Enhancing Health
Infrastructure Resilience

A MULTI-HAZARD RISK ASSESSMENT OF HEALTH FACILITIES IN LAO PDR

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UN-Habitat: Enhancing Health Infrastructure Resilience: A Multi-hazard Risk Assessment of Health Facilities in Lao PDR

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Acronyms and Abbreviations

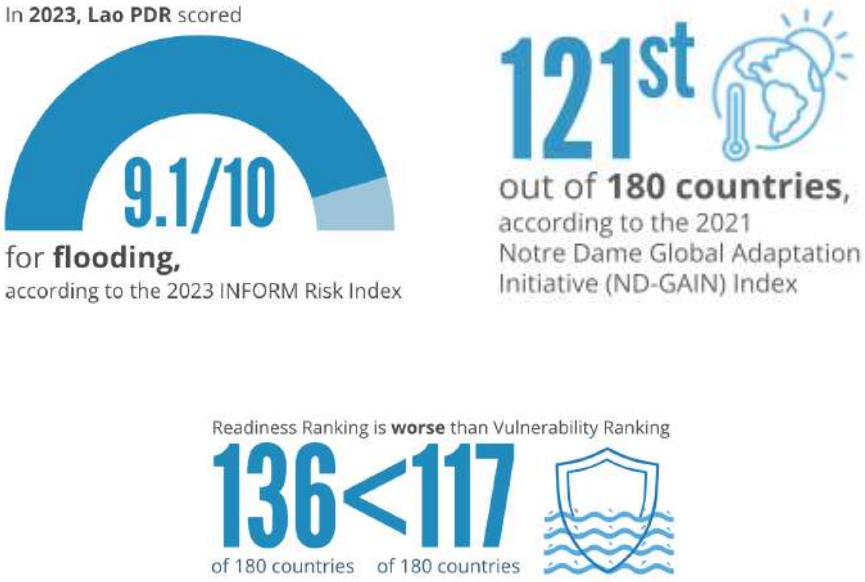
DCDC	Department of Communicable Disease Control
DHHP	Department of Hygiene and Health Promotion
DHO	District Health Office
DHP	Department of Health Personnel
DHR	Department of Healthcare and Rehabilitation
DPC	Department of Planning and Cooperation
DPF	Department of Planning and Finance
FDD	Food and Drug Department
HEPR	Health Emergency Preparedness and Response
IDA	International Development Association
INFORM	Index for Risk Management
Lao PDR	Lao People's Democratic Republic
MOH	Ministry of Health
ND-GAIN	Notre Dame Global Adaptation Initiative
PHO	Provincial Health Office
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Programme
UN-Habitat	United Nations Human Settlements Programme
UNICEF	United Nations Children's Fund
WHO	World Health Organisation

01 Background

Lao PDR is significantly exposed to climate and disaster risks, including floods and droughts. The country's vulnerability is high, and its readiness for climate resilience is low, ranking 121st out of 180 countries according to the 2021 ND-GAIN index. Flooding poses a severe problem, with Lao PDR scoring 9.1 out of 10 for flooding in the 2023 INFORM Risk Index, the 6th highest globally. Major flooding events in recent years have highlighted the critical need for resilient health infrastructure, especially considering the COVID-19 pandemic.

Lao PDR's geographic location and climatic conditions make it particularly susceptible to various natural hazards. The country's extensive river systems and seasonal monsoon rains contribute to frequent flooding. The topography, with its mix of lowland and highland areas, also results in varying susceptibility to other hazards such as droughts, landslides, and storms. This vulnerability is compounded by the country's limited infrastructure and resources, which hinder effective disaster response and recovery efforts.

In recent years, the increasing frequency and intensity of climate-related events have underscored the need for comprehensive risk assessments and resilient infrastructure.



02 Scope of Assessment

The assessment analyzes the exposure and vulnerability of approximately 1250 key public health facilities in Lao PDR, including central hospitals, provincial hospitals, community hospitals, and health centers. It involves conducting multi-hazard assessments for health facilities and related critical service provision in current and future climates, consolidating data into a centralized geospatial asset management database, and developing technical reports in Lao and English.

This comprehensive assessment aims to provide a detailed understanding of the risks posed by natural hazards to health facilities and critical infrastructure. By evaluating the exposure and vulnerability of these facilities, the assessment seeks to identify critical areas of concern and prioritize interventions to enhance resilience. The ultimate goal is to ensure that health facilities can continue providing essential services during and after disaster events, safeguarding public health and well-being.

The scope of the assessment extends beyond the immediate impact of natural hazards to consider the broader implications for health service delivery. This includes analyzing the potential for service disruptions, the interdependencies between health facilities and critical infrastructure, and the cascading consequences of infrastructure failures. By adopting a holistic approach, the assessment aims to provide actionable insights for policymakers, planners, and practitioners involved in disaster risk management and health system strengthening.

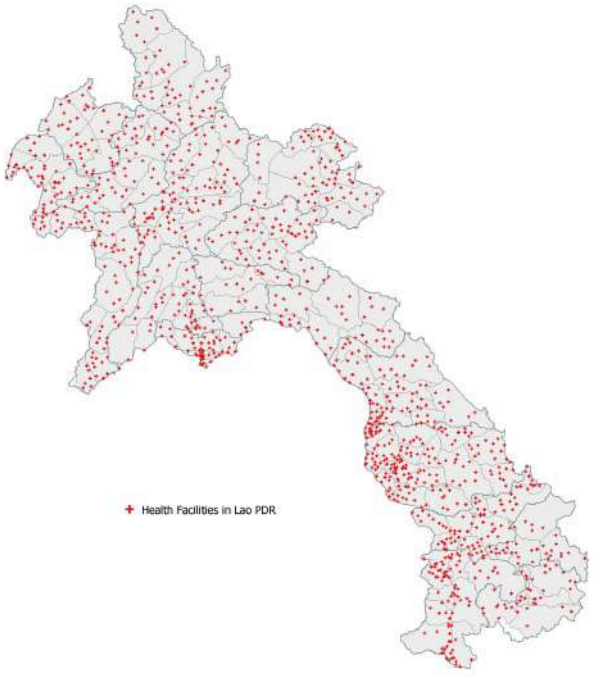


Figure 1: *Map of health facilities in Lao PDR*

03 Methodology

3.1 Exposure and Vulnerability Analysis

The assessment employed a dual approach combining paper-based questionnaires at the district level with digital transformation at the provincial level using the Kobo Toolbox. This method ensured efficient data collection, monitoring, and accountability across administrative levels. Data was collected using paper questionnaires at the district level and then digitized at the provincial level. The data collection involved district health office (DHO) staff and provincial health office (PHO) focal points, with coordination and supervision from the national level.

The data collection process was designed to be thorough and inclusive, capturing a wide range of information related to health facilities' exposure and vulnerability. The paper-based questionnaires used at the district level were developed with relevant stakeholders, including the Ministry of Health (MOH) and the World Bank. These questionnaires were designed to capture detailed information on the occurrence, frequency, and severity of various hazards and their impact on health facilities and critical services.

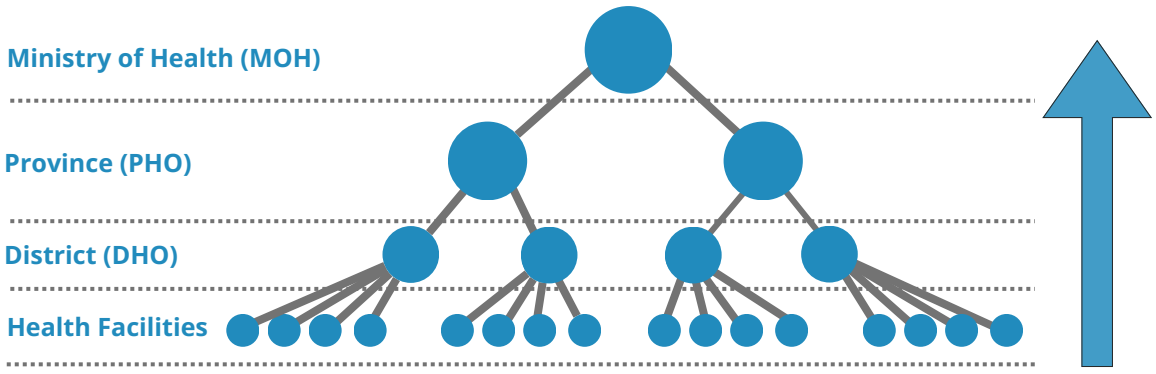


Figure 2: *Data collection and aggregation pathway from health centres to national level.*

The collected data was digitized at the provincial level using Kobo Toolbox, an open-source data collection platform. This platform enabled the aggregation of district-level data into a centralized database, ensuring organized and easily accessible information. Kobo Toolbox also provided data validation and quality control checks, enhancing the accuracy and reliability of the collected data.

Comprehensive training and capacity-building activities for DHO and PHO staff supported the data collection process. These activities ensured that staff were well-equipped to collect and manage data effectively, thereby enhancing the overall quality of the assessment.

3.2 Data Management

The data collected was managed using Kobo Toolbox, an open-source data collection platform. The platform enabled the aggregation of district-level data into a centralized database, ensuring organized and easily accessible information. The data underwent comprehensive SPSS software analysis, integrating hazard risk assessment with critical infrastructure service data to identify high-risk facilities. Spatial analysis using ArcGIS Pro was also conducted to enhance understanding of geographic trends in facility vulnerability.

The data management process involved several key steps: data entry, validation, analysis, and visualization. The digitized data was entered into the Kobo Toolbox platform, subject to validation checks to ensure accuracy and completeness. This validated data was then analyzed using SPSS software, which provided a robust framework for statistical analysis.

The analysis involved integrating hazard risk assessment data with critical infrastructure service data to identify high-risk facilities. This integration allowed for a comprehensive understanding of the vulnerabilities faced by health facilities, considering both the direct impact of hazards and the indirect effects of infrastructure failures.

Spatial analysis using ArcGIS Pro enhanced the understanding of geographic trends in facility vulnerability. This analysis provided valuable insights into the spatial distribution of hazards and vulnerabilities, helping identify areas requiring targeted interventions.

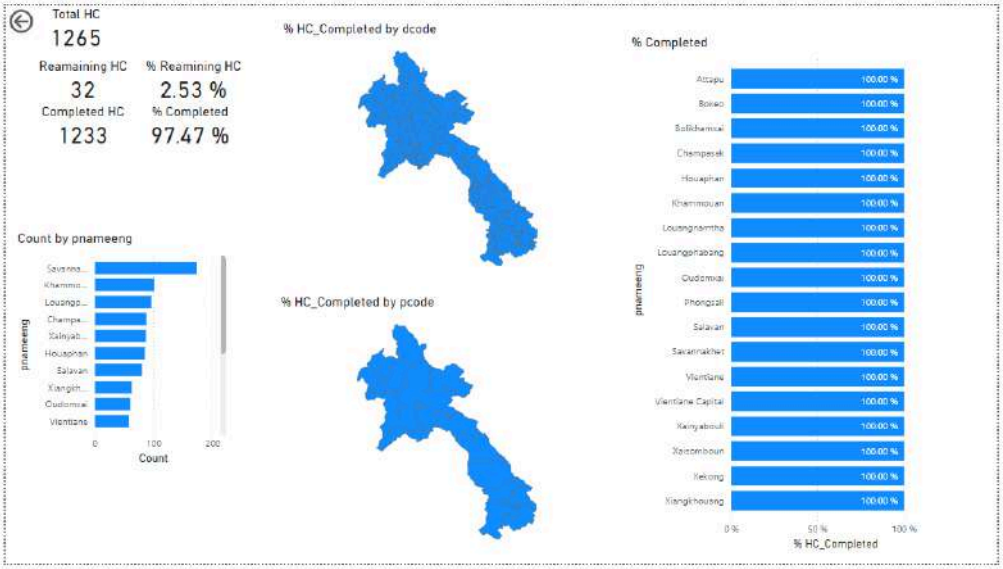


Figure 3: *Dashboard designed for monitoring data collection across the country*

3.3 Data Analysis: Periodicity, Frequency, and Severity

The assessment of vulnerabilities involved analysing the periodicity, frequency, and severity of hazards affecting health facilities. These factors were categorised and weighted to calculate the Individual Hazard Vulnerability Index and the Multi-Hazard Vulnerability Score. Periodicity indicates the regularity of hazard occurrences, severity measures the intensity of impact, and frequency assesses changes in the occurrence pattern of hazards over time.

- **Periodicity** was categorised into four levels: '1 every ten years,' '1 every 3-5 years,' '1 per year,' and 'More than 1 per year.' This categorisation helped identify the regularity and predictability of hazards, enabling better planning and preparedness. Understanding the periodicity of hazards allowed for allocating resources and implementing mitigation strategies proportionate to the frequency of these events.

- **Severity** was classified into three categories: 'less severe,' 'not changing,' and 'more severe.' This classification provided insights into each hazard's intensity and potential damage, guiding prioritisation and response efforts. Hazards classified as 'more severe' posed significant risks and required more substantial mitigation measures.

- **Frequency** was categorised as 'less frequent,' 'not changing,' and 'more frequent.' This categorisation helped identify changes in the occurrence patterns of hazards over time, providing essential information for long-term planning and adaptation strategies. By understanding how the frequency of hazards changes, decision-makers can develop more effective strategies to manage these risks.

The combination of periodicity, severity, and frequency provided a comprehensive understanding of the risks associated with climate hazards. These factors were used to calculate the Individual Hazard Vulnerability Index, which captured the complex interplay between these risk factors and their impact on vulnerability. The Multi-Hazard Vulnerability Score provided a balanced composite score reflecting the overall risk profile of health facilities against multiple climate hazards.

04 National-Level Findings

4.1 Prevalence of Hazard Impact

The national-level findings indicate substantial impact of climate hazards on health facilities across Lao PDR. Storms and floods affect over 40% of health facilities, while droughts impact approximately 39%. Landslides and wildfires also pose significant challenges, affecting 28% and 23% of health facilities.

The prevalence of hazard impact highlights the multi-layered vulnerabilities facing health facilities in Lao PDR. Each hazard has broader implications, affecting the health facilities and communities that rely on them. The quantitative data provides a clear picture of climate hazards' widespread and varied impact on the health sector.

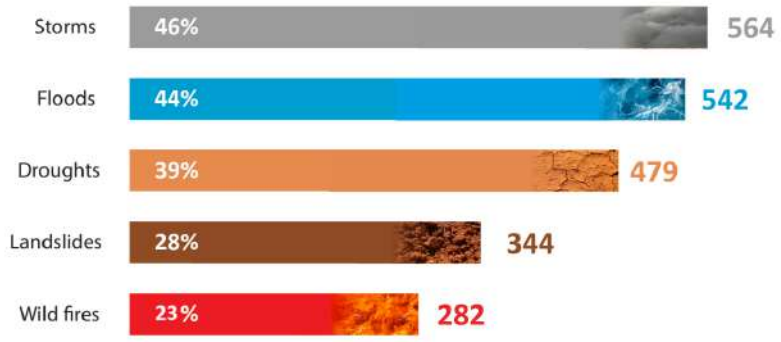


Figure 4: *Percentage of health facilities affected by each hazard*

4.2 Change in Frequency and Severity

The data shows an increase in the frequency of hazards, particularly droughts, storms, and landslides. Severe changes are also notable, with storms increasing the most in severity, followed by droughts, floods, landslides, and wildfires.

Aggregated data reveals that many hazards have increased frequently, aligning with trends observed due to climate change. This increase in frequency poses additional challenges for health facilities, requiring more frequent and robust preparedness measures.

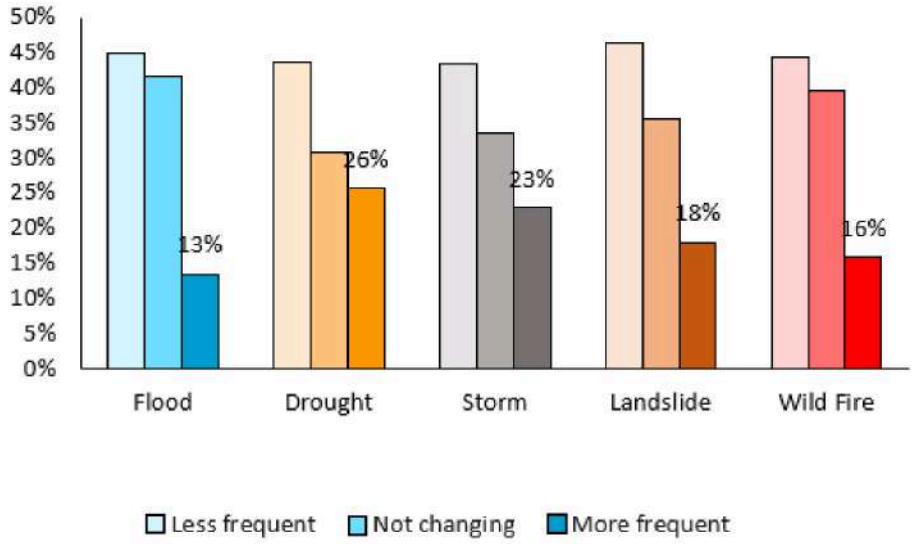


Figure 5: *Change in frequency of each hazard nationally, as a percentage of health facilities*

Changes in severity were more pronounced than changes in frequency. Overall, a substantial portion of hazards increased in severity, highlighting the growing intensity of climate-related events. This increase in severity underscores the need for enhanced resilience measures to protect health facilities and ensure the continued provision of essential services.

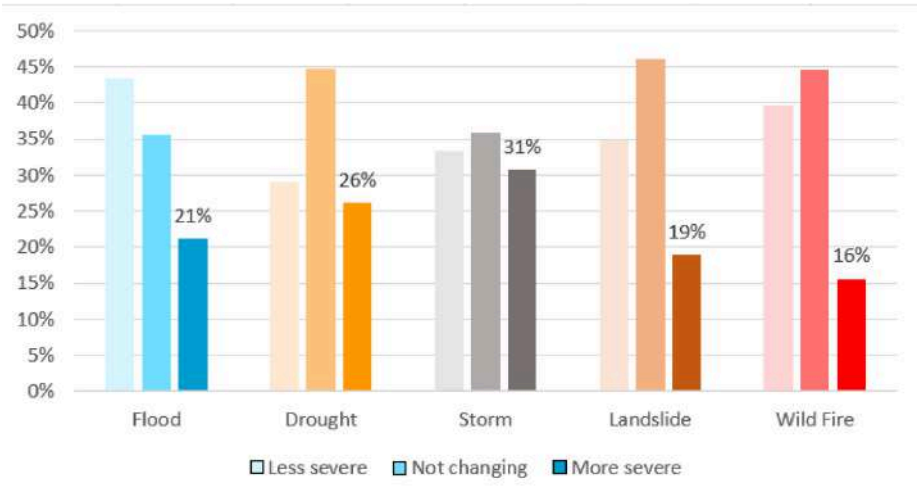


Figure 6: *Changes in severity at the national level, shown as percentage of health facilities*

4.3 Vulnerability at the National Level

As previously explained, the data on each of the hazards was combined according to a specified formula to show their vulnerability. Overall, 5% of the health facilities are shown to be extremely vulnerable to hazards. Storms create the highest vulnerability, followed by droughts and landslides. The data highlights the critical need for resilient water supply and sanitation facilities to address the vulnerabilities posed by these hazards.

The vulnerability analysis provides a nuanced understanding of the risks faced by health facilities. By identifying the facilities that are most vulnerable to specific hazards, the assessment enables targeted interventions to enhance resilience. The high vulnerability of facilities to storms, droughts, and landslides indicates the need for comprehensive risk management strategies that address these specific hazards.

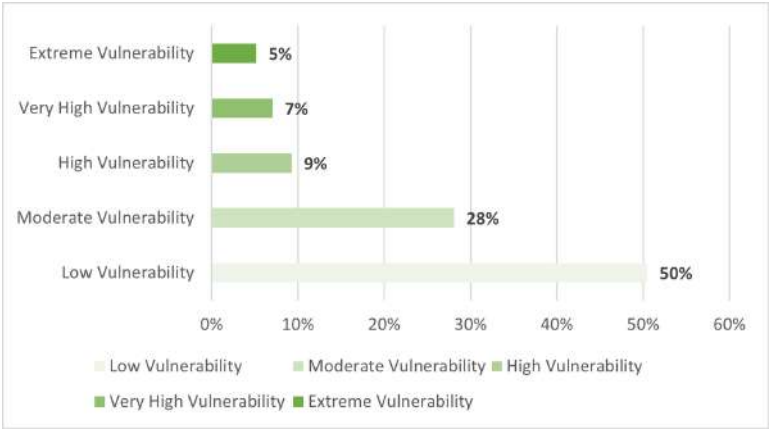


Figure 7: *Level of vulnerability shown by percentage of health facilities*

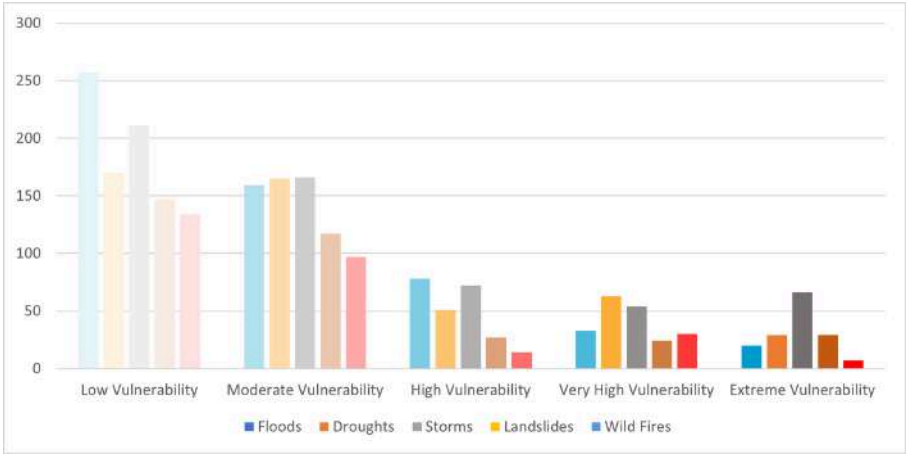


Figure 8: *Level of vulnerability to each hazard, shown as percentage of health facilities*

05 Provincial-Level Findings

5.1 Occurrence of Floods

Savannakhet has the highest number of flood-impacted health facilities, with nearly 7% affected. Khammouane and Huaphanh have the highest flooding rates, with 71% of their health facilities impacted.

Floods are a significant hazard affecting health facilities across Lao PDR. The provincial-level findings provide detailed insights into the specific impact of flooding in different provinces. By analyzing the prevalence and impact of floods, the assessment identifies critical areas where interventions are needed to enhance resilience.

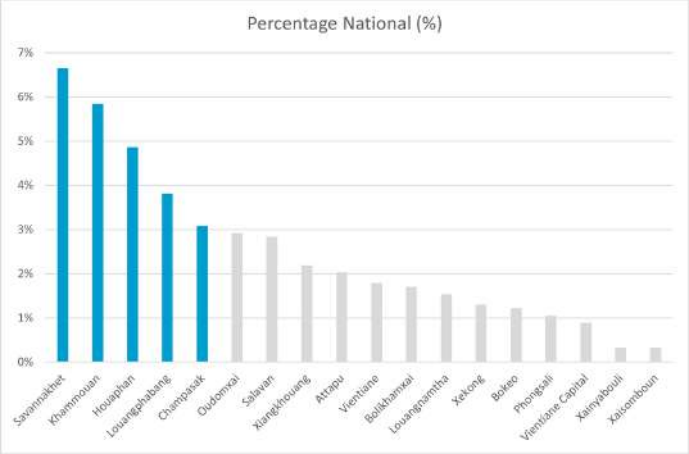


Figure 9: *Flood-affected health facilities as a percentage of total health facilities in Lao PDR*

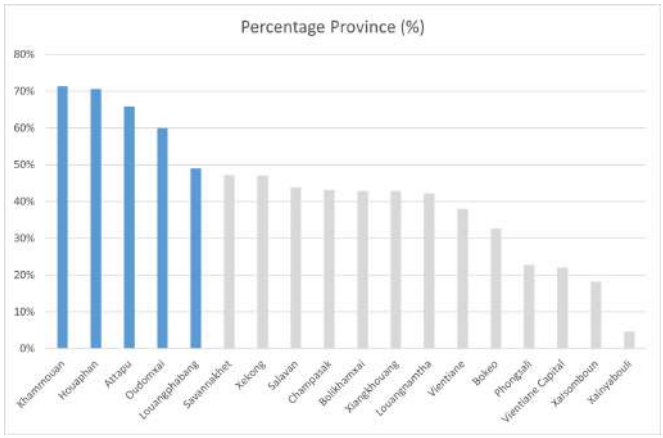


Figure 10: *Percentage of total health facilities in province which are affected by flooding*

5.2 Occurrence of Droughts

Huaphanh has the highest number of drought-affected health facilities, followed by Oudomxay. The northern provinces are more prone to drought, significantly impacting water supply.

Droughts pose a critical challenge to health facilities, particularly in the northern provinces. The provincial-level analysis reveals the widespread impact of droughts on health service delivery, highlighting the need for resilient water supply systems. By understanding the specific vulnerabilities of facilities to droughts, targeted measures can be implemented to ensure the continued provision of essential services.

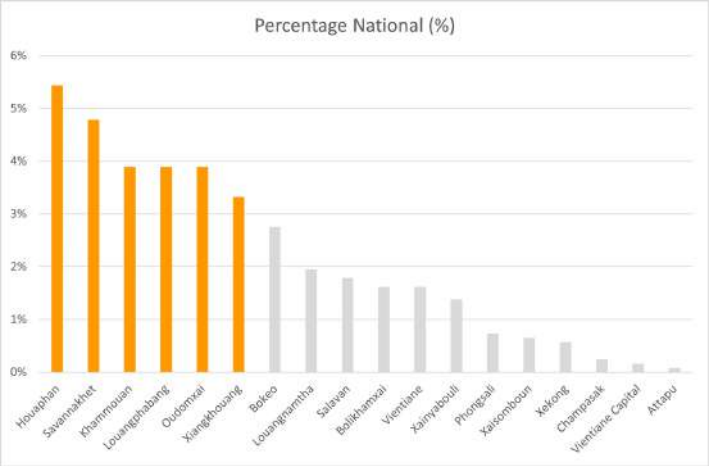


Figure 11: *Drought-affected health facilities as a percentage of total health facilities in Lao PDR*

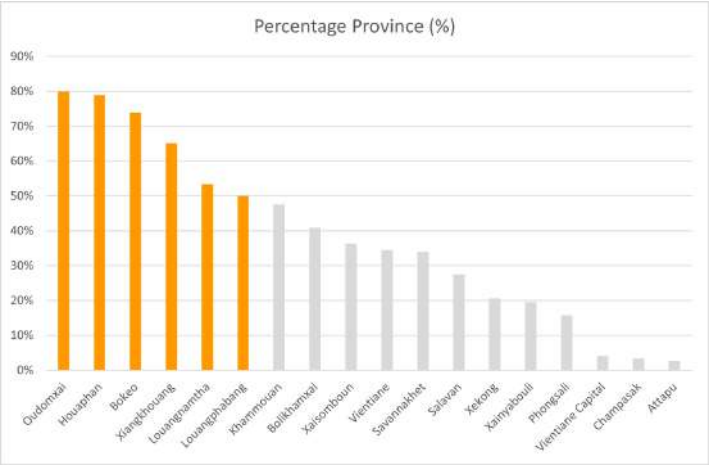


Figure 12: *Percentage of total health facilities in province which are affected by droughts*

Image 3 Sekong Provincial Hospital
Image 4 Handwash basin with hand sanitizer commonly found in the provincial and district hospitals in Laos

5.3 Occurrence of Storms

Storms impact health facilities across all provinces. Savannakhet has the highest number of storm-affected facilities, while Khammouane and Huaphanh have the highest rates of storm-affected facilities.

Storms are a pervasive hazard affecting health facilities throughout Lao PDR. The provincial-level findings provide valuable insights into the geographic distribution of storms impact, helping identify areas requiring targeted interventions. By enhancing facilities' resilience to storms, the health sector can better withstand these frequent and severe events.

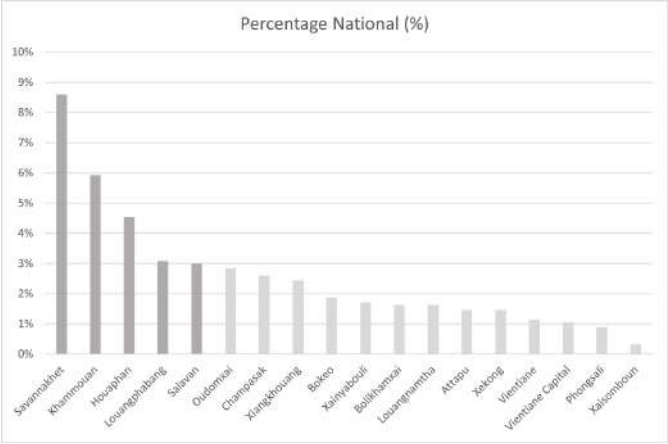


Figure 13: *Storm-affected health facilities as a percentage of total health facilities in Lao PDR*

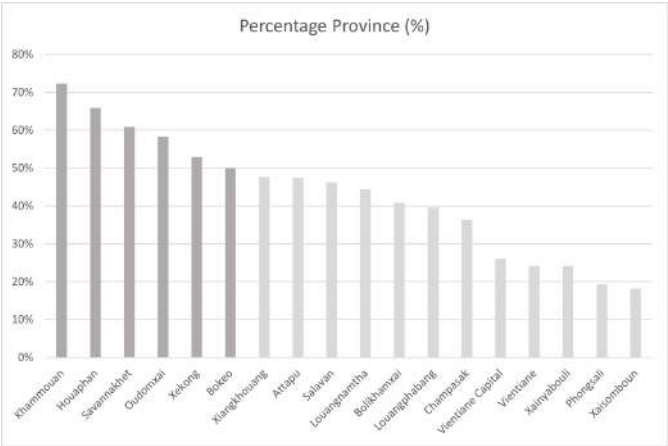


Figure 14: *Percentage of total health facilities in province which are affected by storms*

5.4 Occurrence of Landslides

Huaphanh and Luang Prabang have the highest number of landslide-affected health facilities. The northern provinces, particularly those with hilly terrains, experience higher rates of landslides.

Landslides pose significant challenges to health facilities, particularly in the northern provinces with hilly terrains. The provincial-level analysis highlights the geographic distribution of landslide impact, providing insights into the areas that require targeted resilience measures. The health sector can enhance its preparedness and response capabilities by addressing the specific vulnerabilities of facilities to landslides.

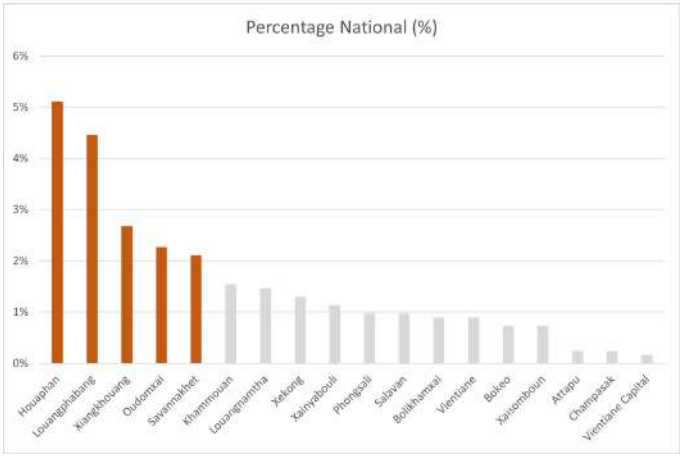


Figure 15: *Landslide-affected health facilities as a percentage of total health facilities in Lao PDR*

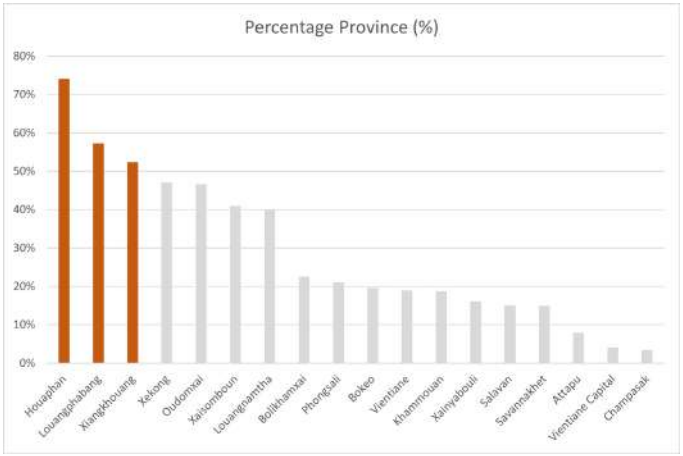


Figure 16: *Percentage of total health facilities in province which are affected by landslides*

5.5 Occurrence of Wildfire

This affects many health facilities, with Huaphanh having the highest number of wildfire-affected facilities. The impact of wildfires is notable, especially in rural settings.

Wildfires are a significant hazard to health facilities, particularly in rural settings. The provincial-level findings provide detailed insights into the specific impact of wildfires on health service delivery. By understanding facilities' vulnerabilities to wildfires, targeted measures can be implemented to enhance resilience and ensure the continued provision of essential services.

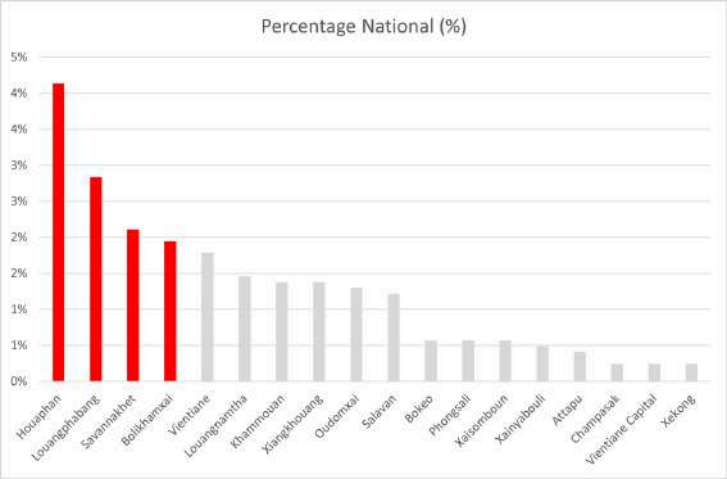


Figure 17: *Wildfire-affected health facilities as a percentage of total health facilities in Lao PDR*

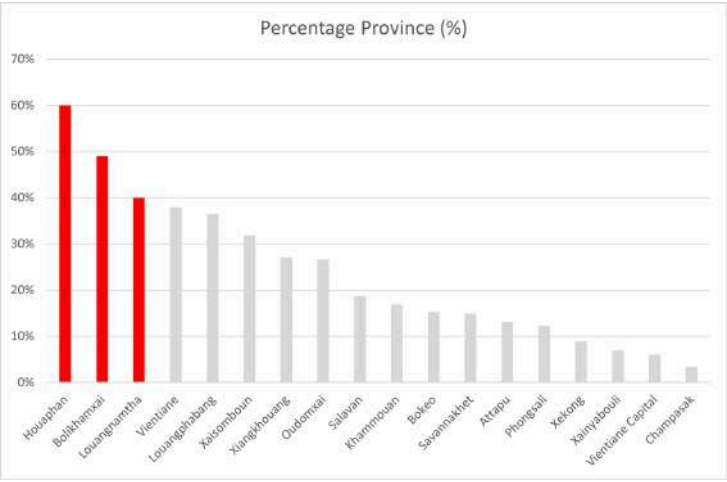


Figure 18: *Percentage of total health facilities in province which are affected by wildfires*

5.6 Multi-hazard Occurrence

The data reveals a comprehensive picture of multi-hazard occurrences, with Savannakhet and Huaphanh having the highest number of hazard-affected health facilities. The distribution of hazards varies across provinces, indicating the need for tailored resilience strategies in different areas.

A comprehensive analysis of multi-hazard occurrences provides valuable insights into the combined impact of various hazards on health facilities. By understanding the geographic distribution of multiple hazards, decision-makers can develop tailored resilience strategies that address different provinces' specific risks. This holistic approach ensures that interventions are effectively targeted and resources are allocated efficiently.

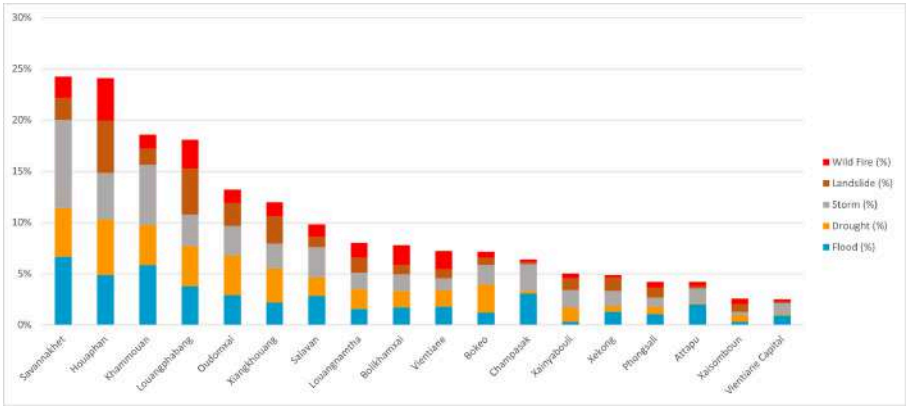


Figure 19: *Percentage of the national total of hazards occurring in each province*

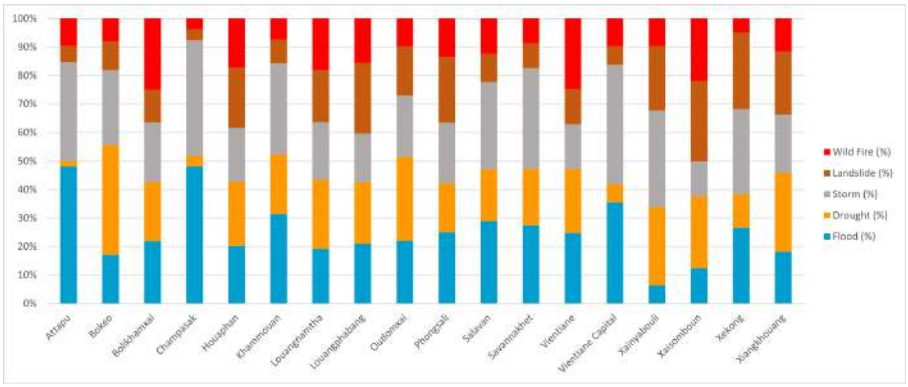


Figure 20: *Distribution of hazards in each province*

06 Infrastructure Impact

6.1 Impact on Infrastructure

The assessment highlights the effects of climate hazards on health facility infrastructure. Droughts severely affect water supply, landslides impact roads, storms affect electricity supply, and floods disrupt waste management and sanitation. Wildfires also significantly impact waste management.

The infrastructure impact analysis provides a detailed understanding of how climate hazards affect critical infrastructure services. By identifying the specific infrastructure vulnerabilities, the assessment highlights the need for targeted resilience initiatives to ensure the continued provision of essential services during and after disasters.

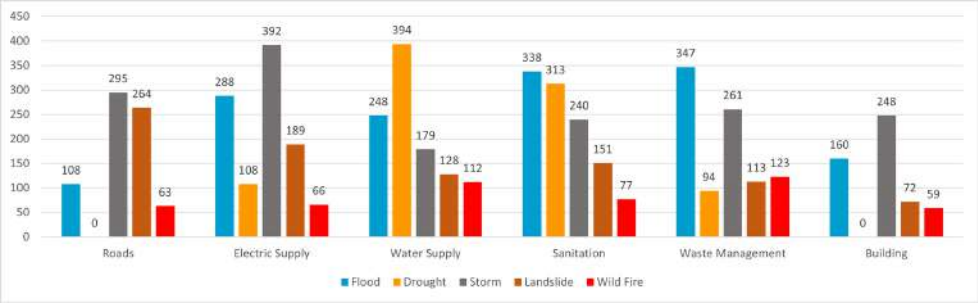


Figure 21: *The number of hazard-affected health facilities experiencing infrastructure issues broken down by infrastructure and hazard type*

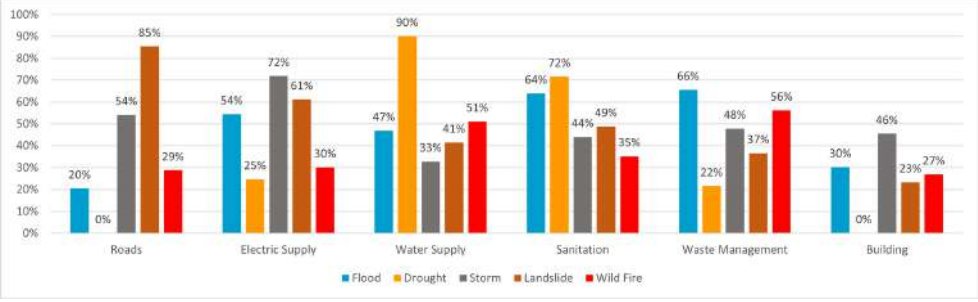


Figure 22: *The percentage of health facilities experiencing hazard-related infrastructure issues broken down by infrastructure and hazard type*

6.2 Prioritizing Infrastructure Resilience

The data underscores the importance of prioritizing infrastructure resilience initiatives to ensure uninterrupted health services during climate hazards. Targeted interventions are essential to address the specific vulnerabilities of health facilities and critical infrastructure.

Prioritizing infrastructure resilience is crucial to safeguarding health services during climate hazards. The health sector can enhance its capacity to withstand and recover from disasters by implementing targeted interventions. This includes strengthening water supply systems, improving road infrastructure, ensuring reliable electricity supply, and enhancing waste management and sanitation services.

07 Conclusion

The Multi-hazard Risk Assessment Study provides a comprehensive analysis of the vulnerabilities of health facilities in Lao PDR to various climate hazards. The findings highlight the urgent need for targeted resilience strategies to strengthen healthcare infrastructure and ensure the continued provision of essential services. By understanding the specific vulnerabilities and impact of climate hazards, decision-makers can implement effective measures to enhance the resilience and preparedness of the health sector in Lao PDR.

The study underscores the importance of adopting a holistic approach to disaster risk management, considering the interdependencies between health facilities and critical infrastructure. By addressing the specific vulnerabilities identified in the assessment, the health sector can enhance its resilience and response capabilities, ensuring that it is better prepared to manage the impact of climate hazards.

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