COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.

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Lao PDR Peer Review Report

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The findings, interpretations and conclusions expressed are those of the named authors alone and do not necessarily reflect those of the agencies involved.

Authorisation for release of this report has been received from the Peer Reviewing Agencies and the Country NMHS as of 05.02.2025.

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Table of Contents

Copyright 2
Disclaimer 3
Acknowledgements 3
Table of Contents 4
Executive Summary 5
Chapter 1: General information 7
Lao PDR 7
Climate 7
CHD methodology 8
Chapter 2: Country Hydromet Diagnostics 10
Element 1: Governance and institutional setting 10
Element 2: Effective partnerships to improve service delivery. 15
Element 3: Observational infrastructure 17
Element 4: Data and product sharing and policies 20
Element 5: Numerical model and forecasting tool application 22
Element 6: Warning and advisory services 24
Element 7: Contribution to Climate Services 30
Element 8: Contribution to hydrology 33
Element 9: Product dissemination and outreach 35
Element 10: Use and national value of products and services 37
Annex 1 Consultations (including experts and stakeholder consultations) 39
Annex 2 Urgent needs reported 41
Annex 3 Information supplied through WMO 42
Annex 4 List of materials used 42
Annex 5 List of Abbreviations 43

Executive Summary

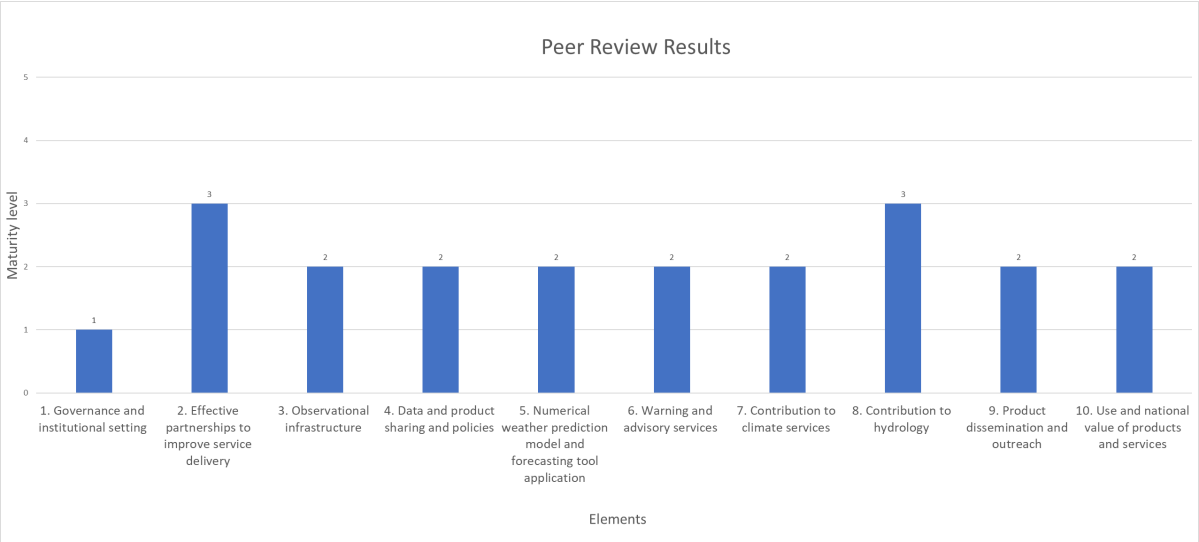
The Department of Meteorology and Hydrology (DMH), under the Ministry of Natural Resources and Environment (MONRE) in Lao PDR is the mandated institution for all meteorological observations, issuing of severe weather warnings, climate products as well as providing information for climate and disaster risk reduction services to a wide range of sectors. In addition, as the hydrologic department, DMH is as well responsible for water level monitoring and flood monitoring and forecasting for major rivers in the country.

In recent years, DMH has undergone significant upgrades in terms of infrastructure (including monitoring stations and forecasting systems among others) and improvements of human capacity, mostly based on third party funding and capacity development initiatives. However, despite these efforts and the fact that DMH plays a critical role in the country, the institution still faces significant challenges affecting all the elements evaluated in the CHD:

1. Lack of personnel resources – It is therefore difficult to match personnel resources with increased needs regarding technical and observational capacity. Due to the inherent variability of the funding situation, the organization keeps suffering the loss of qualified staff. There is a close collaboration with the national university in Lao PDR that could be exploited to channel personnel resources into operations. Unfortunately, DMH has only limited capacity to absorb the expertise generated despite the fact it would urgently need it. This leads to challenges on sustainability and ultimately a shortage of trained experts (lack of meteorologists and hydrologists) that are required.
2. Project dependence and limited coordination – there is a wide range of initiatives that have brought additional capacity into the country and in particular to DMH. Unfortunately, these initiatives are usually project-based, with a limited duration and technical scope and unrelated to each other. This results in an enhanced overall capacity that cannot be sustainably absorbed by DMH, in limited capitalization of the effort invested with potential overlapping actions, again stretching the already limited personnel resources of the institution. Last but not least, the limited coordination among the various actors may lead to issues in interoperability and maintainability of systems, causing bottle-necks with regard to data integration and hampering a comprehensive and effective usage of the resulting data.
3. Limited feedback mechanisms and stakeholder engagement – DMH has only a basic user feedback mechanism in place which limits the possibility to refine and improve the accuracy and usability of the services. The inclusion of a user-centered approach might as well enhance visibility of DMH and in turn highlight the national relevance of the institution. This can positively affect decisions regarding a proper funding of DMH.
4. Lack of cost-recovery mechanisms – since DMH is a solely governmental entity, it has very limited options to initiate cost-recovery mechanisms and to finance staff based on services offered at the market.

In summary, Lao PDR NHMS has existing capacity that provides a good basis for further development in a coordinated way.

The peer reviewed results are presented in Fig 1 below.



Element	
1. Governance and institutional setting	*1*
2. Effective partnerships to improve service delivery	*3*
3. Observational infrastructure	*2*
4. Data and product sharing and policies	*2*
5. Numerical weather prediction model and forecasting tool application	*2*
6. Warning and advisory services	*2*
7. Contribution to climate services	*2*
8. Contribution to hydrology	*3*
9. Product dissemination and outreach	*2*
10. Use and national value of products and services	*2*

Figure 1. Maturity level scores for DMH based on the CHD Methodology.

Chapter 1: General information

Lao PDR

Lao People's Democratic Republic is an elongated landlocked country located in south-eastern Asia with latitudes spanning from 22º 30' N to the north and 13º 54' N to the south. The country shares borders with China on the north, Cambodia on the south, Thailand on the west, Viet Nam on the east, and Myanmar on the northwest. The country has a total area of 237,955 km2 divided into 17 provinces (Figure 2). Lao has a rugged topography, especially in the northern and eastern borders. Its thickly forested landscape is generally comprised of rugged mountains in the north and east with plains and plateaus towards the south west. Lao PDR, with a total estimated population close to 7.5 million, has one of the lowest population densities in Asia. A large proportion of its population is still living in rural areas. Lao PDR belongs to the list of Least Developed Countries (LDC). It is therefore very vulnerable to disasters and extreme events that will only be exacerbated with the effects of climate change.

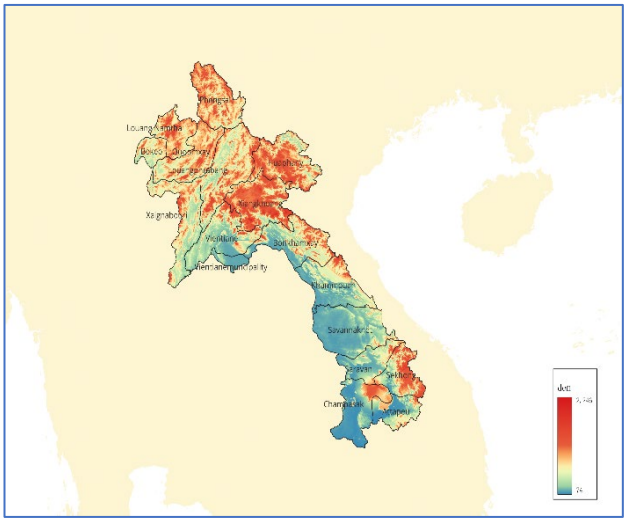


Figure 2: topographic and policical map of Lao

Climate

Lao PDR has the typical monsoon climate with two seasons, the rainy season spanning from May to October, and the dry season, from mid-October to April with some variability from northeast to southwest. The average annual rainfall varies between 1400 mm and 2500 mm, reaching above 3500 mm in the mountainous regions of the center and the south (Figure 3, left). Temperatures (Figure 3, right) follow also those of a tropical climate with lowest temperatures close to 16 ℃. However, in the subtropical northern regions, temperatures can dip significantly lower. Lao is highly sensitive to meteorological or meteorologically driven hazards. Precipitation, or lack of precipitation in the form of droughts, are the dominant hazards in the country and severely affect its population, infrastructure, and the economy. Floods, which is the most frequent hazard, occur typically from May to September, upon accumulation of monsoon rains upstream, while droughts occur between November and March. Tropical storms and landslides are as well impacting Lao PDR.

Overall INFORM risk: 4.0 [0-10]

Hazard and exposure: 3.0 [0-10]

Vulnerability: 3.6 [0-10]

Lack of coping capacity: 6.0 [0-10]

Global warming is expected to increase both the frequency and intensity of extreme hydrometeorological events and therefore lead to increased impacts in the Lao society that may hinder economic growth and development. Presently, the country lacks the adaptive and coping capacity to effectively respond to the forthcoming challenges. The 2019 Inform Risk Index (DRMKC-Inform then **INFORM Risk Index 2023**) ranks Lao PDR 69th out of 191 countries in terms of disaster risk level. The country is considered to have extremely high exposure to flooding (ranked 6th), including riverine and flash flooding. Although drought exposure is ranked 115th, the country's vulnerability is high given its reliance on the agriculture and hydropower sectors.

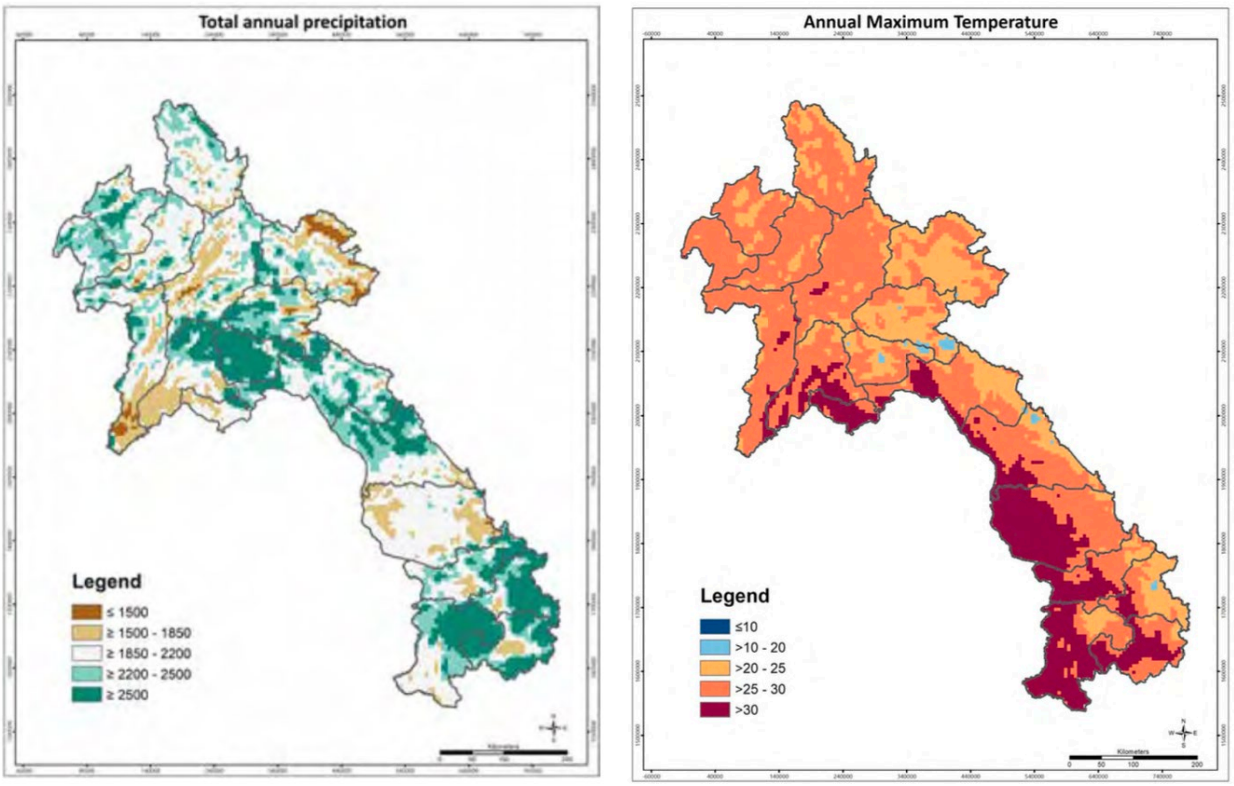


Figure 3: left, 1990-2019 average of total annual precipitation. Right, 1990-2019 average annual maximum temperatures (FAO, MONRE and MAF. 2022. Climatology and agroclimatology atlas of the Lao People's Democratic Republic. Vientiane. https://doi.org/10.4060/cb9713en)

CHD methodology

The Lao People's Democratic Republic (Lao PDR) Country Hydromet Diagnostics (CHD) has been performed under the Systematic Observations Financing Facility (SOFF) umbrella in which the DMH is peer-advised by GeoSphere Austria and China Meteorological Administration in partnership, together with the World Bank as the SOFF Implementing Entity. The CHD includes an assessment of the National Hydrometeorological Service of Laos's monitoring, forecasting, projection and warning systems for climate-related hazards, across timescales (from nowcasting for rapid onset hazards to downscaling for large-scale and long-term climate projections). To achieve this goal, CMA and GeoSphere Austria have performed a remote-based survey of relevant systems and capacities. Additionally, an on-site visit was carried out to facilitate in-person discussions, ensuring a comprehensive understanding of the institution's reality. This CHD has been largely informed by the very complete and recent "Assessment of Capacities of the Department of Meteorology and Hydrology (DMH), Lao PDR", March 2023, under the CREWS Cambodia and Lao PDR and through the WMO and the regional Integrated Multi-hazard Early Warning Systems (RIMES), hereafter called "the 2023 RIMES assessment report".

The CHD integrates existing approaches, standards and data provided by WMO and partners, using a peer review approach. The CHD methodology (2022 update of the Country Hydromet Diagnostics) has been developed under WMO leadership and with guidance of a multi-party Working Group of the Alliance for Hydromet Development. The CHD aims at informing policy and investment decision-making, in particular guiding investments of the members of the Alliance for Hydromet Development. The Alliance brings together major development and climate finance partners behind a joint commitment to strengthen developing country hydromet capacity. Through the Diagnostics, developing countries are expected to benefit from better targeted and aligned financial and technical support.

Following the defined methodology, the CHD is based on the ten most critical elements of the hydro-met value cycle, grouped under four categories – (i) enablers, (ii) observation and data processing system, (iii) service and product production and dissemination, and (iv) user and stakeholder interaction.

For each value cycle element, a limited number of standardized indicators is used, and each indicator uses explicitly defined data sources. The assessment of these critical elements of the National Meteorological Service should lead to their maturity level. Note that Level 5 is the highest attainable maturity level in the CHD assessment. This report is presented along the ten most critical elements of the hydromet value cycles with an indication of their respective maturity level and some high-level recommendations to help lift up that maturity level, and as above mentioned, with a special emphasize on monitoring, forecasting, projection and warning systems for climate-related hazards, across timescales.

Chapter 2: Country Hydromet Diagnostics

Element 1: Governance and institutional setting

1.1 Existence of Act or Policy describing the NMHS legal mandate and its scope

The Department of Meteorology and Hydrology (DMH), has been under the Ministry of Natural Resources and Environment (MONRE)[1] since 2011, and its provincial branches are under the Provincial Office of Natural Resources and Environment (PONRE). MONRE[2] is the responsible ministry for the country's natural resources and environment. MONRE's activities in relation to DMH include the establishment of effective warning systems for hydrometeorological and geological hazards, the improvement and creation of corresponding monitoring stations for the aviation, agriculture and food security sectors, and the dissemination and management of data and information on natural resources and the environment. Very importantly, the Ministry also oversees the management of assets, finance and budgets as well as the collection of fees, service charges and income from natural resources and environmental activities, including meteorology and hydrology. MONRE possesses the authority to formulate amendments, laws, technical services and to sign treaties, protocols and Memorandums of Understanding in relation to natural disasters, climate change, meteorology and hydrology. Last but not least, MONRE is the ministry that decides on the funding allocation for DMH activities and staff.

In 2017, the Law on Meteorology and Hydrology was established[3], In more than 60 articles, this law delineates the basic regulations for the meteorological and hydrological activities in the country, and therefore establishes the baseline for the activities of DMH together with the Decree on the management of meteorological and hydrological stations. The law and decree outline the main national hydrometeorological strategic aspects, the relations with regional and international actors, the monitoring capacity of the country and additional relevant aspects on early warning systems. It therefore sets the mandate of DMH following the current standards of NHMSs. However, while the law sets the initial steps towards the development of an actionable strategy, to date there is no coordinated action plan on the execution of the law.

In addition to the aforementioned law, there are several national policies and plans in place, especially in the area of disaster risk management and reduction, that are relevant for the activities of the Lao PDR NMHS. Among them the following can be highlighted:

1. Prime Minister's Decree No 158 (1999), No 373 (2011) and No 220/PM (2013), that together set the ground for disaster management policies, generate the corresponding National Disaster Management Committees and National Disaster Prevention and Control Committee, and establish the Department of Disaster Management and Climate Change under MONRE.
2. Prime Minister's Decree on Climate Change 321/2019, outlining mitigation and adaptation strategies.
3. The National Strategy for Disaster Risk Reduction (NSDRR) 2021-2030 and the Five-Year Labor and Social Welfare Development Plan from 2021 to 2025, which provide the vision and the main strategies to reach the NSDRR goals, as well as the key points to strengthen prevention control and recovery aspects.

[1] http://www.monre.gov.la/
[2] MONRE was created based on Prime Minister Decree No. 435, 28 November 2011, https://flegtlaos.com/wp-content/uploads/2015/10/2011-No-435-PM-Decree-on-establishment-of-MONRE.pdf
[3] https://faolex.fao.org/docs/pdf/lao184237.pdf - *official translation*

4. The Early Warnings for All (EW4All) roadmap for 2024–2027 aims to protect 80% of the population with multi-hazard early warning systems by 2027, through the implementation of targeted actions outlined in the roadmap[1].

Detailed descriptions of existing or relevant laws, policies and strategies can be found in the document "Assessment of Capacities of the Department of Meteorology and Hydrology (DMH), Lao PDR" (March 2023, CREWS Cambodia and Lao, WMO, RIMES), Appendix D. 2023 RIMES assessment report

The DMH has no strategic plan running or currently in place. The agency is, however, expected to work on a new strategy plan in the near future.

DMH mandate is to provide the national meteorological and hydrological services as well as monitoring of earthquakes in the country. The main responsibilities are:

1. Assess, develop, operate and maintain monitoring stations for meteorology, hydrology, agricultural meteorology, aviation and earthquakes;
2. Monitor, collect and analyze hydro-met data, aviation meteorology and seismic data
3. Coordinate with MONRE and related sectoral agencies in drafting, updating and implementing laws, decrees, regulations, policies, strategies, guidelines and programs related to meteorology, hydrology, earthquakes and early warning systems;
4. Coordinate with relevant stakeholders in organizing workshops, seminars, training on meteorology, hydrology, earthquakes and early warning.

1.2 Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

While there is a set of Decrees and several policy documents in place, there is so far no actionable long-term hydro-meteorological strategy or action plan in place other than the 2017 Law on Meteorology and Hydrology. There are no formalized or structured Quality Management and Control systems for overall institutional risk management approaches.

1.3 Government budget allocation consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions

The primary source of funding of DMH is the government, with a free-of-charge policy for most stakeholders such as government agencies, researchers and students, and a free and open access to real-time monitoring data from the DMH website. There is very little income from commercial or third party activities and limited to no cost-recovery approaches in place. Similarly, payments for the provision of data and aviation forecasts to Laos Air Traffic Management and airline companies go directly to the Ministry of Finance. The Ministry of Finance, through MONRE, covers DMH staff salaries. Other costs (utility costs, maintenance, administration and office costs) are covered directly by MONRE. In 2023 the total Budget of DMH headquarters was 5 billion KIP of which 4.5 billion are salaries. The provinces' offices are managed by PONRE and while the personnel (observers and station caretakers) are outside the control and responsibility of DMH, their basic funding comes from DMH's funding envelope.

DMH is not able to generate sufficient external revenue for the much-needed technical maintenance of its equipment and the recruitment of staff. On the contrary, external revenue, if any, cannot be invested in

[1] https://laopdr.un.org/en/282223-early-warning-all-ew4all-roadmap-2024-2027

personnel and other procurement actions. In addition, DMH relies on internationally funded projects to help coping with some of its operational costs, incl. deployment of infrastructure and station operations.

It is to be noted that currently there is a significant loss of essential memory and expertise due to staff retirement. Unfortunately, once a retirement occurs, the position is usually discontinued. This makes knowledge transfer more difficult. As of Dec. 2024, two new positions have been registered to DMH based on the quota by the government. Both positions are in the field of ICT.

A formal cost-benefit analysis of DMH activities is neither available nor planned at the time of writing the report.

1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS.

Table 1. Staff members directly under DMH

DMH	Male	Female	Total
Headquarters	28	28	56

Table 2. Roles of the staff members of DMH
(Please note that one person can perform more than one role)

Areas of expertise	Total	PhD	MS/MA Graduate	BS/BA Graduate	Diploma	Certificate
Weather forecaster	8	0	0	6	2	0
Climatologists	8	1	0	3	3	1
Hydrologists	6	0	3	1	2	0
meteorological technicians	9	0	0	3	2	4
aviation meteorologists	4	0	0	3	0	1
Agrometeorologist	8	1	0	3	3	1
ICT	2	0	0	2	0	0
Other	37	1	3	19	11	2

Tables 1 and 2 do not include the personnel under DONRE and PONRE since they are not staff members of DMH. However, since they are part of the maintenance and handling of the stations, they are indeed considered in the human capacity development module as an essential part of sustainability of the network and to capitalise on existing structures in the country.

The table shows that most DMH staff have a bachelor's degree, then followed by those with a diploma.

The National University of Laos established a Faculty of Water Resources with sub-units and specialization in meteorology and hydrology. This university has a close collaboration with DMH, with joint courses and seminars, and shows interest in exploring further cooperation under existing national and international umbrellas. The university is also equipped with a manual surface weather station that enables hands-on activities to the potential students. It was, however, highlighted during the on-site visit that the facilities and equipment are outdated and require an update to perform training activities in optimal conditions. Despite the good cooperation and the existing good will on both sides to exploit synergies and establish cross-institutional actions, the institutional settings and recruitment regulations prevent a regular recruitment of freshly graduated students by DMH. This is particularly influenced by the fact that the Ministry of Interior issues an annual quota for the number of new government staff that can be hired.

1.5 Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general.

DMH technological capacity has been expanded in the last years with the investments from external projects (Table). DM3H is well experienced in working with international partners on capacity development projects. However, managing the numerous international projects stretches the resources of staff members, causing an over utilization of staff time with potential delays in project implementation.

Table 3. List of International Project as of November 2023.

Project Name	Donor	Status
Improve Early Warning System for Disaster Response in Lao PDR	South Korea	Ongoing
Southeast Asia Disaster Risk Management Project	World Bank	Ongoing
Reinforcing the capacities of hydro-meteorological services and enhancing early warning systems in Cambodia and Lao PDR	CREWS Initiative WMO, World Bank and UNDRR	Ongoing
Enhanced Severe Weather Response Utilizing an Integrated Typhoon Monitoring and Forecasting Platform in Lao PDR	South Korea-KMA	Completed
Establishment of Climate Change Adaptive Flood Forecasting and Warning System (FFWS) in Xe Banghieng, Savannakhet Province, Lao PDR	South Korea-MoE-K Water	Ongoing
Establishment of Effective Water Resources Management System and Enhancement of Disaster Response Capabilities for Nam Ngum	South Korea-KOICA	Ongoing
Construction of Sub-Centers for the Operation and Maintenance of the Lao National Water Resources Information and Data Center Project	China	Ongoing
Lao National Earthquake Data and Information Center Project	China	Ongoing
Mekong Integrated Water Resources Management Project	World Bank	Completed
Master Plan on Nationwide Flood Forecasting and Early Warning System in Lao PDR	South Korea	Completed
Strengthening Agro-Climate Monitoring and Information System (SAMIS) to improve adaptation to climate change and food security in Lao PDR	FAO, GEF	Completed
The Project for Establishment of Weather Disaster Monitoring System	JICA	Completed
Lao National Water Resources Data and Information Center Project	China	Completed
Flood and Drought Risk Management and Mitigation Project	ADB	Completed

It is important to note that all of the above-mentioned projects address only specific development issues without including a research component, and often lack a sustainable long-term perspective. DMH cannot hire new staff members based on project or third party funding due to the quota approach by the government.

The institutional memory resides within a very small group of staff members, who are aware of past and present projects and retain most of the available knowledge and information. This small number of essential staff members may constitute a corporate risk.

There are no research projects ongoing or in the pipeline.

Summary score and recommendations for Element 1

The CHD Element 1 score for the "Governance and Institutional Setting" is assessed as Maturity **Level 1** on the CHD scale, reflecting " Weakly defined mandate; serious funding challenges; essential skills lacking; little formalized governance and future planning.". In essence the critical challenges are the limited staff resources, insufficient funding and lack of long term strategic plans at national level.

Numerous international activities are currently underway in Lao PDR. As a result, DMH largely rely on project fundings for both human capacity development and infrastructure implementation. Such projects usually have specific actions on technical training, on station management, numerical weather prediction, early warning systems etc. Although these initiatives are offering opportunities and provide a push to the institution, it also comes with associated challenges. Among them the most critical are: limited coordination may lead to effort duplication, inefficiencies and potentially conflicting strategies; the potential resource fragmentation, with resources spreading across areas and projects and with a limited overall impact at institutional level; data management challenges that can arise from the implementation of different systems with incompatible data formats or requiring significant data integration efforts; short term approaches that are only maintained through the duration of the project and, very importantly, lack of ownership and responsibility for sustained development within the national structures.

Recommendations:

1. To advocate towards the generation of an actionable national strategic plan to implement the decrees already existing and strengthen the activities of the NHMS into a wider national plan with all the relevant stakeholders engaged.

2. To enhance the visibility of DMH in order to highlight its relevance both nationally and internationally. This visibility would ideally serve as incubator for enhanced government funding and increased staff quota for sustained operations.

3. To investigate the possibility to add flexibility to the recruitment processes, in particular to enable the hiring of third-party funded staff for short- and long-term positions.

4. To spend more efforts in strengthening DMH official cooperation with international organisations in a coordinated manner with long-term strategical goals defined by DMH, in cooperation with the respective stakeholders and main ministerial actors.

Element 2: Effective partnerships to improve service delivery.

2.1. Effective partnerships for service delivery in place with other government institutions.

DMH is a government institution servicing the ministries and related departments that require weather, climate or hydrological information. Among them it is important to highlight the close cooperation with the Ministry of Labor and Social Welfare and its National Disaster Management Office, with the Emergency Operation Center, where DMH strongly contributes to response activities with hydrometeorological information and participating in the relevant meetings as needed. Similarly, and considering the high relevance of the agricultural sector in the economy of the country, DMH exchanges information with the Ministry of Agriculture and Forestry, with weekly and seasonal forecasts. Additional close exchanges occur with the Ministry of Energy and Mines and the Ministry of Health. DMH also collaborates closely with other government departments on definitions of early warning systems, water resources management, specific agro-meteorological services and on impact-based and impact-oriented approaches. DMH has the flexibility to establish and sign Letters of Agreement or Cooperation Agreements, but no MoUs or higher-level partnership documents that are legally binding. This mandate resides solely at the ministerial level. One Letter of Agreement was established for the aviation services.

2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects.

With academia and research institutions

As already in Element 1, DMH has a long-term collaboration with the National University of Lao with exchanges and also participation in training sessions, especially with Faculty of Water Resources (FWR) and Faculty of Environment. The collaboration however does not lead to a regular transfer of human capacity from the university to DMH due to the quota approach in governmental staffing procedures.

With public and private sector

The delivery of information is part of the mandate of the DMH, and the data is mostly free and open for research purposes. There are some small commercial services existing, but with very limited revenue. Currently there are no existing partnership with the private sector.

With the private sector, research centers and academia in international level

In 2023 and 2024 extensive training was provided to DMH staff by professional trainers from Campbell Scientific France (CSF), as one element of the contract between DMH and CSF which includes also the supply of computer hardware and software systems. This contract comes under the World Bank "South-East Asia Disaster Risk Management" (SEADRM) project which has supported infrastructure development and capacity building at DMH over recent years. A summary of the training provided is as follows:

Weather Forecasting, Climate Services and Impact-based Forecasting	20 days
Using the CSF "Messir NEO" integrated system – for IT staff	10 days
Using the CSF "Messir NEO" integrated system – for Application Managers	10 days
Using the CSF "Messir NEO" integrated system – Forecasters	10 days

In addition to the 50 days of formal training delivered, the CSF trainers hold regular online sessions with the DMH forecasters to assist them in becoming familiar with all of the capabilities of the integrated software system. CSF plan to deliver an on-site refresher training course of 10 days duration in mid-2025.

Bi- and tri-lateral collaboration with neighboring countries are usually under the umbrella of specific projects, and mainly with meteorological administration of other countries, not the public/private sector.

2.3. Effective partnerships in place with international climate and development finance partners.

Through capacity development activities, there are numerous exchanges with development finance partners and also other international climate and weather actors, however with no LoA or other approach to a structured and formalized partnership has been established. Projects are funded, among others, by WMO, the Asian Development Bank, the World Bank, and the Food and Agriculture Organization.

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

Through capacity development activities and the establishment of informal partnerships, new product and service capabilities have been implemented in aspects such as agricultural services, climate monitoring, earthquake monitoring, and weather forecasting. These external actions should be continuously coordinated and further utilized and exploited. On the longer run, they should feed into domestic services as well as continued research activities and programs.

Summary score, recommendations, and comments for Element 2

Numerous organisations and agencies collaborate with DMH within long- or short-term activities or projects. However, DMH has little overall influence on these relationships. The overall lack of coordination and limited scope of the collaborations pose a risk to the sustainability of the activities, may lead to fragmentation as well as duplication of efforts, and may inhibit the overall strategic development at the institutional level.

The maturity level of the Effective Partnerships is assessed to be at **Level 3**.

Recommendations:

1. Improve formalized collaboration and establish long term partnerships with other ministries and their departments, through service agreements and the establishment of platforms with, e.g., the ministry of agriculture, the ministry of water and the ministry of mining.

2. Plan and carry out effective, formalized, contractually regulated partnerships with the private sector, such as power companies, telecommunications companies, energy companies, etc. in order to attract new users for potential products and services, while also supporting the sharing of observational data that are based on user requirements.

3. Strengthen the collaboration with national and international universities, including update of teaching materials; provide guidance on academic curricula in a planned and structured way; participate in regional or international academic cooperation.

Element 3: Observational infrastructure

3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.

DMH is currently operating 64 Automatic Weather Stations (AWSs) and 49 manual weather stations (Figure 4). These stations were funded by different implementation agencies under different projects. The technical characteristics of both instruments and infrastructure of AWSs differ from project to project, and hence the observed variables and data formats are inconsistent and have different levels of transmissivity and potential for in-house data usage. Therefore, while the network is quite dense, the lack of consistency, the lack of interoperability and the lack of data interfaces are severely impairing the full exploitation of the observational capacity. Regarding operational data exchange, there are 19 stations partly exchanging data through the GTS. However, the data frequency and variables do not meet the requirements of GBON.

DMH currently does not operate any upper-air stations.

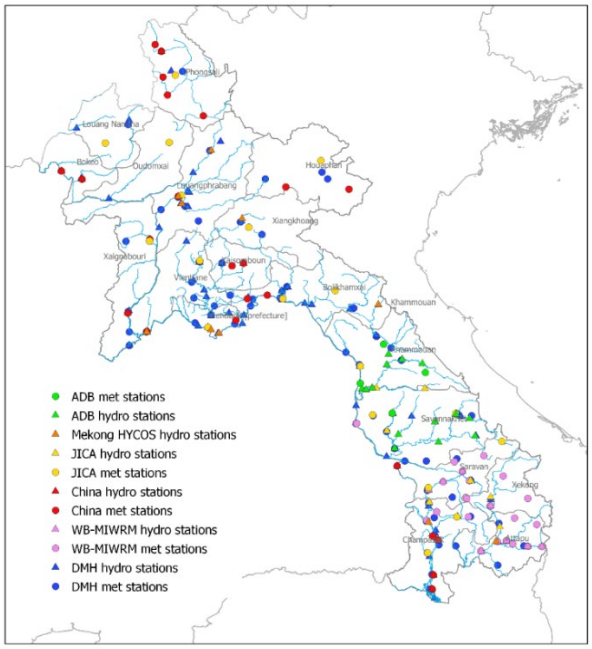


Figure 4: Automatic and manual weather stations of DMH

3.2. Additional observations used for nowcasting and specialized purposes.

Besides AWSs and manual stations, DMH operates 119 stand-alone rain gauges. DMH also used to operate a radar at its headquarters. However, the radar is no longer functioning and the costs for repairing would surpass the costs of a brand-new infrastructure. There are already now ongoing discussions with South Korea to procure a new operational radar.

3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational network.

DMH has a set of light technical guidelines that act as SOPs for the utilization and retrieval of observation data, but not for the procedures required for service provision.

Both from the technical infrastructures and services provision viewpoint, DMH is lacking a structured and sufficiently automated quality assurance and quality control mechanisms. Control and assurance are performed manually and based on a best-effort approach through manual observation logs. As this capability would be essential for a sustained and robust NMHS, the development of automated QA/QC processes should be included in any future project and, specially, in the development of a potential long-term prioritization strategy that should guide the need for capacity development actions.

It is to be noted that DMH faces some additional challenges in relation to the current observational network:

- Different typology of stations impairs the overall maintenance effort (spare parts of different types, knowledge specific to equipment, etc.) and limits the possibility of generating consistent practices across networks and the creation of proper data interfaces.
- Maintenance activities in remote stations are expensive due to the limited access and the complex topography. It is therefore recommended to establish a 2-level maintenance approach whereby basic maintenance and correction of small-scale technical issues can be done locally while only larger upgrades or maintenance actions would be performed by the headquarters staff.
- Unused or underused infrastructure. In addition to station sites, major infrastructures were established during capacity development projects that are not properly utilized after finishing the respective project. For instance, a specific calibration lab (for pressure and temperature) was funded and deployed through FAO, and this infrastructure is currently underused.

3.4. Implementation of sustainable newer approaches to observations.

Currently there are no sustainable approaches in place to observations other than the annual budget, which varies and is solely dependent on the Government. The last solicitude for maintenance and operations of stations was not even granted. This is a clear institutional and national risk to be considered in any activity, taking into account that observations are an essential cornerstone of any functioning weather service. Additionally, observations are essential input for climatological studies and activities related to the complete cycle for disaster management.

SOFF has a sustainable focus that will be useful for the activities of DMH. However, SOFF does not have the mandate to fund the staff that is required for the sustained maintenance of the observational capacity.

3.5. Percentage of the surface observations that depend on automatic techniques.

57% of the weather stations are automatic. DMH Lao PDR is connected to the WIS/GTS via the Regional Telecommunications Hub in Bangkok. The direct connection is operational and there is a back-up connection via DWD. DMH is also connected directly to the WIS centre in Tokyo (GISC); one connection is functioning while a second back-up connection awaits whitelisting of the relevant IP address by Tokyo. Synoptic and climatological data are collected manually from domestic stations, and manually entered into the GTS message switching PC in TAC. Manual Rain gauge data are manually entered as well.

Data transfer from automatic hydro-meteorological stations works through GPRS (General Packet Radio Service). Observation data from manual weather and water level stations are reported to DMH Headquarters every morning through phone call or WhatsApp. These are manually recorded in logbooks and in an excel file in desktop computers for integration in analysis, modelling and forecasting.

Summary score, recommendations, and comments for Element 3

The maturity level of the observational infrastructure is assessed to be at **Level 2**, reflecting "Basic network, large gaps, mostly manual observations with severe challenges and data quality issues."

The main recommendations based on the assessment of this level are:

1. The country would benefit from having DMH operate a radar, as was once the case. It is recommended to restore the radar capacity.

2. To facilitate maintenance, especially in remote or difficult to access stations, a two-level maintenance strategy should be developed. Training should be performed at the regions to facilitate decentralized maintenance.

3. Develop a prioritization strategy in line with the aims of DMH to coordinate and guide the implementation of the capacity development projects. This would optimize the synergies between the projects.

4. Initiate the development and establishment of a proper QC/QM plan based on the above.

5. Develop an SOP for operations and maintenance of stations.

6. It is recommended to first focus on the upgrade of the observational elements of the existing 6 GTS surface weather stations, in order to reach the standard density and quality compliance (increased observing frequency, inclusion of all parameters and reduced delays in transmission).

7. Take into consideration the expansion of the capacities of the existing calibration lab, utilizing in-house staff resources and existing expertise. Subsequently, the Lab could be positioned as a calibration lab for the region. This is a long-term strategic goal that would require significant and sustainable investment.

8. All these steps should be accompanied with an adequate training program for the engineers, technicians as well the staff working on the QC of the data.

9. Develop and establish a proper in-house data access and data handling infrastructure to foster broad utilization of the data.

Element 4: Data and product sharing and policies

4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centres.

At present, the percentage of GBON compliance is zero, for surface as well as for upper air stations.

According to the statistics of the surface stations obtained through the RWC-Beijing and based on the WIGOS Data Quality Monitoring System, DMH registered 25 surface stations to OSCAR/Surface and 19 stations exchange data through GTS (Figure 5). The inclusion of data into the GTS is performed manually. Four stations transmit data every three hours (orange dots in Figure 5); 13 stations transmit data five times a day; and the remaining two stations four times a day. No reporting of precipitation at any of the 19 stations. Therefore, establishing automatic data transmission capability and improving the frequency and elements of data sharing are urgent tasks for DMH.

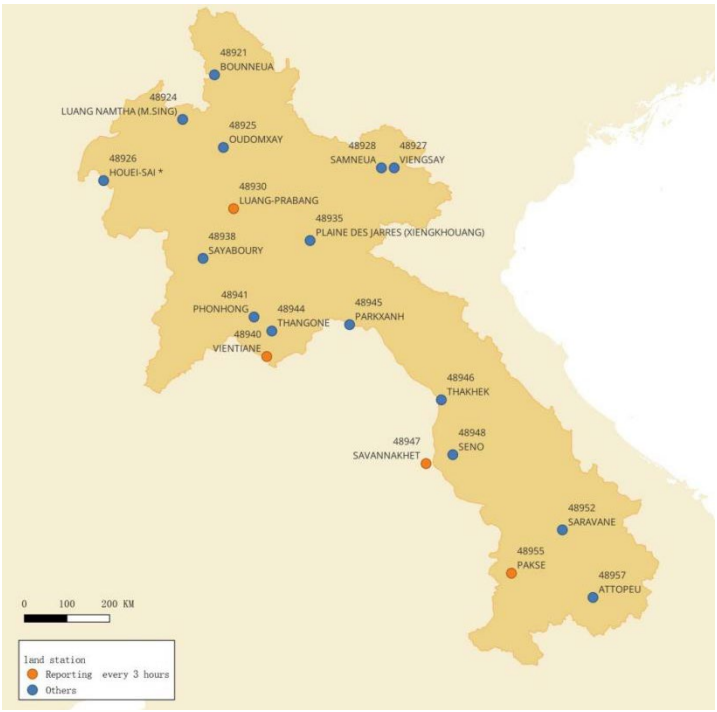


Figure 5: The distribution of Laos surface stations exchanging data (manually) by GTS. The orange dots correspond to those stations that provide all day round information in intervals of three hours. The blue dots are those stations that do transmit to GTS but only during daytime and in different intervals.

4.2. A formal policy and practice for the free and open sharing of observational data.

Article 43 of the 2017's Law on Meteorology and Hydrology stipulates the provision of access to hydro-meteorological data and information through a database for individuals, entities, and organizations. This leads de facto to a free of charge data policy. Upon submission of official request letters to the institution, the agency offers data free for research purposes. However, access to and utilization of hydro-meteorological data for investment or business purposes incurs fees and service charges, the amounts of which depend on the parameters and time period of the requested data. Nevertheless, these charges cannot be invested into hiring of new staff.

4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data.

DMH receives external data from various sources, including WMO Centers' websites, the US Geological Survey (USGS), NOAA, Bangkok Regional Telecommunication Hub in GTS Circuits Association II, Japan's Himawari Satellite, CMA Cast, and South Korea's communication ocean meteorological satellite.

DMH has the capability to receive satellite data from various sources, including the Korean Communication, Ocean and Meteorological Satellite-1 (COMS-1), the Chinese FengYun satellites, and the Japanese Himawari-8 satellite (formerly the Japanese Multifunctional Satellite). This data is accessed through channels such as the China Meteorological Administration Satellite Broadcasting System (CMACAST), the Himawari-8 Satellite Data Broadcasting System (HIMAWARICAST), the World Meteorological Organization Global Telecommunication System (GTS), and the internet. Since 2016, the transmission speed of the GTS has been increased to 128-kbps.

We should note, though, that DMH staff mention they have access to processed satellite products only, not raw data. The data comes through satellite receivers at DMH (Himawari 8, FY and GK2A) and it is accessible to the forecasters.

Summary score, recommendations, and comments for Element 4

The maturity level of the Data and Products Sharing and Policies is, assessed to be at **Level 2.** Reflecting "A limited amount of GBON compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing."

Based on the assessment of Element 4, the following recommendations are provided:

1. Currently, the automatic transmission of surface station data to the WMO WIS is not possible. It is therefore essential to introduce a data management system with an interface to WIS 2.0. Such an activity should be funded, in a coordinated fashion, by the capacity development projects existing both in the country and in the region.
2. To provide the operational center with adequate data handling equipment, with particular emphasis on data interfaces to the different station typologies within the network.
3. To consider, in order to facilitate cost-recovery approaches, a revision of the data policy, with potentially more competitive rates for tailored data services building on the importance of making use of the authoritative voice. Furthermore, such income should be available to DMH to hire staff.

Element 5: Numerical model and forecasting tool application

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

DMH actively utilizes forecast products from various World Meteorological Centers (WMCs) and Regional Specialized Meteorological Centers (RSMCs) to support its service delivery. Numerical weather prediction (NWP) products used for forecasting at DMH come from both local limited area models (LAM) and global models.

For short to medium range forecasts, the following data sources are mostly used: JMA SATAID, ECMWF forecast charts and EPS data, JAXA GMap, Earth Wind Map, SWFP from Regional Forecasting Support Center (RFSC) Hanoi, GSM model (JMA), RSMC Tokyo Typhoon Center data for typhoon forecasts, guidance and data from RSMC Hong Kong.

For monthly to seasonal forecasts, the data used is mostly from ECMWF, SCOPIC, FoCus and the WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble.

Under WMO training programs, DMH staff is trained to access and use WMCs/RCs products and guidance for forecasting of hazards. The level of access to products provided by global and regional centres visibly improved in recent years. Although weather forecasters in Laos can refer to the results of multiple models, such as ECMWF, GFS, CMA, KMA, JMA, etc., there has been until recently no unified integrated display and analysis tool platform or system in place. Through the World Bank SEADRM project, Campbell Scientific France are installing the Messir NEO integrated system in DMH; this includes modules for the integrated display and analysis of meteorological data, and also a platform for the development and issue of forecast and warning products. The installation and configuration of Messir NEO at DMH is scheduled to be fully complete by Q3 2025.

World Bank experts have conducted training of DMH personnel on how to establish a forecast verification system, and a simple system has been established. This work was supported by the CREWS regional project which has engaged the World Bank, WMO and UNDP in capacity-building activities in Lao PDR and Cambodia.

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

DMH currently does not have the capability to run operational numerical weather forecasting models on its own. There is a certain degree of ability to run the WRF model, but without data assimilation.

A project with KMA is currently in the approval process to implement and train DMH staff on the application of the KIM model.

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

DMH has access to ensemble NWP calculations from many sources, such as LACSA (for agriculture), ECMWF, KMA, CMA, JMA and WRF. For flood forecasting, the URBS model and Regression model and SEA FFGS are used. Currently DMH does not release any probabilistic forecast products, but probabilistic models are used for the generation of the warnings (such as heavy rain and strong wind).

DMH does currently not perform any NWP post-processing, but plans to carry out this work in the near future.

Summary score, recommendations, and comments for Element 5

DMH's maturity level for "Numerical model and forecasting tool application" is assessed as **Level 2**, the CHD scale reflecting "*Prediction based mostly on model guidance from external and limited internal sources (without data assimilation) and remotely sensed products in the form of maps, figures and digital data and cover nowcasting, short and medium forecast time ranges*".

Gaps

1. DMH lacks the ability to run its own model. NWP post-processing work is not performed either. Significant weather events, in particular strong convective storms producing lightning, show poor predictability based on the models and products available.
2. DMH does not carry out nor provide probabilistic forecasts.
3. DMH can receive a variety of numerical forecasting model results, but the sources and methodologies differ, and some models do not provide output data. There is no integrated application system available to support numerous numerical models.

Recommendations

1. Enhance the training in long-range forecasting to prevent dependence on third party support for the agro-climate products to be integrated in LACSA.
2. To enhance the access to third party NWP sources to gather not only final products but also the underlying model output data. This should be accompanied by the introduction of an appropriate data management tool and the strengthening of expertise on data analysis.
3. Create a multi-model integrated application system to process multiple models results and generate customized products such as multi-model comparisons products for forecasters and products to support other NWP-based services.
4. Establish research collaboration for NWP development, including post-processing, data assimilation, and verification.
5. To hire data scientists to handle the various data sources and data streams.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

DMH has no 24/7 capacity to provide warning and alerting services. All forecasting and warning services are covered by staff during daytime hours only, except for the observers and basic IT maintenance. Currently, through a project funded by the World Bank, the MESSIR_NEO software suite by Campbell Scientific is being implemented. This system provides EWS functionality and is expected to facilitate the complete warning procedure, including the issuing of CAP-compliant messaging. At the same time, the number of forecasting staff should be increased from 10 to 15-20 to ensure that there is an appropriate level of human resources to provide warning services at night and truly achieve 24/7.

DMH has the responsibility to issue weather alerts. Joint hydrometeorological warnings, exploiting the in-house capacity, are also prepared. In case of a large-scale phenomenon, all relevant stakeholders are in charge to agree on the alert level. Through the Emergency Operations Center (EOC), the National Disaster Management Office (NDMO), a secretariat of National Disaster Management Committee (NDMC) is responsible to host a NDMC meeting led by Deputy Prime Minister including high level representation from sectoral ministries and other stakeholders to collectively decide.

The overall warning dissemination process at regional level obeys the following process f flow:

1. DMH issues the alert information, which is transferred to PONRE through the hydrometeorological regional offices under PONRE responsibility,
2. PONRE, including additional local information, updates the DMH information if needed and passes it down to the district level via DONRE.
3. DONRE distributes the warnings to all the population of the district.
4. In addition, the Ministry of Labor and Social Welfare (MoLSW) plays a key role as crisis coordinator through the Emergency Operations Center (EOC); the Disaster Management structures in Lao fall under the responsibility of the MoLSW.

DMH has a Multi-Hazard Early Warning System (MHEWS) in place. Japan Meteorological Agency is assisting them in several scientific and technological activities related to weather monitoring and forecasting. When issuing warnings, rainfall, flash flood and mudflows are considered together.

In Laos, the warnings of severe weather events are generated and released at the national level, while at the regional/provincial level, the nowcasting (0-2 hours), and warnings of severe weather events (Example 1) are generated and released based on the process described above. Daily and weekly weather forecasts (Example 2), seasonal forecasts (monthly updated) (Example 3), , flood forecasts, 7-day rainfall estimation, and forecasts of typhoon tracks are also produced (see the example below). Cascading effects are partially considered with potential of flooding and landslides. The Social Welfare Ministry has the EOC, which is the crisis coordination unit of the country and is in charge of both mitigation, prevention, response and recovery.

Example 1: Warnings of severe weather events (Super Typhoon): The graphic and text below relate to Super Typhoon Yagi which affected China, Vietnam and Lao in September 2024, having already impacted the northern Philippines. The graphic shows the position of the centre of Yagi on September 5th and the text provides forecast and warning information. Yagi brought very heavy rain to the upper catchment of the Mekong river between September 7th and 9th, and this in turn brought severe flooding to many parts of Lao during the following days, resulting in seven deaths and considerable destruction, notably to Luang Namatha Airport and the associated meteorological observing equipment located there.

ສາທາລະນະລັດ ປະຊາທິປະໄຕ ປະຊາຊົນລາວ
ສັນຕິພາບ ເອກະລາດ ປະຊາທິປະໄຕ ເອກະພາບ ວັດທະນາຖາວອນ

ກະຊວງຊັບພະຍາກອນທຳມະຊາດ ແລະ ສິ່ງແວດລ້ອມ
ກົມອຸຕຸນິຍົມ ແລະ ອຸທົກກະສາດ

ເລກທີ 0868 /ກອຕທ

ນະຄອນຫຼວງວຽງຈັນ, ວັນທີ 05 ກັນຍາ 2024

ແຈ້ງເຕືອນໄພ ພາຍຸພາຍຸໄຕ້ຝຸ່ນ ຢາກີ (Super Typhoon YAGI)
ໃນລະຫວ່າງວັນທີ 06 – 09 ກັນຍາ 2024

ສະບັບທີ: 2

ໃນເວລາ 07 ໂມງ 00 ຂອງວັນທີ 05 ກັນຍາ 2024 ພາຍຸໝຸນເຂດຮ້ອນ ຢາກີ **(YAGI)** ຫົວທີ 11 ປະຈຳປີ 2024 ໄດ້ເພີ້ມກຳລັງແຮງຂຶ້ນຕາມລຳດັບກາຍເປັນ ພາຍຸ ໄຕ້ຝຸ່ນ ຢາກີ (Super Typhoon YAGI) ຍັງເຄື່ອນທີ່ຢູ່ທາງຕອນເໜືອຂອງທະເລຈີນໃຕ້, ເຊິ່ງມີຈຸດສຸນກາງໃນເສັ້ນຂະໜານທີ 19.1 ອົງສາເໜືອ ແລະ ເສັ້ນແວງທີ 115.7 ອົງສາຕາເວັນອອກ, ພາຍຸຫົວນີ້ ຈະເຄື່ອນທີ່ຜ່ານເກາະໄຮໜານ ໃນໄລຍະ 1-2 ວັນຕໍ່ໜ້ານີ້. ຈາກນັ້ນຈະອ່ອນກຳລັງລົງກາຍເປັນພາຍຸດີເປຼຮຊັນຈະເຄື່ອນທີ່ຜ່ານ ພາກເໜືອຂອງ ສສ ຫວຽດນາມ ແລະ ສປປ ລາວ ຕາມລຳດັບ. ຊຶ່ງຈະເຮັດໃຫ້ ມີຝົນຕົກ ຟ້າຮ້ອງ ຟ້າເຫຼື້ອມ ໃນລະດັບຄ່ອຍຢູ່ຫົ່ວໄປ ແລະ ຕົກໃນລະດັບປານກາງ ຫາ ໜັກ ພ້ອມມີລົມພັດແຮງຢູ່ບາງທ້ອງຖິ່ນ ເຊັ່ນ: ແຂວງ ຜົ້ງສາລີ, ຫົວພັນ, ຊຽງຂວາງ, ອຸດົມໄຊ, ບໍ່ແກ້ວ, ຫຼວງນ້ຳທາ, ຫຼວງພະບາງ, ໄຊຍະບຸລີ, ນະຄອນຫຼວງວຽງຈັນ, ໄຊສົມບຸນ, ວຽງຈັນ, ບໍລິຄຳໄຊ, ຄຳມ່ວນ ແລະ ສະຫວັນນະເຂດ ໃນໄລຍະທີ 06 ຫາ 09 ກັນຍາ 2024 ນີ້.

ດັ່ງນັ້ນ, ຈຶ່ງແຈ້ງເຕືອນເຖິງປະຊາຊົນບັນດາເຜົ່າ, ອົງການປົກຄອງທ້ອງຖິ່ນ ແລະ ອົງການຈັດຕັ້ງທຸກພາກສ່ວນໃນແຕ່ລະພາກ ລວມທັງນະຄອນຫຼວງວຽງຈັນ ຈົ່ງມີສະຕິລະມັດລະວັງ ແລະ ກຽມພ້ອມຮັບມື ຕໍ່ສະພາບຝົນຕົກໜັກຕິດຕໍ່ກັນຫຼາຍວັນ ທີ່ຈະເຮັດໃຫ້ມີດິນເຈື່ອນ, ນ້ຳຖ້ວມຮຸ, ນ້ຳຖ້ວມຍັ່ງ ແລະ ນ້ຳຖ້ວມອັ່ງໃນຕົວເມືອງ. ຂໍໃຫ້ຕິດຕາມຂ່າວພະຍາກອນອາກາດ ຈາກກົມອຸຕຸນິຍົມ ແລະ ອຸທົກກະສາດ ຢ່າງຕໍ່ເນື່ອງ.

ຫົວໜ້າກົມ

ນ.ອຸທອນ ເພັດຫຼວງສີ

Example 2: Weekly weather forecasts. The example below illustrates the structure and content of the weekly weather forecast issued by DMH. For each of the nine locations the weather is indicated by a suitable graphic and the temperature range (min/max) is given.

ພະຍາກອນອາກາດ 7 ວັນຕໍ່ໜ້າ ແຕ່ໄລຍະວັນທີ 04 ຫາ 10 ມັງກອນ 2023

ອອກຂ່າວ ປະຈຳວັນທີ 03 ມັງກອນ 2023

ສະຖານີ		04/01/2023	05/01/2023	06/01/2023	07/01/2023	08/01/2023	09/01/2023	10/01/2023
ຜົ້ງສາລີ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	08/17	08/19	08/16	06/17	06/18	07/20	08/20
ຫົວພັນ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	11/20	12/19	13/19	10/19	09/20	10/23	13/22
ຊຽງຂວາງ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	10/23	11/24	11/20	09/20	08/13	10/25	12/26
ອຸດົມໄຊ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	12/25	11/26	12/24	11/24	08/25	08/26	10/27
ຫົວຍຊາຍ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	15/28	14/29	15/28	13/27	12/28	13/29	14/30
ຫຼວງນ້ຳທາ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	12/26	12/25	12/25	11/26	09/26	08/26	10/27
ນະຄອນ ຫຼວງພະບາງ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	17/28	15/29	16/28	14/27	12/28	13/29	14/30
ໄຊຍະບູລີ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	17/29	16/29	15/27	13/26	12/27	13/28	15/29
ນະຄອນຫຼວງ ວຽງຈັນ	ສະພາບອາກາດ							
	ຕ່ຳສຸດ/ສູງສຸດ(°C)	18/28	17/29	18/30	17/27	16/28	17/30	19/31

Example 3: Forecasts provided for the agricultural community. The graphic below is an example of the forecast information provided be DMH under the "Laos Climate Services for Agriculture (LaCSA) project which has been provided with the support of the UN's Food and Agriculture Organisation (FAO). This example is for the province of Oudomxai, which is in the north of the country. The clear graphics and succinct, focused text are designed to make these products very accessible and useful to the agriculture community.

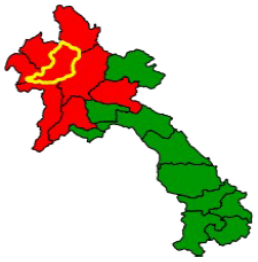
China Meteorological Administration | GeoSphere Austria | SOFF Systematic Observations Financing Facility | Weather and climate data for resilience

P. OUDOMXAI
SEASONAL FORECAST BULLETIN
[FEB~APR / 2025]

issued on 02/01/2025

SEASONAL FORECASTS

FEB-APR

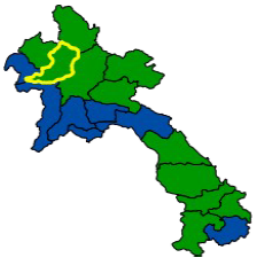


WARMER

0.4°C

22.4°C

(Normal years)



(Normal years)

57.3mm

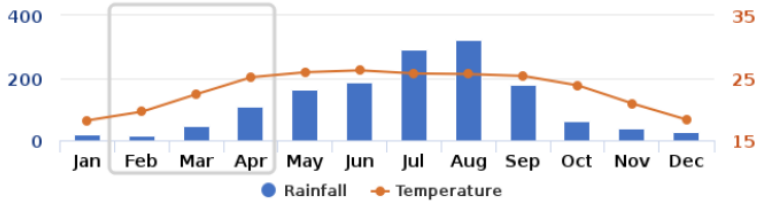
NORMAL

Based on seasonal forecast for *FEB-APR*, **P. OUDOMXAI** province is expected to have an enhanced probability of **warmer temperature (40.0%)**, and **normal rainfall** compared to Normal Years.

☞ *"Normal Years" indicates average temperature and total rainfall for FEB-APR of the past 30 years (1989-2018)*

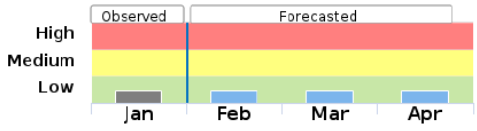
Climate Observation Point	
Name of Station	Oudomxay

Climate Trend of Past Normal Years(1989-2018)

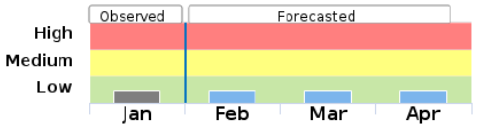


AGRICULTURAL CLIMATE RISK FORECASTS

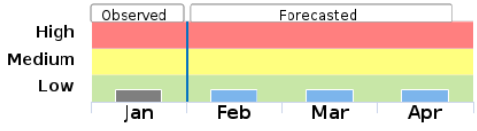
AGRICULTURAL DROUGHT



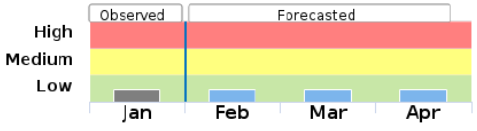
EXCESSIVE RAINFALL



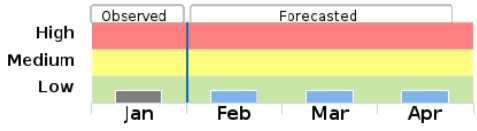
CROP DISEASES



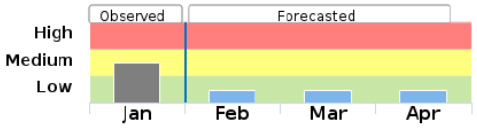
INSECT PESTS



HEAT STRESS



COLD STRESS



SEASONAL FORECAST BULLETIN

Climate Smart Recommendations for Pumpkin

[FARMING MANAGEMENT]

Pest Management	☐ Monitor the crop daily for disease and pest and spray according to approved spray guideline. Monitor the crop at sprouting time for snails/slugs and spread poison-pellets if needed. Monitor the crop carefully for rats eating fruits and treat by spreading rat poison if needed. When there are insects biting the leaves, it is necessary to spray pesticides 3 times a month. At flowering, do not spray in the early morning or early evening when bees are out in peak numbers.
Water Management	☐ Irrigate if soil gets dry enough to give stress to plants

This is an initial and temporary version of the provincial level seasonal forecast. For more details and information, please contact DMH 021 510030. Please receive more information at http://www.fao.org/in-action/samis/en/ and at https://www.facebook.com/samisdmh. The online system is accessible at the web page: https://lacsa.net/

Exchanges with DMH's stakeholders demonstrated that the development of tailored services is very important and hence should take place in a more end-user-centric approach, for example in the sectors of agriculture and disaster risk management. This should be considered in the recommendations on better dissemination approaches.

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

DMH issues warnings related to extreme meteorological events including: landslide/mudslide & debris flow, heat wave, frost, fog, drought/dry spell, wind, tropical cyclone, thunderstorms/squall lines, rain/wet spell, lightning, hail, haze/smoke, riverine floods, flash-floods, cold wave.

- Joint potential flash flood and heavy rainfall warnings are issued once a day when pre-defined thresholds are reached. These warnings may include a reference to potential landslides.
- Storm warnings depending on intensity and location of the storm.
- Flood warnings depending on water levels.

DMH is now conducting National Early Warnings System perception Survey aiming to receive feedback particularly from last mile communities. The final report is expected to be published by first quarter of next year.

There is a mechanism for the evaluation of the warnings, such as their accuracy, timing, and specific area. However, this evaluation needs to be improved in terms of easy understanding.

DMH use guidance products provided by various RSMCs, and they also use a flash flood guidance system for issuing warnings, like SEA FFGS and MRCFFGS. DMH only archive their warning and forecast on some occasions. There are redundant systems in place at DMH, but they are covering the production only partly (just for UPS and Generators).

6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities.

DMH has not yet adopted the Common Alerting Protocol (CAP) format for the delivery of warnings. However, the new integrated visualization, analysis, forecast and warning production system, which is currently being installed, Messir Neo (Campbell Scientific France), has the capabilities to output warnings in the CAP format. DMH's staffs are being trained on how to use CAP in the NEO system. by CSF; this training will be completed in mid-2025. However the introduction of CAP in Lao PDR will require significant outreach to potential users of CAP format messages to enable them to take and use the output from DMH.

Impact-based services are not yet fully developed. Warnings include to some extent an approximation towards impact by considering secondary hazards like flooding or potential landslides/mudflows after rainfall. Through capacity development projects, targeted regions or selected river basins will have a more detailed risk assessment and data gathering for exposure information in place. There is no nation-wide exposure and vulnerability database for quantification of the impact.

There are no formal SOPs in place with registered authorities and stakeholders yet There is some exchange on the impact information, but this happens rather on an ad-hoc basis and not through a formalized and traceable system, which is not sufficient. Finally, DMH lacks hazard-specific impact models.

Summary score, recommendations, and comments for Element 6

DMH's maturity level for "Warning and Advisory Services" is assessed as **Level 2** on the CHD scale reflecting "Weather-related warning service with modest public reach and informal engagement with relevant institutions, including disaster management agencies."

Gaps

1. DMH does not provide 24/7 warning and alerting services.
2. Impact Based Forecasting (IBF) is inadequate, particularly for severe weather-related hazards, and early warning services remain insufficient.
3. There is a lack of feedback mechanisms to verify warnings.
4. DMH is currently facing a shortage of capacity and human resources to operate and develop contemporary early warning services.

Recommendations

1. Increase of the number of staff members to cover the nighttime hours – this recommendation, while important, is hard to achieve due to the staffing procedure based on quotas defined by MONRE. Lobbying actions are required to highlight the importance of 24/7 operations. An increase of the number of forecasting staff from 10 to 15-20 is required to ensure services provision at night, and to ensure 24/7 coverage.
2. To increase the efficiency of early warning production and information dissemination, a forecast analysis and early warning system for multiple hazards is required. This system would ensure proper data processing, product generation, and data sharing.
3. Impact-Based Forecasting (IBF) should be enhanced. The CAP format for generating and disseminating weather warnings has to be operationally introduced.
4. Improving the use of satellite and remote sensing data for monitoring meteorological and hydrological conditions will be beneficial.
5. Impact oriented services require a better exchange with the end-users and stakeholders. Feedback mechanisms on the warnings and a better understanding of stakeholder-specific impacts are a prerequisite to initiate such services. Some of the ongoing or future capacity development projects may help in this direction, for example fostering better exchange with MAF and the agricultural sector.
6. In case of major events or high impact situations, it may be considered to increase the update frequency of alerts directed both to specific end-users and the population. At least two updates per day would be important.
7. Improve the last-mile information transmission using digital means.
8. More training in forecasting and early warning systems is needed.

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services.

DMH provides climate information on various timescales from daily forecasts to seasonal bulletins. The latter are generated with the help of an external consultant financed through third party funding and subject to the length of the project.

While there is a wide range of stations and monitoring data available, no structured way of producing information exists. Only through capacity development activities, for example the SAMIS project, station data were gathered and processed for the production and delivery of climate services for the benefit of the agriculture sector. Similarly, in a number of projects, data management tools were made available to produce climate information, for example: Meteo-France provided CLICOM, JICA provided CLIM, FAO provided the LACSA system and SEADRM provided the NEO system.

DMH developed a Climate Yearbook by using Excel, and now by using LACSA and NEO system to provide climate services to the agriculture, hydropower and other sectors. An English version of the climatology and agroclimatology atlas of the Lao People's Democratic Republic has been developed in cooperation with FAO, MONRE and MAF in 2022[1]. A specific data portal has been generated[2]: this app has a relatively widespread use across the farming sector.

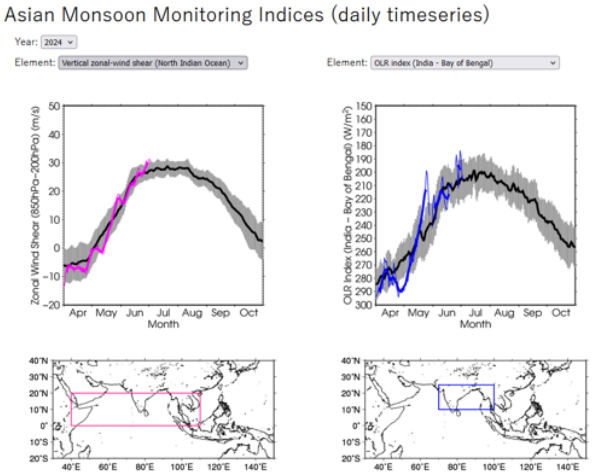
Climate information is provided through a climate outlook that contains rather general information. An example is shown below.

The example below shows the seasonal outlook in two parts: the first is the weather report for the month, the second part is the outlook for the following three months.

The Seasonal Forecast is issued for three months ahead, and updated every month. Each update typically comprises the following elements:

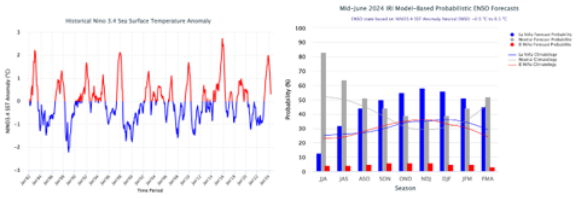
1. A summary of the weather for the month just past (rainfall, temperature statistics etc.)
2. An overview of the relevant seasonal indices, such as the MJO, the ENSO, and the Asian Monsoon Monitoring Indices.
3. A section providing information on the likely temperature and rainfall conditions across Lao for the coming one month.
4. A section providing information on the likely temperature and rainfall conditions across Lao for the coming three-month period.
5. A section illustrating the Tropical Cyclone probability across the wider region for the coming TC season (from the global models, in this case ECMWF),
6. A final section giving a summary of the risks of weather-related hazards impacting Lao over the coming season.

[1] https://doi.org/10.4060/cb9713en
[2] https://www.lacsa.net/mapView.do



ຮູບພາບທີ 6 ດັດສະນີການປ່ຽນແປງລົມມໍລະສຸມຕາເວັນຕົກສ່ຽງໃຕ້

7. ການປ່ຽນແປງຂອງອຸນຫະພູມໜ້ານ້ຳທະເລ ແລະ ຄາດຄະເນ ENSO

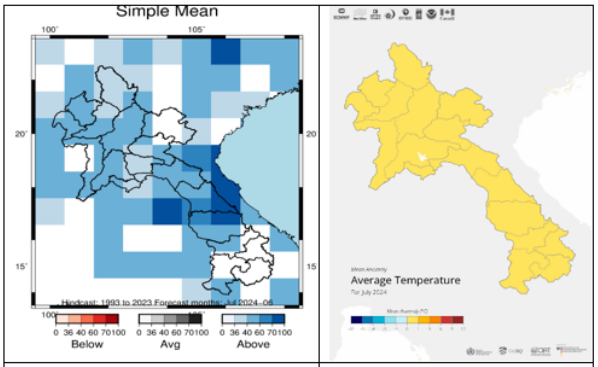


ຮູບພາບທີ 7 ການປ່ຽນແປງຂອງອຸນຫະພູມໜ້ານ້ຳທະເລ ແລະ ຄາດຄະເນ ENSO

ໃນໄລຍະເດືອນມິຖຸນາ 2024, ສະພາບອຸນຫະພູມໜ້ານ້ຳທະເລຢູ່ເຂດໃກ້ເສັ້ນສູນສຸດຂອງມະຫາສະໝຸດປາຊີຟິກຕອນກາງ ໄດ້ເຢັນລົງ (ຮູບເບື້ອງຊ້າຍ) ຊຶ່ງປະກົດການ ENSO ຢູ່ໃນພາວະ Neutral. ຄາດຄະເນສະພາບອຸນຫະພູມໜ້ານ້ຳທະເລຈະສືບຕໍ່ເຢັນລົງຕື່ມອີກ ເຊິ່ງຄ່າແຕກຕ່າງໝູດລົງ ໃນໄລຍະເດືອນ ມິຖຸນາ-ກໍລະກົດ-ສິງຫາ 2024 ແລະ ຈະເຂັ້ດໃຫ້ຢູ່ໃນສະພາວະເປັນກາງ (Neutral) ຫາ ສະພາວະປະກົດການລານີນຍ່າ (La Nina) (ຮູບເບື້ອງຂວາ).

8. ພະຍາກອນສະພາບຝົນ ແລະ ອຸນຫະພູມປະຈຳເດືອນ ກໍລະກົດ 2024

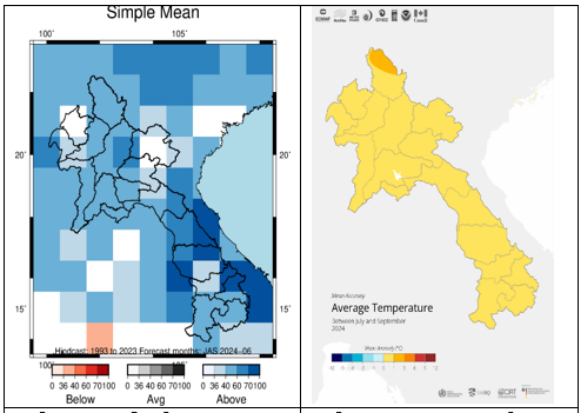
ໃນໄລຍະຕົ້ນເດືອນກໍລະກົດ, ກະແສລົມມໍລະສຸມຕາເວັນຕົກສ່ຽງທີ່ມີກຳລັງອ່ອນຫາປານກາງຝັກຍົກຄຸ້ມຢູ່ທົ່ວທຸກພາກຂອງປະເທດລາວ ຊຶ່ງຈະເຮັດໃຫ້ມີຝົນຕົກຟ້າຮ້ອງຟ້າເຫຼື້ອມໃນລະດັບຄ່ອຍ ຫາ ປານກາງຢູ່ເກືອບທົ່ວໄປໃນແຕ່ລະພາກ ແລະ ຕົກໜັກ ຫາ ໜັກຫຼາຍຢຸ່ບາງທ້ອງຖິ່ນ, ໄລຍະກາງຫາທ້າຍເດືອນ ຮ່ອງຄວາມກົດດັນອາກາດຕ່ຳຈະພາດຜ່ານພາກເໜືອແລະພາກກາງ ປ້ອງໃສ່ພາຍຸໝຸນເຂດຮ້ອນທີ່ເຄື່ອນທີ່ຢູ່ເຂດທະເລຈີນໃຕ້ ຊຶ່ງຈະເຮັດມີຝົນຕົກໃນລະດັບຄ່ອຍຫາປານກາງຢູ່ເກືອບທົ່ວໄປ ແລະ ຕົກໜັກ ຫາ ໜັກຫຼາຍຢຸ່ບາງທ້ອງຖິ່ນ. ຄາດຄະເນປະລິມານນ້ຳຝົນໃນເດືອນ ກໍລະກົດ 2024 ຈະມີຝົນຫຼາຍເກນປົກກະຕິເປັນສ່ວນຫຼາຍ ແລະ ສຳຫຼັບແຂວງ ຫົວພັນ ເຊກອງ ຈຳປາສັກ ແລະ ອັດຕະປື ຈະມີຝົນຢູ່ໃນເກນປົກກະຕິ ຫຼື ຫຼາຍກວ່າເລັກນ້ອຍ (ຮູບເບື້ອງຊ້າຍ). ສະພາບອຸນຫະພູມຈະສູງກວ່າເກນປົກກະຕິພຽງເລັກນ້ອຍ ໃນແຕ່ລະພາກ (ຮູບເບື້ອງຂວາ)



ຮູບທີ 7 ພະຍາກອນຝົນ ເດືອນ 7/2024 | ຮູບທີ 8 ພະຍາກອນອຸນຫະພູມ, ເດືອນ 7/2024

9. ພະຍາກອນສະພາບຝົນ ແລະ ອຸນຫະພູມປະຈຳລະດູການ ກໍລະກົດ-ສິງຫາ-ກັນຍາ 2024

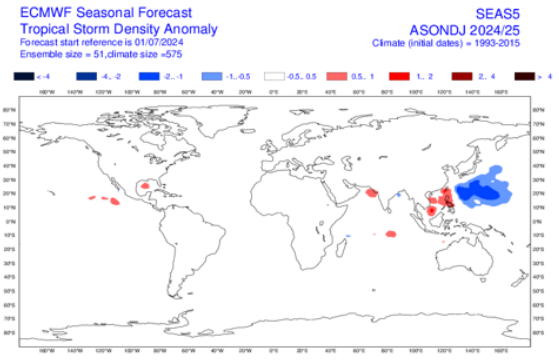
ໃນໄລຍະເດືອນ ສິງຫາ ຫາ ກັນຍາ ຮ່ອງຄວາມກົດດັນອາກາດຕ່ຳ ຈະພາດຜ່ານພາກເໜືອ ແລະ ພາກກາງ ສົມທົບກັບກະແສລົມມໍລະສຸມຕາເວັນຕົກສ່ຽງໃຕ້ຝັກຍົກຄຸມດ້ວຍກຳລັງແຮງ, ພ້ອມດຽວກັນ ຈະມີພາຍຸໝຸນເຂດຮ້ອນເຄື່ອນທີ່ຢູ່ເຂດທະເລຈີນໃຕ້ຕອນກາງ ຫາ ຕອນເໜືອ ເຊິ່ງຈະເຮັດໃຫ້ຝົນຕົກໃນລະດັບຄ່ອຍຫາປານກາງເປັນບໍລິເວນກ້ວາງ ແລະ ຕົກໜັກຫາໜັກຫຼາຍຢຸ່ບາງທ້ອງຖິ່ນ. ຊຶ່ງຈະເຮັດໃຫ້ເກີດມີດິນເຈື່ອນ ແລະ ນ້ຳຖ້ວມຂຸ່ຢູ່ບັນດາແຂວງພາກເໜືອ ຫາພາກກາງ ແລະ ນ້ຳຖ້ວມຍືງຢຸ່ເຂດພາກກາງ ແລະ ພາກໃຕ້. ຄາດຄະເນປະລິມານນ້ຳຝົນສະເລ່ຍໃນໄລຍະ 3 ເດືອນ: ກໍລະກົດ-ສິງຫາ-ກັນຍາ 2024 ຈະມີຝົນຫຼາຍເກນປົກກະຕິເປັນສ່ວນຫຼາຍ ແລະ ສຳຫຼັບແຂວງ ຫົວພັນ ແລະ ຫຼວງນ້ຳທາ ຈະມີຝົນຢູ່ໃນເກນປົກກະຕິ ຫຼື ຫຼາຍກວ່າເລັກນ້ອຍ (ຮູບເບື້ອງຊ້າຍ). ສະພາບອຸນຫະພູມຈະສູງກວ່າເກນປົກກະຕິພຽງເລັກນ້ອຍ ໃນແຕ່ລະພາກ (ຮູບເບື້ອງຂວາ)



ຮູບທີ 9 ພະຍາກອນຝົນ ເດືອນ 7-8-9/2024 | ຮູບທີ 10 ພະຍາກອນອຸນຫະພູມ ເດືອນ 7-8-9/2024

10. ຄາດຄະເນສະພາບພາຍຸໝຸນເຂດຮ້ອນໃນໄລຍະ 3 ເດືອນຕໍ່ໜ້າ

ຄາດຄະເນຈະມີພາຍຸໝຸນເຂດຮ້ອນ ກໍ່ເກີດຢູ່ເຂດທະເລຈີນໃຕ້ ຈະຫຼື້ນກວ່າເກນປົກກະຕິ ສ່ວນຢູ່ເຂດມະຫາສະໝຸດປາຊີຟິກຈະຫຼຸດເກນປົກກະຕິບ້ວ. ໃນໄລຍະເດືອນ ກໍລະກົດ-ກັນຍາ 2024 ມີປະມານ 1 – 3 ຫົວ ມີທ່າອ່ຽງເຄື່ອນທີ່ຜ່ານ ສປປ ລາວ, ຊຶ່ງໃນນີ້ ຈະເຄື່ອນທີ່ຜ່ານພາກກາງຂອງ ສປປ ລາວ ຈຳນວນ 1 ຫົວ ໃນເດືອນ ກໍລະກົດ ແລະ 2 ຫົວ ໃນໄລຍະເດືອນ ສິງຫາ ຫາ ກັນຍາ 2024 ນີ້.



ຮູບທີ 11 ຄາດຄະເນສະພາບພາຍຸໝຸນເຂດຮ້ອນໃນໄລຍະເດືອນ ສິງຫາ ຫາ ຕຸລາ 2024

11. ບັນດາຄວາມສ່ຽງຕ່າງໆ

- ໃນໄລຍະເດືອນ ກໍລະກົດ ຫາ ກັນຍາ 2024 ຈະມີຝົນຕົກຕິດຕໍ່ກັນຫຼາຍວັນ ເຊິ່ງຈະເຮັດໃຫ້ດິນມີຄວາມຊຸ່ມຊື້ນຫຼາຍ ແລະ ມີຄວາມສ່ຽງທີ່ຈະເກີດມີດິນເຈື່ອນແລະນ້ຳຖ້ວມຂຸ່ຢູ່ບາງທ້ອງຖິ່ນແຂວງພາກເໜືອ ແລະ ພາກກາງ.
- ໃນໄລຍະຕົ້ນເດືອນ ກໍລະກົດ ຫາ ກັນຍາ 2024, ອາດຈະມີພາຍຸໝຸນເຂດຮ້ອນກໍ່ເກີດຂຶ້ນຢູ່ເຂດທະເລຈີນໃຕ້ ແລະ ມີທ່າອ່ຽງເຄື່ອນຜັດຜ່ານພາກກາງຂອງ ສປປ ລາວ ເຊິ່ງຈະເຮັດ

There is climatological data since 1971 but with regional and temporal gaps. In addition, while some preliminary attempts to assure data quality exist, currently there is no robust and regularized data quality system.

The agricultural sector is very important in Lao PDR. Services for this sector are therefore essential in view of climate change. Droughts are targeted as one of the hazards that is already important now and will become even more impactful in Lao society in the future.

Summary score, recommendations, and comments for Element 7

DMH's maturity level for "Contribution to Climate Services" is assessed as **Level 2**: "Basic Capacity for Climate Services".

Gaps

1. The current observation network is insufficient, and there is no a regularized way of producing information.
2. There is a lack of resources and a need to train observers and data managers
3. Climate database and climate prediction systems need to be improved to enable climate services.
4. Delivery methods are basic, with limited channels for spatial and temporal information dissemination. Expanding dissemination through various means is an opportunity.

Recommendations

1. Try to acquire additional expertise (staff) in-house to develop sub-seasonal and seasonal forecasts in a more autonomous and sustainable manner.
2. Strengthen the cooperation with MAF to enhance the services towards the agriculture sector. If possible, include a socio-economic component in this feedback loop.
3. Strengthen the observation network to provide improved data, and establish a proper data quality control system
4. Investigate data rescue activities.
5. Enhance data and data management systems, climate prediction systems and dissemination services.

Element 8: Contribution to hydrology

8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community.

DMH established the National Early Warning Center (NEWC) for meteorology and hydrology, which aims to help reduce the impact of disasters through the provision of reliable and timely flood and drought forecasts and warnings, and consists in approximately 7 or 8 staff members. The goal of the hydrological department is to provide hydrological forecasting (such as water level prediction) and services during the flooding season from June to October each year, as well as operational hydrological data collection. DMH operates and maintains 126 automatic water level stations and 147 manual hydrological stations, and provides standard hydrological data (water level and rainfall) to the Mekong River Commission (MRC), the Ministry of Water Resources, and the dam handling institution. DMH has an operational exchange of water level monitoring data with the Ministry of Water Resources, and has established a flood probability model that can predict the water level of the Mekong River and its tributaries two days in advance based on precipitation forecasts.

However, there is currently no effective method in place to verify the accuracy of water level forecasting and to obtain relevant disaster information, and how to use this information to improve the flooding model. This is one of the main issues and challenges that the department is currently facing.

Due to the current inability to operate a weather radar system, radar quantitative precipitation estimation products are not generated, and thus cannot be provided to the hydrological community.

The Hydrology Division has one Acoustic Doppler Current Profiler (ADCP), it was used to update nine cross sections/rating curves back in 2019. The rest of the rating curves are not up-to-date. DMH suggests that this is due to the limited funding available to support routine field operation and maintenance activities, which require substantial travel and accommodation costs. Some PONRE staff have basic backgrounds in station operation and maintenance, but are generally unable to conduct more complex technical tasks like updating of rating curves, or assessing and repairing equipment issues. Therefore, the majority of operation and maintenance activities need to be conducted by DMH staff or by the equipment supplier/manufacturer.

8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

In Laos, meteorological services and hydrological services are provided by the same Agency. There are no SOPs in place to formalize the relationship between DMH and DWR (Department of Water Resources). Hydrology monitoring and warnings are done by DMH. DWR is responsible for water resources and management policy. Currently there is no SOP that details the inter-operations of the two organisations. There is a formal mechanism within the country under NDMC (National Disaster Management Center) to regularly coordinate activities between meteorological and water resources departments. They share the national and regional meteorological and hydrological data, floods (flash and riverine), streamflow, droughts, landslides, tropical storms, soil moisture and ground water. However, there are no regular coordination activities with regard to the reduction of impact of flooding events or droughts. The only committee in which DMH participates is the Mekong River Commission. DMH is developing a flood management plan. On 01 Dec 2023, the Prime Minister issued a degree on Endorsement and Promulgation National Master Plan on Flood Forecasting and Early Warning System.

.8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development.

DMH disseminates monitoring, forecast and warning information towards local and regional meteorological and hydrological agencies, and shares water level monitoring data with DWR. It should be understood that DWR is a sister agency to DMH; both are under the Ministry of Natural Resources and Environment (MoNRE). DWR is responsible for policies in relation to hydrology, while DMH is responsible for the operational aspects, including the monitoring of river levels and the issue of river level forecasts and flood warnings.

Lao is one of the member of the Mekong River Commission (MRC), and uses this platform to carry out data sharing, hydrological monitoring and other activities in the Mekong River Basin. Currently, Laos shares data from a total of 6 hydrological stations under MRC and with China.

8.4.Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation.

DMH participates in the international Mekong River Commission, comprised of Cambodia, Lao PDR, Thailand and Viet Nam.

Summary score, recommendations, and comments for Element 8

The maturity level for contribution for hydrology assessed at **Level 3**, reflecting "There is a moderately well-functioning relationship between the meteorological, hydrological and water resources communities but considerable room for formalizing the relationship and SOPs."

In Lao, meteorology and hydrology are under the same agency: DMH. However, the one obvious deficiency at present is that hydrological services mainly focus on basin floods. Although there is water level and rainfall monitoring, real-time observation has not been fully achieved, and there is no quantitative heavy precipitation prediction and service. DMH participates in the work of the Mekong River Commission and there is data exchange and sharing under this framework.

Recommendations

1. Should additional staff members and expertise be available, it would be advisable to enhance the hydrological modelling capacities
2. Promote the establishment of activity platforms with relevant ministries and water conservation departments. Actively participate in regional or international hydrological services seminars and strengthen cooperation with upstream and downstream watersheds or neighboring countries.
3. Enhance infrastructure development, and enhance the capabilities of meteorological and hydrological information officers and volunteers.

Element 9: Product dissemination and outreach

9.1. Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?).

DMH uses different channels at district level via DONRE to communicate its products: tv; radio; printed media; e-mail; mobile phone application (in-house); social media (Youtube, Facebook, WhatsApp), loud speakers.

DMH has a full TV facility to produce weather forecasts and information to be broadcasted on national television once per day. The weather brief is about 3 minutes long. Radio briefings are also provided through the Lao National Radio, Vientiane Radio Station and Lao Army Radio .

It is to be noted that the forecast and warnings are also disseminated through the MONRE website[1], (https://monre.gov.la), which has been under development for some time and is currently unstable, and frequently inaccessible. There is a specific app and website for climate services and bulletins for the farmers (LACSA). Verbal communication is organized in the form of a meeting in case of a crises, where the EOC is called and all the stakeholders attend, including the head of the NCDM office, who is the vice-president. DMH has in addition a Youtube channel (3.94k subscribers), a Facebook page (26k followers) and several WhatsApp groups. Members of the groups are from different sectors: such as government organizations, media, NGOs and private companies. They receive the weather forecast bulletins 3 times a day through these groups.

9.2. Education and awareness initiatives in place.

There is close collaboration with the National University of Lao PDR, which established a Faculty of Water Resources with sub-units and specialization in meteorology and hydrology. DMH staff contributes to some of the courses. In addition, the university operates a weather station where students can be trained first-hand. Unfortunately, the station is hardly updated and is not aligned with those most frequently used by DMH, so the students are not trained in accordance with DMH's needs.

There are no active connections with sectors of civil society, like religion groups or monasteries, or local cultural groups. Such outreach could be beneficial for purposes of education and awareness with regard to climate change, weather hazards and proper preparedness measures.

To enhance outreach, DMH has established an open house, during which educational institutions and the private sector can visit DMH. DMH further organizes the National Climate Outlook Forum, inviting stakeholders and universities to participate. Finally, the organization also participates in the ASEAN Climate Outlook Forum.

9.3. Special measures in place to reach marginalized communities and indigenous people.

It is very important to establish prompt and effective communication with remote areas. DMH uses local point of contacts to distribute the information via WhatsApp.

The de-centralized disaster risk management structure, with MONRE at national level and PONRE at provincial/district levels facilitates closer exchanges with local communities at the time of response.

However, there is no direct structured exchanges between DMH and local communities, and there have been no attempt to consider using local dialects for delivering services thus far. Warnings are only issued in Lao and sometimes in English (on request). The ad-hoc exchange with DONRE (Distric District Office of Natural Resources and Environment) officers may be in other dialects but it is on a personal basis and dependent on the individuals.

Summary score, recommendations, and comments for Element 9

The maturity level for product dissemination and outreach assessed at **Level 2**, reflecting "Traditional communication channels and a basic dedicated website is used to disseminate forecasts and basic information.".

The recommendations for this element are as follows:

1. It is still necessary to strengthen education and raise awareness at all levels of society through online and offline channels, including raising awareness of meteorological and hydrological disaster prevention and reduction at higher government levels. There is the need for awareness workshops especially targeted at the community of farmers, but also at grassroots level and for media personnel.
2. Plan to develop DMH's social media presence and explore other possibilities for prompt and effective communication, to increase the public exposure regarding meteorological knowledge and to spread popular, well elaborated meteorological science through the internet, especially to attract the attention of students and young people.
3. Better plan and organize the collaboration with universities and secondary schools, establishing diverse platforms to help young students to better understand scientific results and to update their meteorological knowledge and skills. Perhaps also considering talent exchange with universities in other countries.

Element 10: Use and national value of products and services

10.1. Formalized platform to engage with users in order to co-design improved services.

At present, DMH still lacks a linkage and exchange platform with other departments and users. There is no formalized feedback approach in place that would facilitate an end-user centered approach. However, the annual National Climate Outlook Forum enables to exchange and perform end-user engagement for Climate aspects. Other fields of activities (warnings, etc.) are not included in details in the discussions and there is no formal written exchange on a regular basis, with standardized templates and feedback approaches.

Regarding commercial services, DMH provides aviation services under ICAO regulations. It provides weather reports to domestic and foreign airlines that utilize one of Lao PDRs domestic and regional airports.

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

There are no independent end-user satisfaction surveys performed ad interim or in a regularized approach. A user satisfaction survey was performed was only performed once under the SEA DRM project.

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

In late 2022 DMH were provided with a training course aimed at assisting the organisation to obtain QMS certification (ISO 9001:2008) for the aeronautical meteorological services which they provide. This certification is necessary to ensure full compliance with ICAO regulations. DMH advise that the implementation of this QMS is underway with full implementation scheduled for 2026.

Summary score, recommendations, and comments for Element 10

The maturity level for use and national value of products and services assessed at **level 2**, reflecting "Service development draws on informal stakeholder input and feedback."

There is quite some room for improvement on the engagement of the end-users and stakeholders and how to develop added value in the products. Among others, the following recommendations are offered:

1. Conduct, similar to/or building on the National Climate Outlook Forum, an annual end-user/stakeholder workshop where the all heads of the different departments and all the relevant ministries discuss the status and uptake of the products provided within the year and define strategic improvements for the year(s) to come, for sectors such as energy, agriculture, tourism and aviation.
2. A regularized and structured feedback mechanism should be designed and implemented. The system, likely realized in the form of an online survey (in addition to the annual workshops mentioned previously), should be designed in a way that the end-user does not require to invest a lot of resources in filling in the required information.

3. It would be advisable to have one person at DMH dedicated to user and customer relations, acting as a focal point for customer care and designing the end-user satisfaction surveys.
4. Enhance coordination between national and inter-agency processes.

Annex 1 Consultations (including experts and stakeholder consultations)

Table 3: List of Stakeholders Consulted

Name	Position	Organisation	Additional Notes
Ms. Outhone PHETLUANGSY	Director General	DMH-MONRE	PR Lao PDR with WMO
Mr. Bounteum SISOUPHANTHAVONG	Deputy Director General	DMH-MONRE	Supervise Weather Forecasting and Warning Division
Ms. Sonephet PHOSALATH	Director of Division	DMH-MONRE	Meteo - Network and Earthquake Hydrology Division
Dr. Mayphou MAHACHALEUN	Director of Division	DMH-MONRE	Climate and Agro-meteorological Division
Mr. Keo OUNLAVONG	Deputy Director of Division	DMH-MONRE	Meteo-Network and Earthquake Division
Ms. Alounlath SOUKSAVATH	Technical Staff	DMH-MONRE	Policy Division
Mr. Phuthavanh PHOTHISAN	Technical Staff	DMH-MONRE	Meteo-Network and Earthquake Division
Mr. Viphanou PHETHANY	Deputy Director of Division	DMH-MONRE	Hydrology Division
Mr. Inthanongxay HEUANGBANDITH	Deputy Director of Division	DMH-MONRE	Hydrology Division
Mr. Peto MOUAKHAMPAO	Technical Staff	DMH-MONRE	Hydrology Division
Ms. Phonevilay THAMMAVONG	Technical Staff	DMH-MONRE	Hydrology Division
Mr. Amdula SALINTHONE	Director General	Ministry of Public Work and Transportation/Lao Civilisation of Aviation Department	Lao Air Navigation Services

Mr. Mana KOUNLATH	Deputy Director General	Ministry of Public Work and Transportation/Lao Civilisation of Aviation Department	Lao Air Navigation Services
Mr. Thatsana CHANVILAY	Deputy Head of Division	DMH-MONRE	Aeronautical Division
Dr. Mayphou MAHACHALEUN	Director of Division	DMH-MONRE	Climate and Agro-meteorological Division
Mr. Phousavanh SIYAVONG	Technical Staff	DMH-MONRE	Climate and Agro-meteorological Division
Ms. Rumbidzayi MACHIRIDZA	Head of Research Assessment and Monitoring	World Food Program	
Ms. Manithaphone MAHAXAY (PhD)	Head of Vulnerability Analysis and Mapping	World Food Program	
Mr. Jock RUTHERFORD	Risk Disaster Specialist	World Food Program	
Mr. Dale WILSON	Resilience Programme Manager	World Food Program	

Annex 2 Urgent needs reported

The main needs are detailed throughout the document summarized in the blue-colored boxes. However, the more pressing ones, that affect most if not all the elements evaluated, are as following:

- Lack of personnel resources – government-based quotas limit the staff possibilities and do not align with neither the mandate nor the technological capacity that is and will be building up. Clear needs exist within the forecasting staffing capacity, challenging the possibility to become 24/7 with respect to warnings, which is a critical component of the mandate.
- Project dependance and limited coordination – many actors play a role in the country but often in an uncoordinated manner. This leads to exceeding the absorbing capacity of DMH at all levels, from observations to data transfer and data interfaces to even management.
- Limited feedback mechanisms and stakeholder engagement - DMH has only a basic user feedback mechanism which limits the possibility to refine and improve the accuracy and usability of the services.
- Lack of cost-recovery mechanisms – being DMH solely governmental, it has very limited options to effectively initiate cost-recovery mechanisms and additional approaches to services-funded staff.

Annex 3 Information supplied through WMO

- 2022 WMO Global gap Analysis and updated 2023 table. WMO monitoring data
- WMO Lao PDR Rapid Assessment for Pillar 2 of the Early Warnings for All initiative.

Annex 4 List of materials used

- OSCAR https://space.oscar.wmo.int
- DMH https://dmhlao.la/joomla/index.php/en/
- WIGOS https://community.wmo.int/en/activity-areas/WIGOS
- https://www.unisdr.org/files/33988_countryassessmentreportlaopdr%5B1%5D.pdf
- "Assessment of Capacities of the Department of Meteorology and Hydrology (DMH), Lao PDR", March 2023, under the CREWS Cambodia and Lao PDR and through the World Meteorological Organization (WMO) and the regional Integrated Multi-hazard Early Warning Systems (RIMES).
- Country Hydromet Diagnostics, 2022
- CHD Operational Guidance for SOFF, 2023
- For all the decrees and legal references, the reader is referred to the recent "Assessment of Capacities of the Department of Meteorology and Hydrology (DMH), Lao PDR", March 2023.

Annex 5 List of Abbreviations

ADCP Acoustic Doppler Current Profiler
ASEAN Association of Southeast Asian Nations
AWS Automatic Weather Stations
CAP Common Alerting Protocol
CMA China Meteorological Administration
CREWS Climate Risk and Early Warning Systems
DMH Department of Meteorology and Hydrology
DONRE District Office of Natural Resources and Environment
DPCC Disaster Prevention and Control Committee
DRM Disaster Risk Management
DWR Department of Water Resources
ECMWF European Centre for Medium-Range Weather Forecasts
EOC Emergency Operations Centre
EWS Early Warning System
FAO Food and Agriculture Organization of the United Nations
FFGS Flash Flood Guidance System
FWR Faculty of Water Resources of the University of Vientiane
GBON Global Basic Observing Network
GFS Global Forecast System
GTS Global Telecommunication System
IBF Impact-Based Forecasts
ICT Information and Communication Technologies
JICA Japan International Cooperation Agency
JMA Japan Meteorological Agency
KMA Korea Meteorological Administration
LaCSA Laos Climate Service for Agriculture
LAM limited area models
MAF Ministry of Agriculture and Forestry
MHEWS Multi-Hazard Early Warning System
MONRE Ministry of Natural Resources and Environment
MOU Memorandum of Understanding
MRC Mekong River Commission
NDMC National Disaster Management Office
NDMO National Disaster Management Office
NEWC National Early warning CentreNEWC National Early Warning Centre
NGO Non-Governmental Organization
NMHS National Meteorological Hydrological Services
NWP Numerical Weather Prediction
PONRE Provincial Office of Natural Resources and Environment
PR Permanent Representative
QMS Quality Management System
RFSC Regional Forecast Support Centre
RIMES Regional Integrated Multi-Hazard Early Warning System
RSMC Regional Specialized Meteorological Centre
RTH Regional Telecommunication Hub
RWC Region WIGOS Centre

SAMIS Strengthening Agro-climatic Monitoring and Information Systems
SOFF Systematic Observations Financing Facility

SOP Standard Operating Procedure
SWFP Severe Weather Forecasting Programme
UNDP United Nations Development Programme
WFP World Food Programme
WIGOS WMO Integrated Global Observing System
WMC World Meteorological Centre
WMO World Meteorological Organisation
WRF Weather Research & Forecasting Model