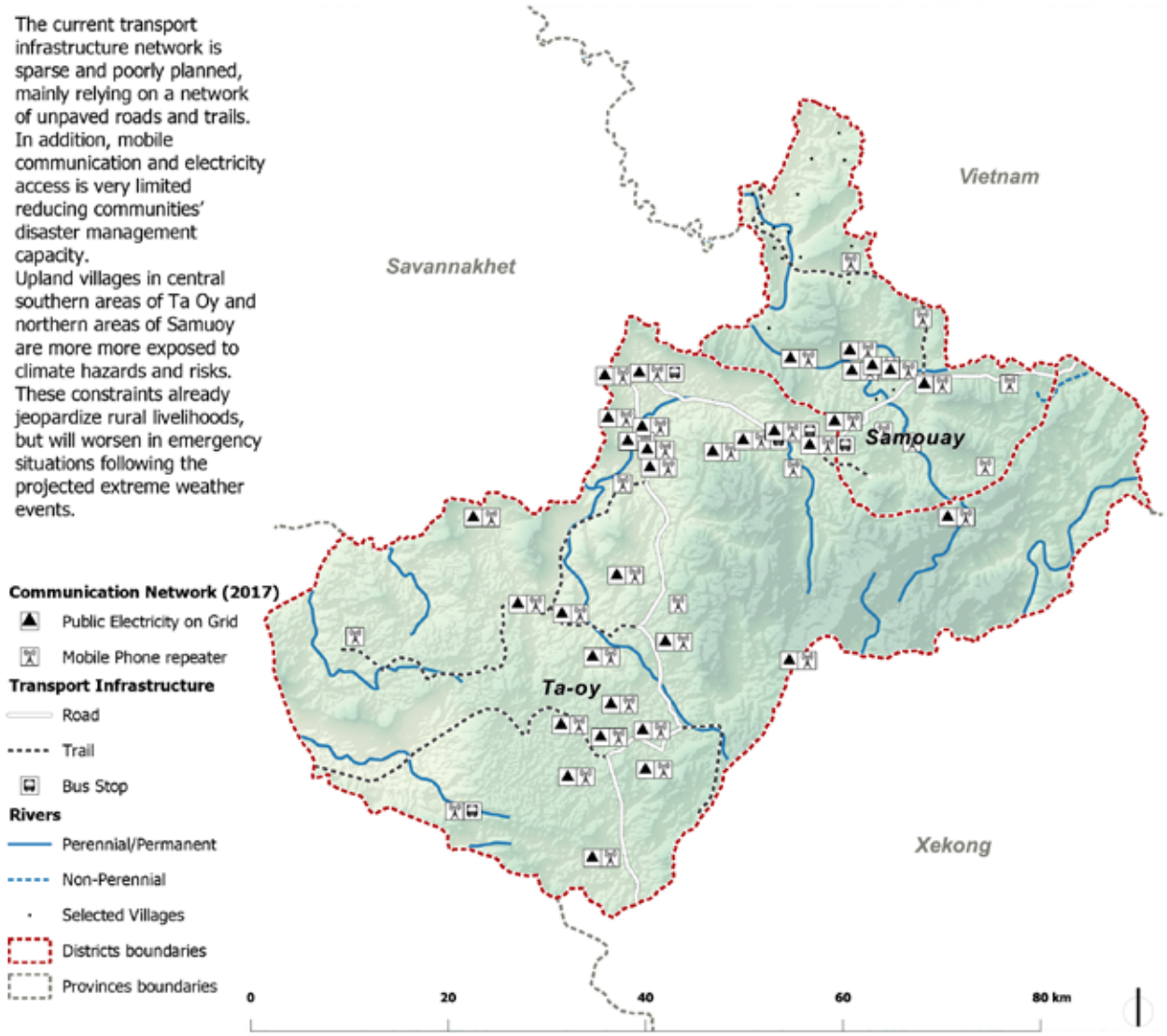
Figure 31 - Proportion of households with mobile phones by district

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

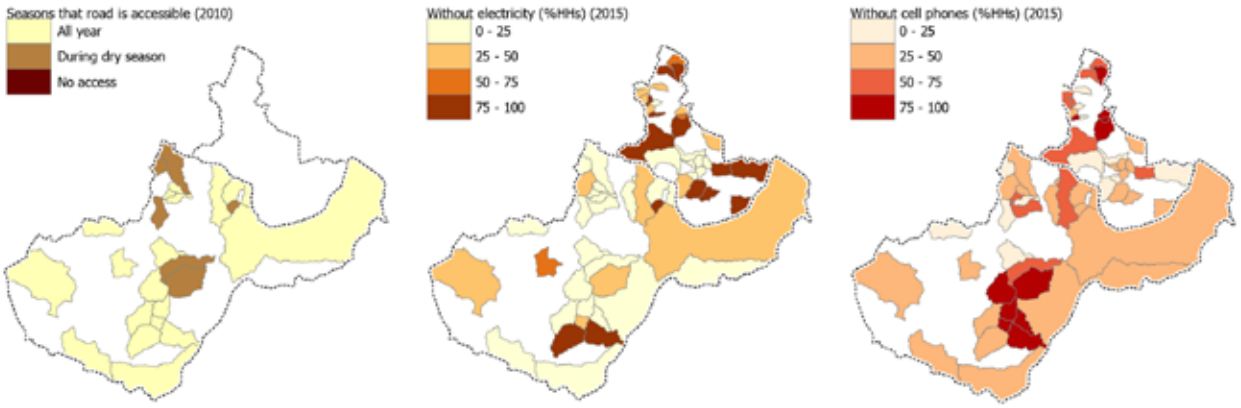
141 http://news.xinhuanet.com/english/2017-01/09/c_135967940.htm.
142 The 4th Population and Housing Census (PHC) 2015. Lao Statistics Bureau.

SPATIAL DISTRIBUTION OF MAIN TRANSPORT AND COMMUNICATION INFRASTRUTURE

The current transport infrastructure network is sparse and poorly planned, mainly relying on a network of unpaved roads and trails. In addition, mobile communication and electricity access is very limited reducing communities' disaster management capacity.
Upland villages in central southern areas of Ta Oy and northern areas of Samuoy are more more exposed to climate hazards and risks. These constraints already jeopardize rural livelihoods, but will worsen in emergency situations following the projected extreme weather events.



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 and Sanitation

The 2013 Law on Water Resources 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."[143]

According to the 2015 Census, most households in Saravan Province depend on surface sources[144] for drinking water. In fact, both target districts mountain sources and streams, rivers and/or dams are the primary source of water. Piped water and bottled water are almost non-existent as drinking water sources in the two districts, while wells and/or boreholes are the most frequent underground source[145].

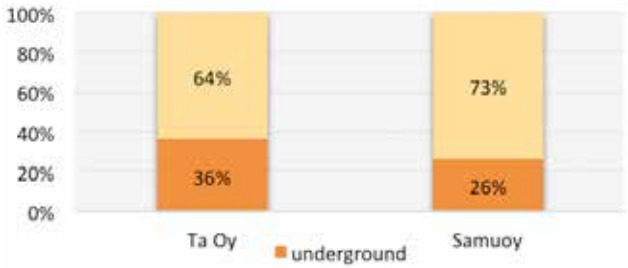


Figure 32 - Proportion of households by main natural source of drinking water in the target districts
Source: 4th Population and Housing Census (PHC) 2015

The assessment found that over 60 per cent of the selected villages in both districts primarily depend on gravity systems for water distribution. In the plateau areas of Ta Oi and Samuoi Districts deep wells and handpumps complement the gravity systems. In Samuoi, wells are rarer, appearing in 18 per cent of surveyed villages, while there is no water supply in 24 per cent of the villages. None of the surveyed villages in either district have rainwater harvesting facilities.

While surface water access is more accessible to the population than underground sources, because extraction is simpler and requires less maintenance, surface water is also less reliable, more variable by season and more at risk from extended dry periods projected under future climate change.

Figure 33 - Deep well with handpump in Samuoi District UN-Habitat, 2017

Some villages on the Samuoi Plateau reported having irrigation systems. In most cases, this was primarily because of their location along the Xe Kong riverbanks. However, these systems are basic and not protected from prolonger periods of rain and floods that can occur in these locations.

Almost three-quarters of selected villages across the two target districts rely on unprotected water sources, which exposes people to contamination – either from flood or storm water or from non-climate related contaminants such as chemicals or fertilizers.

Table 4 - Proportion of selected villages by type of water supply and distribution systems by district[146]

	Gravity System	Deep well	Rain harvesting	Small water system	Tank+ Well	Rand pump	Water network	Irrigation	None
Ta Oi	61%	74%	0%	0%	0%	0%	0%	6%	6%
Samuoi - *upland*	76%	18%	0%	0%	0%	0%	0%	6%	24%
Samuoi - *plateau*	67%	50%	0%	0%	0%	8%	0%	33%	8%

Source: Vulnerability Assessment Survey

143 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
144 According to Census 2015 categories, surface water sources are river, stream, dam, mountain, rain.
145 According to Census 2015 categories, underground water sources are wells; boreholes; piped and bottled.
146 Vulnerability Assessment Survey

Communities in both districts report that temperature variations affect water availability. In Ta Oi, 55 per cent of target villages reported a lack of water due to high temperatures or temperature variation. Future climate change projections combined with high dependence on surface water indicates that this situation will worsen in the future. It is also likely that groundwater aquifers will also be affected as greater recharge times will be needed.

This high proportion of households exposed to unprotected water sources coupled with the projected changes in precipitation patterns and increase in mean temperature, is also likely to lead to higher risks of water borne diseases, especially if we consider, that quantity is also foreseen to be reduced, as droughts might increase[147].

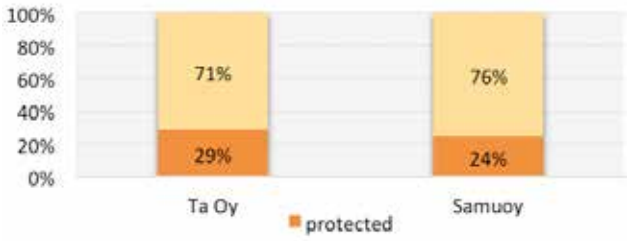


Figure 34 - Proportion of households by type of water supply and distribution systems by district

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

The vulnerability assessment survey and the 2015 Census also indicate a very limited coverage of sanitation across the province, and particularly the two target districts. 86 per cent of households in Ta Oi District and 72 per cent in Samuoi practice open defecation. Combined with high dependence on open, unprotected water sources this presents a great risk of contamination, leading to the spread of water-borne disease[148].

Considering access to water and sanitation and as shown in map SAL05b, northern and southern villages of Ta Oi District and northern, eastern and southern areas of Samuoi District have the highest levels of unreliable and unsafe drinking water sources and the lowest use of improved sanitation facilities.

Health and Education Services

The network of health services in Lao PDR is structured in four levels: (i) Primary health-care services; (ii) Intermediate level healthcare 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 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.

Both targeted districts have a weak primary health coverage. In Ta Oi District only 13 per cent of the selected villages have access to health centre with physician, while 10 per cent also have a midwife. Health service coverage is even worse in Samuoi. 6 per cent and 25 per cent of villages in the upland and plateau areas, respectively have health centres, only 8 per cent of villages have access to a doctor. In Ta Oi, no villages have access to drug kits while in Samuoi just over 30 per cent of villages have access to drug kits.

These very limited health services across the selected villages of the province highlight a high health risk to which people in the two target districts, and Saravan Province more generally, are exposed. In fact, under projected future climate hazards, including storms, floods and landslides may interrupt the already fragile road access preventing people from getting any external medical supplies or service.

Table 5 - Basic Health Services by province

	Drug kits	Health Centre	Doctor	Midwife
Ta Oi	0%	13%	13%	10%
Samuoi - *upland*	29%	6%	0%	0%
Samuoi - *plateau*	33%	25%	8%	0%

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 compulsory education in total[151]. There are two types of primary school, complete and incomplete. Due to some infrastructure constraints, incomplete primary schools do not provide a complete primary education up to grade 5. Most of 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 complete[152]. The National School Construction Guidelines set the minimum standards that school construction must meet, including safety key principles against natural hazards[153].

Most of the surveyed villages in Saravan Province have one primary school (100 per cent of villages in Samuoi plateau, 88 per cent in Samuoi upland and 97 per cent in Ta Oi), which constitute a good basis to reinforce communities' awareness and coping capacity to deal with climate hazards.

The Prime Minister's Decree No. 220/PM[154] establishes Disaster Prevention and Control Committees (DPCCs) at national, provincial, district and villages to look after Disaster Risk Management (DRM) issues in Lao PDR. At community level, the Village Disaster Prevention Units (VDPU)/Village Disaster Prevention and Control Committees (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.[155]

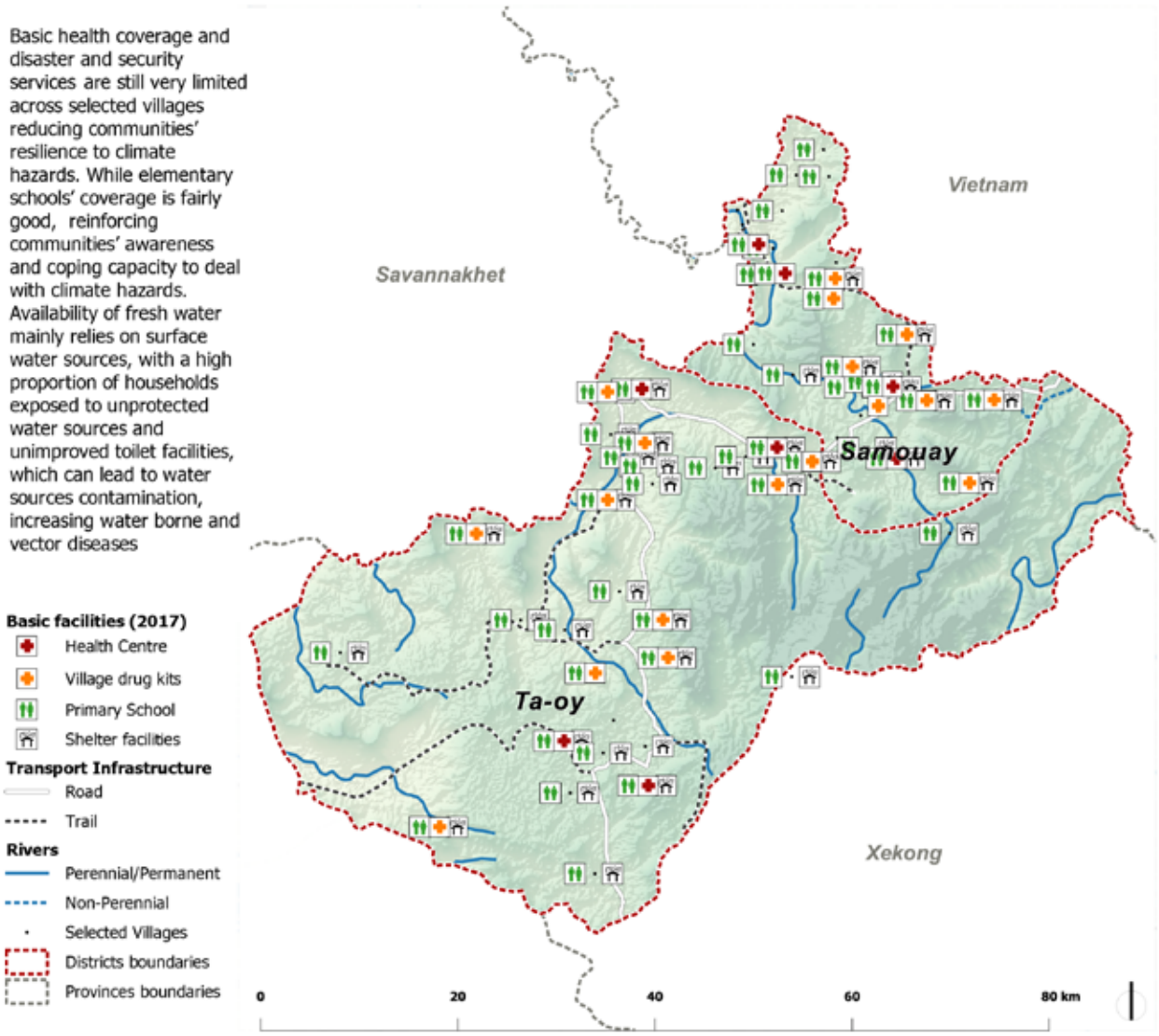
Few of the target villages in the vulnerability assessment survey have a disaster management committee. In Ta Oi, only 19 per cent of villages have one, while in the upland part of Samuoi only 12 per cent do. Disaster facilities, such as common areas for shelter are more common, with 30 per cent having such facilities, rising to 42 per cent in the plateau areas of Samuoi.

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.

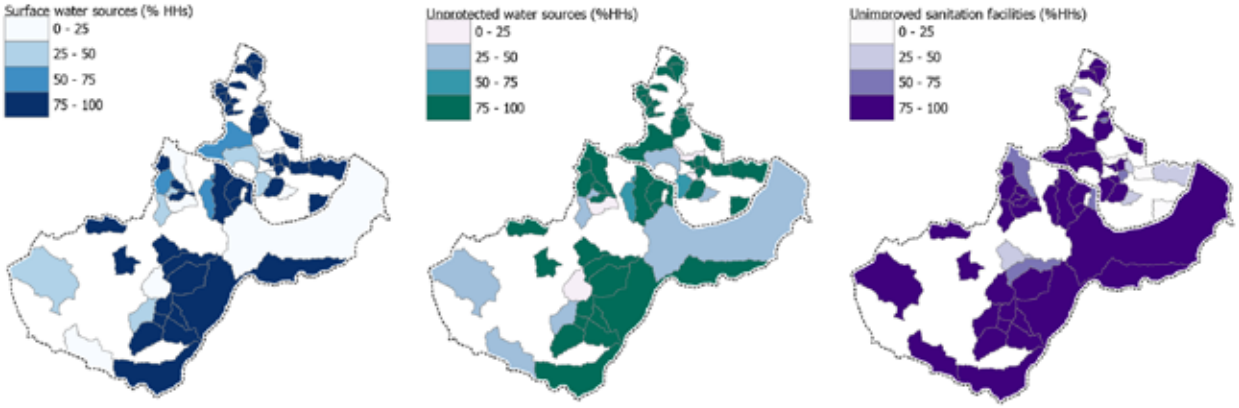
151 Law on Education No. 149/PDR Vientiane Capital City dated 17/07/2007.
152 Education for All 2015 National Review. National EFA 2015 Review Report, Lao PDR August 2014.
153 MoES, 2009
154 28 August 2013.
155 Community-Based Disaster Risk Reduction (CBDRR) Manual in Lao PDR, MoNROE.

SPATIAL DISTRIBUTION OF MAIN PUBLIC FACILITIES AND BASIC SERVICES

Basic health coverage and disaster and security services are still very limited across selected villages reducing communities' resilience to climate hazards. While elementary schools' coverage is fairly good, reinforcing 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 sources and unimproved toilet facilities, which can lead to water sources contamination, increasing water borne and vector diseases



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

• Saravan Province has a very high rate of absolute poverty. Ta Oi is the 2nd poorest district in the country, while Samuoi is the 5th poorest.

• Highly climate-dependent livelihood sources like agriculture and livestock herding are the most common sources of income throughout both districts.

• Literacy rates are very low across both districts.

• Low literacy rates are highly likely to be connected to low school enrolment rates, which are as low as 3.4 per cent of youth enrolled in upper secondary in Samuoi District.

Poverty continues to be a pressing challenge for Saravan Province; the overall poverty headcount for the province is 48.2 per cent, almost double the national average of 24.8 per cent[156]. Ta Oi and Samuoi Districts have even higher rates of poverty; at 64.3 and 52.8 per cent, respectively. Indeed, Ta Oi's poverty rate makes it the 2nd poorest district in the country, only behind Toomlarn District, also in Saravan Province, which has a poverty rate of 73.1 per cent. Samuoi is the 5th poorest district in the country[157]. The poverty gap index, which measures the depth of poverty (as opposed to absolute number of the poor), shows a poverty gap of 21.9 per cent for Ta Oi District and 16.5 per cent for Samuoi, higher than both the Saravan provincial average of 14.6 per cent and the national average of 6 per cent.

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. Livestock farming and agriculture were the two most common livelihood sources, with 43 and 41 villages across both districts reporting dependence on them. Both livelihood sources were reported in all villages in Ta Oi, but in Samuoi there is an even distribution of agriculture, livestock and casual labour.

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 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 family (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 found that livelihoods are not diverse in the two target districts. Almost all villages report a dependence on agriculture and livestock herding. In Ta Oi District, 6 Villages reported that they get income from casual labour, while in Samuoi 13 villages reported dependence on casual labour.

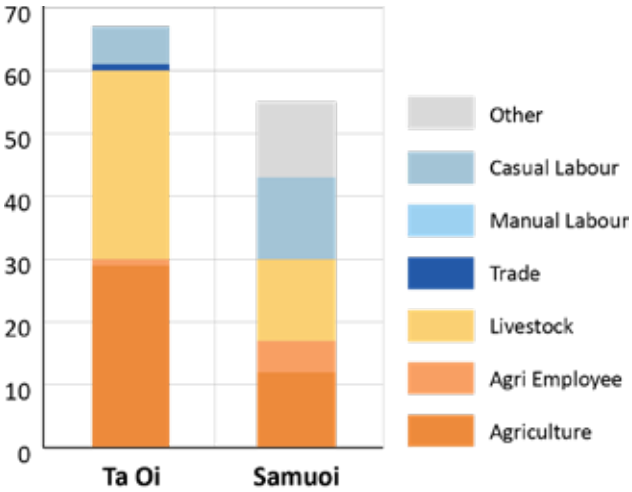


Figure 35 - Livelihood sources by village in the target districts

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

Officially, unemployment is very low both in Saravan Province and the target districts at 0.4 per cent, 0.3 per cent and 0.5 cent respectively for Ta Oi and Samuoi. The dependency rate (also known as the percentage of people who are economically inactive) is 40.4 per cent in Saravan Province, slightly higher than the national average of 37.2 per cent. However, the target districts are considerably higher than both the national and Saravan averages at 49.2 per cent in Ta Oi and 51.1 per cent in Samuoi. Samuoi's dependency rate is the

156 Ibid, p.21.

157 Author's analysis, based on 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, pp. 91-99

second highest in the country after Kaleum District, in Sekong Province (also a target district under the current project). Ta Oi's dependency rate is the fifth highest in the country.

A high dependency rate is indicative of a greater level of vulnerability, because there are fewer income earners per household. While the rate of women in non-agricultural employment is higher in Saravan Province – 43.7 per cent – than the national average of 37.2 per cent, it is low in the target districts; 31.7 per cent in Ta Oi and 26 per cent in Samuoi. If we assume that agriculture is the most vulnerable form of employment this suggests that women in the target districts are more sensitive to climate impacts than both the Saravan and national averages.

Table 6 – Literacy Rates in Saravan Province[158]

District	Literacy Rate – 15-25 year olds (%)	Literacy Rate – 15-64-year olds (%)
Ta Oi	67.5	45.4
Samuoi	75.1	42.1
Saravan Average	86.7	77.5
National Average	92.0	82.5

The literacy rate for 15-64-year olds in Saravan is 77.5 per cent, which compares slightly unfavourably to the national average of 79.4 per cent. However, the literacy rates in the target districts are much lower; 45.4 per cent in Ta Oi and 42.1 per cent in Samuoi. The net primary school enrolment rate in Saravan is 69.4 per cent, below the national average of 75.5 per cent. The lower and upper secondary enrolment rates 33.2 and 15.9 per cent, respectively, are well below the national average of 51.4 per cent and 36.2 per cent. Enrolment rates in the target districts are much lower still, however; 60.3 per cent, 11.5 per cent and 3.4 per cent, for primary, lower secondary and upper secondary respectively, in Ta Oi District and 71.2 per cent, 20.5 per cent and 5.1 per cent, respectively, in Samuoi.

Table 7 - School Enrolment Rates in Saravan Province[159]

District	Primary enrolment (%)	Lower secondary enrolment (%)	Upper secondary enrolment (%)
Ta Oi	60.3	11.5	3.4
Samuoi	71.2	20.5	5.1
Saravan Average	69.4	25.7	10.4
National Average	75.5	41.0	21.7

Some of this low enrolment rate can be explained by a lack of access. As shown in Map SAL 5b, primary school coverage is fairly good. However, access to lower and upper secondary schools quickly drops off. The survey conducted by the assessment team found that only three target villages in Ta Oi District and four in Samuoi have access to a high school (which in most cases is incomplete, meaning that not all classes is available – usually due to a lack of teachers). In Samuoi District there are a total of seven lower secondary schools covering classes 1-4, but only 1 covering classes 5-7, and one complete covering both lower secondary (classes 1-4) and upper secondary (classes 5-7). In Ta Oi, only five groups of villages have access to a secondary school. If we assume that children only attend high school if they can walk, cycle or go by public transport, the low school attendance rate correlates.

However, the diverse mix of ethnic groups is also a challenge. Of the 31 villages surveyed in Ta Oi District, 14 were mainly comprised of the Ta Oi ethnic group , while 10 were Katang group and seven were a mix of other ethnic groups. In Samuoi, meanwhile, 20 of the 29 villages surveyed were primarily made up of the Kado ethnic group, with 8 being from other groups. There is no data available on to what extent these ethnic groups speak Lao, or the ethnic make-up of classes. However, informal evidence from the consultations suggests that many of the ethnic groups don't speak Lao – or have a limited grasp of the language – and as education facilities are not provided in ethnic minority languages, this is undoubtedly a contributing factor in the low rate of school enrolment.

Low school enrolment and poor educational outcomes is indicative of higher sensitivity and lower adaptive capacity to climate change. Low enrolment correlates directly with lower literacy, which makes it impossible for people to access both traditional print and electronic media. It also strongly suggests a low skills base, which restricts people to working in agriculture (usually on a subsistence or very small-scale basis), livestock herding or working as casual labourers. Migration rates are fairly low – only 13 of the 61 villages (22 per cent) surveyed across Saravan Province reported that they experience outward migration. Where people have limited access to media (traditional and electronic) they tend to be more vulnerable as they do not access official information about the potential for droughts, storms or floods, while those working in agriculture and livestock are also likely to be affected – animals are prone to die in hot, drought or flood conditions, while agricultural yields, and thus incomes, are highly sensitive to climate hazards.

158 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.105

159 Ibid, p.106.

4.5 Adaptive Capacity: Spatial Structure of the Province

- Northern areas of Samuoi District have the lowest levels of socio-economic and infrastructure development.
- Better transportation infrastructure enables better access to socio-economic services in more urbanized areas than in villages classified by the assessment as 'local rural'
- The territorial and socio-economic development of Ta Oi District is mainly centred in two villages; Tulunglalao and Pachoudone, which are located at the junction of two major roads.
- Samuoi District has weaker infrastructure and lower levels of socio-economic development. Its development is mainly centred on the of *Lahang*, *Atouk* and *Tangko*.

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*[160] and *centrality score*[161] 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.[162]

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

160 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.
161 The "centrality score" is calculated by adding up the weights of all functions present in each administrative unit,
162 Refer to Annex MoF for a complete explanation of the methodology and detailed matrix of ordered functions.

Unlike exposure and sensitivity, of 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 Ta Oi and Samuoi Districts, 26 of the 60 villages have only the most basic level of functions and services at levels 1 and 2 in the hierarchy, allowing us to surmise that they have very limited adaptive capacity.

Only three villages in the target area – 2 in Ta Oi District and 1 in Samuoi have the highest score in the level of hierarchy, providing further evidence for low adaptive capacity throughout the two districts because people can't easily travel to those locations to access functions and services.

Type	Local Rural Villages (LRV)				
Centrality Score	4.35- 52.20	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/trails, however mobile repeater and electricity on grid is often accessible. Gravity feed system and deep hand pump wells are the main water facilities available. Only primary education is provided, while health facilities are not available. Agriculture and livestock are the main economic activities, together with casual labour work.				
Functions	16 functions				
Villages	26 Villages (40%)				
Type	Intermediate Rural Villages (IRV)				
Centrality Score	138.80-242.80	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	385.88–396.05	Level of hierarchy	10		
Level of Development	This type of village has the highest level of socio-economic and infrastructure development of the two districts. The presence of better transportation and communication facilities (such as petrol stations and bus stops) increase business and industrial opportunities (hydroelectric power production and mining exploitation) and the range of private professionals (veterinary, agricultural employee, carpenters). In addition, this category provides more security services (police check points) and cultural and recreational facilities (such as cultural centres and playgrounds).				
Functions	51 functions (30 from the previous category)				
Villages	3 villages				

Territorial Linkages and Infrastructure and Socio-Economic Development

As shown in map SAL06, the analysis of the spatial distribution of type of settlements and the cartographic representation of levels of hierarchy as based on isopleths[163] allows planners to make assumptions on how balanced the spatial development of the region is, and the degree of territorial influence (where any) of each settlement over neighbouring settlements:

Northern areas of Samuoi District have the lowest levels of socio-economic and infrastructure development

Around 60 per cent of the selected villages in Samuoi District are categorised as Local Rural Villages, mainly those villages in northern areas of the district because they have the lowest level of socio-economic and infrastructure development. Only 25 per cent of villages in Ta Oi have been classified as local rural villages. The lack of adequate transportation infrastructure coupled with access to only basic education coverage leave these communities highly dependent on agriculture and livestock sources of income.

The territorial and socio-economic development of Ta Oi District is mainly centred in two villages, Tulunglalao, located close to the junction of the main north-south road between Savannakhet and Sekong Provinces with the provincial road to the western areas of the district; and the village of Pachoudone located at junction of the main west-east road with the southern provincial road. Both villages are also connected by road to the border with Vietnam.

The territorial influence of Tulunglalao Village, is mainly concentrated along the north-south road to Sekong, through the neighbouring villages of Katen, Kape and Paten. These four settlements concentrate around 14 per cent (2,306 inhabitants) of the total population of the selected villages in the district (17,051 inhabitants), and provide the highest levels of health services, education facilities, and security services, while also providing the main market to the neighbouring rural communities.

The villages of Pachoudone, Lakhab, Sanang, Paseer and Porbeui make up the second cluster in the district, concentrating around 15 per cent (2,481 inhabitants) of the total population of the target villages in Ta Oi District. These villages are the economically productive area of the region because they have most of the Hydroelectric Power activities.

Samuoi District has weaker infrastructure and socio-economic development.Its development is mainly centred on the Lahang, Atouk and Tangko cluster of villages, which are located on the east-west road between Savannakhet Province and the Vietnam Border and at the junction of various minor roads that connext northern areas of the district.. This cluster has 7 per cent (1,641 inhabitants) of the total population of the target villages in Samuoi District (6,987 inhabitants) and provides the highest levels of health services, education facilities, and security services

Better transportation infrastructure enables better access to socio-economic services than in villages

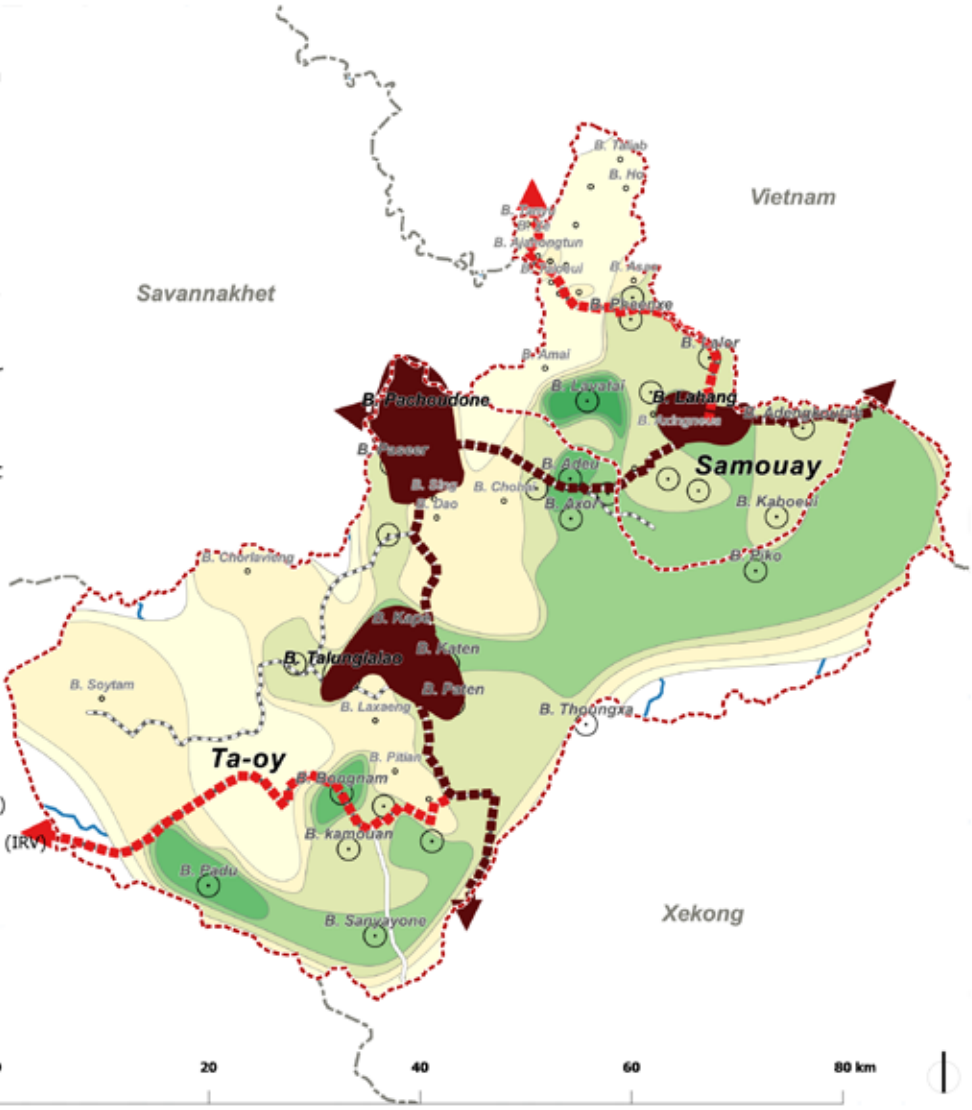
Villages that have better accessibility because of improved road infrastructure or more means of transportation have better coverage of public services and more economic activities and opportunities than villages without roads.

Most of the Intermediate Rural Villages (IRV) have access to primary (paved/unpaved) road infrastructure and more means of transportation (bus transport) which enable better coverage of public services (health and education).

163 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 Ta Oy district is mainly centred in two villages, Tulunglalao and Pachoudone strategically located at cross-junction of main north-south axe of transportation (Savakhanet - Xekong) with the provincial road to western and southern areas of the district
Samouy district shows weaker infrastructure and socio-economic development, mainly centred on the tri-polar set of villages of Lahang, Atouk and Tangko, strategically located at cross-junction of the main west-east axe of transportation (Savakhanet - Vietnam) with the provincial road towards the northern areas of the district.



Spatial structure
- Primary Corridor
- Secondary Corridor
- Main cluster of villages

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

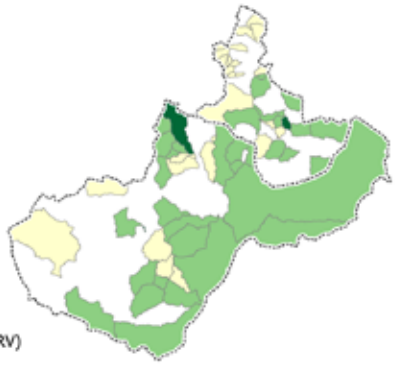
Level of Hierarchy
- Level 1
- Level 2
- Level 3
- Level 4
- Level 5
- Level 6
- Level 7
- Level 8
- Level 9

Road infrastructure
- Paved road
- Unpaved road

Rivers/Streams
- Perennial
- Non-Perennial
- Districts
- Provinces

SPATIAL DISTRIBUTION OF THE TYPE OF VILLAGES

Northern areas of Samuoy district show the lowest levels of socio-economic and infrastructure development. Around 60% of the selected villages in Samuoy are categorised as Local Rural Villages (LRV), mainly located in northern areas of the district against 25% in Ta Oy
Better transportation infrastructure enable better access to socio-economic services than in villages



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 36. 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 SAL 07a, below), we see that villages throughout Ta Oi and Samuoi Districts face severe impacts. However, villages in Samuoi have been especially severely impacted, and these villages are often clustered together. 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 likely reduced.

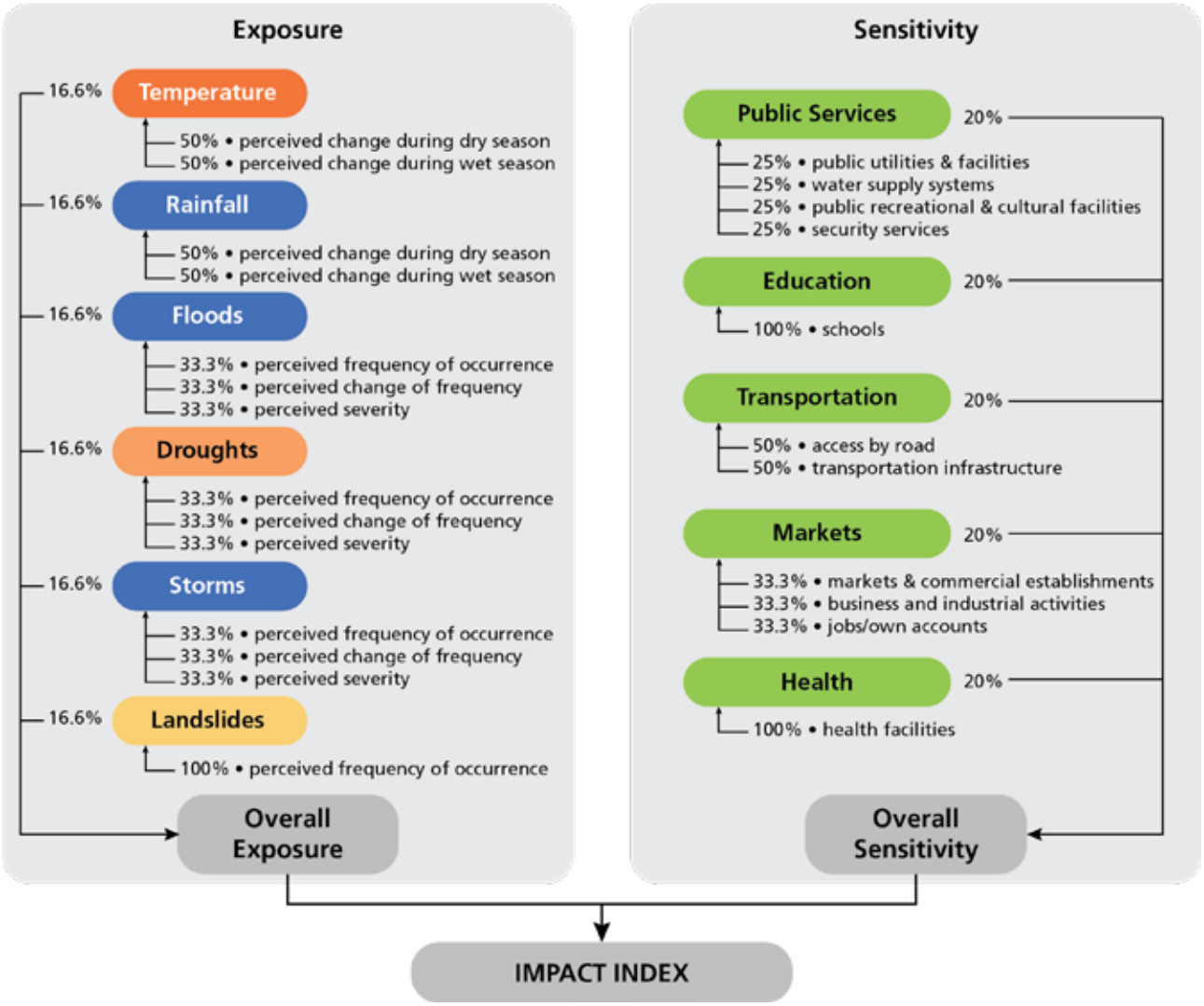
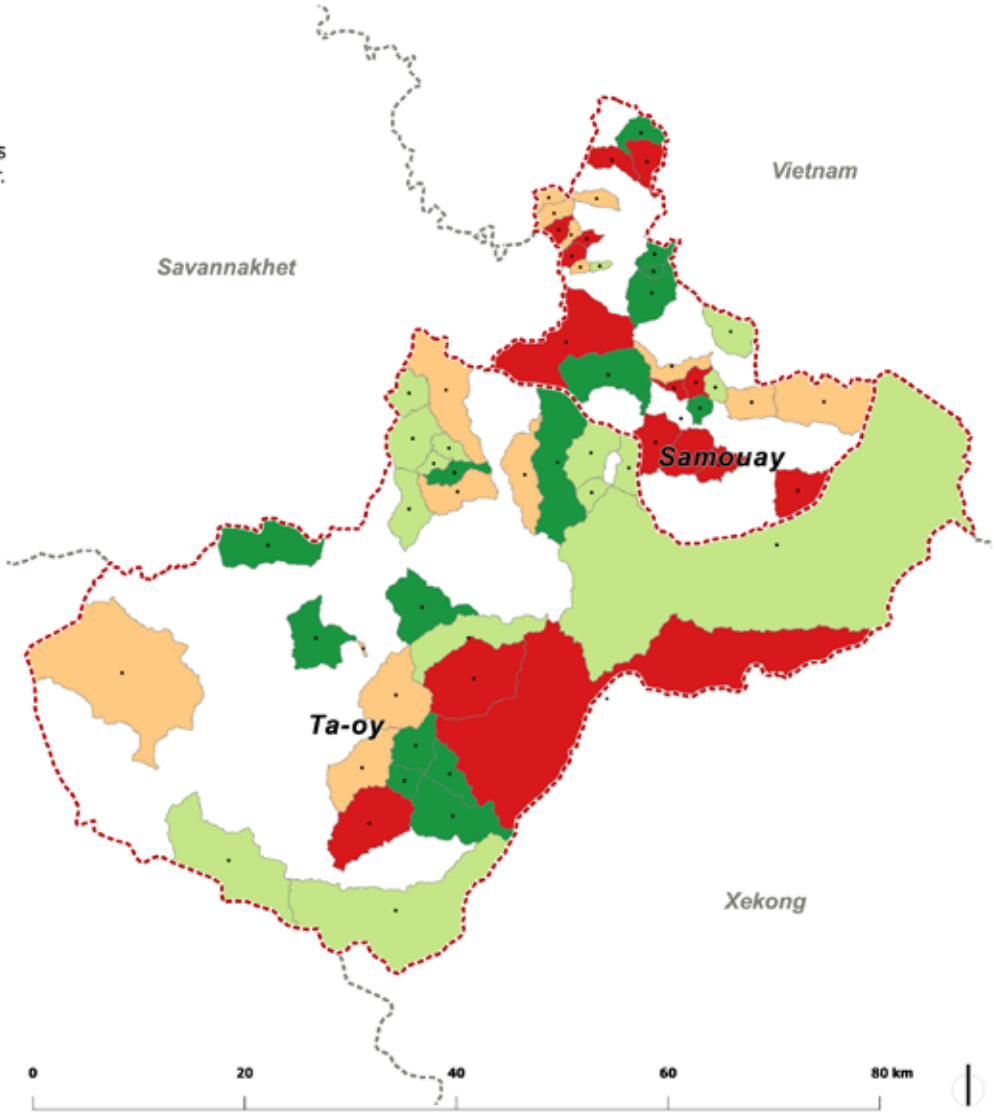


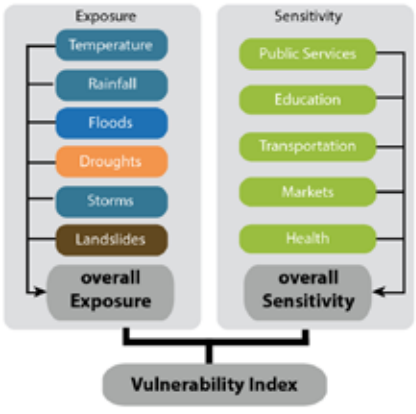
Figure 36 - Method for calculating the Impact Index

IMPACT INDEX

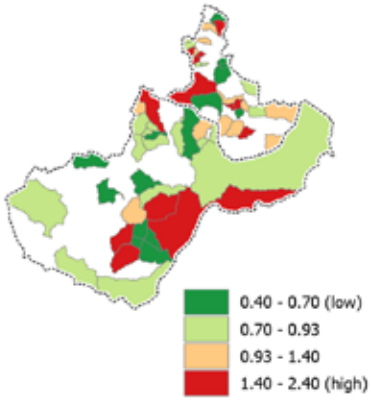
Villages throughout Ta Oi and Samuoi Districts face severe impacts. However, villages in Samuoi have been especially severely impacted, and these villages are often clustered together. This is very problematic because where an isolated village is impacted, people may still be able to access markets and 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 likely reduced.



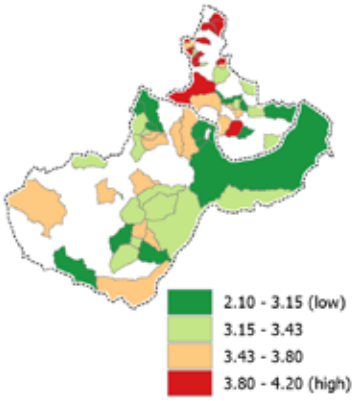
VULNERABILITY



EXPOSURE



SENSITIVITY



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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 37. 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 highly vulnerable villages throughout the two districts, with similar patterns as the impact index. However, the villages in the central and eastern parts of Ta Oi District show very little capacity to respond to future climate change related impacts. This is an important consideration for decision makers; though Ta Oi has only been moderately impacted in the past, there is a high chance it will be hit by a climate related even in the future, and if it is hit by major flooding or a tropical cyclone, its capacity to respond is very low. Samuoi District is also very vulnerable, because adaptive capacity, while slightly higher overall, is still very low and it would likely not have the capacity to respond to a serious climate change related event or impact.

According to the vulnerability index, Ta Oi and Samuoi face high levels of vulnerability, though slightly lower than Kaleum and Dakcheung Districts in neighbouring Sekong Province. The mean vulnerability score of villages in Saravan Province is 6.09 (with 10 being the highest), higher than Attapeu Province, but lower than Sekong. Vulnerable villages are found throughout Ta Oi and Samuoi, but are particularly prevalent in the central and eastern parts of Ta Oi and northern Samuoi.

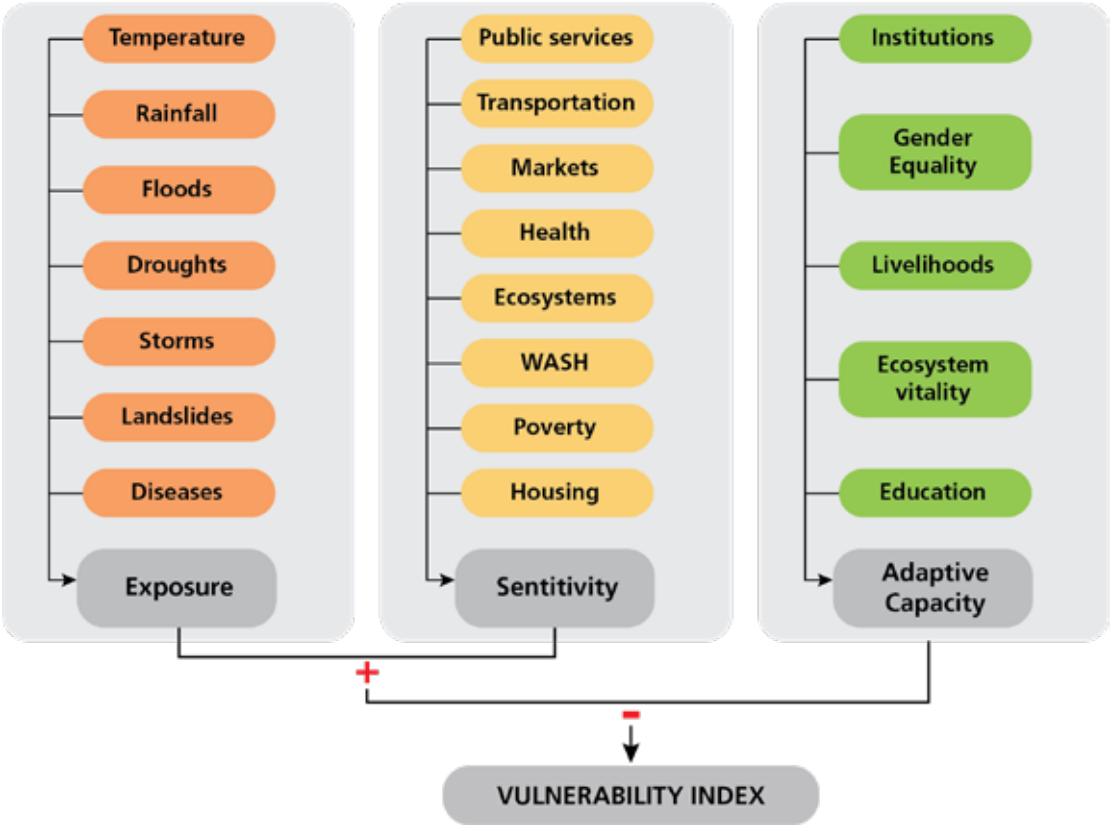
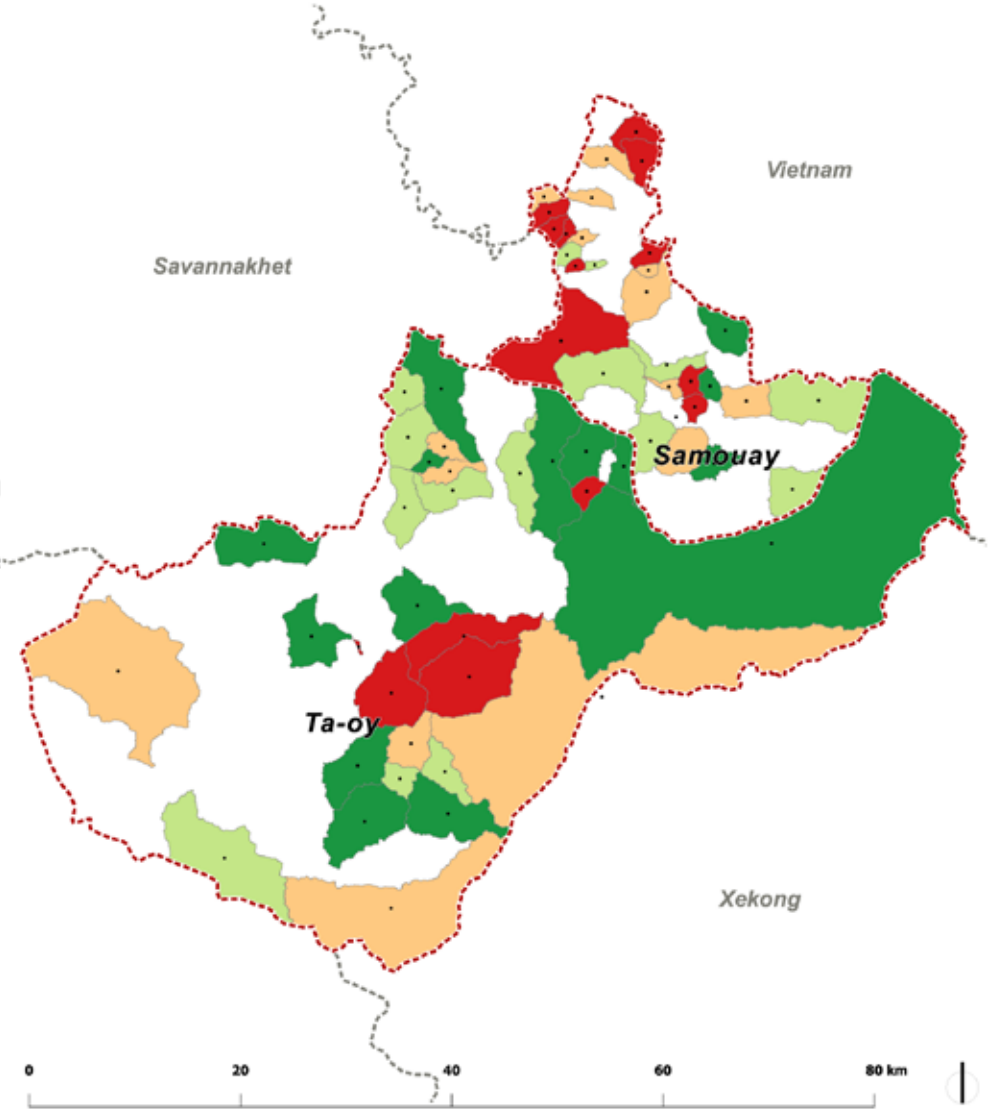


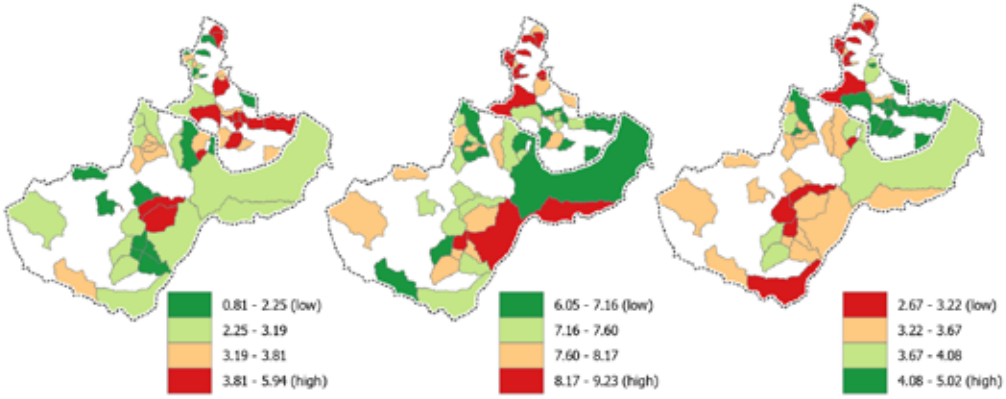
Figure 37 - Calculating the Vulnerability Index

VULNERABILITY INDEX

The villages in the central and eastern parts of Ta Oi District show very little capacity to respond to future climate change related impacts. This is an important consideration for decision makers; though Ta Oi has only been moderately impacted in the past, there is a high chance it will be hit by a climate related even in the future, and if it is hit by major flooding or a tropical cyclone, its capacity to respond is very low. Samuoi District is also very vulnerable, because adaptive capacity, while slightly higher overall, is still very low and it would likely not have the capacity to respond to a serious climate change related event or impact.



VULNERABILITY | **EXPOSURE** | **SENSITIVITY** | **ADAPTIVE CAPACITY**



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Climate Change Vulnerability Assessment of Samuoy and Ta Oy Districts in Salavan Province **SAL07b**

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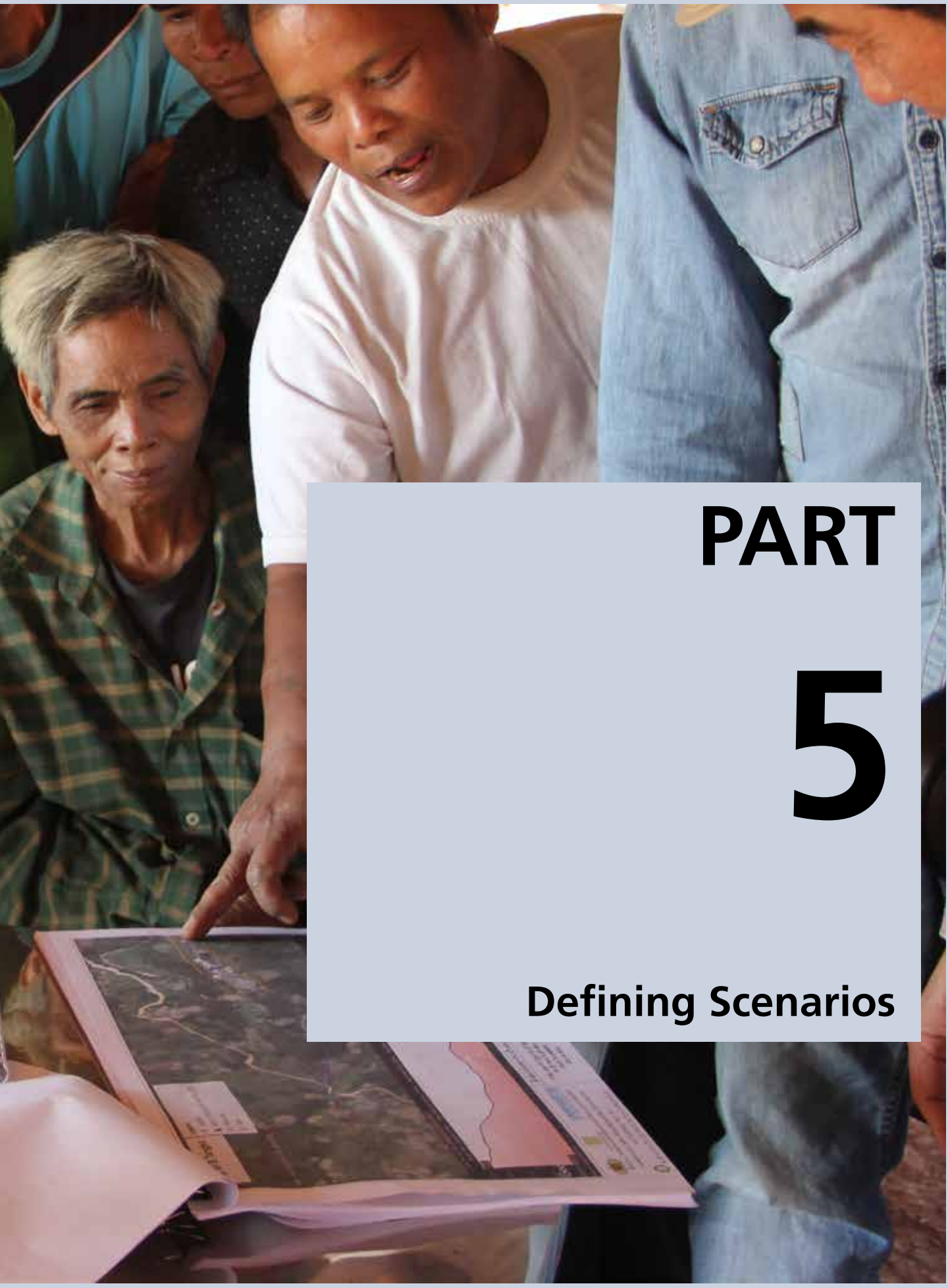


PART 5

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.

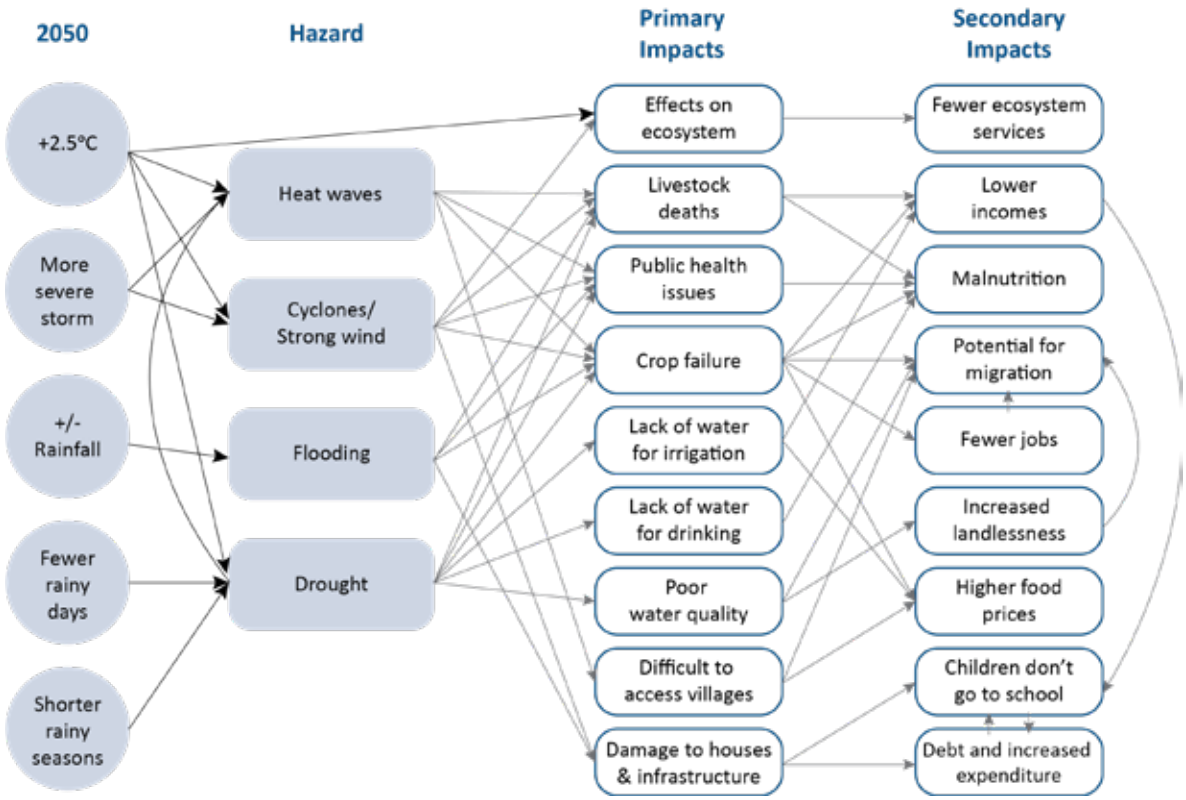


Figure 38 - Pathway to Impact Graphic

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

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

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[164].

	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.

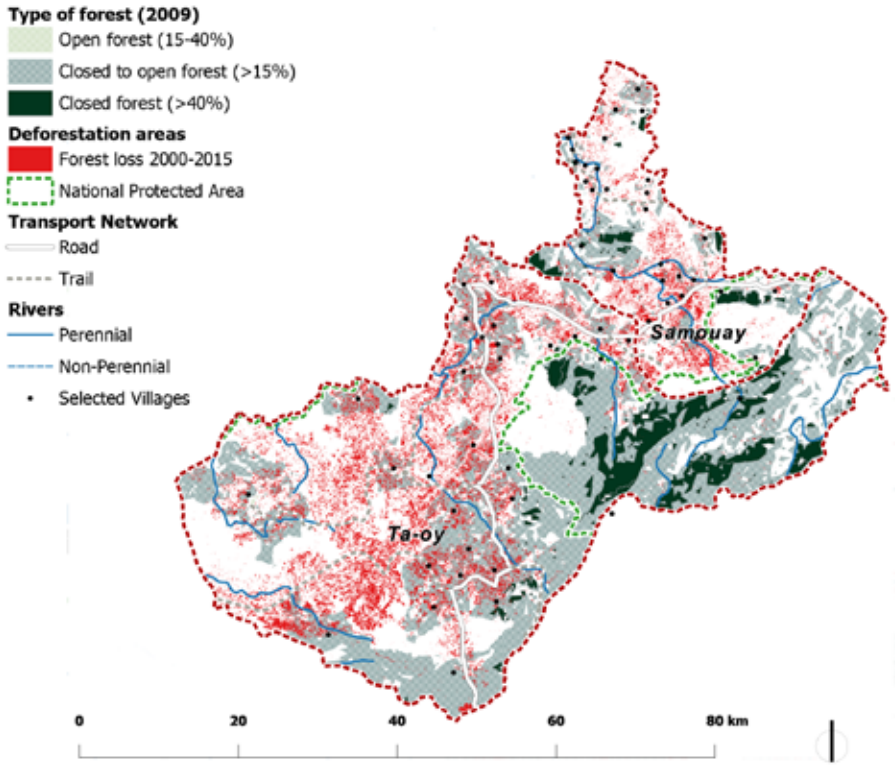
- This continuing deforestation, both low land areas and upstream, will make communities close to rivers highly vulnerable to more frequent and severe intense rainfall events.

- 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.

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

FOREST COVERAGE IN SELECTED VILLAGES IN 2017

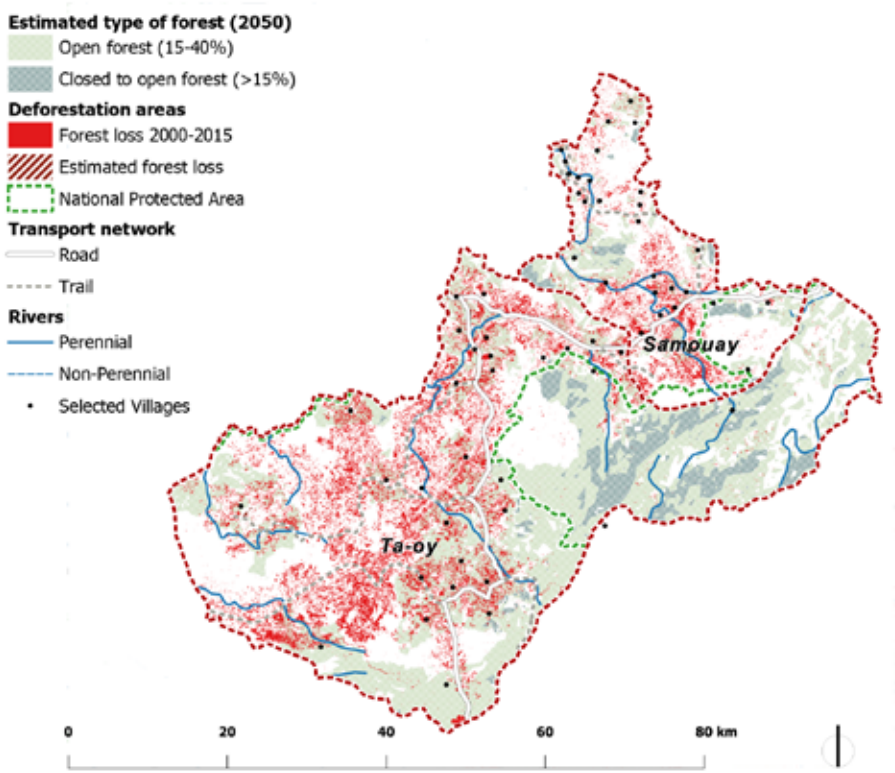
Forests are the source of timber and non-timber products that are critical income and livelihood resources for rural communities. National forest cover is reported to have declined dramatically between 1992 and 2002, at an average rate of 134,000 hectares per year (equivalent to 1.2 -1.3%).
Main drivers of forest and habitat loss are linked to shifting cultivation, legal and illegal logging, conversion to agriculture and forest plantations, and infrastructure development.
In the absence of more updated data the forest coverage for 2017, has been calculated based on GlobCover land cover map produced for the year 2009.



ESTIMATED FOREST COVERAGE IN SELECTED VILLAGES IN 2050

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

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 heavy storm and natural habitats- may also be lost.
This continuing deforestation, both within low land areas and upstream, will make communities in floodplain areas highly vulnerable to more frequent and severe intense rainfall events.
In addition, the capacity of the population to benefit from forestry sources to build their houses and for fuel wood will be highly compromised, forcing them to travel ever farther.



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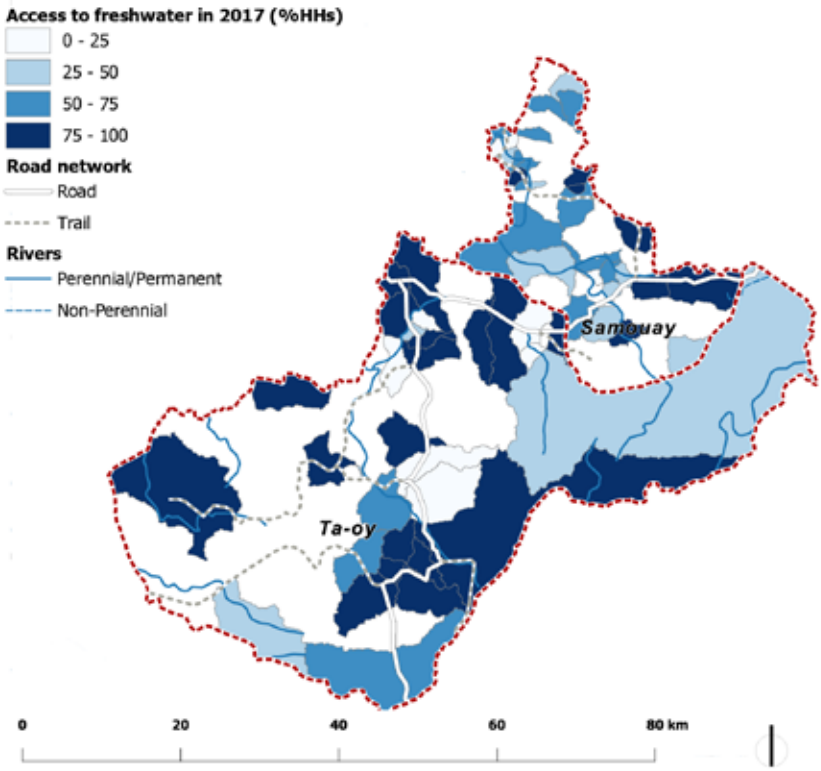
Access to Freshwater for Drinking Water Uses by 2050

The projected changes in precipitation patterns and 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 improvement (tank capacity, borehole depth). In addition, stronger storms and unusually heavy rainfall will inevitably damage water infrastructure.
Access to freshwater for drinking use may be highly impacted by the projected future 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.

CAPACITY OF THE POPULATION TO ACCESS FRESHWATER FOR DRINKING WATER USES IN 2017

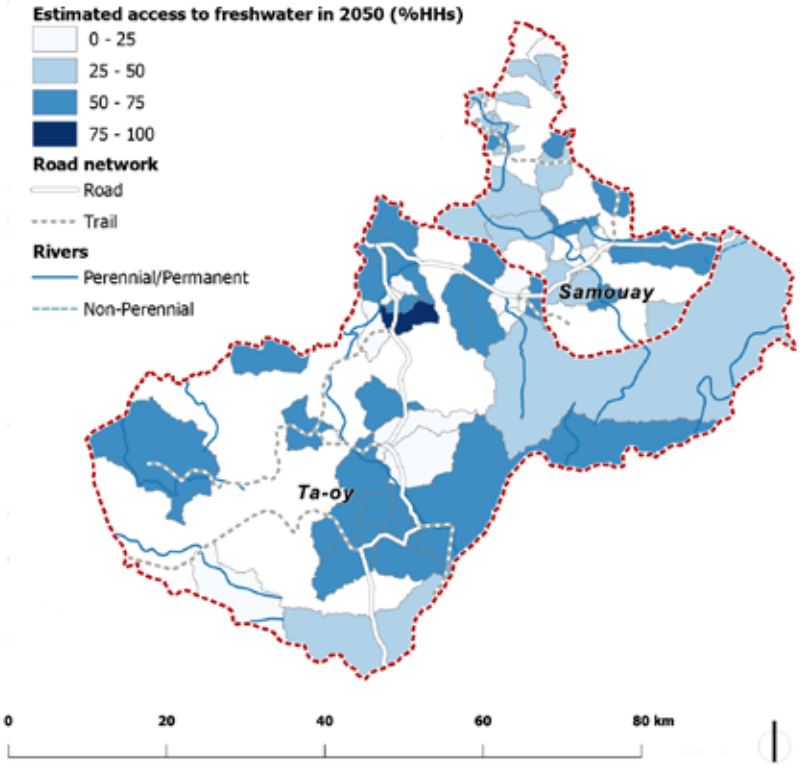
The great majority of the households across Saravan province depend on surface sources for drinking water. In fact, both targeted districts, Ta Oy and Samuoy, are mostly supplied by mountain sources and streams, rivers and/or dams. Piped water and bottled water are both sources almost negligible; wells and/or boreholes are the most frequent underground source The percentage of the households having access to freshwater sources is calculated by applying to Census 2015 data coefficient of current impacts to those selected villages where damages to water sources and infrastructure where reported



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.

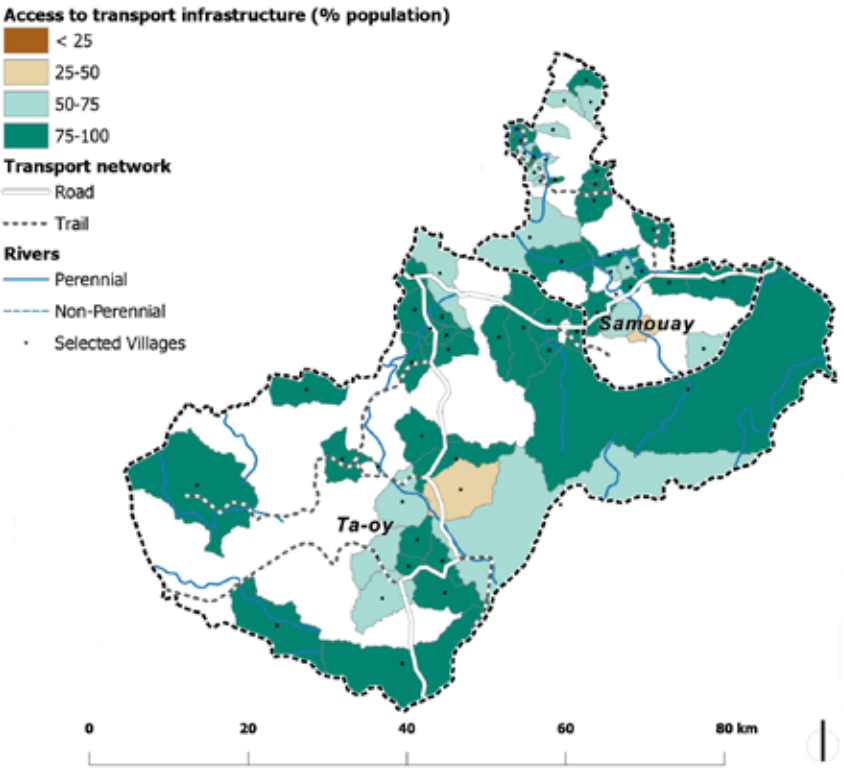
Rural road networks are critical infrastructure highly exposed to climate change, as they mainly depend on the interaction of two main eco-system services (types of vegetation and soil):

	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 the impact of erosion through infrastructure coupled with limited transportation, 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

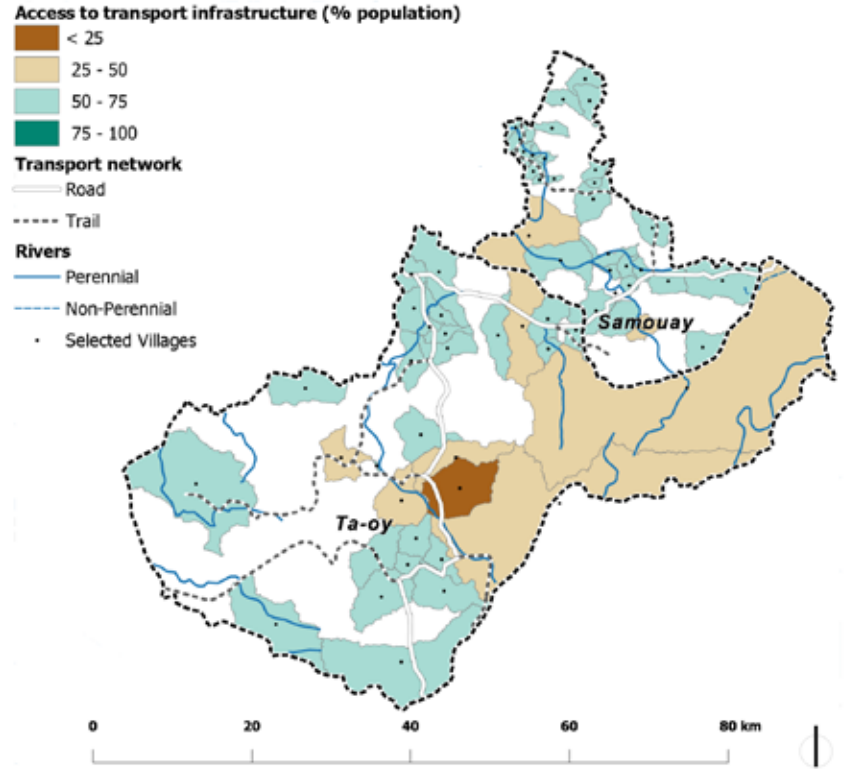
In Ta Oy and Samuoy districts' highland areas, mobility seems to be the main constraint for the socio-economic and livelihood development of rural communities. The rural transport network, mainly relies on secondary and tertiary unpaved roads/ trails, which make these rural communities highly vulnerable to strong storms and unusually heavy rainfall. These mobility constraints will worsen in emergency situations following the projected extreme weather events.
The percentage of population having access to transportation network in 2017, is calculated by combining the type of roads and the type of transportation services available in each village with landslides and floods' impacts on infrastructure reported in selected villages



ESTIMATED ACCESS TO TRANSPORT NETWORK IN SELECTED VILLAGES IN 2050

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

If no adaptive measures are implemented, the lack of capacity to mitigate erosion through formal infrastructure coupled with weak transport communication, will lead communities highly vulnerable to more floods and inundation
In highland areas, specially in nothern and eastern villages in Samuoy and Ta-Oy district respectively, where the transport communication mainly relies on a network of rural unpaved roads on sloping land, more intense rainfall events will magnify the instances of road degradation, road inaccessibility due to water coverage, and road and bridges destruction by landslides and flash floods.
Access to transportation network in 2050, is determined by combining landslide susceptibility zones (National Risk Profile of Lao PDR, 2010).



Data Sources: Lao Decide (www.decide.la), Population and Housing Census (2015), Lao Census of Agriculture (2010/2012), National Risk Profile of Lap PDR (2010), VA survey UN Habitat (2017)
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PART 6

Conclusions – Planning for Adaptation

6 Conclusions – Planning for Adaptation

6.1 Towards Action Planning

At present, the selected villages in Saravan Province don't show evidence of resilient conditions and attributes, given the current climate conditions and projected future climate change. As explained in previous chapters, the projected change in climate is likely to cause significant impacts, unless resilience is prioritized now and built over time.
Poor livelihood options, underdeveloped infrastructure and continued deforestation create a very vulnerable context, which is likely to be exacerbated in the future by more severe climate hazards.

- **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 mitigate erosion through formal infrastructure coupled with weak transport links, 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, and have lower adaptive capacity, and that their sensitivity would be reduced and adaptive capacity increased by providing the services that are missing.

However, from 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 help built resilience in both, main and basic settlements, as they are strongly interconnected.

The territorial and socio-economic development of Ta Oi District is mainly centred in two villages, *Tulunglalao* and *Pachoudone*. Samoui District has weaker infrastructure and socio-economic development, which, where it exists, is mainly centred on the tri-polar set of villages of *Lahang*, *Atouk* and *Tangko*. If we overlay vulnerability to climate change – as identified through the vulnerability index by combining exposure, sensitivity and adaptive capacity – these main villages show high levels of vulnerability (orange to red colors in SAL12 map), which already points towards some strategic adaptation measures at regional 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 of the district**, to improve its agricultural productivity 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.

Furthermore, the analysis of the functions available and absent in each type of village against the proposed spatial structure (clusters) and the vulnerability ranking to climate change, suggests some "specific functions" (adaptive measures) that could be added to reduce the district's vulnerability, as shown below.

b. Prioritized actions in each village

How to move forward from the vulnerability assessment, towards an action plan? This section very briefly describes the adaptation action planning process that could be implemented in Saravan 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 in conjunction with provincial and district level officials, based on the village-level infographics, maps and impact index. 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 measure the achievement of objectives.

• Once indicators are decided, prioritize 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 to the objectives.

• Conduct an initial screening of the long-list against the objectives. 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

• Complete a village-level questionnaire about the long-listed actions. This is likely to be done using a similar methodology to the questionnaire developed and delivered as part of this vulnerability 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.

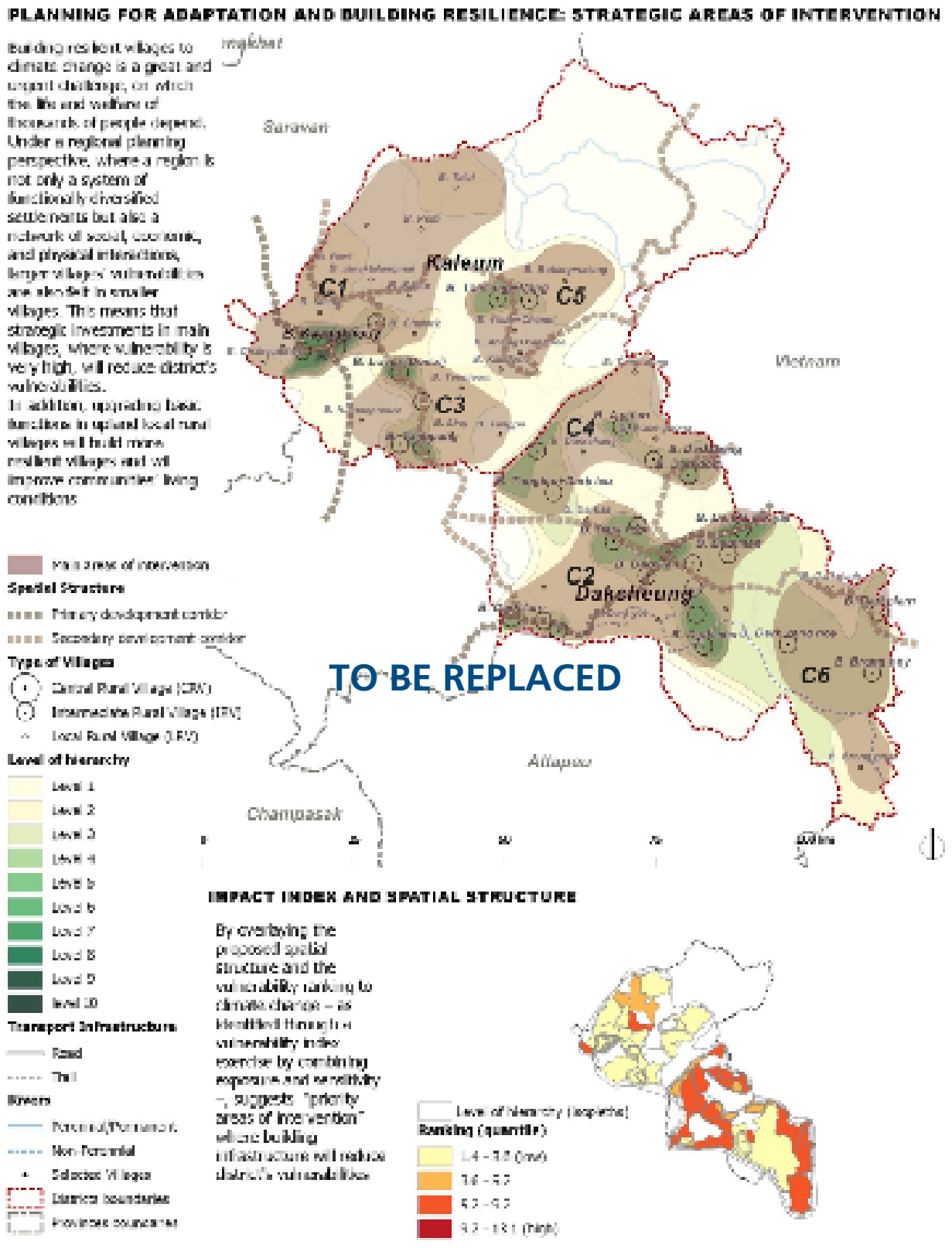
• Gain acceptance at the village level through the survey process.

Prioritised 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 donors.



Data Sources: Lao Decide (www.decide.la), Population and Housing Census 2015, Lao Census of Agriculture 2010/2011, UN Habitat
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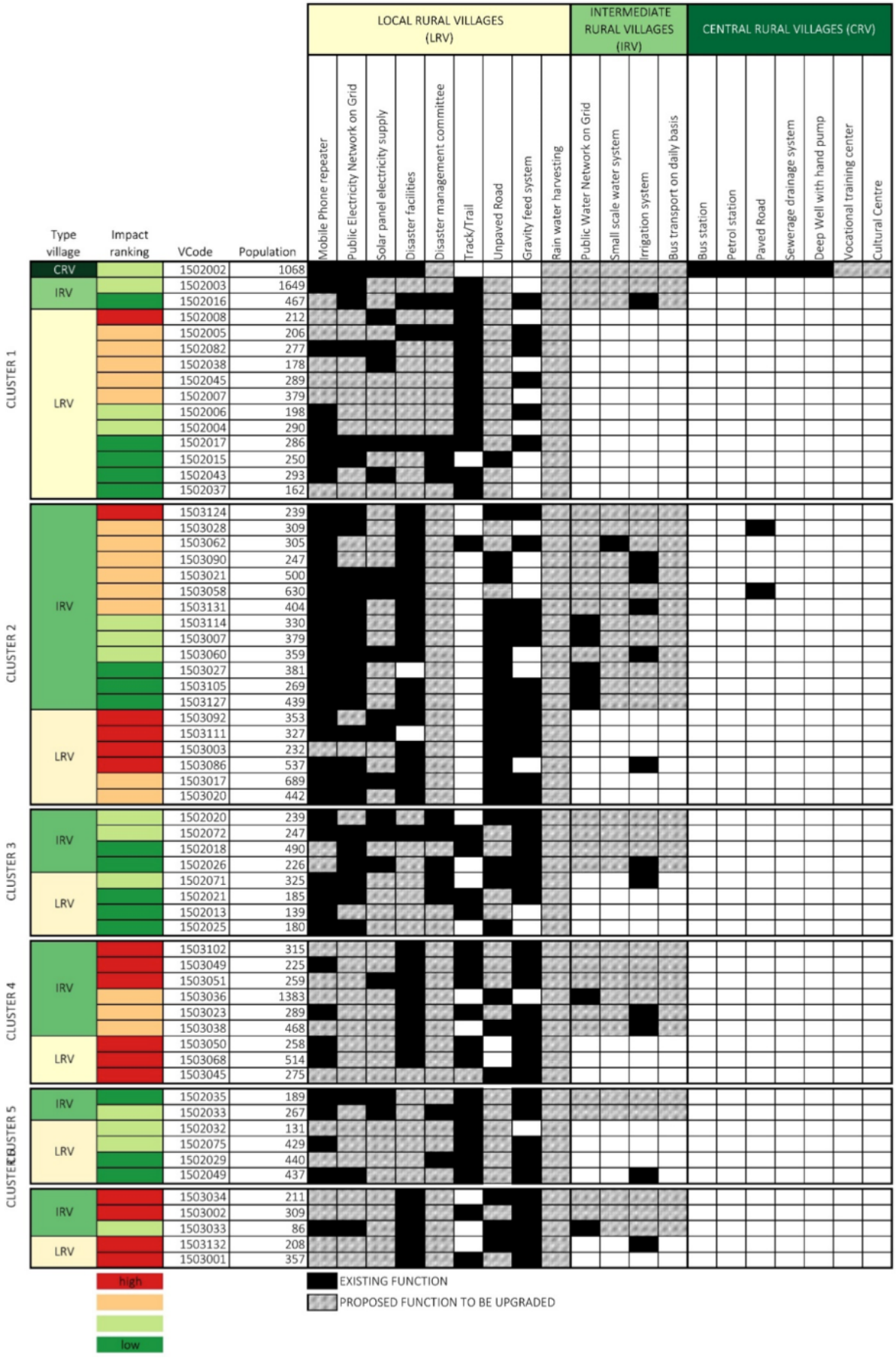

Figure 39 - Priority functions to be added in selected villages

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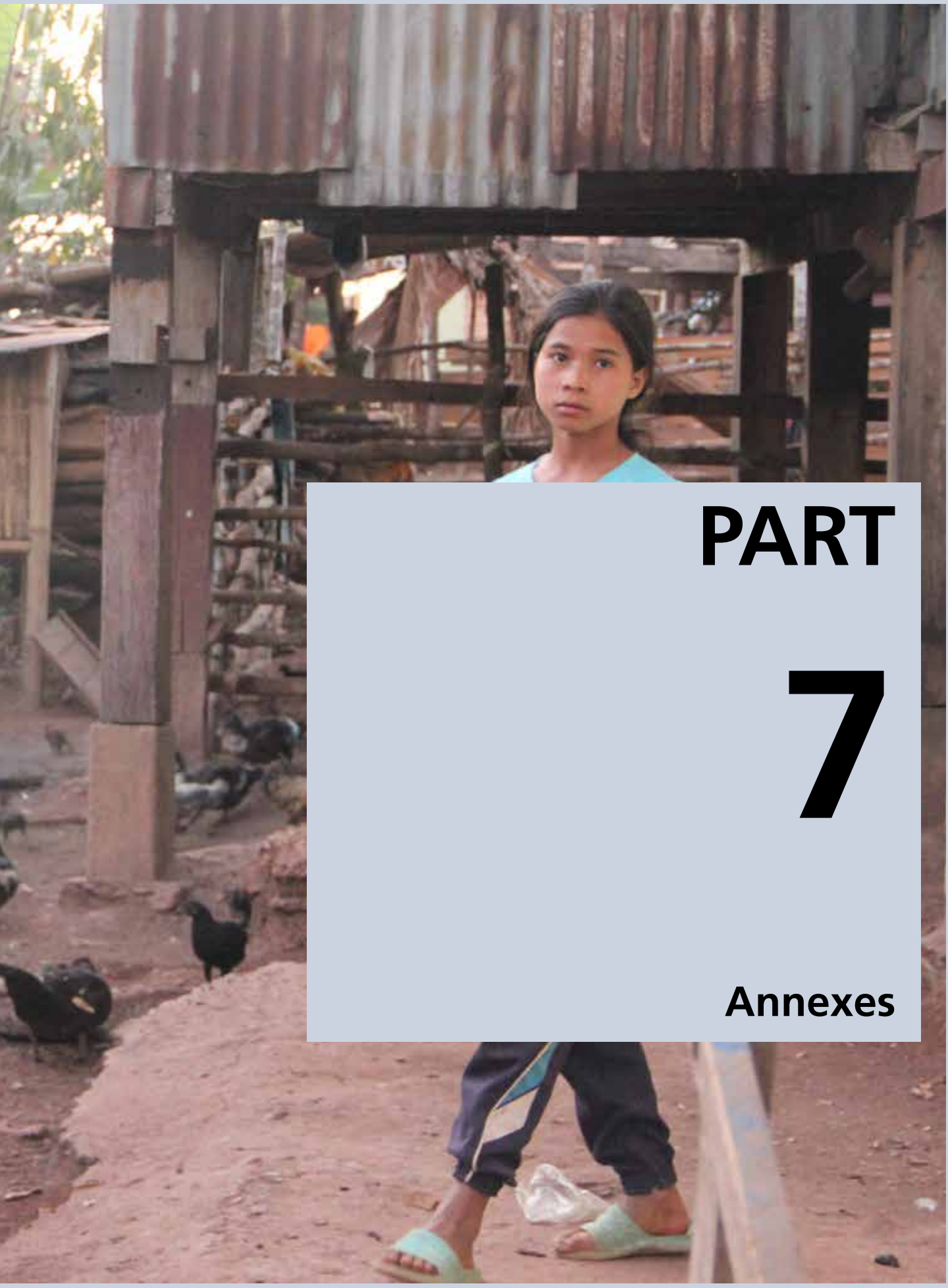


PART 7

Annexes

Annex 1 List of target villages by district

District	Village Code	Village Name	Population (2015)
TA OI	1402002	B. Talunglalao	827
	1402004	B. Laxaeng	643
	1402005	B. Lakhab	473
	1402006	B. Paseer	430
	1402007	B. Pachoudone	1003
	1402011	B. Chohai	761
	1402012	B. Tungkorng	888
	1402013	B. Piko	686
	1402014	B. Adone	556
	1402016	B. Axor	185
	1402017	B. Adeu	335
	1402027	B. Sanyayone	104
	1402029	B. Toungkatai	119
	1402030	B. Thongkahai	443
	1402031	B. kamouan	368
	1402032	B. pasom	308
	1402033	B. Thoungxa	661
	1402034	B. Pitian	222
	1402035	B. Bongnam	594
	1402039	B. Padu	960
	1402043	B. Soytam	1007
	1402045	B. Chorlavieng	596
	1402049	B. Kang	572
	1402053	B. Kape	644
	1402054	B. Katen	590
	1402055	B. Paten	590
	1402060	B. Toumlykhao	509
	1402061	B. Dao	328
	1402062	B. Sing	289
	1402063	B. Sanang	456
	1402064	B. Porbeui	388
	Total	31 Villages	16,523

District	Village Code	Village Name	Population
	1408004	B. Taloung	268
	1408005	B. Taliab	316
	1408006	B. Ho	158
	1408007	B. Paluatieng	233
	1408009	B. Amen	190
	1408012	B. Lasen	190
	1408013	B. Ajahongtun	179
	1408014	B. Xe	150
	1408016	B. Tanyu	104
	1408017	B. Samouay	132
	1408020	B. Tandy	206
	1408021	B. Asao	106
	1408023	B. Pheenxe	256
	1408028	B. Taloeui	171
SAMUOI	1408029	B. Kilignai	167
	1408030	B. Amai	228
	1408036	B. Lavatai	711
	1408037	B. Lavaneua	138
	1408041	B. Lalor	111
	1408044	B. Lahang	576
	1408045	B. Tangko	618
	1408046	B. PinA	286
	1408053	B. Acheungleng	661
	1408056	B. Atouk	302
	1408057	B. Adengkoutab	255
	1408059	B. Avay	300
	1408061	B. Kaleng	399
	1408064	B. Kaboeui	153
	1408067	B. Axingneua	208
	Total	29 Villages	7,772

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 functions165 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

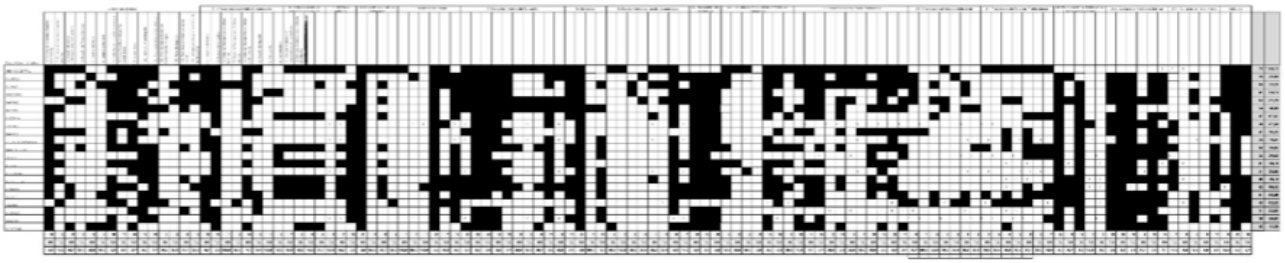


Figure 40 - Matrix of Ordered Functions (MoF) spreadsheet

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).

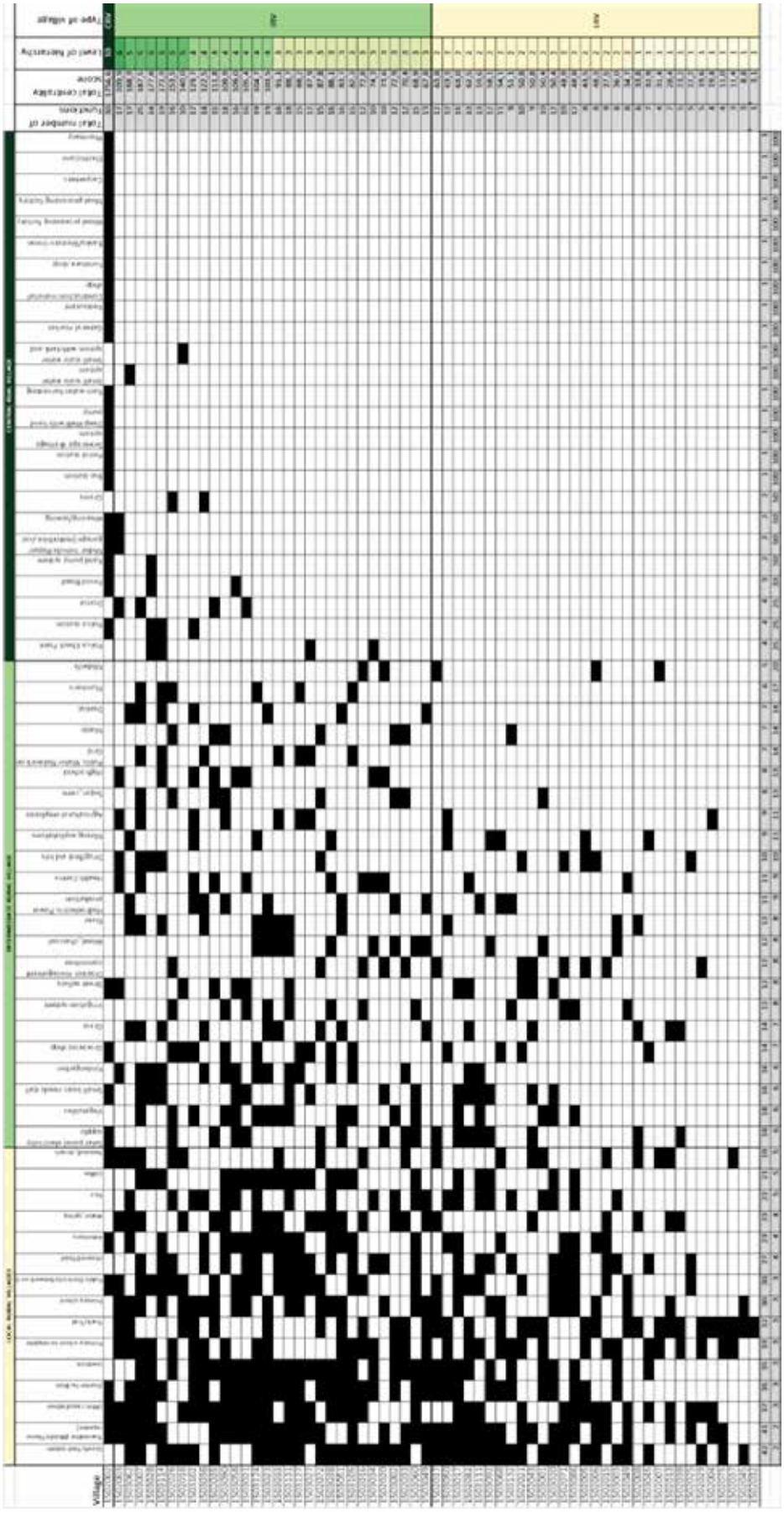
- **Functions** are sorted according to their frequency, basic functions on the left side of the matrix
- **Villages** are sorted according to their centrality score, higher values on the top of the matrix

165 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 8- 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 41 - 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 9 - 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 trasport on daily basis	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 Deep Well with a hand pump	Irrigation system	Rand pump system
SOCIO-ECONOMIC SERVICES	**Health facilities and services**		Drug/first aid kits Health Centre	Doctor Midwife
	Educational institutions	Primary school	Kindergarten High school	
	Public recreational and Cultural Facilities			Cultural Centre Playground
	DRR and Security Services	Disaster facilities Disaster management committee		Police Check Point
	Markets and Commercial Establishments	Groceries shop		Bicycle Repair garage Motor Vehicle Repair garage (motorbike /car) Restaurant Construction material shop
	Business and industrial activities			Hydroelectric Power production Mining exploitations
	Jobs/own account workers	Other casual labour	Street sellers	Veterinary Agricultural employee Agriculture (small holder/self-suficient) Carpenters
ECO-SYSTEM SERVICES	**Provisioning services**	Livestock Rice Maize Vegetables River	Sugar cane Coffee Grass Wood charcoal Seasonal stream	
Total		**16**	**22**	**21**

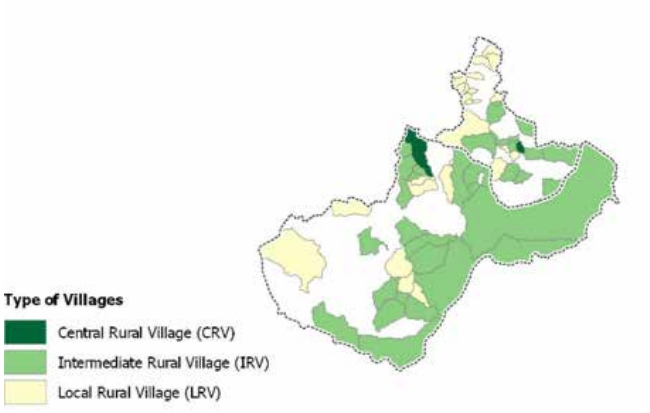


Figure 42 - Spatial distribution of the type of villages

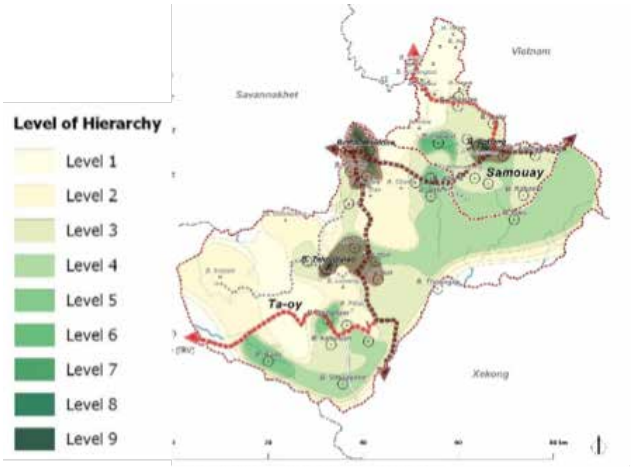


Figure 43 - Territorial linkages ans spatial structure

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:

- **Northern areas of Samuoi District show the lowest levels of socio-economic and infrastructure development. Around 60% of the selected villages in Samuoi are categorised as Local Rural Villages (LRV), mainly located in northern areas of the district against 25% in Ta Oi.**

- **Better transportation infrastructure enable better access to socio-economic services than in villages.**

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 43). From the isopleth map the spatial structure emerges. t 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 Ta Oi District is mainly centred in two villages, Tulunglalao and Pachoudone strategically located at cross-junction of main north-south transportation axis between Savannakhet and Sekong) with the provincial road to western and southern areas of the district.**

- **Samuoi District shows weaker infrastructure and socio-economic development, mainly centred on the tri-polar set of villages of Lahang, Atouk and Tangko, strategically located at cross-junction of the main west-east transportation axis between Savannakhet and Vietnam) with the provincial road towards the northern areas of the district.**

Territorial and socio-economic linkages

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 first primary Cluster in Ta Oi District centred in the village of Tulunglalao is strategically located at cross-junction of the main north-south transportation axis between Savannakhet and Sekong) with the provincial road to the western areas of the district.**

Tulunglalao is the main settlement of the district, categorised as Central Rural Village (CRV) concentrates the highest levels of physical and socio-economic development (level of hierarchy 9) of this district. Its "territorial influence" is mainly observed along the north-south road to Sekong, over the neighbouring villages of Katen, Kape and Paten, all three of them categorised as Intermediate Rural Villages (IRV), providing a range of intermediate public services and infrastructure to the surrounding rural population living in central areas of Ta Oi District.

	Name	Level	Type of village
Villages	Tulunglalao (1402002)	9	Central Rural Village (CRV)
	Katen (1402054)	4	Intermediate Rural Villages (IRV)
	Kape (1402053)	4	Intermediate Rural Villages (IRV)
	Paten (1402055)	3	Intermediate Rural Villages (IRV)
Main services provided	Infrastructure services	Mobile Phone repeater, Public Electricity Network on Grid	
	Socio-economic services	Kindergarten, Primary school Drug/first aid kits	
	Eco-system Provisioning services		
Main sources of income	Other casual labour, Hydroelectric Power production, Wood processing factory		
Main recommendations	Efforts should be made to create Vocational Trainings Centres to provide skilled people needed in the agro-industries and enhance agricultural practices at household levels		

• The second primary cluster in Ta Oi District centred in the village of Pachoudone is strategically located at cross-junction of the main west-east transportation axis between Savannakhet and the Vietnam border) with the provincial road to the southern areas of the district.

Pachoudone is the main settlement of the district, categorised as Central Rural Village (CRV) concentrates the highest levels of physical and socio-economic development (level of hierarchy 8) of this district. Its "territorial influence" is observed over the neighbouring village of Lakhab located along the west-east transportation axis towards Savannakhet Province, and through the neighbouring villages of Sanang, Paseer and Porbeui located along the primary road towards south, all categorised as Intermediate Rural Villages (IRV).

	Name	Level	Type of village
Villages	Pachoudone (1402007)	8	Central Rural Village (CRV)
	Sanang (1402063)	4	Intermediate Rural Villages (IRV)
	Paseer (1402006)	3	Intermediate Rural Villages (IRV)
	Lakhab (1402005)	3	Intermediate Rural Villages (IRV)
	Porbeui (1402064)	3	Intermediate Rural Villages (IRV)
Main infrastructure and public services provided	Infrastructure service	Mobile Phone repeater, Public Electricity Network on Grid, Water gravity feed systems, Deep Well with hand pump, Irrigation	
	Socio-economic services	Kindergarten, Primary school, High school Drug/first aid kits, Health Centre	
	Eco-system Provisioning services	Rice, Maize and Coffee	
Main sources of income	Agriculture (small-holder/self-sufficient), Street sellers, Veterinary, Carpenters, Other casual labour		
Main recommendations	Enhance road infrastructure and transport services to/from northern areas of the district		

• The primary cluster in Samuoi District is centred in the village of Lahang, strategically located at cross-junction of the main west-east transportation axis between Savannakhet and the Vietnam border with the provincial road towards the northern areas of the district.

Lahang is the main settlement of the district, categorised as Central Rural Village (CRV) concentrates the highest levels of physical and socio-economic development (level of hierarchy 8) of this district. Its "territorial influence" is observed over the neighbouring village of Atouk located along the west-east axe of transportation towards Vietnam, and over the neighbouring village of Tangko located along the primary road towards north, all categorised as Intermediate Rural Villages (IRV).

	Name	Level	Type of village
Villages	Lahang (1408044)	8	Central Rural Village (CRV)
	Tangko (1408045)	5	Intermediate Rural Villages (IRV)
	Atouk (1408056)	4	Intermediate Rural Villages (IRV)
Main infrastructure and public services provided	Infrastructure service	Mobile Phone repeater, Public Electricity Network on Grid, Water gravity feed systems, Deep Well with hand pump, Irrigation system	
	Socio-economic services	Kindergarten, Primary school, High school	
	Eco-system Provisioning services	Rice, Maize and Coffee	
Main sources of income	Agriculture (small-holder/self-sufficient), Carpenters, Other casual labour		
Main recommendations	Enhance road infrastructure and transport services to/from northern areas of the district		

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[166] and adjusted to fit the context of the vulnerability assessment in Saravan, Sekong, and Attapeu and to utilise the data available.

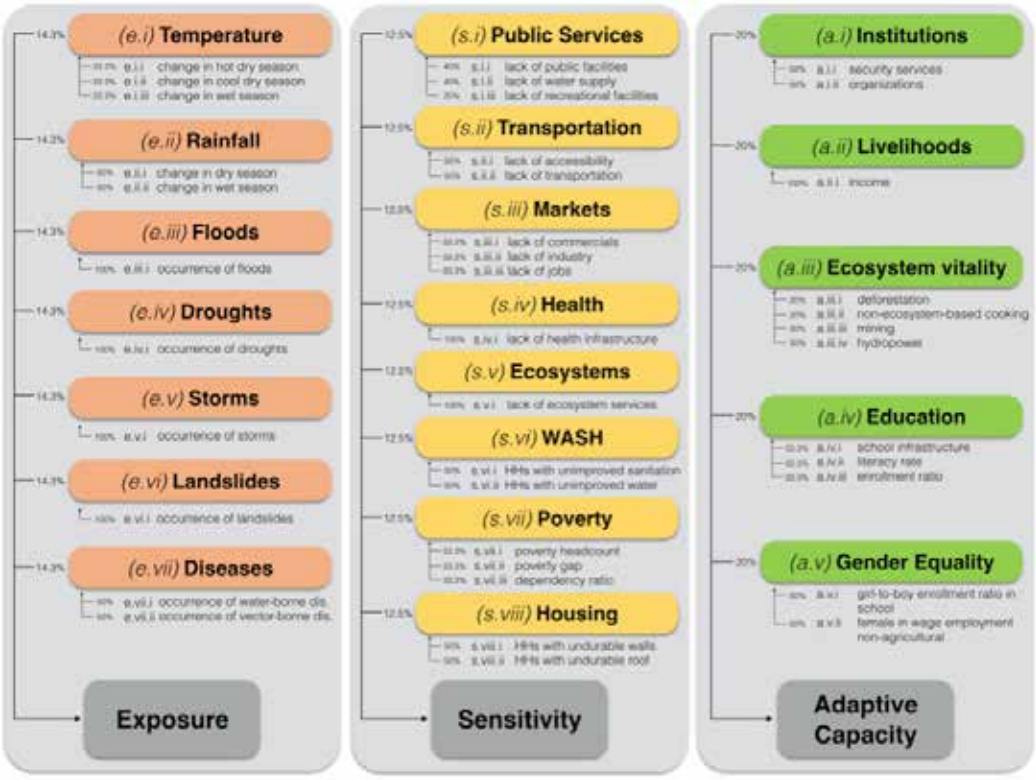


Figure 44 - an overview of vulnerability index indicators, including weight for Exposure calculation

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

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

- **Disease**
  - Occurrence of water-borne disease
  - Occurrence of vector-borne disease

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 (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_rain y 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 45 - an overview of the determination of exposure and its indicators

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); intervall: 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); intervall: 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); intervall: 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); intervall: 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); intervall: 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); intervall: 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 46 - an overview on 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 47 - an overview of 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 48 - 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.

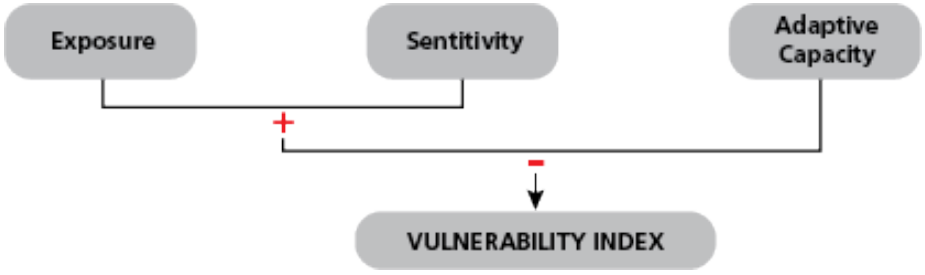


Figure 49 - an overview of vulnerability calculation based on the afore determined elements

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.

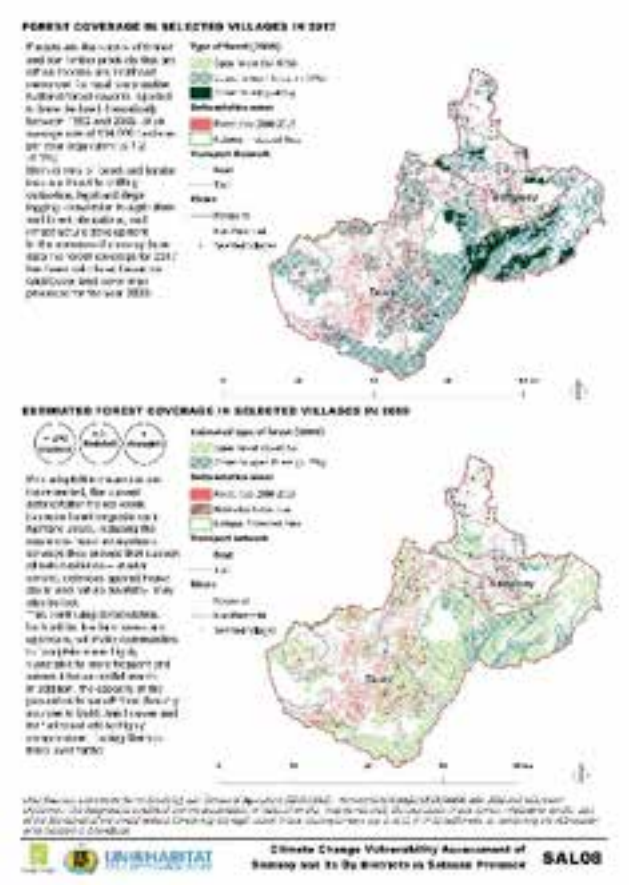
Assumptions

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[167] (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.



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

Calculations

District	VCODE	Type of Forest 2017	Estimated type of forest 2050	Area (Ha)
Ta Oi	1402002	Closed to open forest (>15%)	Open forest (15-40%)	3.00
	1402004	Closed forest (>40%)	Closed to open forest (>15%)	6,00
	1402004	Closed to open forest (>15%)	Open forest (15-40%)	2,779.00
	1402005	Closed to open forest (>15%)	Open forest (15-40%)	901.00
	1402006	Closed to open forest (>15%)	Open forest (15-40%)	1,529.00
	1402007	Closed forest (>40%)	Closed to open forest (>15%)	13.00
	1402007	Closed to open forest (>15%)	Open forest (15-40%)	2,248.00
	1402007	Open forest (15-40%)	No forest	3.00
	1402011	Closed forest (>40%)	Closed to open forest (>15%)	577.00
	1402011	Closed to open forest (>15%)	Open forest (15-40%)	763.00
	1402012	Closed forest (>40%)	Closed to open forest (>15%)	700.00
	1402012	Closed to open forest (>15%)	Open forest (15-40%)	2,325.00
	1402013	Closed forest (>40%)	Closed to open forest (>15%)	10,159.00
	1402013	Closed to open forest (>15%)	Open forest (15-40%)	24,238.00
	1402014	Closed to open forest (>15%)	Open forest (15-40%)	262.00
	1402016	Closed forest (>40%)	Closed to open forest (>15%)	6.00
	1402016	Closed to open forest (>15%)	Open forest (15-40%)	240.00
	1402017	Closed to open forest (>15%)	Open forest (15-40%)	1,049.00
	1402027	Closed forest (>40%)	Closed to open forest (>15%)	95.00
	1402027	Closed to open forest (>15%)	Open forest (15-40%)	10,521.00
	1402029	Closed forest (>40%)	Closed to open forest (>15%)	32.00
	1402029	Closed to open forest (>15%)	Open forest (15-40%)	1,206.00
	1402030	Closed forest (>40%)	Closed to open forest (>15%)	286.00
	1402030	Closed to open forest (>15%)	Open forest (15-40%)	2,553.00
	1402031	Closed to open forest (>15%)	Open forest (15-40%)	2,733.00
	1402032	Closed to open forest (>15%)	Open forest (15-40%)	570.00
	1402033	Closed forest (>40%)	Closed to open forest (>15%)	3,358.00
	1402033	Closed to open forest (>15%)	Open forest (15-40%)	18,631.00
	1402034	Closed to open forest (>15%)	Open forest (15-40%)	1,380.00
	1402035	Closed to open forest (>15%)	Open forest (15-40%)	2,582.00
	1402039	Closed forest (>40%)	Closed to open forest (>15%)	0.00
	1402039	Closed to open forest (>15%)	Open forest (15-40%)	5,309.00
	1402043	Closed to open forest (>15%)	Open forest (15-40%)	8,263.00
	1402043	Open forest (15-40%)	No forest	39.00
	1402045	Closed forest (>40%)	Closed to open forest (>15%)	48.00
	1402045	Closed to open forest (>15%)	Open forest (15-40%)	2,799.00
	1402049	Closed to open forest (>15%)	Open forest (15-40%)	1,681.00
	1402053	Closed forest (>40%)	Closed to open forest (>15%)	48.00
	1402053	Closed to open forest (>15%)	Open forest (15-40%)	1,609.00
	1402054	Closed forest (>40%)	Closed to open forest (>15%)	15.00
	1402054	Closed to open forest (>15%)	Open forest (15-40%)	2,851.00
	1402055	Closed forest (>40%)	Closed to open forest (>15%)	201.00
	1402055	Closed to open forest (>15%)	Open forest (15-40%)	3,557.00

	1402060	Closed to open forest (>15%)	Open forest (15-40%)	1,128.00
	1402061	Closed to open forest (>15%)	Open forest (15-40%)	1,158.00
	1402062	Closed to open forest (>15%)	Open forest (15-40%)	520.00
	1402063	Closed to open forest (>15%)	Open forest (15-40%)	266.00
	1402064	Closed to open forest (>15%)	Open forest (15-40%)	453.00
Samuoi	1408005	Closed to open forest (>15%)	Open forest (15-40%)	684.00
	1408006	Closed forest (>40%)	Closed to open forest (>15%)	176.00
	1408006	Closed to open forest (>15%)	Open forest (15-40%)	402.00
	1408007	Closed forest (>40%)	Closed to open forest (>15%)	11.00
	1408007	Closed to open forest (>15%)	Open forest (15-40%)	364.00
	1408009	Closed forest (>40%)	Closed to open forest (>15%)	35.00
	1408009	Closed to open forest (>15%)	Open forest (15-40%)	71.00
	1408012	Closed to open forest (>15%)	Open forest (15-40%)	44.00
	1408013	Closed forest (>40%)	Closed to open forest (>15%)	83.00
	1408013	Closed to open forest (>15%)	Open forest (15-40%)	134.00
	1408014	Closed to open forest (>15%)	Open forest (15-40%)	182.00
	1408016	Closed to open forest (>15%)	Open forest (15-40%)	147.00
	1408017	Closed forest (>40%)	Closed to open forest (>15%)	9.00
	1408017	Closed to open forest (>15%)	Open forest (15-40%)	81.00
	1408021	Closed to open forest (>15%)	Open forest (15-40%)	102.00
	1408023	Closed forest (>40%)	Closed to open forest (>15%)	15.00
	1408023	Closed to open forest (>15%)	Open forest (15-40%)	574.00
	1408028	Closed to open forest (>15%)	Open forest (15-40%)	116.00
	1408029	Closed to open forest (>15%)	Open forest (15-40%)	9.00
	1408030	Closed forest (>40%)	Closed to open forest (>15%)	1,295.00
	1408030	Closed to open forest (>15%)	Open forest (15-40%)	3,200.00
	1408036	Closed forest (>40%)	Closed to open forest (>15%)	51.00
	1408036	Closed to open forest (>15%)	Open forest (15-40%)	1,341.00
	1408037	Closed to open forest (>15%)	Open forest (15-40%)	205.00
	1408041	Closed forest (>40%)	Closed to open forest (>15%)	215.00
	1408041	Closed to open forest (>15%)	Open forest (15-40%)	652.00
	1408044	Closed to open forest (>15%)	Open forest (15-40%)	172.00
	1408045	Closed to open forest (>15%)	Open forest (15-40%)	206.00
	1408046	Closed to open forest (>15%)	Open forest (15-40%)	50.00
	1408053	Closed to open forest (>15%)	Open forest (15-40%)	210.00
	1408056	Closed forest (>40%)	Closed to open forest (>15%)	500.00
	1408056	Closed to open forest (>15%)	Open forest (15-40%)	140.00
	1408057	Closed forest (>40%)	Closed to open forest (>15%)	444.00
	1408057	Closed to open forest (>15%)	Open forest (15-40%)	1,766.00
	1408059	Closed forest (>40%)	Closed to open forest (>15%)	6.00
	1408059	Closed to open forest (>15%)	Open forest (15-40%)	588.00
	1408061	Closed forest (>40%)	Closed to open forest (>15%)	23.00
	1408061	Closed to open forest (>15%)	Open forest (15-40%)	357.00
	1408064	Closed forest (>40%)	Closed to open forest (>15%)	298.00
	1408064	Closed to open forest (>15%)	Open forest (15-40%)	539.00
	1408067	Closed to open forest (>15%)	Open forest (15-40%)	135.00

Access to freshwater for drinking use by 2050

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

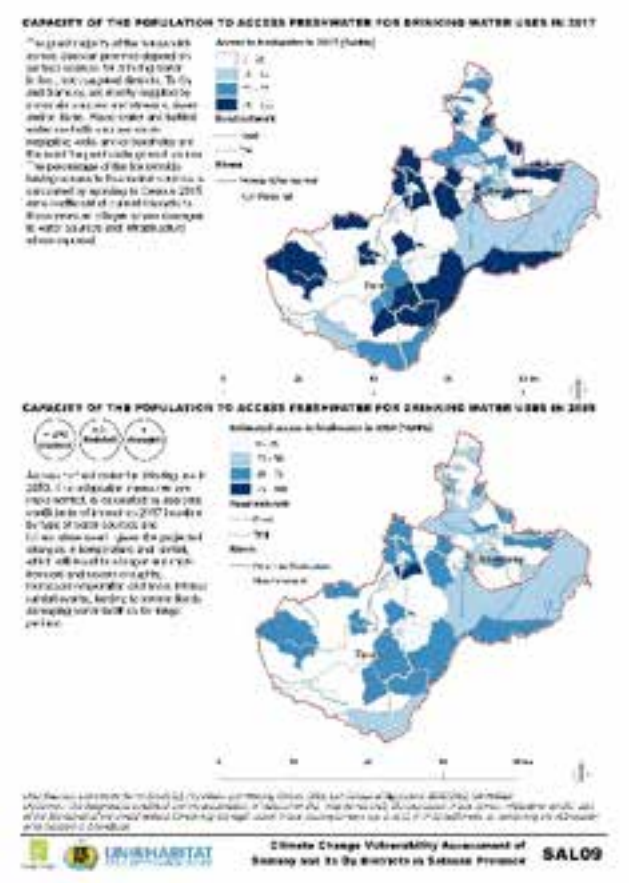
Calculations

(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 (% HHs)								(iii)	(v)
		a	b	c	d	e	f	g	h		
Ta Oi	1402002	18	36	0	45	0	0	0	0	31.59	22.97
	1402004	78	0	0	22	0	0	0	0	67.40	56.17
	1402005	0	0	0	44	56	0	0	0	100.00	65.56
	1402006	0	0	25	0	75	0	0	0	100.00	70.00
	1402007	0	20	67	13	0	0	0	0	100.00	70.67
	1402011	0	33	7	7	53	0	0	0	100.00	72.67
	1402012	0	0	0	33	67	0	0	0	100.00	66.67
	1402013	0	50	33	0	17	0	0	0	41.60	31.20
	1402014	0	0	0	0	100	0	0	0	100.00	70.00
	1402016	0	0	0	100	0	0	0	0	19.80	11.88
	1402017	0	0	0	0	100	0	0	0	14.85	10.40
	1402027	0	0	0	100	0	0	0	0	60.00	36.00
	1402029	0	0	0	100	0	0	0	0	100.00	60.00
	1402030	0	0	0	0	100	0	0	0	100.00	70.00
	1402031	0	0	0	67	33	0	0	0	100.00	63.33
	1402032	0	0	0	0	100	0	0	0	100.00	70.00
	1402033	0	0	0	71	29	0	0	0	100.00	62.86
	1402034	0	0	0	100	0	0	0	0	100.00	60.00
	1402035	0	73	0	27	0	0	0	0	74.55	55.57
	1402039	0	53	29	12	0	0	6	0	28.47	21.43
	1402043	0	50	0	50	0	0	0	0	100.00	70.00
	1402045	0	0	11	0	89	0	0	0	100.00	70.00
	1402049	0	11	0	89	0	0	0	0	100.00	62.22
	1402053	0	0	0	0	100	0	0	0	100.00	70.00
	1402054	0	0	0	0	100	0	0	0	14.85	10.40
	1402055	0	0	0	43	57	0	0	0	11.29	7.42
	1402060	0	63	0	38	0	0	0	0	24.23	17.57
	1402061	0	100	0	0	0	0	0	0	100.00	80.00
	1402062	0	0	0	0	100	0	0	0	100.00	70.00
	1402063	0	57	0	43	0	0	0	0	29.56	21.11
	1402064	0	0	0	100	0	0	0	0	6.53	3.92
Samuoi	1408004	0	0	0	0	100	0	0	0	50.00	35.00
	1408005	0	0	0	40	60	0	0	0	34.92	23.05
	1408006	0	0	0	100	0	0	0	0	60.00	36.00
	1408007	0	0	0	100	0	0	0	0	60.00	36.00
	1408009	0	0	0	100	0	0	0	0	60.00	36.00
	1408012	0	0	0	100	0	0	0	0	60.00	36.00
	1408013	0	0	0	0	100	0	0	0	50.00	35.00
	1408014	0	0	0	100	0	0	0	0	6.53	3.92
	1408016	0	0	0	100	0	0	0	0	60.00	36.00
	1408017	0	0	0	100	0	0	0	0	60.00	36.00
	1408020	0	0	0	100	0	0	0	0	100.00	60.00
	1408021	0	0	0	100	0	0	0	0	100.00	60.00
	1408023	0	0	0	75	25	0	0	0	57.50	35.94

	1408028	0	0	0	0	100	0	0	0	100.00	70.00
	1408029	0	0	0	100	0	0	0	0	60.00	36.00
	1408030	0	0	25	75	0	0	0	0	62.50	39.06
	1408036	0	50	0	13	38	0	0	0	45.75	33.74
	1408037	0	100	0	0	0	0	0	0	66.00	52.80
	1408041	0	0	0	0	100	0	0	0	100.00	70.00
	1408044	0	0	0	0	100	0	0	0	33.00	23.10
	1408045	0	0	0	10	90	0	0	0	51.00	35.19
	1408046	0	0	0	100	0	0	0	0	19.80	11.88
	1408053	0	44	22	33	0	0	0	0	55.00	39.11
	1408056	0	0	0	17	83	0	0	0	100.00	68.33
	1408057	0	0	0	40	60	0	0	0	100.00	66.00
	1408059	0	14	0	0	86	0	0	0	46.11	32.94
	1408061	0	0	13	0	88	0	0	0	100.00	70.00
	1408064	0	0	0	0	100	0	0	0	50.00	35.00
	1408067	0	0	0	0	100	0	0	0	29.70	20.79

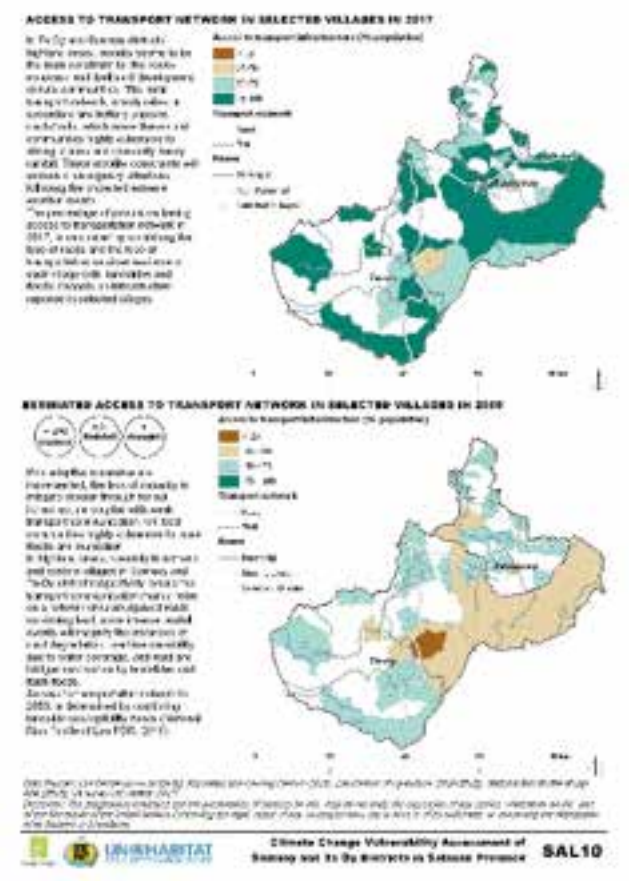
Water sources and systems: a) piped water; b) protected well/borehole; c) unprotected borehole; d) river/stream/dam; e) mountain water. f) Rain water; g) Bottled/Canned; h) Tank

Access to transportation services by 2050

In Ta Oi and Samuoi 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 Ta Oi and Samuoi are accessible only by trails/tracks or unpaved gravel roadsVery few have access to paved roads.

Communities report important storm and flood's impacts on infrastructure. Indeed, 81 per cent and 50 per cent of the selected villages pointed damages in the community's infrastructures due to storms and floods, respectively.



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)
Ta Oi	1402002	827	0.9	90	0.90	0.90	0.90	66
	1402004	643	0.75	75	0.75	0.90	0.90	46
	1402005	473	0.9	90	0.90	0.90	0.90	66
	1402006	430	0.9	90	0.90	0.90	0.90	66
	1402007	1003	0.75	75	0.90	0.90	0.90	55
	1402011	761	0.9	90	0.90	0.90	0.90	66
	1402012	888	0.9	90	0.50	0.90	0.90	36
	1402013	686	0.9	90	0.50	0.90	0.90	36
	1402014	556	0.9	90	0.90	0.90	0.90	66
	1402016	185	0.9	90	0.90	0.90	0.90	66
	1402017	335	0.9	90	0.90	0.90	0.90	66
	1402027	104	0.9	90	0.75	0.90	0.90	55
	1402029	119	0.9	90	0.90	0.90	0.90	66
	1402030	443	0.9	90	0.75	0.90	0.90	55
	1402031	368	0.75	75	0.90	0.90	0.90	55
	1402032	308	0.9	90	0.90	0.90	0.90	66
	1402033	661	0.75	75	0.50	0.90	0.90	30
	1402034	222	0.9	90	0.75	0.90	0.90	55
	1402035	594	0.75	75	0.90	0.90	0.90	55
	1402039	960	0.9	90	0.75	0.90	0.90	55
	1402043	1007	0.9	90	0.90	0.90	0.90	66

	1402045	596	0.9	90	0.90	0.90	0.90	66
	1402049	572	0.9	90	0.50	0.90	0.90	36
	1402053	644	0.9	90	0.90	0.90	0.90	66
	1402054	590	0.9	90	0.50	0.90	0.90	36
	1402055	590	0.5	50	0.50	0.90	0.90	20
	1402060	509	0.9	90	0.90	0.90	0.90	66
	1402061	328	0.9	90	0.90	0.90	0.90	66
	1402062	289	0.9	90	0.90	0.90	0.90	66
	1402063	456	0.9	90	0.90	0.90	0.90	66
	1402064	388	0.9	90	0.90	0.90	0.90	66
Samuoi	1408004	268	0.9	90	0.90	0.90	0.90	66
	1408005	316	0.9	90	0.90	0.90	0.90	66
	1408006	158	0.75	75	0.90	0.90	0.90	55
	1408007	233	0.75	75	0.90	0.90	0.90	55
	1408009	190	0.75	75	0.90	0.90	0.90	55
	1408012	190	0.9	90	0.90	0.90	0.90	66
	1408013	179	0.75	75	0.90	0.90	0.90	55
	1408014	150	0.9	90	0.90	0.90	0.90	66
	1408016	104	0.9	90	0.90	0.90	0.90	66
	1408017	132	0.75	75	0.90	0.90	0.90	55
	1408020	206	0.9	90	0.90	0.90	0.90	66
	1408021	106	0.9	90	0.90	0.90	0.90	66
	1408023	256	0.9	90	0.90	0.90	0.90	66
	1408028	171	0.75	75	0.90	0.90	0.90	55
	1408029	167	0.75	75	0.90	0.90	0.90	55
	1408030	228	0.75	75	0.75	0.90	0.90	46
	1408036	711	0.9	90	0.90	0.90	0.90	66
	1408037	138	0.9	90	0.90	0.90	0.90	66
	1408041	111	0.9	90	0.90	0.90	0.90	66
	1408044	576	0.9	90	0.90	0.90	0.90	66
	1408045	618	0.75	75	0.90	0.90	0.90	55
	1408046	286	0.75	75	0.90	0.90	0.90	55
	1408053	661	0.9	90	0.90	0.90	0.90	66
	1408056	302	0.9	90	0.90	0.90	0.90	66
	1408057	255	0.9	90	0.90	0.90	0.90	66
	1408059	300	0.75	75	0.90	0.90	0.90	55
	1408061	399	0.5	50	0.90	0.90	0.90	36
	1408064	153	0.75	75	0.90	0.90	0.90	55
	1408067	208	0.9	90	0.90	0.90	0.90	66

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