



# TECHNICAL REPORT

## HYDROMETEOROLOGICAL NETWORK UPGRADES AND EARLY WARNING SYSTEM UPDATES FOR FLOOD AND DROUGHT

Xe Bang Hieng River Basin,  
Savannakhet Province

Implemented by:



Integrated Water Resources Management and  
Ecosystem based Adaptation in Xe BangHieng River  
basin and Luangprabang City

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## Abbreviation

DMH:	Department of Meteorology and Hydrology
DONRE:	District Natural resources and Environment Office
EbA:	Ecosystem-based Adaptation (EBA)
EWS:	Early warning systems
ICM:	Integrated Catchment Management
GEF:	Global Environment Facility
GPM:	Global precipitation measurement
KOICA:	Korea International Cooperation Agency
Lao PDR:	Lao people’s Democratic Republic
NASA:	National Aeronautics and Space Administration
MONRE:	Ministry of Natural resources and Environment
PONRE:	Provincial Natural resources and Environment
UNDP:	United Nations Development Programme

# 1 Introduction

## 1.1 Project scope and goal

The UNDP-GEF “Integrated Water Resource Management and Ecosystem-based Adaptation in the Xe Bang Hieng River Basin and Luang Prabang city” (the program) aims to support the Government of Lao PDR in strengthening the climate resilience of communities in two particularly vulnerable areas of Lao PDR – namely Savannakhet Province and Luang Prabang city. The program focusses on the impacts of floods and droughts, both of which are projected to become more intense and frequent under future climate scenarios, through promoting the integrated management of land and water resources at target sites in the Xe Bang Hieng River Basin and in Luang Prabang city. In the Xe Bang Hieng River Basin, Savannakhet Province, the program focuses on five target districts – the lowland districts of Songkhone, Champhone and Xonnabouly and the upland districts of Sepone and Nong. The program will be implemented over a period of four years from December 2022 to December 2026 by the Department of Water Resources (DWR) of the Ministry of Natural Resources and Environment (MONRE).

The program is comprised of three components, the first of which is *Developing national and provincial capacities for Integrated Catchment Management (ICM) and integrated urban Ecosystem-based Adaptation (EBA) for climate risk reduction*. Component 1 is further divided into two outpoints, the second of which is *Integrated Climate-Resilient Flood Management Strategies developed for Luang Prabang and the Xe Bang Hieng River Basin, supported by an updated hydrometeorological monitoring network, EWS (Early Warning System) and revised emergency procedures for the Xe Bang Hieng River Basin (the project)*.

The project scope includes the following two work packages (among others):

- Task 5: Hydrometeorological network upgrades
- Task 6: Early Warning System updates

The focus of these two work packages is at the basin level for the hydrometeorological network and at-risk villages for the EWS.

## 1.2 Purpose of this report

This report describes the objectives, methods and recommendations from a review of the hydrometeorological network and early warning system in Xe Bang Hieng River Basin. The purpose of the hydrometeorological and early warning services assessment is to identify opportunities to improve and update the systems to reduce the socio-economic risks associated with weather, climate, and hydrological events.

## 2 Methodology

The assessment focused on five districts and fifteen target villages. In this assessment, the team summarised and collected data from relevant agencies and visited the target villages to evaluate the issues with the hydrometeorological and early warning system services. This included assessing the understanding of warning information as well as the number and location of hydrometeorological and EWS infrastructure. The goal is to support and update the warning service systems to protect lives and economic development for communities in the Xe Bang Hieng River Basin, and to provide recommendations on investments that the program can make in support of this goal.

The analysis draws on the UNDP framework for EWS (Figure 1)<sup>1</sup>. The framework provides expected elements of successful EWS across themes of risk knowledge; monitoring and warning system services; dissemination and communication between responsible agencies and users; and the response capability of agencies and local people.



Figure 1. UNDP framework for early warning systems <sup>1</sup>

The review and recommendations process has followed the following steps:

1. **Situational assessment** of flood and drought risks.
2. **Situational assessment** of the current hydrometeorological network and EWS.
3. **Gaps analysis** of hydrometeorological network and EWS in addressing flood and drought risks
4. **Recommended investments** for hydrometeorological network upgrades and EWS updates to reduce flood and drought risks within the available project budget of approximately \$80,000 USD.

The situational assessment (Steps 1 and 2) is based on a literature review, village and district consultations, a review of the climate risk maps in the report from the “Technical Support for modelling and development of risk maps in Lao PDR” project (Antea, 2024), and a review of the KOICA project that is developing hydrometeorological network upgrades and EWS updates in the same basin.

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<sup>1</sup> United Nations Development Programme (UNDP), 2018. Five approaches to build functional early warning systems.

### 3 Flood and drought risks

#### 3.1 Flooding in Xe Bang Hieng River Basin

The Xe Bang Hieng River Basin is located in the southern part of Savannakhet province, Lao PDR. It spans approximately 370 km and includes five main tributaries: Xechamphone, Xexangxoy, Xethamouak, Sepon, and Xelanomg. The annual precipitation averages about 1,500 mm, with a mean annual discharge of 518 m<sup>3</sup>/s. The mean maximum discharge is 4,341 m<sup>3</sup>/s, and the mean minimum discharge is 31 m<sup>3</sup>/s, depending on climatic conditions.

Savannakhet province is affected by two dominant meteorological phenomena: typhoons and the southwest monsoon. These phenomena often lead to flooding. The flood season typically occurs from August to September each year, especially in the Xe Bang Hieng Basin. Runoff during these months can account for 70-80% of the total annual runoff.

According to 40 years of meteorological and hydrological data, Savannakhet province has frequently experienced floods. The average flood frequency in the Xe Bang Hieng River Basin is 2.7 years. Records from the meteorology-hydrology stations indicate six severe flooding events along the Xe Bang Hieng River Basin from 1975 to 2023: in 1978, 1996, 2005, 2007, 2019, and 2020. The main causes of flooding in the basin are:

- Overflowing of the Mekong River in its upper and middle reaches during the southwest monsoon season (August to September).
- Overtopping of tributaries due to tropical storms or tropical depressions, resulting in heavy rainfall and runoff in the Xe Bang Hieng River and its tributaries.

In 2019 and 2020, all districts along the Xe Bang Hieng River Basin watershed experienced about one month of inundation, with water depths ranging from 1 to 3 meters in eight districts: Sepon, Nong, Phine, Atsaphangthong, Xonboulouy, Champhone, Songkhone, and Thabangthong. Example inundation extent from September 2019 is presented in Figure 2. In parallel with floods, drought events also occur regularly including in 1993, 1998, 2008, 2012, 2014, and 2015, often due to El Niño events.

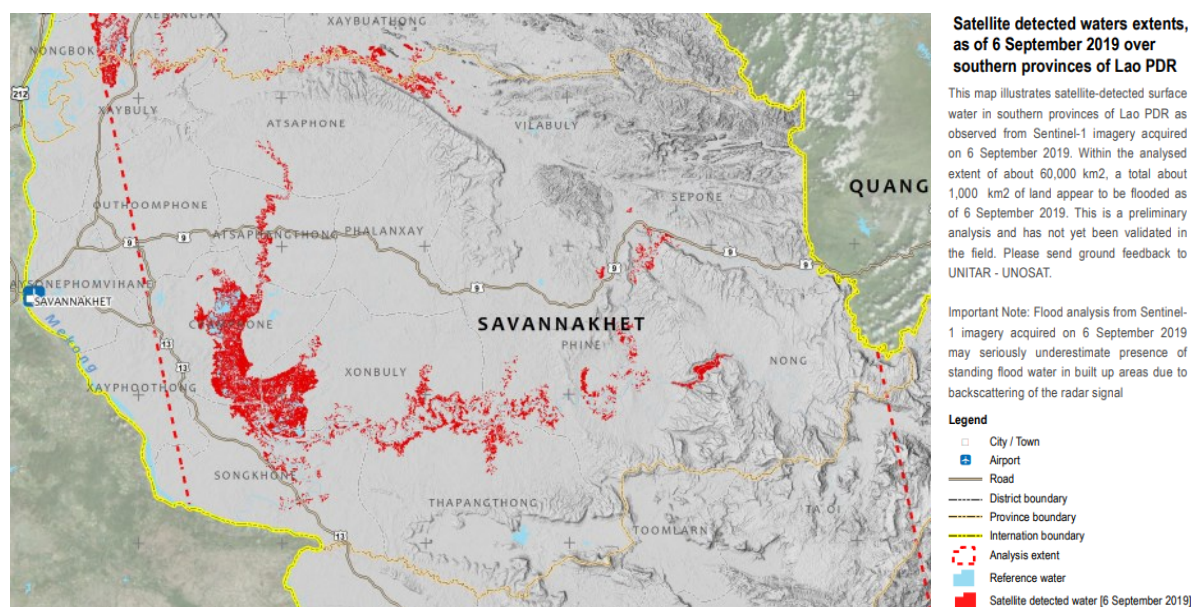


Figure 2. Example Savannakhet province inundation extent in September 2019<sup>2</sup>

<sup>2</sup> United Nations Institute for Training and Research. 2019. Satellite detected waters extents as of 6 September 2019 over southern provinces of Lao PDR.

### 3.2 Droughts in Xe Bang Hieng River Basin

Referred to data of 4 meteorological monitoring stations in the province found that the climatic variability such as dry spell is a major subject to the drought in this area. The drought often combines with flood in the same year and there are two types of droughts have been identified namely: early season and late season drought

In general, Savannakhet province is vulnerable to drought because most area lies under moderate risk level drought and there is slightly difference between total annual rainfalls in different parts of the province, their spatial distribution rise upslope towards the west to east direction. The severe drought is different from meteorological, hydrological and physical perspective.

The province is under low risk from the meteorological drought as there are most low risk meteorological drought areas was found in five districts namely: Thapangthong, Phine, Xepon, Vilabouri, and Atsaphone districts which located in the central and mountainous part of the province; in addition, a part of its spanning also covers partially territory of Xonbouri, Phalanxai, Atsaphangthong, and Nong districts.

The hydrological drought in most areas of the province is under high risk level however some areas like Champhone and Songkhone are less suffering from hydrological drought impact due to abundance of water resources. Most area of the province is under medium level risk of physical drought. Thus, hydrological drought due to poor water resources is more severe in Savannakhet province as compared to meteorological and physical drought.

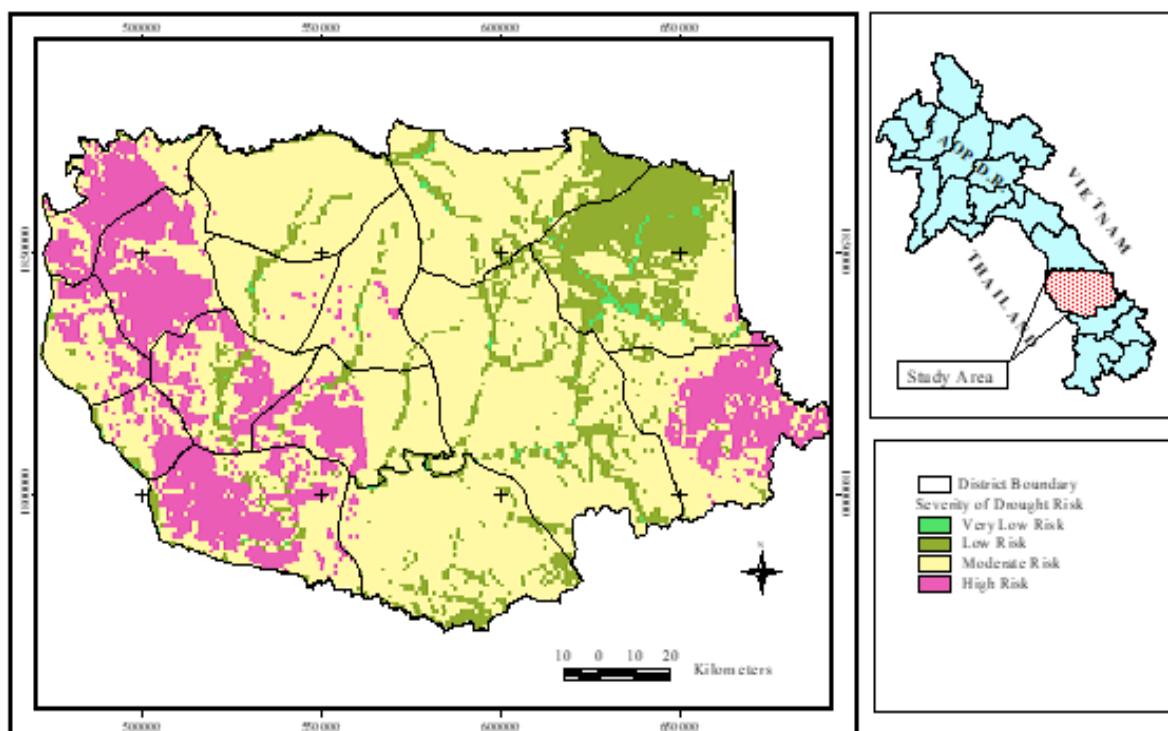


Figure 3. Drought risk Map in Savannakhet Province<sup>3</sup>

<sup>3</sup> Kaisone Tanthatep (2006). An assessment of drought risk area using Geographic Information System (GIS): A case study in Savannakhet province of Lao PDR.

### 3.3 Identifying at-risk villages

The UNDP supported “Technical Support for modelling and development of risk maps in Lao PDR” report (Antea, 2024)<sup>4</sup> undertook analysis of flood and drought risk for Xe Bang Heing basin and Savannakhet province. The analysis of flood and droughts risks show that:

- **Flooding**
  - Flood impacts on infrastructure and population is higher in the lowland districts compared to the upland districts. For example, Songkhone Village, Dongmeuang village, and Phiaka Village, are at risk to flood occurring every 5 to 10 years. Kaengdon Village is prone to less frequent but more severe floods with a return period of 50 to 100 years.
  - While villages like Nonsavang Village and Nachanyai are exposed to flooding they have lower risk scores due to their location and generally lower flood levels.
- **Drought**
  - Meteorological drought risk at a farm/household level varies only slightly across the basin.
  - High drought risks for agriculture are particularly prevalent in the western regions with extensive agricultural activities. Villages like Sivilai village face significant potential losses during droughts
  - Upstream villages like Tangalai Neua and Nongvilai village, although experiencing severe drought conditions, have lower agricultural intensity, resulting in comparatively lower regional impact but likely similar impacts on farming households.

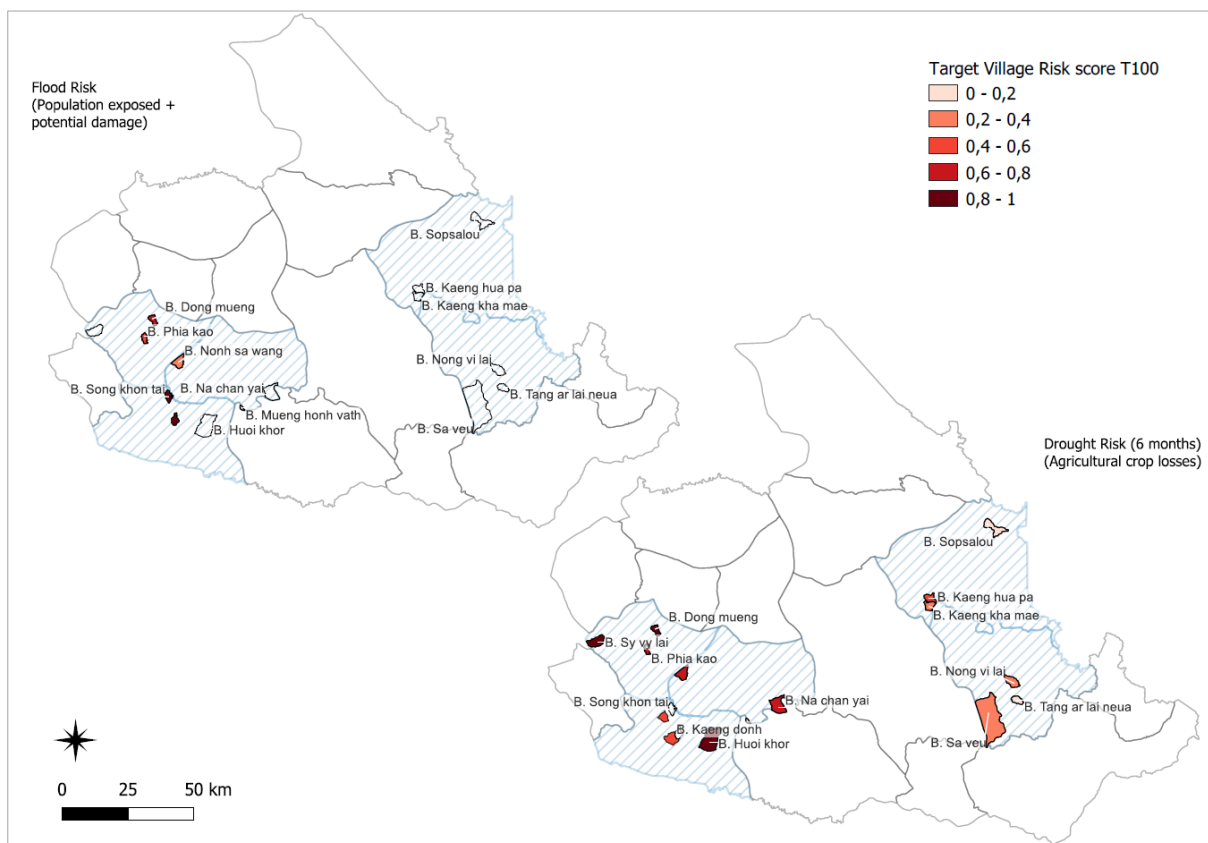


Figure 4. Flood and drought risk scores for target villages based on current climate and for a 1 in 100-year event<sup>3</sup>

<sup>4</sup> United Nations Development Programme (UNDP), 2024. Technical Support for modelling and development of risk maps in Lao PDR. Antea Group

In addition to the flood and drought risk findings, the report outlined several challenges related to the availability of hydrometeorological data in the basin:

- Daily precipitation for 12 stations in Xe Bang Hien basin and surrounding areas (MRCs and DMH) are for a short nine-year period from 1999 to 2008. This data was not used though as improved calibration results were achieved using satellite data from the global precipitation measurement (GPM) by NASA.
- Climate stations for four stations in Xe Bang Hien basin and surrounding areas (MRCs and DMH) are for a short nine-year period from 1999 to 2008.

The limited hydrometeorology data available for flood risk assessment indicates that there is significant room for improvement in the collection, quality assurance and sharing of hydrometeorology data in the basin.

The risk analysis presented in the “Technical Support for modelling and development of risk maps in Lao PDR” report (Antea, 2024) and summarised above has the following implications for the analysis of hydrometeorological network and EWS:

- To improve flood and drought risk mapping, significant investment is required in the hydrometeorology network including collection as well as quality assurance and data sharing
- EWS interventions for floods should address impacts in the lowland areas, with a focus on villages such as Songkhone, Dongmeuang, Phiaka and Kaengdon
- EWS interventions for drought should address impacts in the western regions of the basin with extensive agricultural activities, such as villages like Sivilai and upstream villages such as Tangalai Neua and Nongvilai village.

## 4 Current status of hydrometeorological network and EWS

The system for forecasting and warning for flood and drought in Savannakhet Province is presented in Figure 5. Under this system, the Department of Meteorology and Hydrology (DMH) of MONRE is mandated to collect, evaluate, and disseminate information on hydrometeorological parameters including rainfall, evaporation, river water level, and flow. Monitoring and observation systems run by DMH consist of observation stations, data transmission and telecommunication networks, data processing and storage systems, and data management systems. According to the Early Warnings for All (EW4ALL) initiative in Lao PDR (United Nations, 2024), DMH is the flood hazard warning authority – however warning messages cover weather only general forecast for a week or two and are not specific enough to be an early warning for any particular area.

The Provincial Natural Resources and Environment (PONRE) has responsibility for hydrometeorological data collection. It also has responsibility for dissemination of daily weather forecasting from DMH to districts and communities. On a normal day, weather forecasting information from DMH is sent directly to Provincial Meteorology and Hydrology at 11 am. In the case of an emergency, DMH sends information twice per day depending on weather situation and water level, with average synoptic every 6-12 hours.

From the Provincial Meteorology and Hydrology, weather forecasting information is sent to provincial flood and drought committee and other line agencies including DONRE which in turns sends the information to District Governor and District line agencies. Information is then sent to village communities by phone and warnings issued to villagers through megaphones and other facilities that villages have. It takes on average 24 hours for weather forecasting information from DMH to reach villages, but longer for remote communities that have limited communication and telecommunication services.

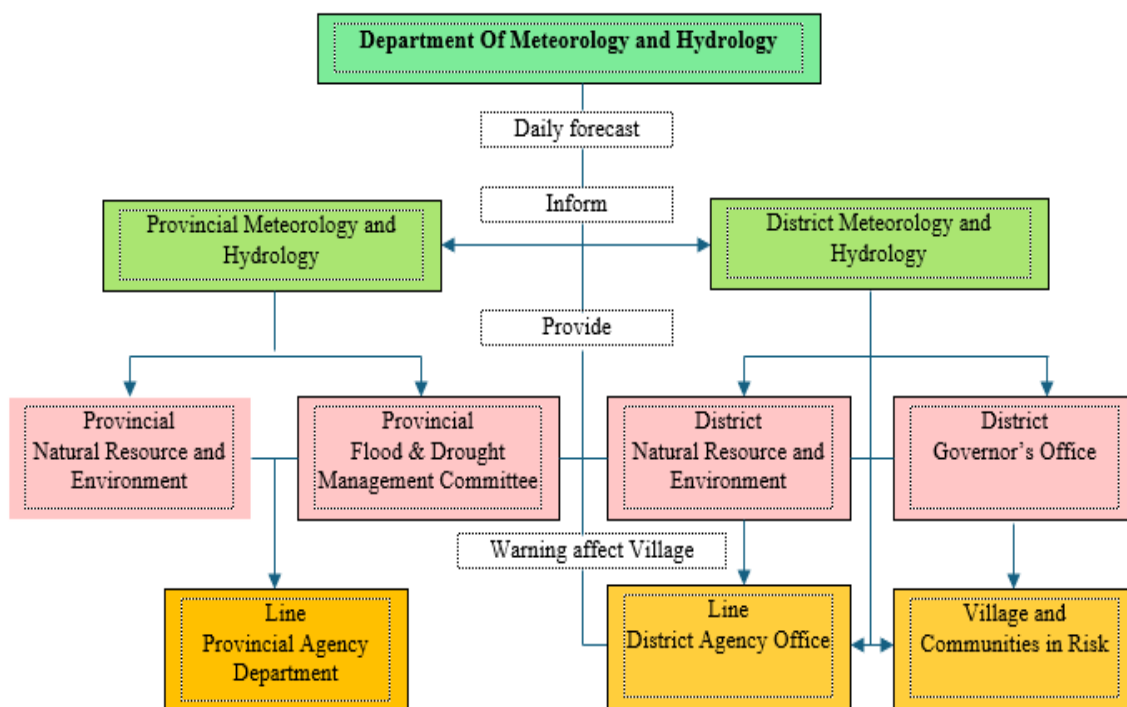


Figure 5. The system of forecasting and warning for flood and drought in Savannakhet Province.

## 4.1 Existing hydrometeorological network

The provincial hydro-meteorological service operates under the Provincial Natural Resources and Environment Department. Its roles and responsibilities include installing and implementing fieldwork for data collection, disseminating daily weather forecasts, monitoring, and providing data services to relevant agencies. Additionally, it is responsible for maintaining an inventory of the river system and managing the hydrometeorology network within the province.

The hydrology and warning network in Savannakhet province have been established across the five main tributaries of the Xe Bang Hieng River and Xe Bangfai River. This network includes seven meteorological stations, 21 water level gauge stations and two discharge measurement stations, 21 rain gauge stations, and three water quality sampling stations (Figure 6) in whole Province (list of stations provided in Appendix A) and there are specifically 15 water gauges and 17 rain gauge was install in Xebanghiang River basin. However, the hydrological observation activities were halted at 12 water level gauge stations during the severe flooding of 2019 and 2020 due to technical and management issues such as insufficient maintenance of equipment, a shortage of consumable materials, lack of staff, and budget constraints.

Hydrological data is extremely limited, fragmented, and generally of limited reliability, making it difficult to analyze water resource issues. Consequently, many agencies often install their own networks to collect the necessary data. Currently, various agencies and projects generate natural resources and environmental data for their development projects in the province. The project was not able to collect hydrometeorological network information from these other agencies and partners.

### 4.1.1. Newly installed network supported by KOICA

DMH under the Ministry of Natural Resources and Environment (MONRE), in collaboration with the Korea International Cooperation Agency (KOICA)<sup>5</sup>, are implementing a project to enhance the hydrological data collection system in Savannakhet Province. The purpose of this project is to obtain better data for flood and drought forecasting.

The project has completed the installation of equipment at 33 rain gauge stations, 10 water gauge stations, five warning posts, four CCTV stations, and one LED display (Figure 6 and full list in Appendix A). However, those stations are not in use and not yet handed over to government. For the purposes of this review, we assume that the instrumentation will be handed over to the Provincial Natural Resources and Environment Department along with training on operation and maintenance.

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<sup>5</sup> Korea International Cooperation Agency (KOICA), 2024. Manufacture & installation of climate change adaptive flood forecasting and warning system in Xe Bang Hieng River Basin, Lao PDR

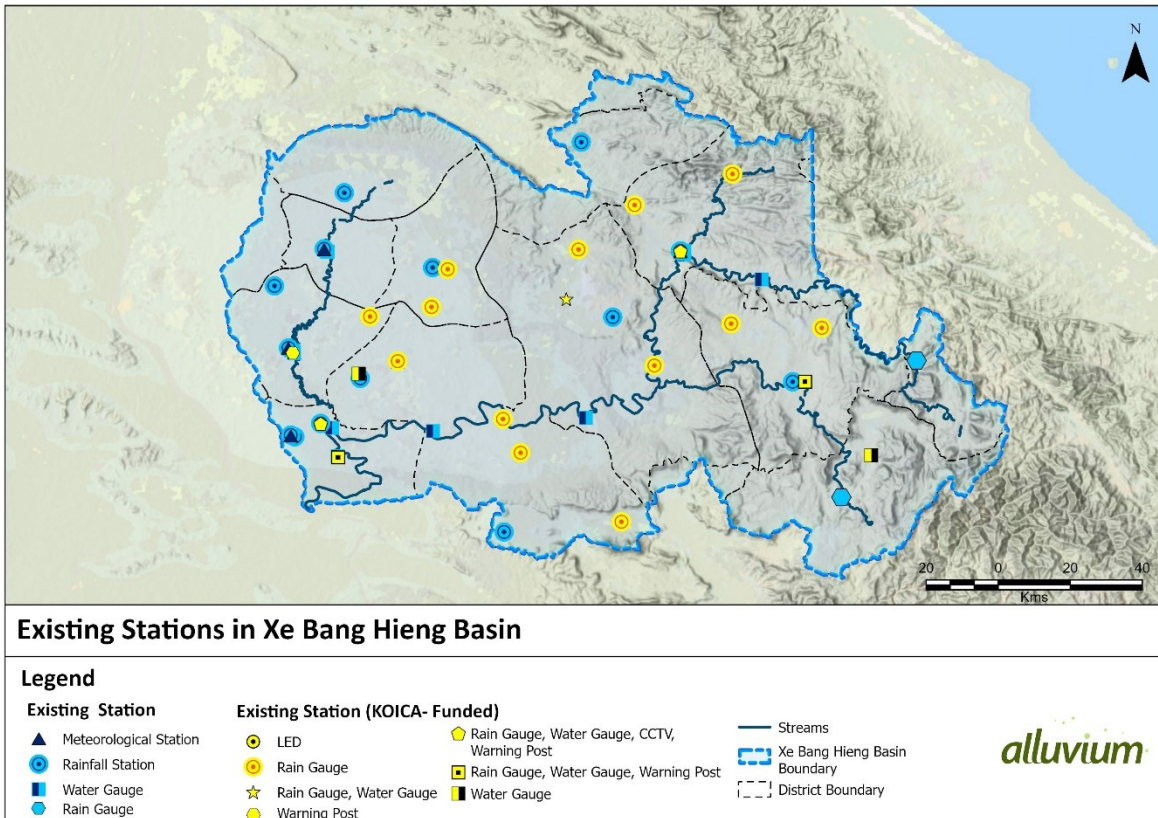


Figure 6. Meteorological and hydrological stations in Savannakhet Province.

## 4.2 Anticipatory Action Protocol

The Lao Government is currently collaborating with the Food and Agriculture Organisation (FAO) to develop Anticipatory Action Protocols for agricultural drought. It is an Early Warning System consisting of trigger points (risk level) informed by an Effective Drought Index (EDI) using rainfall observations and forecast data. Anticipatory Actions are proposed to reduce negative impacts of droughts including food security and farmers' income due to crop and livestock damage and loss. The FAO is also working the DMH on flood trigger points and Anticipatory Actions for livestock evacuation. The trigger points are informed by rainfall observations and forecast which are in turn used to forecast river water levels. It is understood that the system is being tested and will be deployed to DMH.

## 4.3 Early Warnings For All Road Map 2024-27

Early Warnings for All (EW4ALL) is a special initiative of the United Nations (UN) Secretary General, which aims to spearhead action to ensure every person on Earth is protected by early warning systems by 2027. Under the umbrella of EW4ALL, Lao People's Democratic Republic (Lao PDR) aims to scale up prior efforts and strengthen national early warning systems

According to the EW4ALL Road Map for Lao PDR (United Nations, 2024), the DMH has undergone major upgrades in terms of their observation network and forecasting systems. However, there is now an increased demand for **localized and actionable** early warning information among agencies and end-users from different sectors, including agriculture and disaster risk management. This is important to help build trust in warning services amount communities. The report also outlines that communities lack of knowledge about risks and appropriate responses. Furthermore, the 9th National Socio-Economic Development Plan (NSEDPlan) emphasizes the need to **strengthen the capacity** of disaster management committees in central, provincial and district level in disaster risk reduction and preparedness. It also aims to improve the **quality of reporting and effectiveness of news alerts** related to temperature, weather, earthquakes, and water levels. Gaps and proposed activities in the Road Map that are relevant to addressing challenges at the district and village community levels for this project are outlined in Section 5.

#### 4.4 District summary

A more detailed assessment of the hydrometeorological network and EWS system in five districts and 15 villages was undertaken including through consultation with local stakeholders and authorities. The detailed assessment is presented in Appendix B with a summary provided below.

**Table 1. Summary of district and village assessment**

Element	Current status (floods)	Current status (drought)
Nong district	<ul style="list-style-type: none"> <li>• There is one non-automatic rain gauge and one automatic water level gauge in Xelanong River.</li> <li>• KOICA installing a water gauge and warning post in Nong Municipality</li> <li>• Current network is not covering all risk areas</li> <li>• EWS system not functioning well, lacking equipment for communication</li> <li>• No action plan for disaster management</li> </ul>	<ul style="list-style-type: none"> <li>• Limited or no focus on early warning for drought</li> <li>• No system for warning of drought</li> <li>• Not enough facilities to support water for some communities</li> <li>• Deeper ground water in some village even though this district is close to Xelanong river, but more villages setting up in highland</li> </ul>
Sepon District	<ul style="list-style-type: none"> <li>• There is one synoptic meteorology station and 2 water level gauges (Xepon and Xebanghiang Rivers)</li> <li>• KOICA installed 4 rain gauge stations, one CCTV and one warning post in Xepon District Namely: Sopnam, Sopmi, Phabang and Ban dong villages</li> <li>• EWS is considered to operate well in the site of water gauge but is not covered to whole district area, that mean, Data dissemination does not cover all areas at risk, some village and community have difficulty to access data because communication and telecommunication are limited,</li> <li>• No action plan for disaster management</li> </ul>	<ul style="list-style-type: none"> <li>• Limited or no focus on early warning for drought</li> <li>• No system for warning of drought</li> <li>• No data for drought research</li> <li>• Not enough water for productivities</li> <li>• No plan and Not clear on drought solving problems</li> </ul>
Xonboully District	<ul style="list-style-type: none"> <li>• There is one automatic meteorology station in Keokhamdy dipterocarp forest centre; as well as one non-automatic rain gauge and two automatic water level gauge in Muanghong and Xianghom villages</li> <li>• KOICA installed one water level gauge and two rain gauges in Xonboully district namely: water gauge at Xexangxoy Bridge at Xianghom Village and Raingauge in Keokhamdy Village</li> </ul>	<ul style="list-style-type: none"> <li>• Limited or no focus on early warning for drought</li> <li>• No system for warning of drought</li> <li>• More water in rainy season but less water in dry season,</li> <li>• More evaporation Average 3.4 mm/day</li> <li>• Ground water is main water use for villager</li> <li>• Deeper ground water</li> </ul>

Element	Current status (floods)	Current status (drought)
	<ul style="list-style-type: none"> <li>EWS not functioning well. Data dissemination does not cover all risk areas including remote areas given limited internet and telephone network</li> <li>Draft of action plan for Disaster management from 2025-2030 was completed but is not approved yet</li> </ul>	
Champhone	<ul style="list-style-type: none"> <li>There is one automatic meteorology station, one non-automatic rain gauge and one automatic water level gauge in Xechamphone River at Kengkok village</li> <li>KOICA installing four automatic rain gauges in Houymaknhau, Laosoulinga, Lak 35 and Dongkhammuen villages; one automatic water level gauge at Champhone River Bridge in Kengkok village; and one warning post in Champhone Municipality</li> <li>No action plan for disaster management</li> </ul>	<ul style="list-style-type: none"> <li>Limited or no focus on early warning for drought</li> <li>No system for warning of drought</li> <li>One ground water monitoring in Dongkhammeun Kengkok villages, but less data for Drought hydrological planning</li> <li>More water in rainy season and more irrigation systems, but less on water management</li> <li>There are Invade from saltwater level in dry season of some village</li> </ul>
Songkhone District	<ul style="list-style-type: none"> <li>There is one automatic meteorology stations; two non-automatic rain gauges; one non-automatic water level; and one automatic water level gauge</li> <li>KOICA installing four automatic rain gauges, two automatic water level gauges; one CCTV and two warning posts</li> <li>EWS considered to operate well in Kengdon village, but only the site has received that information from system</li> <li>No action plan for disaster management</li> </ul>	<ul style="list-style-type: none"> <li>Limited or no focus on early warning for drought</li> <li>No system for warning of drought but there are More irrigation systems for drought solution</li> <li>No action plan on controlling water use in Dry season</li> <li>More water in rainy season but not enough water in some village in dry season</li> </ul>

## 5 Gap analysis and responses

The effective management of flood and drought risks is crucial for safeguarding communities and ensuring resilience against natural disasters.

This gap analysis draws on the findings of Chapter 3 (flood and drought risks) and Chapter 4 (current status of network) as well as a review of other available documents to identify key deficiencies across several critical areas. These include ineffective communication with the public, insufficient monitoring infrastructure, outdated forecasting capabilities, poor dissemination of alerts, and inadequate community preparedness (Table 2). Addressing these gaps is essential for improving the overall effectiveness of flood and drought risk management systems and ensuring the safety and resilience of vulnerable communities.

In the absence of a comprehensive water resources assessment data system and standardized hydrological information, the government of Laos has encouraged various donor-financed studies and investments in hydrological data collection. The aim is to cope with disaster risk reduction by installing and updating hydrometeorological and early warning systems to cover all risk areas. However, these efforts have resulted in the implementation of systems with varying standards, making evaluation difficult.

Currently, the early warning system information is not widely known among local people, despite government and project efforts to improve these systems in the Xe Bang Hieng River Basin.

While the current state of flood and drought risk management presents challenges, it also offers an opportunity for significant improvement. Table 2 outlines actionable recommendations that, when implemented, can address the identified gaps and build a more robust and proactive approach in the Xe Bang Hieng River Basin.

**Furthermore, gaps identified in the EW4ALL Road Map for Lao PDR relevant to district and village communities where Development Partner or UNPD can contribute (United Nations, 2024) are outlined in**

Table 3. These will assist to inform potential investments for the Xe Bang Hieng Basin under this project.

Table 2. Gap analysis and possible responses

Component	Gaps identified	Possible responses
<b>Risk knowledge</b>	Limited to no capacity building for village groups and commune officials to apply meteorological and hydrological data.	Conduct targeted campaigns to improve community understanding of flood and drought risks and appropriate responses.
	Insufficient assessment of areas vulnerable to flood and drought risks  Inadequate preparedness resources and limited community engagement in preparedness activities.	Develop community-based communication strategies and enhance public awareness programs through workshops, educational materials, and community meetings.
<b>Monitoring and warning service</b>	Provincial meteorology and hydrology agencies only provide weather forecasting data which are receiving from DMH, but there is limited on flood forecasting knowledge on warning service into specific Risk locations of warnings.	Upgrade and expand the hydrometeorological network to include more sensors and automated data collection systems.
	There is insufficient coverage and frequency of data collection for key variables such as rainfall, river flow, and soil moisture.	Implement real-time monitoring systems and increase the number of data collection points to improve data accuracy.
	Sparse monitoring infrastructure and lack of real-time data collection points.	Enhance training programs for staff to ensure proper maintenance and use of the network.
	Shortage of instruments and facilities in the hydro meteorological network, outdated technology, limited number of qualified staffs, and limited annual budget for maintenance.	Invest in modern forecasting technologies and training for local meteorologists to improve prediction accuracy.
	Lack of sustainability of monitoring and forecasting systems in the province, with efforts largely confined to DMH.	Update forecasting models, provide advanced forecasting tools, and conduct training for local staff to enhance forecasting capabilities.
<b>Dissemination and communication</b>	Fragmented monitoring responsibilities between central, provincial, and district levels.	
	Inefficient dissemination of warnings to at-risk communities, with delays and gaps in coverage. For instance, villages which have no internet access and phone signal (Sopsalou, Saveu, and Tangalai Neua, and Nachanyai villages).	Provide technological support to the community, especially phone signals and internet access.  Increase community outreach and education programs to ensure comprehensive risk communication.

Component	Gaps identified	Possible responses
	<p>Lack of clarity in the regulation and responsibilities of provincial organizations, leading to poor coordination and communication between the warning agency (Provincial Meteorology and Hydrology) and response agencies.</p> <p>Not enough knowledge on education and dissemination between provincial and district on Meteorology and hydrology</p> <p>Inadequate communication systems to provide timely, accurate, and meaningful warning information to those at risk</p> <p>Lack of access warning information, especially for the most vulnerable groups</p>	<p>Improve communication infrastructure to ensure timely transmission of weather forecasts and warnings.</p> <p>Implement a robust EWS with multiple communication channels (e.g., SMS, radio, community loudspeakers) to ensure timely dissemination of alerts.</p> <p>Clarify regulations and responsibilities of provincial organizations and improve coordination and communication between warning and response agencies.</p> <p>Develop tailored communication strategies to ensure warnings are accessible and understandable by vulnerable groups.</p>
<b>Response capability</b>	<p>Limited community awareness and preparedness for emergency situations.</p> <p>Lack of community training and resources for effective response to flood and drought warnings.</p> <p>Insufficient capacity building for commune and district officials to support safer land use planning, infrastructure, and building practices.</p> <p>Lack of engagement of those at risk in the design and operation of EWS.</p>	<p>Conduct regular drills and provide resources such as emergency kits and evacuation plans to communities.</p> <p>Provide training, organize community drills, and develop detailed preparedness plans to improve community response preparedness.</p> <p>Implement capacity-building programs for village groups, commune officials, and district officials to enhance their ability to apply meteorological and hydrological data and support safer land use and infrastructure planning.</p> <p>Involve communities in the design and operation of EWS through participatory approaches.</p> <p>Address practical challenges by allocating resources for community engagement and planning activities within realistic time frames.</p>

**Table 3. Other gaps identified in EW4ALL Road Map for Lao PDR relevant to district and village communities where Development Partner and/or UNPD can contribute (Source: United Nations, 2024)**

Gaps	Activities	Responsibility	
		Lead	Contributors
<b>Pillar 1: Disaster risk knowledge</b>			
The current system faces challenges due to the lack of timely access to quality information. Unofficial reporting channels further compound the issue. Information sharing between communities and the government is not separated, hindering effective communication.  Additionally, communities lack knowledge about risks and appropriate responses.	Improve Information Communication and Technology (ICT) infrastructure (equipment for communication) to ensure data reporting/analysis	MOLSW	DP
	Establish a feedback mechanism where communities can request/validate risk information	MOLSW MOPT	DP
Lack of specific EW management committee in both national and provincial level	Setup EW management body with agency focal points, including mandates, roles, responsibilities, and coordination mechanism	DMH, MONRE	DPs
<b>Pillar 2: Detection, observation, monitoring, analysis and forecasting of hazards</b>			
Hydro met stations still insufficient and full coverage of the country is lacking	Install 70 new hydro-met stations	MONRE	WB
Lack of sufficient trained forecast staff to maintain a 24/7 weather watch and issue warnings as necessary	Staff allocation, training, and capacity building	MONRE, DMH	DPs, IFRC, LRC, PSs
DMH forecast and warning messages are too technical for many users	Staff allocation, training, and capacity building	MONRE, DMH	DPs, PSs
Lack of hydro information to support flood forecasting	Conduct discharge measurement and river cross section surveys	MONRE	DPs
<b>Pillar 3: Warning Dissemination and Communication</b>			
Official warning messages are too difficult to be further disseminated by community level representatives and community outreach workers and volunteers.	Develop and disseminate simplified standard early warnings messages using appropriate means	MONRE	MOLSW, DPs
There is also lack clarity regarding the technical capacity of such community representatives and community outreach workers and volunteers.	Establish and operate a network of volunteers and the private sector to support early warning dissemination and communication (connected to disaster management coordination structures)	MONRE, MOLSW, MOICT, MOCT	UNDP, DPs

Gaps	Activities	Responsibility	
		Lead	Contributors
	Identify appropriate roles, responsibilities and opportunities for private sector, NGOs, Civil Society Organizations (CSOs) and volunteer networks to engage in EW4ALL advocacy and EWS information dissemination.		
There is no mechanism to verify that warnings have been received and to correct	Establish a feedback mechanism for two-way community engagement and real time reporting to the national-level warning authorities	MTC, MONRE MOLSW	ITU, DPs
There is limitation and lack clarity regarding the coverage and reach of alert warning at subnational and local level	Conduct study on local authority messaging systems (including village speakers etc.).	MONRE	WMO, DPs
Agencies have specific connectivity information on services, but this is often ad-hoc in coverage and not widely available.	Conduct study on local authority messaging systems (including village speakers etc.).	MONRE	WMO, DPs
There is no clarity regarding who and how to assess and monitor the warning dissemination and communication channels to the ground.	Conduct study on traditional / local communications (message relay approaches) to determine modalities, effectiveness, trust, speed, etc.)	MONRE MOLSW	WMO, DPs
The public are aware of the Dept of Meteorology and Hydrology (MONRE) as a warning authority. However, warning messages cover weather only general forecast for a week or two and not specific enough to be an early warning for any particular area.	Establish clear roles and accountabilities for information dissemination under the EWS SOP.	MONRE, MOLSW	UN-Habitat, DPs
Limited evidence suggests that communities do not have confidence in early warning messaging as often advice is too broad, has a large geographic area and does not provide easily understood language as to the expected timelines, impacts and actions communities should take. There is a general understanding on the role of DMH in issuing alerts and the DOSW in managing disaster response operations – but gaps exist in understanding the specific roles of technical agencies in providing early warning alerts and messages.	Undertake a National EWS information dissemination advocacy campaign to educate communities on the multisectoral approach and joint responsibility to EWS	MONRE, MOLSW, LRC	UN-Habitat, IFRC, DPs
<b>Pillar 4: Preparedness and Response Capabilities</b>			
No common procedure at village level to respond to disaster / climate events	Develop Village level disaster response Standard Operating Procedures (SOP)	MOLSW, LRC	IFRC, LRC, UNICEF, DPS

Gaps	Activities	Responsibility	
		Lead	Contributors
There is limited climate and disaster resilience awareness at subnational levels	Develop and Disseminate awareness raising videos, audios, posters, pamphlets on climate and disaster resilience considering the inclusivity, and Leaving No One Behind (LNOB) approach	MOLSW, MONRE	UNICEF, DPs
	Conduct inclusive and accessible public awareness and education campaigns for target groups (e.g., Women, Children, Older People, Illiterate, and Persons with Disabilities)	MOLSW /MONRE	DPS
Inadequate of infrastructure and resources and lack of appropriate communication channels	Inventory assessment on the available infrastructure and resources and allocating essential infrastructures and communication systems	MONRE, MPT	UNDP, DPs
Preparedness and response plans are fragmented in different sector and inadequate level of awareness among public in disaster response	Conduct drills and simulation exercises periodically with regard to National and sub national disaster Preparedness and Response Plans	MOLSW, NDMC	UNDP, WFP, UNICEF, LRC, IFRC, DPs

## 6 Potential investments

There are a range of potential improvement areas for the hydrometeorology network and EWS in the Xe Bang Hieng River Basin. These areas can be categorised into:

1. Hydrometeorological infrastructure and technology installation and upgrades
2. EWS communication system infrastructure investment and technology installation and upgrades
3. Community capacity development including a focus on vulnerable groups
4. Institutional capacity development and clarification of roles and responsibilities
5. Improved inclusion of drought forecasting and risk management.

The program has a total budget of approximately USD 169,000 (\$65,000 for hydrometeorological station upgrades and \$104,000 for communication tools and trainings) and timeframe for implementation of 2 years. It is important to note that this budget is not sufficient to meet all the identified needs of the hydrometeorology network and EWS in the Xe Bang Hieng River Basin. For instance, investments are required to improve Information Communication and Technology (ICT) infrastructure for warning dissemination and communication (closing gaps in phone coverage/mobile network for SMS or similar). Such investments are beyond the scope and budget of this project.

However, there are investments under this project that can make a meaningful contribution. Two components of investments are proposed.

- Support improvement of the hydrometeorological monitoring system focusing on district and community level investments (aligned with category 1 above). Based on gaps identified in the hydrometeorological network and early warning, and villages identified as at-risk to floods and droughts, the proposed infrastructure investments are outlined in Figure 7 and Table 4.
- Support improvement of early warning of flood and drought hazards through capacity building activities including:
  1. Capacity building of district-level organisations (including Civil Society Organizations (CSO) or Non-Governmental Organisations (NGO), Private sector and volunteers) involved in warning dissemination. A key element will be help clarify roles and responsibilities of all actors involved in warning dissemination and communication.
  2. Awareness raising programs and communication materials (megaphones, loud speakers, walkie talkies, posters, pamphlets) for village communities including target groups to improve their understanding of flood and drought risks, warning information, and appropriate responses in line with village level disaster response SOPs. This should include conducting drills and simulation exercises for flood responses.
  3. Building institution capacity development in formal communication mechanisms, including integration with village level communication and knowledge management tools. A key element will be to assist establish a feedback mechanism for two-way community engagement and real time reporting to the warning authorities (e.g. to ensure warning messages are not too difficult to understand and are correct).

The infrastructure investments to improve the hydrometeorological network and for early warning in at-risk villages consist of installing new and repairing existing water gauges and rain gauges. The total cost of the proposed infrastructure is **\$ USD 31,500**.

The estimated cost of the capacity building and awareness raising programs outlined above for target districts and at-risk communities is estimated at **\$ USD 70,000**.

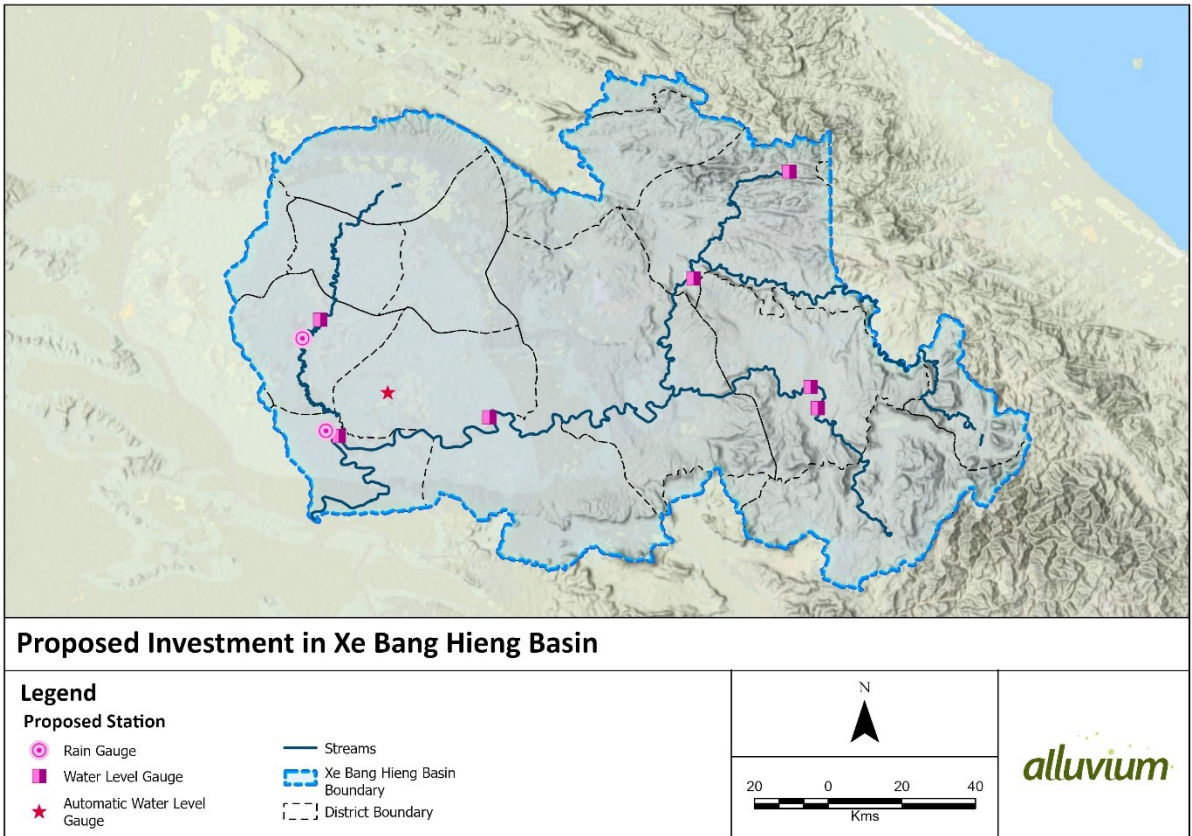


Figure 7. Proposed locations of hydrometeorological network improvement and installation investments

Table 4. List of proposed infrastructure investments

No.	Name of stations	Types of station	Locations				Estimate Cost (USD)	Remarks
			Village	District	Coordinates*			
					X	Y		
1	Meuanghong	Automatic Water level gauge	Meuanghong	Xonnabouly	545241.587	1809489.537	7,500	Improve existing station for collecting data of river flow (sensor and gauge level damage from flood 2019)
2	Nongvilai	Water level gauge	Nongvilai	Nong	659964.621	1810965.541	5,000	Improve existing station for collecting data of river flow
3	Songkhone	Water level gauge	Songkhone	Songkhone	531931.047	1797678.744	2,500	Install new asset for Village to monitor water level and take action on trigger level
4	Lahanam	Raingauge	Lahanam	Songkhone	528429.372	1799059.405	2,000	Improve existing station for collecting data of river flow
5	Dongmeuang	Water level gauge	Dongmeuang	Champhone	526846.472	1829194.230	2,000	Install new asset for Village to monitor water level and take action on trigger level
6	Phiaka	Raingauge	Phiaka	Champhone	522065.084	1824140.202	2,000	Install new one
7	Nachanyai	Water level gauge	Nachanyai	Xonnabouly	572776.888	1802718.155	3,000	Install new asset for Village to monitor water level and take action on trigger level
8	Tangalai Neua	Water level gauge	Tangalai Neua	Nong	661935.993	1805209.973	2,500	Install new asset for Village to monitor water level and take action on trigger level
9	Thamaeh	Water level gauge	Thamaeh	Xepone	628168.331	1840415.102	2,000	Install new asset for Village to monitor water level and take action on trigger level
10	Sopsalou	Water level gauge	Sopsalou	Xepone	654179.906	1869344.435	3,000	Install new asset for Village to monitor water level and take action on trigger level
<b>Total</b>							<b>31,500</b>	

\*Note: Coordinates are not exact locations where works are required

## 7 References

1. United Nations Development Programme (UNDP), 2018. Five approaches to build functional early warning systems.
2. United Nations Institute for Training and Research, 2019. Satellite detected waters extents as of 6 September 2019 over southern provinces of Lao PDR.
3. Korea International Cooperation Agency (KOICA), 2024. Manufacture & installation of climate change adaptive flood forecasting and warning system in Xe Bang Hieng River Basin, Lao PDR
4. Kaisone Tanthatep, 2006. Assessment of drought risk area using Geographic Information System (GIS): A case study in Savanakheth Province, Lao PDR
5. United Nations Development Programme (UNDP), 2024. Technical Support for modelling and development of risk maps in Lao PDR.
6. United Nations Lao PDR, 2024. Early Warnings For All Road Map 2024-2027.

## Appendix A: Existing and KOICA project hydrometeorological stations in Savannakhet Province

Table 1: List of existing water gauge stations in Savannakhet Province

No.	River name	Location			Coordinator		Organization support	Reposable agency	Status
		Village	District	Province	Lat	Long			
1	Mekong	Xayaphoum	Kaisone	Savannakhet	16.558611	104.744167		PMH	Good
2	Xepon	B.Dong	Sepon	Savannakhet	16.625278	106.416944	ADB	PMH	Stop working
3	Xebanghieng	Sopnam	Sepon	Savannakhet	16.688611	106.215278	MRC	PMH	Good
4	Xebanghieng	Tadhai	Phin	Savannakhet	16.280833	105.958056	ADB	PMH	Stop working
5	Xebanghieng	M.hong	Xonbouly	Savannakhet	16.248889	105.560833	UNDP	PMH	Stop working
6	Xebanghieng	Lahanam	Songkone	Savannakhet	16.26889	105.269167	JICA	PMH	Stop working
7	Xebanghieng	Kengdone	Songkone	Savannakhet	16.185833	105.313056	MRC	PMH	Stop working
8	Xelanong	Nongvilay	Nong	Savannakhet	16.368056	106.496111	ADB	PMH	Stop working
9	XeChamhone	Donghene	Atsaphone	Savannakhet	16.700278	105.286111	JICA	PMH	Stop working
10	XeChamhone	Donghen Bridge	Champhone	Savannakhet	16.699444	105.28750	Thai	PMH	Stop working
11	XeChamhone	KengkokNua	Champhone	Savannakhet	16.451944	105.198333		PMH	working
12	XeChamhone	Kengkok dong	Champhone	Savannakhet	16.44556	105.200278	JICA	PMH	Stop working
13	XeXangxoy	Phalanetai Bridge	Phalan	Savannakhet	16.658056	105.562222	MRC	MRC	Stop working
14	XeXangxoy	Xianghom	Xonbouly	Savannakhet	16.393056	105.367778	ADB	PMH	Stop working
15	Xebangfai	KhuaXe Bridge	Xaybouly	Savannakhet	17.076111	104.98500	MRC	PMH	Good
16	Xebangfai	Tonhen	Xaybouly	0	17.050556	104.894167	ADB	PMH	Stop working
17	xenoy	nater	Vilabouly	Savannakhet	17.067222	105.759722	JICA	PMH	Stop working
18	xenoy	Dongmakfai	Xaybouly	Savannakhet	17.075000	105.045556	JICA	PMH	Stop working
19	Xebangnouan	Sebangnouan	Songkhone	Savannakhet	16.257778	105.298333	MRC	MRC	Stop working
20	Xethamouak Bridge	Oudomvilay	Phin	Savannakhet	16.002778	105.478889	MRC	WR	Stop working
21	Xebanghiang	Thakhong	Sepon	Savannakhet	16.698333	106.216667	Thai	WR	working

Remark; all system of Data loggers in whole station were stop working since flood 2019,

Table 2: List of existing raingauge stations in Savannakhet Province

No	Station name	Location			Coordinator		Organization support	Reposable agency	Status
		Village	District	Province	Lat	Long			
1	Savannakhet	Thahae (airport)	Savannakhet	Savannakhet	16.554167	104.755556		PMH	Good
2	Outhumphone	Chareunsouk	Outhumphone	Savannakhet	16.666944	104.994444		PMH	Good
3	Atsaphangthong	Donghen	Atsaphangthong	Savannakhet	16.706667	105.278611		PMH	Good
4	Phalane	Phalantai	Phalane	Savannakhet	16.659167	105.561111		PMH	manual
5	Phin	Phin	Phin	Savannakhet	16.533056	106.029444		PMH	manual
6	Xepon	Nouanvilay	Xepon	Savannakhet	16.698333	106.206389		PMH	Good
7	Nong	Nongvilay	Nong	Savannakhet	16.368056	106.496111		PMH	manual
8	Kengkabao	Kengkabao	Xayboully	Savannakhet	16.812500	104.748889		PMH	manual
9	Boung	Boungkham	Vilaboully	Savannakhet	16.972500	105.949722		PMH	manual
10	Nonsavang	Nonsavang	Sonboully	Savannakhet	16.381667	105.372222		PMH	manual
11	Nakhoutchan	Nakhoutchan	Atsaphone	Savannakhet	16.847500	105.331667		PMH	manual
12	Lahanam	lahanam	Songkhon	Savannakhet	16.268889	105.269167		PMH	manual
13	Paksong	Vongvilay	Songkhone	Savannakhet	16.235278	105.201944		PMH	manual
14	Nonsavang	Nonsavang	Xonnaboully	Savannakhet	16.381667	105.372222		PMH	manual
15	Kengkabao	Kengkabao	Xayboully	Savannakhet	16.812500	104.748889	China	DMH	Good
16	Thadokkeo	Nakhoutchan	Atsaphone	Savannakhet	16.847500	105.331667	China	DMH	Good
17	Laosulinha	Laosulinha	Champhon	Savannakhet	16.613889	105.149444	China	DMH	Good
18	Dongkhammouen	Dongkhammouen	Champhon	Savannakhet	16.45806	105.185833	China	DMH	Good
19	Thapangthong	Thasalakham	Thapangthong	Savannakhet	15.995286	105.744589	China	DMH	Good
20	Xayphouthong	Dan	xayphouthong	Savannakhet	16.329444	104.955000	China	DMH	Good
21	Paksong	Vongvilay	Songkhone	Savannakhet	16.239722	105.191389	China	DMH	Good

**Table 3: List of existing meteorological stations in Savannakhet Province**

No	Station name	Location			Coordinator		Organization support	Reposable agency	Status
		Village	District	Province	Lat	Long			
1	Savannakhet	SVK (airport)	Savannakhet	Savannakhet	16.554167	104.755556		PMH	Good
2	Outhumphone	Chareunsouk	Outhumphone	Savannakhet	16.666944	104.994444		PMH	Good
3	Atsaphangthong	Donghen	Atsaphangthong	Savannakhet	16.706667	105.278611		PMH	Good
4	Sepon	Nonvilay	Sepon	Savannakhet	16.698333	106.206389		PMH	Good
5	Xonbouly	Keokhamdy	Xonbouly	Savannakhet	16.424722	105.469722		PMH	Good
6	kengkok	Dongkhammouen	Champhone	Savannakhet	16.459167	105.185000	China (2022)	DMH	Good
7	Songkhione	Paksong	Songkhone	Savannakhet	16.239722	105.191389	China (2022)	DMH	Good

**Table 4: List of meteorological, Hydrological and EWS stations in Savannakhet Province supported by KOICA**

No.	Name of station	Village	Districts	Province	Coordinate		Type of element	Remark	Status
					Lat	Long			
1	Thahae Village	Kaisone Phomvihan	Kaisone Phomvihan	Savannakhet			LED	DMH	New installed
2	Phonsim	Kaisone Phomvihan	Kaisone Phomvihan	Savannakhet	16.588875	104.875281	RG	DMH	New installed
3	Kouakhaokad	Kaisone Phomvihan	Kaisone Phomvihan	Savannakhet			RG	DMH	New installed
4	Nonvilay	Nonvilay	Outhoumphone	Savannakhet		105.117133	RG	DMH	New installed
5	Phonsavang	Phonsavang	Outhoumphone	Savannakhet	16.820608	105.015428	RG	DMH	New installed
6	Naphangkhek	Naphangkhek	Outhoumphone	Savannakhet			RG	DMH	New installed
7	Donghen	Donghen	Atsaphangthong	Savannakhet			RG	DMH	New installed
8	Kengxaynoy	Kengxaynoy	Phalan	Savannakhet	16.560336	105.557975	RG	DMH	New installed
9	Phontan	Phontan	Phalan	Savannakhet			RG	DMH	New installed
10	Phalantai	Phalantai	Phalan	Savannakhet	16.654936	105.600319	RG	DMH	New installed
11	Tangalai	Tangalai	Phin	Savannakhet	16.278783	105.742819	RG	DMH	New installed
12	Houyhoi	Houyhoi	Phin	Savannakhet	16.411156	106.136833	RG	DMH	New installed
13	Houyxay	Houyxay	Phin	Savannakhet	16.703258	105.940903	RG	DMH	New installed
14	Vernhongkham	Vernhongkham	Phin	Savannakhet			RG	DMH	New installed
15	Oudomxay	Oudomxay	Phin	Savannakhet	16.578703	105.908950	RG, WG	DMH	New installed
16	Tadhaixe	Tadhaixe	Phin	Savannakhet			WG	DMH	New installed
17	Boungkham	Boungkham	Vilabouly	Savannakhet			RG	DMH	New installed
18	Sopmi	Sopmi	Sepon	Savannakhet	16.813931	106.087806	RG	DMH	New installed
19	Gadore	Gadore	Sepon	Savannakhet	16.890331	106.343344	RG	DMH	New installed
20	Dong	Dong	Sepon	Savannakhet			RG, WG,	DMH	New installed
21	Oudomsouk	Oudomsouk	Sepon	Savannakhet	16.698233	106.206436	RG, WG, CCTV, WP	DMH	New installed
22	Lapid	Lapid	Nong	Savannakhet	16.515114	106.337067	RG	DMH	New installed

23	ASingsane	ASingsane	Nong	Savannakhet	16.502828	106.572786	RG	DMH	New installed
24	Nongvilay	Nongvilay	Nong	Savannakhet	16.375511	106.495942	RG, WG, WP	DMH	New installed
25	Dongnokkhoun	Dongnokkhoun	Champhone	Savannakhet			RG	DMH	New installed
26	Lak 35	Lak 35	Champhone	Savannakhet	16.484256	105.043136	RG	DMH	New installed
27	Houymaknhao	Houymaknhao	Champhone	Savannakhet	16.536831	105.397864	RG	DMH	New installed
28	Kengkok nua	Kengkok nua	Champhone	Savannakhet			WG,	DMH	New installed
29	Kengkok kang	Kengkok kang	Champhone	Savannakhet	16.445453	105.196914	WP	DMH	New installed
30	Xianghom	Xianghom	Xonnabouly	Savannakhet	16.393439	105.368172	WG,	DMH	New installed
31	Keokhamdy	Keokhamdy	Xonnabouly	Savannakhet	16.424722	105.469722	RG	DMH	New installed
32	Nonsavang	Nonsavang	Xonnabouly	Savannakhet			RG	DMH	New installed
33	Lakmuang	Lakmuang	Songkhone	Savannakhet			RG	DMH	New installed
34	Senouan	Senouan	Songkhone	Savannakhet			RG	DMH	New installed
35	Lahanam	Lahanam	Songkhone	Savannakhet	16.268861	105.269211	RG, WG, CCTV,	DMH	New installed
36	Kengdon	Kengdon	Songkhone	Savannakhet	16.183607	105.314531	WG, WG, WP	DMH	New installed
37	Donemuang	Donemuang	Songkhone	Savannakhet			WG,	DMH	New installed
38	Sekeu	Sekeu	Thabangthong	Savannakhet	16.019681	106.049203	RG,	DMH	New installed
39	Kathong Nua	Kathong Nua	Thabangthong	Savannakhet	16.193969	105.788222	RG,	DMH	New installed
40	Nonchan	Nonchan	Thabangthong	Savannakhet			RG,	DMH	New installed
41	Thethsaban	Thethsaban	Samouy	Savannakhet			RG,	DMH	New installed
42	Phosen	Phosen	Taoiy	Savannakhet	16.182497	106.698578	WG,	DMH	New installed

Remark: RG: rain gauge station, WG: Water gauge station, WP: Warning Post

## Appendix B: Detailed situational assessment

### Nong District

Element	Current status (floods)	Current status (drought)
Risk knowledge	<ul style="list-style-type: none"> <li>Nong district is vulnerable to Both of flood and drought Risk and It's located in upland of Xebanghiang river, 3 times severed flood occurred 2006, 2011, 2019 and 2020</li> <li>There are more than 15 Villages at risk to flooding, almost was affected flood from Xelanong River which are flow to Xebangheing River in Phin district</li> <li>With minorities group living along the river with Low knowledge on adaptation</li> <li>No action plan for disaster management</li> </ul>	<ul style="list-style-type: none"> <li>Some of village located in highland and living with natural resources</li> <li>Lacking and not enough water in dry season</li> </ul>
Monitoring and forecasting – hydrometeorological infrastructure/services	<ul style="list-style-type: none"> <li>There is one non-automatic rain gauge and one automatic water level gauge in Xelanong River,</li> <li>KOICA, now was completed to installing water gauge and Warning post in Nong municipality and</li> <li>Forecasting information was received Directly from PMH after sent to HMO</li> </ul>	<ul style="list-style-type: none"> <li>No system and warning for water scarcity</li> <li>They are few irrigation systems but its damage and less capacity on water supplying,</li> </ul>
Warning infrastructure/services including dissemination and communication	<ul style="list-style-type: none"> <li>Hydrological network is not covering risk area and less investment for meteorology and Hydrology data collection</li> </ul>	<ul style="list-style-type: none"> <li>Limit on Management and maintenance</li> <li>The system of irrigation was transfer to farmer group responsible</li> </ul>
Response capability	<ul style="list-style-type: none"> <li>In the district are not have action plan for disaster management</li> <li>knowledge and understanding of warning are low,</li> <li>difficult to communication among village-to-village</li> <li>Information system of warning and preparedness are not easy</li> </ul>	<p>Not well known on drought risk in all community, focus only flood in communities</p> <p>80 % of village in that district are using water from stream and ground water</p>

Element	Current status (floods)	Current status (drought)
	<ul style="list-style-type: none"> <li>• local peoples were resolution disaster occurred by themselves</li> <li>• lacking equipment for helping each other</li> </ul>	

### Xepone District (Kenghuapa, Thamae, Soppalou Villages)

Element	Current status (floods)	Current status (drought)
Risk knowledge	<ul style="list-style-type: none"> <li>• Sepon district is vulnerable and exposure to flood and Land slide, it's located in upstream of Xebanghiang river and resettlement along the Vietnamese Mountain area and risk to flash flood and landslide</li> <li>• severed flood occurred in 1990, 2010, 2019 and 2020</li> <li>• 2 rivers flow past and influence on Xebanghiang River; Kok River and xeepon river,</li> <li>• More village along xepon river was affected to flood and 6 villages was resettlement in high zone since 2019 follow up to district planning for flood resolution</li> <li>• Minorities group of more Village living along the river are not enough knowledge on Flood management</li> <li>• No action plan for disaster management in district</li> </ul>	<ul style="list-style-type: none"> <li>• Some of village resettlement highland and living with natural resources</li> <li>• Savue village not enough water in dry season</li> <li>• natural resources were changing and destroy by community</li> <li>• Awareness and campaign peoples in remote area for forest protection and water management are not widely done</li> <li>• Not finish on integrated spatial planning</li> </ul>

Element	Current status (floods)	Current status (drought)
Monitoring and forecasting – hydrometeorological infrastructure/services	<ul style="list-style-type: none"> <li>• There are 2 hydrological stations setting up in 2 rivers at Xepon river Ban Dong Village and Xebanghiang River at Sopnam Village,</li> <li>• One Meteorology and 4 rain gauge stations, one CCTV and one warning post which are installed and improved from KOICA</li> <li>• The system of hydrological service is DONRE responsible and only receiving and transferring daily data forecasting and river water forecasting to line agency concerned</li> </ul>	<ul style="list-style-type: none"> <li>• In the district focus on only flood disaster</li> <li>• Less organization support for drought disaster management</li> <li>• Less irrigation systems in Xepon and limited budget for repair and maintenance</li> </ul>
Warning infrastructure/services including dissemination and communication	<ul style="list-style-type: none"> <li>• There is one warning post which setting in the Meteorology station in Sepon</li> <li>• Weather forecasts and warnings for floods and severe weather events are disseminated to DORE and District Governor’s office</li> <li>• Data dissemination are not cover all area risk, some village and community are difficult to access data, because communication and telecommunication are limited,</li> </ul>	<ul style="list-style-type: none"> <li>• Limit on Management and maintenance</li> <li>• responsible</li> </ul>
Response capability	<ul style="list-style-type: none"> <li>• Lacking knowledge on flood management and adaptation</li> <li>• some of communities are not well known on receiving forecasting</li> <li>• Not enough equipment for rescues and helping peoples during disaster event</li> </ul>	<ul style="list-style-type: none"> <li>• Not well known on drought risk in all community, focus only flood in communities</li> <li>• Water sources for living is from river and stream and some villages are use ground water for consumption</li> </ul>

### Xonnabouly District (Nonsavang, M.hong and Nachan nhai Villages)

Element	Current status (floods)	Current status (drought)
Risk knowledge	<ul style="list-style-type: none"> <li>• Xonbouly district is one of the Vulnerable and exposure to flooding, in particular M.hong village and Nachannhai which is</li> </ul>	<ul style="list-style-type: none"> <li>• 3 of that villages are lacking and not enough water in dry season even through those village are setting along the river but no infrastructure for solving water for</li> </ul>

Element	Current status (floods)	Current status (drought)
	<p>located in the xebanghiang River bank</p> <ul style="list-style-type: none"> <li>• There are more Experience and familiarly to flood adaptation by themselves</li> <li>• Not enough knowledge for flood adaptation</li> <li>• There is one evacuated zone, about 5 hectares, far from village 4 Km, but is not completed and lacking facilities: water consumption systems, shelter...</li> <li>• No action plan for disaster management</li> </ul>	<p>consumption, only Nonsavang village have the system of water supply but not enough for using in dry season</p> <ul style="list-style-type: none"> <li>• Less data and information on drought</li> </ul>
Monitoring and forecasting – hydrometeorological infrastructure/services	<ul style="list-style-type: none"> <li>• There is one non-automatic rain gauge and two automatic water level gauge in Xexangxoy and Xebanghiang River, one Meteorology Station in the Dry Dipterocarp Forest center</li> <li>• KOICA project was now completed to installing water gauge and rain gauge in some area</li> <li>• Forecasting information was received Directly from PMH by application and telephone</li> <li>• No warning post systems and emergency notice, only warning by megaphone from temples</li> <li>• DONRE responsible for weather dissemination but not cover all prone areas,</li> <li>• Difficult for communication and warning because limited internet and telephone Network</li> </ul>	<ul style="list-style-type: none"> <li>• No system and warning for water scarcity</li> <li>• They are few irrigation systems but its damage and less capacity on water supplying,</li> <li>• Lacking infrastructure for service,</li> <li>• Warning system information are not widely known for the local peoples</li> <li>• Less disseminate and giving knowledge to community</li> </ul>
Warning infrastructure/services including dissemination and communication	<ul style="list-style-type: none"> <li>• There is no system of warning only notice by letter or application</li> <li>• Almost warning was from district Governor’ letter and inform after receiving weather or flood forecasting from DONRE (PMH)</li> <li>• The remote areas people can also receive warning and announcement through local authority.</li> </ul>	<ul style="list-style-type: none"> <li>• Low capacity for drought management, local peoples solving and finding water by themselves</li> <li>• Lacking infrastructure for service,</li> <li>• Warning system information are not widely known for the local peoples</li> <li>• Less disseminate and giving knowledge to community</li> </ul>

Element	Current status (floods)	Current status (drought)
	<ul style="list-style-type: none"> <li>No warning post systems and emergency notice, only warning by megaphone from temples</li> <li>DONRE responsible for weather dissemination but not cover all prone areas,</li> <li>Difficult for communication and warning because limited internet and telephone Network</li> </ul>	
Response capability	<ul style="list-style-type: none"> <li>Low-capacity building to response and preparedness for flooding and evacuated when flood event coming</li> <li>Solving problems by community self</li> <li>Lacking knowledge for adaptation</li> </ul>	<ul style="list-style-type: none"> <li>Lacking infrastructure to resolution water scared in communities</li> </ul>

#### Songkhone district (Songkhone, Kengdone and Houykho Villages)

Element	Current status (floods)	Current status (drought)
Risk knowledge	<ul style="list-style-type: none"> <li>Songkhone District are Vulnerability and exposure to flood average 2.7 year of return period</li> <li>Moderated of Experience and familiarly to flood adaptation by themselves</li> <li>Low knowledge and capacity on climate change adaptation are low - There is one evacuated zone, which is setting up by district in Songkhone Village and its about 5 hectares allocated to villager for evacuation which are far from village 4 Km,</li> <li>More village along the Xebanghiang River was risk to flood</li> <li>No action plan for flood management</li> </ul>	<ul style="list-style-type: none"> <li>Lacking water in dry season for Houykho Village,</li> <li>More irrigation system in Songkhone district,</li> <li>No irrigation system in Houy kho village</li> <li>The villager using only ground water for consumption</li> <li>Low understanding on drought risk management</li> <li>Self-resolution to finding water in dry season</li> <li>No action plan on drought risk management</li> </ul>
Monitoring and forecasting – hydrometeorological infrastructure/services	<ul style="list-style-type: none"> <li>There are two non-automatic rain gauges, one automatic water level gauges in Kengdon and one water gauge in Lahanam Villages</li> </ul>	<ul style="list-style-type: none"> <li>No infrastructure for solving water for consumption, only Nonsavang village have the system</li> </ul>

Element	Current status (floods)	Current status (drought)
	<p>which is downstream of Songkhone Village about 3 Km</p> <ul style="list-style-type: none"> <li>The Responsibilities for data collection and Monitoring in that stations belong to district authority</li> </ul>	<p>of water supply but not enough for using in dry season</p> <ul style="list-style-type: none"> <li>Less data and information on drought</li> </ul>
Warning infrastructure/services including dissemination and communication	<ul style="list-style-type: none"> <li>No warning systems, only receiving and informing forecasting information from district and provincial by Cell phone</li> <li>Weather forecasts and warnings for floods and severe weather events are disseminated to district's Governor office.</li> <li>Data forecasting Dissemination is quite late to risk village, even though there are gauge observation</li> </ul>	<ul style="list-style-type: none"> <li>Low capacity for drought management, local peoples solving and finding water by themselves</li> <li>Lacking infrastructure for service,</li> <li>Warning system information are not widely known for the local peoples</li> <li>Less disseminate and giving knowledge to community</li> </ul>
Response capability	<ul style="list-style-type: none"> <li>Low capacity on preparedness</li> <li>Not have integrated Spatial planning and Lacking information concerned to flood and drought</li> </ul>	<p>Focus on only flood but for drought are not</p>

#### Champone district (Dongmeuang, Phiaka, and Sivilai Villages)

Element	Current status (floods)	Current status (drought)
Risk knowledge	<ul style="list-style-type: none"> <li>Two of village (Dongmuang and Phiaka) are risk to flood and one Village (Sivilai Village) is risk to drought</li> <li>There are more Experience and familiarly to flood happened in each year</li> <li>Risk knowledge for flood adaptation are not enough</li> <li>There is one evacuated zone, about 5 hectares, far from village 4 Km, but is not completed and lacking facilities</li> </ul>	<ul style="list-style-type: none"> <li>Sivilai village Suffered to drought risk and salinity intrusion on dry season</li> <li>Not enough water for agriculture in Dry season</li> </ul>
Monitoring and forecasting – hydrometeorological infrastructure/services	<ul style="list-style-type: none"> <li>There are one manual rain gauges station in the DNRE office, and two automatic rain record stations in kengkok and Laosoulinha village, one automatic water level gauge but is not working and record data and one staff gauge in Chanphone Bridge</li> </ul>	<ul style="list-style-type: none"> <li>No ground water monitoring station</li> <li>Lacking infrastructure for service,</li> <li>warning system information for drought are not widely known for the local peoples</li> </ul>

Element	Current status (floods)	Current status (drought)
	<ul style="list-style-type: none"> <li>This district needs to install new rain gauges and water level gauges in Phierka, Dongmeuang and Sakuen Villages.</li> </ul>	
Warning infrastructure/services including dissemination and communication	<ul style="list-style-type: none"> <li>No specific warning systems, but all of data received from PMH after DMH forecasting and sent to provincial</li> </ul>	<ul style="list-style-type: none"> <li>Dissemination information on drought is not doing yet,</li> <li>Forecast information by technical in is not appropriate to be communicated beyond this group</li> <li>Warning system information are not widely known for the local peoples</li> </ul>
Response capability	Rather good on response capacity, but still have some problems with some villages on preparedness, they are often face to flood and adapt themselves	<ul style="list-style-type: none"> <li>Lacking knowledge and capacity for drought response</li> <li>Lacking knowledge on water conservation in agricultural production</li> </ul>

## Appendix C: Existing hydrometeorological equipment



**Figure 8.** *Xechamaphine water gauge of Kengkok, Champhone District*



**Figure 9.** *Xe Bang Hieng River, water gauge at Meuanghong station, Xonbouly District*



**Figure 10.** *Xe Bang Hieng River, water gauge of Sopnam Station, Xepon District*



**Figure 11.** *Xethanmouak River, water gauge of Xethamuak station Phin district*



Figure 12. Water gauge of Xelanong station at Nong district



Figure 13. Flooding 2019 Xianghome station, Xonbouly district

**IWRM-EbA Project**  
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