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WFP World Food Programme

A Comprehensive Report

Readiness Assessment for Impact-based Forecasting and Warning (IbFW) in Lao PDR

January 2022

Supported by USAID's Bureau for Humanitarian Assistance (BHA)

Readiness Assessment for Impact-based Forecasting and Warning (IbFW) in Lao PDR

Lao PDR Report

28th January 2022

Submitted to

World Food Programme

Submitted by

Asian Disaster Preparedness Centre (ADPC)

World Food Programme
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Document Summary:

Name of Project: Readiness Assessment for Impact-based Forecasting and Warning (IbFW) in Cambodia and Lao PDR

Client Name: World Food Programme

Document Status: Final Report

Team Leader: Dr. Peeranan Towashiraporn

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Name of Organization: Asian Disaster Preparedness Center (ADPC)

January 2022

Acknowledgements

The “Readiness Assessment for Impact-Based Forecasting and Warning (IbFW) in Lao PDR” has been conducted under aegis of the World Food Programme (WFP). The readiness assessment process involved a number of Key Informant Interviews (KII’s) and Focus Group Discussions (FGD’s) and consultations with National Meteorological and Hydrological Services (NMHS), National Disaster Management Organizations (NDMO) and other key national institutions, especially agriculture and water resources institutions in Lao PDR.

ADPC would also like to extend its deepest appreciation to all key regional and national stakeholders who participated in this readiness assessment process in Lao PDR. ADPC would like to thank Mr. Viengxai Manivong (DDG, DMH, MoNRE and his team); Mr. Phonesavanh XAYSOMPHENG (Director Division of Disaster Prevention and Risk Reduction, NDMO, DSW, MoLSW) and Mr. Kynong KEOPASEUTH (Deputy Head of Planning Division, Department of Planning and Cooperation, MAF).

ADPC is grateful for the significant contributions provided by the World Food Programme (WFP) Team. Specifically, we would like to highlight the support and in-depth engagement of Mr. Nicolas Bidault, Mr. Dale Wilson, Mr. Jothiganesh Sundaram and other team members of WFP Country Office in Lao PDR.

The guidance and support of the ADPC national consultant is highly appreciated. Specifically, we would like to highlight the support and in-depth engagement of Ms. Phaylom Keokhamphoui in Lao PDR.

A word of special thanks to Mr. Hans Guttman (Executive Director, ADPC), Mr. Aslam Perwaiz (Deputy Executive Director, ADPC) and Dr. Senaka Basnayake (Director, Climate Resilience Department, ADPC) for the guidance throughout the assessment process.

Also, a word of thanks to Dr. Peeranan Towashiraporn (Director, Geospatial Information Department) who has been overseeing the overall outcome of this readiness assessment in Lao PDR and guiding us through the implementing process. This readiness assessment was conducted by a four-member team with experience in areas of meteorology, hydrology, disaster risk management, hazard risk assessment, early warning system design/development and climate risk management in Southeast Asia. The team includes Dr. Rishiraj Dutta, Susantha Jayasinghe, Lalit Kumar Dashora and Chinaporn Meechaiya.

ABBREVIATIONS

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
AFD	Agence Française de Development
CMIP5	Coupled Model Intercomparison Project Phase 5
DDMCC	Department of Disaster Management and Climate Change
DDPCC	District Disaster Prevention and Control Committees
DIMS	Disaster Information Management System
DMH	Department of Meteorology and Hydrology
FAO	Food and Agriculture Organization
FGD	Focus Group Discussions
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GFDRR	Global Facility for Disaster Reduction and Recovery
IbFW	Impact-based Forecasting and Warning
JICA	Japan International Cooperation Agency
KII	Key Informant Interviews
KOICA	Korea International Cooperation Agency
LaCSA	Laos Climate Service for Agriculture
LDCF	Least Developed Countries Fund
MAF	Ministry of Agriculture and Forestry
MoLSW	Ministry of Labor and Social Welfare
MoNRE	Ministry of Natural Resources and Environment
NDMC	National Disaster Management Committee
NDMO	National Disaster Management Office
NDPCC	National Disaster Prevention and Control Committee
NMHS	National Meteorological and Hydrological Services
PDPCC	Provincial Disaster Prevention and Control Committees
RCP	Representative Concentration Pathways
SAMIS	Strengthening Agroclimatic Monitoring and Information Systems

SDC	Swiss Agency for Development and Cooperation
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
VDPU	Village Disaster Prevention Units
WFP	World Food Programme
WMO	World Meteorological Organization

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EXECUTIVE SUMMARY

Impact-based forecasting and warning is a structured approach for combining hazard, exposure, and vulnerability data to identify risk and support decision-making, with the aim to reduce damages and loss of life from natural hazards through early action. While traditional forecast providing scientifically accurate information is important, it is also equally important to communicate to the people on how to respond effectively to hazard risks. In order to do so, it will require very specific information and relevant potential consequences with respect to local contexts, not just for public end-users, but also for different sectors and agencies.

Impact-based forecasting and warning (IbFW) goes beyond forecasting hydro-meteorological events such as floods or droughts into estimating the extent, location, and severity of the impact from those of hydro-meteorological events. To implement successful IbFW, Hydro-met agencies need to strengthen their capacity to adequately monitor hydro-meteorological parameters, improving their existing communication system for data transmission and dissemination of forecasts information including high speed computing system for data assimilation and ensemble forecasting. Similarly, NDMOs will need to be able to receive such forecast information, understand it and be able to use it for emergency preparedness and early response actions. For this to be achieved, institutional capacity building is needed to enhance the capacity of individual institutions so that knowledge and skills on IbFW is built and operational planning and decision-making is improved.

ADPC in partnership with WFP has conducted a readiness assessment of Impact-based Forecasting and Warning (IbFW) in Lao People's Democratic Republic to improve the institutional capacities of national stakeholders such as the National Meteorological and Hydrological Services (NMHS), the National Disaster Management Offices (NDMOs) and the Ministry of Agriculture so that the existing mechanism for impact-based forecasting information are improved for operational planning and decision-making. The readiness assessment (RA) was carried out to provide a better understanding of the current capacity and gaps on IbFW implementation of these institutions and how the expertise of Asian Disaster Preparedness Center (ADPC) and the World Food Programme (WFP) can be leveraged to further strengthen and enhance such capacities at individual and organizational levels. The overall IbFW readiness assessment in Lao PDR was carried out based on the six key areas that includes (i) Level of Understanding about IbFW; (ii) Stakeholder Mapping and Assessment of IbFW Understanding Level (iii) Risk and Impact Assessment (iv) IbFW Generation; (v) IbFW Dissemination; and (vi) Forecast/Impact Verification as defined under international and regional guidelines of IbFW. Overall assessment results from Lao PDR have suggested limited capacity on IbFW ranging from low (Score of 2) to medium (Score of 3). The overall recommendation suggests more training and capacity building at institutional level enhancing the capacity on the use of IbFW in Lao PDR.

Section A: Introduction

SECTION

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A.1 | Introduction

Hydro-meteorological hazard risk, fueled by extreme weather events reached beyond coping capacities of many countries in Asia and the Pacific and extreme weather events in recent past have shown the devastating impacts on people and property (Thomas et al., 2014; UNESCAP, 2019). Countries in Southeast Asia are severely affected by recurrent hydro-meteorological hazards such as droughts, floods, cyclones and storm surge and owing to climate change, frequency and intensity of such hydro-meteorological hazards is on rise and impacts are manifold (Pulwatry and Sivakumar, 2014; UNESCAP, 2019). Hydro-meteorological hazards in the Southeast Asian countries pose direct and indirect impacts on lives and livelihoods by damaging and destroying key lifeline infrastructure, businesses, and agriculture (Pulawatry and Sivakumar, 2014). Impact based forecasting and warning is one of the cost-effective non-structural mitigation measures to monitor and manage hydro-meteorological hazards all over the globe (WMO, 2015; UK Met, 2020; UNESCAP, 2021). Impact based foresting and warning system provide an opportunity to emergency services as well as communities to act with knowing the impact of impending hazard with adequate lead time before onset of any hydro-meteorological hazard to reduce risk to life by evacuation from risk prone areas, and also to protect possessions and properties (Sai et al., 2018; Merz et al., 2020; Dashora, 2020; L M Sidek et al., 2021). Impact based foresting and warning play significant role in all phases of disaster management cycle including, Preparedness, Response, Recovery and Mitigation, which requires collective and coordinated efforts by various stakeholders at different level from national to community (Sai et al., 2018; Merz et al., 2020; Dashora, 2020; L M Sidek et al., 2021). Effectiveness and reliability of an Impact based foresting and warning system depend on many factors such hazard, exposure and vulnerability information, risk information, architecture of forecast system, technology used during development of forecast products and most important capacities of Impact based foresting and warning information producers, co-producers and users such as national meteorological and hydrological services and national disaster management organisations (Sai et al., 2018; Merz et al., 2020; Dashora, 2020; L M Sidek et al., 2021; Wei et al., 2018). Impact based foresting and warning essentially comprises of three major key components including Co-design IBFW, Co-production IBFW and Delivery IBFW (UK Met, 2020). There are six sub-components linked to these three-key components of impact-based foresting and warning. Many stakeholders from national to local levels need to coordinate well across these three components for an effective Impact based foresting and warning to work. Failure in one component or lack of coordination across them could lead to the failure of the whole system (Sai et al., 2018, Merz et al., 2020, Dashora, 2020; L M Sidek et al., 2021, Bierens et al., 2018).

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In addition to these key component, governance and gender are also important cross cutting components to support each component and sub-component for have an effective and people-centric impact-based forecasting and warning system. Impact based forecasting and warning supported by effective institutional capacities and advanced technologies can predict hazards impacts in a timely and effective manner, thereby assessment and accordingly enhancement of capacities of national meteorological and hydrological services is a significant step towards achieving overall targets of Sendai Framework for Disaster Risk Reduction. As mentioned previously, responsibilities of issuance of impact-based forecasting and warning is mandate of national meteorological and hydrological services; thus, readiness capacities of such institutions for better implementation of impact-based forecasting and warning should be well assessed time to time and reflected in the regional to national regulatory frameworks, planning, budgetary, coordination, and operational mechanisms. Traditionally, majority of research was focused only on early warning system technologies and infrastructure and limited attention was given to readiness capacities of producers, co-producers and users on impact-based forecasting and warning.

However, in recent past the focus also shifted towards understanding capacities and needs of national meteorological and hydrological services (Bhat et al., 2013; Dutta et al., 2015; Dutta et al. 2018; Haigh et al., 2018; Sufri et al., 2020; Hippola et al., 2020, Dashora, 2020). Impact-based forecasting goes beyond forecasting hydro-meteorological events such as floods or droughts into estimating the extent, location, and severity of the impact from those hydro-meteorological events. The impact-based forecasting will make emergency preparedness and early response more effective since the efforts, usually by NDMOs, will be targeted to the potential impacted areas. To implement successful impact-based forecasting, countries need to enhance their capacity. Hydro-met agencies need to strengthen their capacity to adequately monitor hydro-meteorological parameters, improving their existing communication system for data transmission and dissemination of forecasts information including high speed computing system for data assimilation and ensemble forecasting. NDMOs will need to be able to receive such forecast information, understand it and be able to use it for emergency preparedness and early response actions. Institutional capacity building is needed. Capacity development is the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time. Capacity development is not a one-off intervention but an iterative process of design-application-learning-adjustment. Therefore, it is important to assess the existing capacities and gaps and what additional capacities would be required to support the capacity development process of a country. Readiness assessment will help evaluate the actual existing gaps within targeted organizations in terms of knowledge, skills, strengths and gaps required for them to achieve the pre-specified objectives. In the present assessment an attempt was made to assess and

visualize readiness of impact-based forecasting and warning producers, co-producers and users at national level in two countries of Lower Mekong Region including Cambodia and Lao PDR.

A.2 | Lao PDR

The Lao People's Democratic Republic (Lao PDR) is a landlocked nation in Southeast Asia that lies between latitudes 14° and 23°N and longitudes 100° and 108°E. It is the only country in the region to have no coastline. The country, which shares borders with five other nations, is located in Southeast Asia's lower Mekong River Basin, and its capital is Bangkok. A total surface area of 236,800 km^2 is covered by the country, which runs 1,700 kilometers (km) from north to south and 100 kilometers (km) to 400 kilometers (km) from east to west. Mountainous terrain covers around 80 percent of the country's geographical area. Remaining 20 percent of the geographical area is comprised of low-lying plains bordering the Mekong River and vulnerable to recurrent annual floods. The elevation varies from 104 meters above sea level at Attapeu to 2,820 meters above sea level in Xiengkhuang, where Phoubia Mountain is located. The southern and central regions of the nation are home to more than two-thirds of the country's population. Apart from high mountains, Mekong river is also one of the key geographical features of Lao PDR.

Lao PDR is one of the most vulnerable Countries in the Southeast Asia region and is affected predominantly by hydro-meteorological hazards such as drought, flood and landslide induced by rainfall. Climate change has increased the number and severity of hydro-meteorological hazards which adversely affecting water resource and agricultural sectors in country. Seasonal droughts that occurred with regularity could be managed only by proper IWMR practices and basin wise approaches. The key challenge for country is the unexpected drought due to variation in rainfall pattern and a long spell of dry weather that could affect the crop production and the country losses most of crop during that season. Mountain ranges resulting in low rainfall on the lee sides of the mountain certainly affect the agricultural crops. In general, moisture is retained more on north and northwest faces than on south and east faces.

Agriculture is one of the most important activities in Lao PDR (19% of the National economic structure and 76.3% of total population are in the agricultural system). Literature reviews, consultative meetings and interviews have led to a conclusion that the drought issue in Lao PDR is getting more often and more unpredictable. In 2019, the monsoon period appears to be shorter that the norm. The rain was delayed around 1-2 months and finished earlier, resulting in damage to agriculture, livestock and fisheries within the country. There are many factors such as the increasing of dams upstream, leading to unpredictable water level. On the other hand, climate change lead to less precipitation further to next year 2020. Moreover, drought issue in 2019 happened during monsoon season in the dry area which create severe damage to

many people in Laos as there is still lacking in Multi-hazards Early Warning system within the country to have a better plan for decision making.

Lao PDR experienced major droughts like situation in past, caused by erratic rainfall in wet and an almost total lack of rainfall during winter seasons. Some studies of past drought suggest that unusual events were randomly found in the country's historical records. Agriculture production was dropped due to drought and insects attack in 1954-55. In 1976, drought threatened most of the country there by required the relief assistance. Dry spell damaged plants even in the month of July 1978 (Steyaert, et al., 1981). It is reported that two weeks of dry spell was experienced between the month of June and July (Oudomcit, 2009). Except Saravane and Champasak provinces, other parts of the country suffered from drought and insects in the year 1979 and acute food shortages especially in northern part was observed. Four months drought from late 1979 affected secondary rice crop in nine provinces (Steyaert, et al., 1981). The main rice crop in southern and most parts of central regions was adversely impacted by drought during wet season in 1981. Agro-climatic/crop condition indices were 30 percent below normal for these regions as stated in the crop assessment of November 2, 1981 (Achutuni, et al., 1982). During present decade almost each year, at least few parts of the country experience either a short or long dry period even within the wet season (Oudomcit, 2009). So, study on drought in time and space is most essential. It is also important to study the probability of having a consecutive dry period during the growing season of a crop. Despite several technical constrains, early warning and drought monitoring system in Lao PDR is urgent need due to the wake of recent global warming and resulting climatic changes. The present study on drought in Lao PDR is the first attempt to analyze the drought in detail by using standardized precipitation index.

1. Climate Trends

1.1 Baseline Assessment

The Lao People's Democratic Republic has a tropical climate, which is affected by the southeast monsoon, which provides 70 percent of the country's annual rainfall and causes significant humidity. According to the most recent climatology (1991–2020), there are two distinct seasons: the wet season, or monsoon, which runs from May to mid-October, and the dry season, which runs from mid-October to April. Lao PDR receives average 3,000 millimeters (mm) of rain each year. The northern and eastern mountainous regions, as well as the plateaus, have average annual temperatures of 20°C, although temperatures in the southern plains are higher, averaging 25–27°C (World Bank, n.d.[1]). **Figure (1)** represents month wise average temperature and precipitation in Lao PDR (1991–2020).

[1] World Bank (n.d.). Climatology of Lao PDR. URL:

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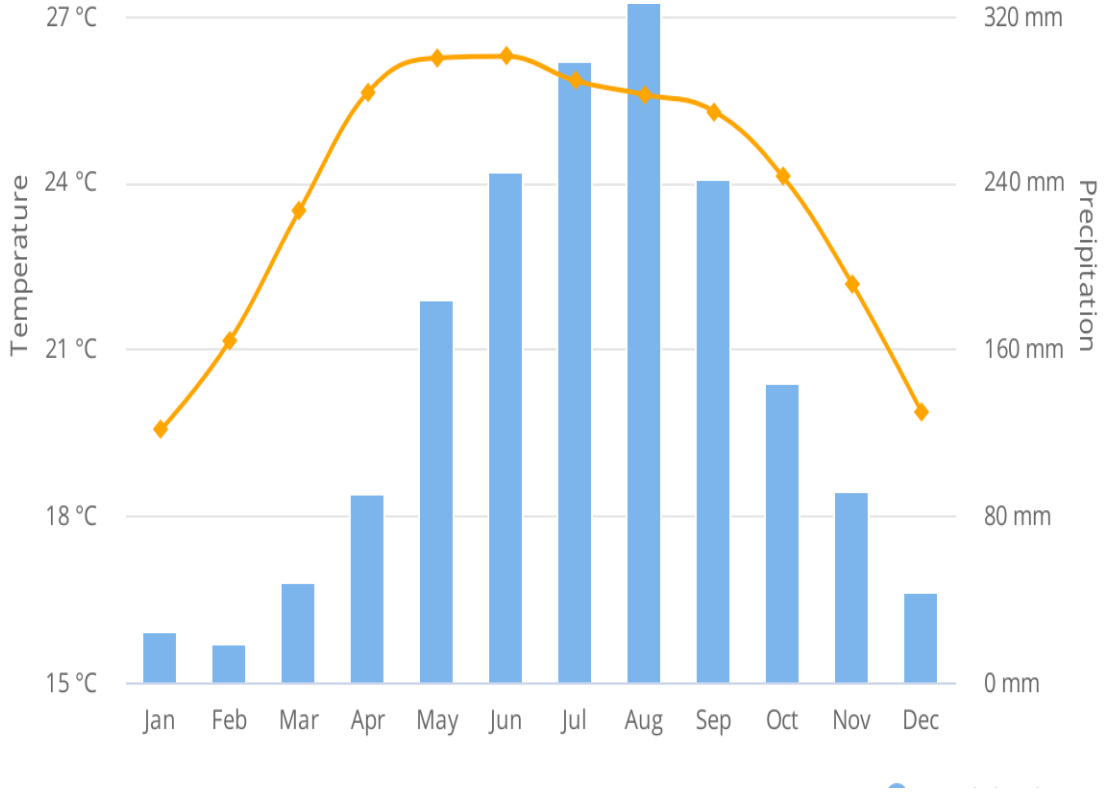

Figure (1): Average monthly temperature and precipitation in Lao PDR (1991–2020) (Source: World Bank, n.d.[2])

The annual mean temperature of Lao People's Democratic Republic has risen by as much as 0.05 degrees Celsius every year, with the maximum increase observing in the southern provinces. Between 1951 and 2000, temperatures increased on average by 0.1 to 0.3°C every decade. In 1998, the average temperature reached 30°C, which was the highest recorded in the previous two decades. This was also the driest year on record, with an average rainfall of 800 millimeters falling during the year. Over the course of the twentieth century, the Lao People's Democratic Republic's precipitation regime shifted toward more intense precipitation periods, with the number of months with more than 600 mm of rainfall rising. Between 1961 and 1998, the amount of rain fell decreased. The number of droughts and floods has grown significantly during the previous three decades (World Bank, n.d.[3]).

The Lao People's Democratic Republic can be classified into three distinct climate zones based on its elevation. The northern mountainous areas over 1,000 meters (m) have a montane temperate and hilly sub-tropical climate, whilst the southern mountainous parts have a sub-

https://climateknowledgeportal.worldbank.org/country/laos/climate-data-historical

[2] World Bank (n.d.). Climatology of Lao PDR. URL: https://climateknowledgeportal.worldbank.org/country/laos/climate-data-historical

[3] World Bank (n.d.). Climatology of Lao PDR. URL: https://climateknowledgeportal.worldbank.org/country/laos/climate-data-historical

tropical climate. The temperature ranges are lower in this region compare to the rest of the country. The middle mountainous parts of the Annamite Chain range in elevation from 500 to 1,000 meters above sea level and are characterized by a tropical monsoonal climate with high temperatures and average rainfall totals, which is influenced by the El Nio phenomenon. More than half of the population resides in the tropical lowland plains and floodplains of the Mekong River and its major tributaries, which include the Mekong Delta. It has been demonstrated that the temperature and precipitation rates in the Lao People's Democratic Republic are susceptible to the El Nio Southern Oscillation (ENSO), albeit to a lower extent when compared to other Southeast Asian countries.

1.2 Climate Projection

The Coupled Model Intercomparison Project Phase 5 (CMIP5) models are the major global data source for the predictions of future climate including temperature and precipitation. Each of the four Representative Concentration Pathways (RCP) are characterized by its total radiative forcing pathway and level by 2100 (RCP2.6, RCP4.5, RCP6.0, and RCP8.5). The research focuses on RCP2.6 and RCP8.5, the low and high emissions trajectories. RCP2.6 implies substantial mitigation, whereas RCP8.5 assumes business as usual (IIASA, n.d.). These models show a steady warming trend for Lao PDr, varying by GHG scenario. But rainfall forecasts are less clear. Forecasts predict a rise in the frequency and severity of heavy rain episodes, along with an increase in total rainfall (ADB, 2021[4]).

Box (2): Climate Summary of Lao PDR

- *Lao PDR faces projected warming of 3.6°C by the 2090s against the baseline conditions over 1986–2005, under the highest emissions pathway (RCP8.5).*
- *Lao PDR is amongst the most vulnerable countries to projected climate change trends, as its communities face significant climate-related hazards that are exacerbated by poverty, malnourishment, and high exposure of poor and marginalized communities.*
- *Increased incidence of extreme heat represents a major threat to human health, especially for outdoor laborers and, given rapid ongoing urban migration, potentially for urban populations as well.*
- *Without action, the population annually exposed to river flooding is projected to double to over 80,000 people by the 2030s. However, flooding impacts could be even greater as the potential for increased loss and damage from flash flooding and landslides are poorly understood.*

[4] Asian Development Bank (2021). Climate Risk Country Profile of Lao PDR. URL: https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15505-Lao%20PDR%20Country%20Profile-WEB.pdf

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- *A significant adaptation effort is required to address reductions in yields driven by projected increases in the incidence of extreme heat during the growing season of staple crops such as rice, particularly for poorer communities operating subsistence and rain-fed agriculture.*
- *The impacts of climate change are likely to fall disproportionately on the poorer and more marginalized communities. Inequality is widening in Lao PDR and evidence suggests that this may further amplify the impacts of climate-related disasters*

Figure (2) represents historic and projected average annual temperature in Lao PDR under RCP2.6 (blue) and RCP8.5 (red).

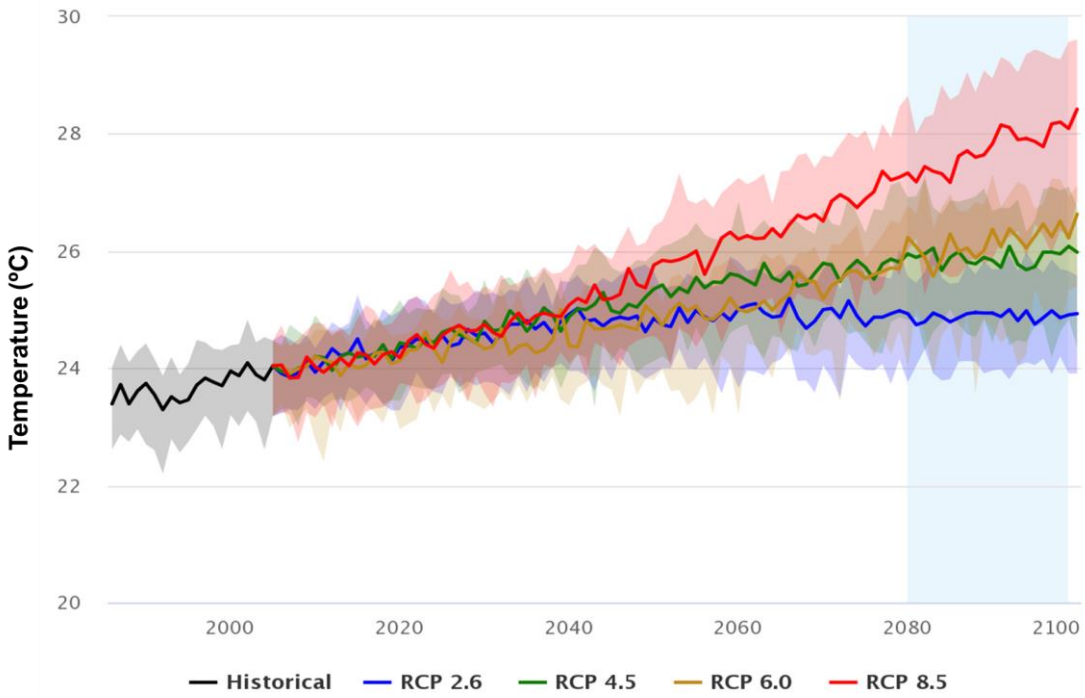

Figure (2): Historic and projected average annual temperature in Lao PDR under RCP2.6 (blue) and RCP8.5 (red) (Source: World Bank, n.d.[5])

By 2100, it is expected that mean annual temperatures would rise by 1.4 to 4.3 degrees Celsius, with comparable estimated rates of warming for all four seasons. Although some studies predict that similar warming would occur across all areas, others predict that the country's southern climatic zone will see less warming than the country's northern and north central zones. The number of hot and cold days each year might alter significantly, with the number of days considered 'hot' under the current climate increasing by 2-3 weeks and the number of cool days

[5] World Bank (n.d.). Future Climate Change in Lao PDR. URL: https://climateknowledgeportal.worldbank.org/country/laos/climate-data-projections

falling by 2-3 weeks, depending on the climate. The mean annual rainfall is forecast to increase, with the greatest increases expected during the rainy season. The mean annual rainfall is projected to increase. Increases in rainfall are expected to range from 10 to 30 percent, with the greatest potential increases occurring in the eastern and southern regions of Lao PDR. The number of wet days over the southern region of the Mekong River is expected to grow overall, according to the forecast.

2. Riskscape of Lao PDR

The Lao People's Democratic Republic's national risk profile has identified five primary natural hazards, which include droughts, flooding, and storms, as well as earthquakes, and landslides (GFDRR, n.d.).

In the Lao People's Democratic Republic, one-fourth of the land area is regarded to be a high-risk earthquake zone, while more than 30 percent of the nation is located in a moderate seismic risk zone (GFDRR, n.d.). However, there have been no big earthquake-related disasters documented in the recent past (JICA, 2015). Heavy rain, flooding, and accompanying landslides have the potential to cause loss of life, property, and agricultural productivity in Lao PDR despite the fact that the mountainous mountains separating it from Viet Nam frequently shield the nation from typhoon impacts (Government of Lao PDR, 2014). Because flooding occurs often on the eight river basins that run across the nation, hydrometeorological hazards pose the biggest threat to people, livelihoods, infrastructure, and the economy. The low-lying flood plains along the Mekong River and its major tributaries in the central and southern sections of Lao PDR are the most susceptible areas of the nation (Government of the Lao PDR, 2011). Landslides, which are associated with excessive precipitation and endanger roughly 5.24 percent of the nation in the southeast and central parts of the country due to steep topography and soil conditions, are also a concern in these regions (GFDRR, n.d.).

Lao PDR is vulnerable to a wide range of hydro-meteorological hazards, including floods, droughts, landslides among others. **Table (1)** represents summary of Riskscape of Lao PDR.

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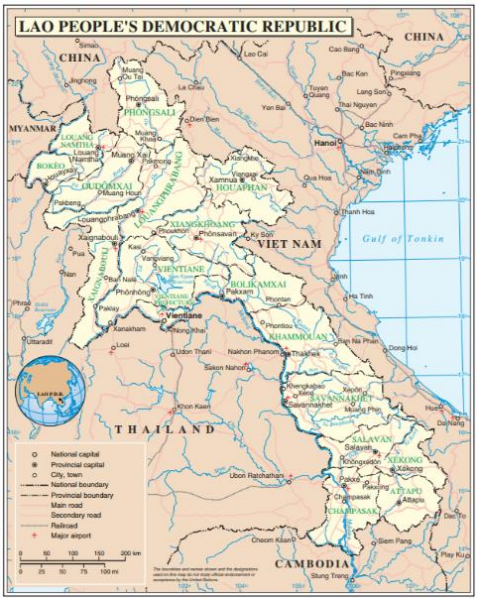
Table (1): Summary of Riskscape of Lao PDR

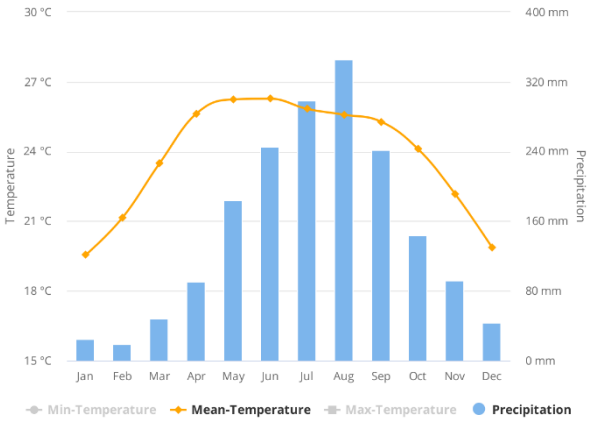
Capital: Vientiane
Location: 19.8563° N, 102.4955° E
Geographical Area: 236,800 km²
Number of Provinces: 18
Number of Districts: 142
Population: 72,75,556[8]
Male: 3,651,794 | Female: 3,623,762
WMO Region: II | Asia
NMHS: Department of Meteorology and Hydrology (DMH), A. Ministry of Natural Resources and Environment (MoNRE), Government of Lao PDR WMO Member: July 1955[9] NDMO: National Disaster Management Committee
Germanwatch Global Climate Risk Index: Climate Risk Index Score: 55.17[10] Climate Risk Index Rank: 45
INFORM Country Profiles: INFORM Risk Index: 4.1[11] INFORM Risk Rank: (79)[12] INFORM Risk Class: Medium INFORM Hazard and Exposure Index: 3.4 INFORM Vulnerability Index: 3.4 INFORM Lack of Coping Capacity: 6.0

Figure (3.1): Geographical Location



Source: United Nations, n.d.[6]

Figure (3.2): Monthly Climatology of Mean-Temperature and Precipitation in Lao PDR from 1991-2000



Source: The World Bank[7]

[6] United Nations (n.d.). URL: https://www.un.org/Depts/Cartographic/map/profile/laos.pdf
[7] The World Bank (n.d.). URL: https://climateknowledgeportal.worldbank.org/country/laos/climate-data-historical
[8] The World Bank (n.d.). URL: https://data.worldbank.org/indicator/SP.POP.TOTL?locations=LA
[9] WMO (n.d.), https://contacts.wmo.int/all_members/details_all_members/?id=7d1074ca-816a-e811-a959-000d3a38c9b5
[10] Germanwatch (2021). URL: https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf
[11] European Union (2021). Inform Risk Index-2022 https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Results-and-data/moduleId/1782/id/433/controller/Admin/action/Results
[12] European Union (2021). Inform Risk Index-2022 https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Profile

Figure (4) represents Global Climate Risk Index Ranking from 2000-2019.

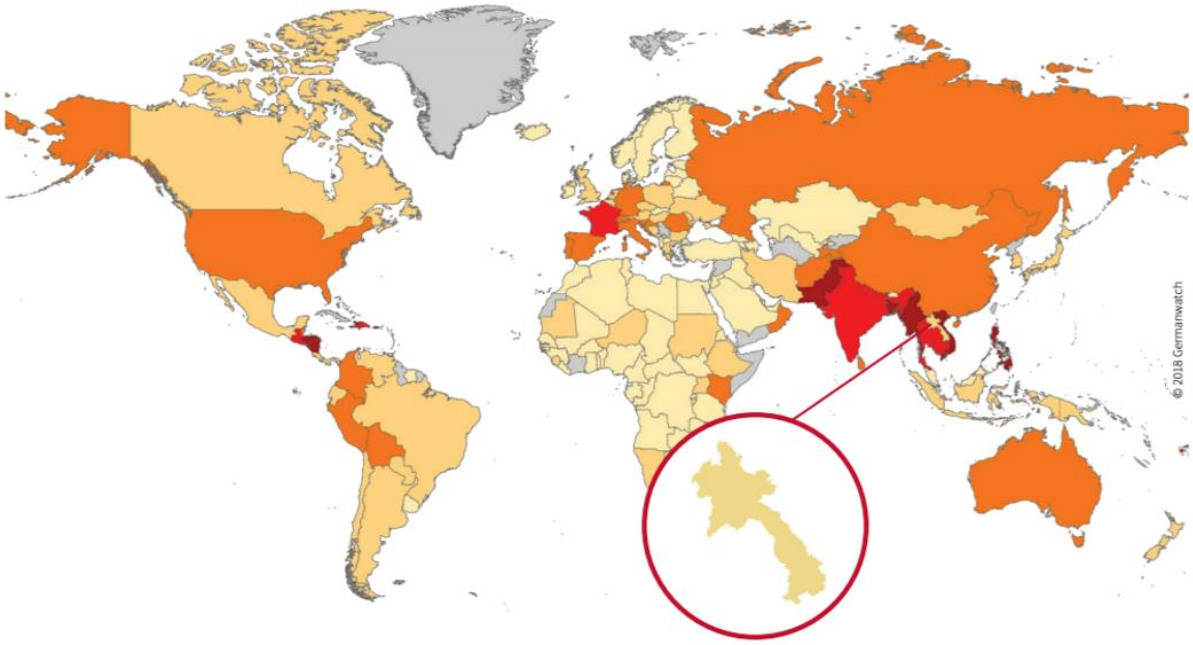


Figure (4): Global Climate Risk Index: Ranking 2000-2019 (Source: Germanwatch, 2021[13])

According to the 2022 INFORM Risk Index, Lao PDR has a medium degree of catastrophe risk, ranking 79th out of 191 nations (EU, 2021). This is mostly due to the country's high exposure and vulnerability to drought and floods (GFDRR, n.d.). Floods are very common in Lao PDR, and it includes both riverine and flash flooding. Drought exposure is also high compare to the other parts of the Southeast Asia. Tropical storm and their related impacts are also a major challenge to Lao PDR, but to a lesser extent. Due to the high spatial and regional variability of these natural hazards and climate risks, the impacts on people and communities are not even and will vary with locations. The poor coping capability of the Lao People's Democratic Republic, as well as the susceptibility of the country's people, contribute to the country's overall score on the INFORM risk index. However, the resilience of people to climate and disasters is affected by their wealth, access to land, livelihood opportunities, poverty rates, climate sensitivity of income sources and by climatic trends of the region, lack of which contribute to increasing vulnerabilities. The agriculture sector is the backbone of economy of Lao PDR, accounting for 29.9 % of GDP, and approximately 70-80% of the population is dependent on the sector for their livelihoods (GEF, 2019). Around 80 percent of the rural population is still subsistence farmers, depending heavily on rice-based agriculture, raising livestock and collection of food from the wild, including forest products, to meet food and nutritional needs.

[13] Germanwatch (2021). Global Climate Risk Index: Ranking 2000-2019. URL: https://germanwatch.org/sites/germanwatch.org/files/2021-01/cri-2021_map_ranking_2000_-_2019.jpg

Section A: Introduction

3. Flood and Drought Monitoring and Forecasting In Lao PDR

Department of Meteorology and Hydrology (DMH) is the mandated agency under the Ministry of Natural Resources and Environment (MoNRE). It is responsible for the collection and analysis of hydro-meteorological data and the provision of water supply conditions, weather forecasts, and issuing early warning. As the designated WMO NMHS of Lao PDR's and mandated agency for hydrometeorological observing network, DMH collects these data to describe the water, climate, and weather setting in the country. In addition to data collection, the Department analyses hydrometeorological data to provide summary statistics and information on trends and extreme hydrometeorological conditions. Furthermore, the forecast and early warning capability of DMH is an essential part of the department's mandate for the safety and security of the public. **Figure (23)** represent the organization structure chart of DMH in Lao PDR.

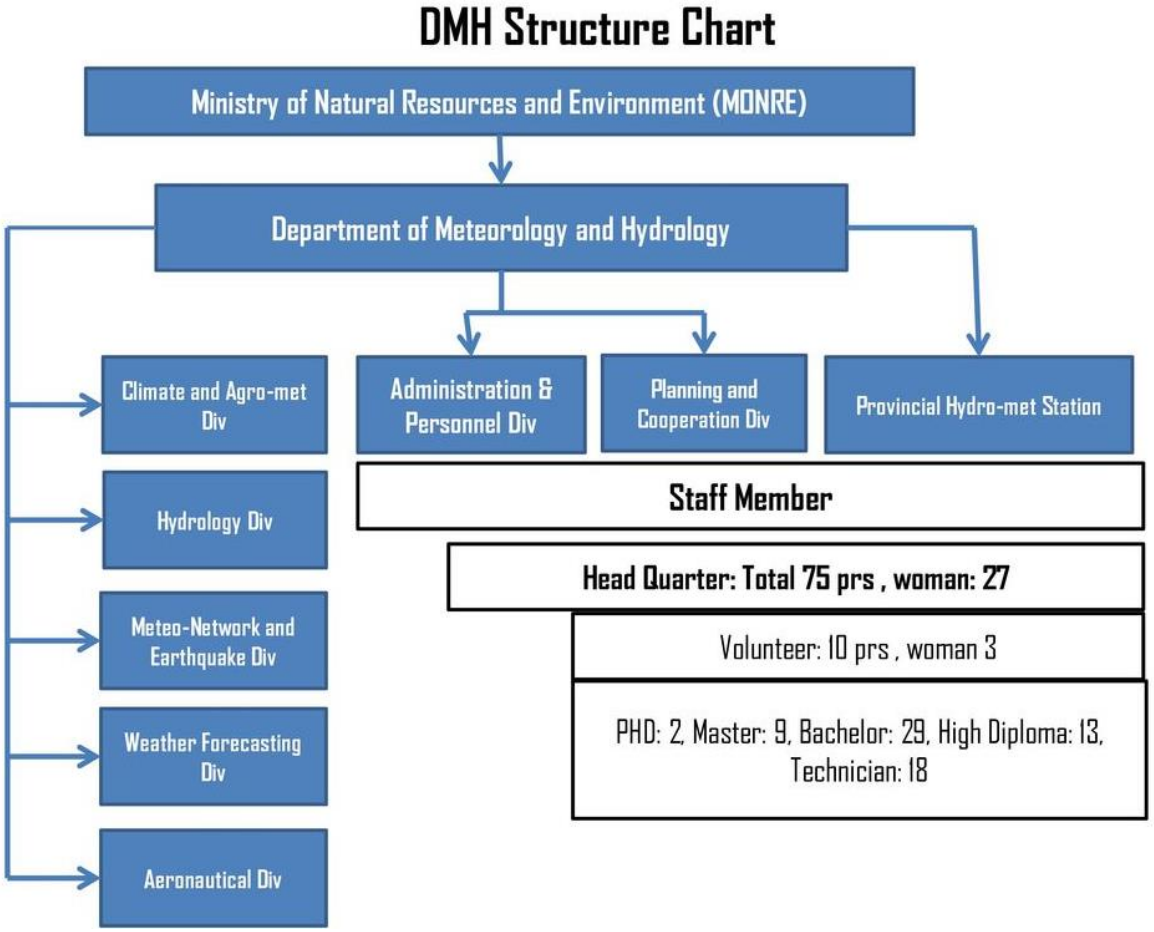


Figure (5): Organization Structure of DMH, Lao PDR (Source: WMO, 2018-19)

3.1 Existing Monitoring Capacity:

Currently, DMH is able to collect hydro-meteorological data through various sources, including Manual Weather Stations 53, Automatic Weather Station 43, Manual Water Level Station 110, Automatic Water Level Station 37, Manual Rain Gauge posts 119, Satellite

Ground Receiving Station 3 (Coms-1, FenYung, Himawari-8), Weather Radar 1 (Doppler: C-Band).

Figure (6) represents locations of meteorological stations (left) and hydrological stations (right) in Lao PDR

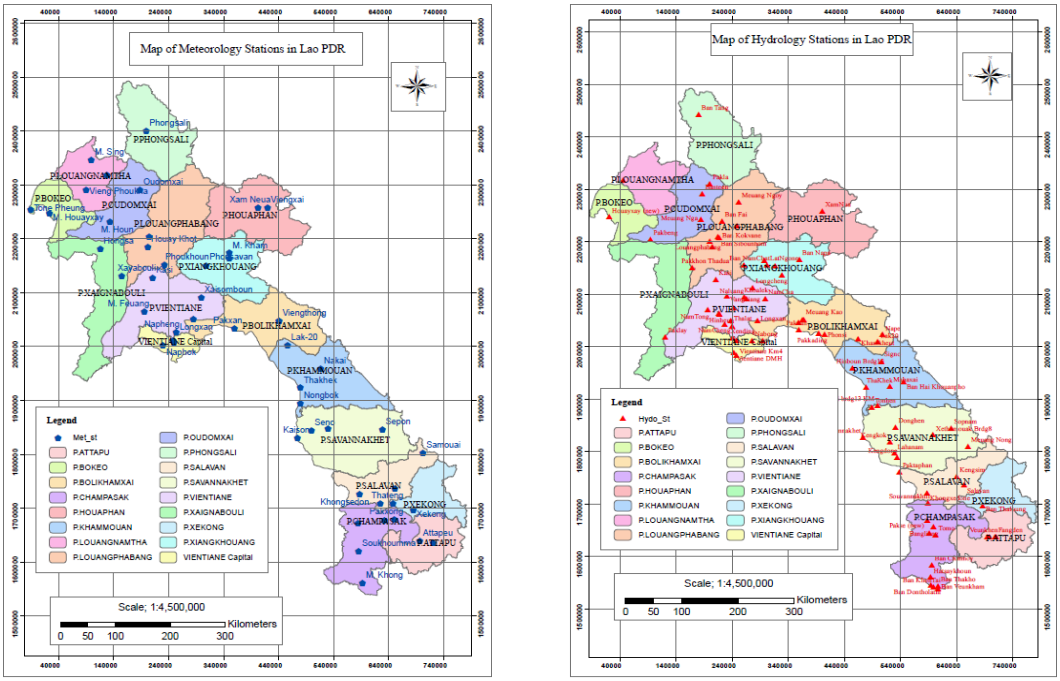


Figure (6): Locations of Meteorological Stations (left) and Hydrological Stations (right) in Lao PDR (Source: ADPC, 2020)

DMH also receives the information from international sources such as the U.S. Geological Survey (USGS), U.S. National Oceanic and Atmospheric Administration (NOAA), and their own C-Band Doppler weather RADAR. DMH regularly issues 3-day weather forecast and 1-week water level forecast. They selected Sebangfai as a pilot site to run hydrodynamic model, simulating water level forecast. They usually run 2 times during monsoon season.

DMH has an institutional linkage from National level to Provincial Office of Natural Resource and Environment (PoNRE) at the provincial level and to District Office of Natural Resources and Environment (DoNRE) at the district level to the villages respectively. They disseminate the warning information through hard copy, TV, radio, Newspaper, WhatsApp and Facebook. They issue three types of warnings according to water level and forecasted rainfall, which are normal stage (green color), alarm stage (yellow color) and flood warning (red color). The potentiality disaster resulting from the flood warning stage will be different from place to place due to various conditions.

In terms of drought, DMH has a limited knowledge and capacity in this regard. There is no drought monitoring and drought early warning system in place yet within DMH. However, there is an on-going project "Strengthening Agro-climatic Monitoring and Information Systems (SAMIS) funded by FAO to improve adaptation to climate and food security in Lao PDR. Through this project, DMH, especially Climate and Agro-met Division has been working and training by FAO on how to consolidate hydro-met information and generate drought indices basically focusing on Effective Drought Index (EDI). Climate and Agro-met Division works closely with National Agriculture and Forestry Research Institute (NAFRI) under Ministry of Forestry (MAF). Mostly DMH provides the 3-hour, 7-day and seasonal weather forecast to the Laos Climate Service for Agriculture (LaCSA). More details about LaCSA is provided in Section 6 of this report.

3.2 Data Availability

- 3-day weather forecast
- 1-week water level forecast in Sekong
- Daily rainfall
- Daily water level
- Daily weather information such as temperature, wind speed and ET
- Soil moisture (with 15 manual sensors and will be installed 15 automatic sensors by FAO next year across country)
- Weekly Effective Drought Index (EDI)

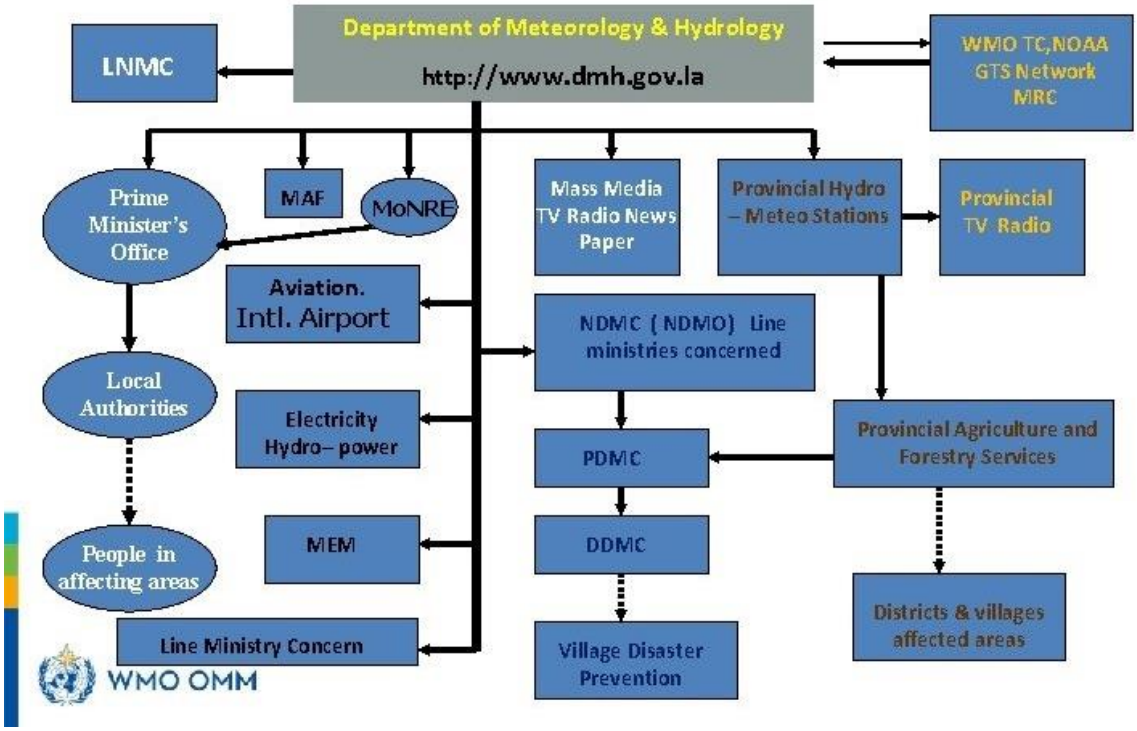


Figure (7): Forecast information & Early Warning Dissemination system (Source: WMO, 2018-19)

4. Flood and Drought Impact Assessment in Lao PDR

In the past, the DRM in Lao PDR was primarily concerned with reaction and relief, as well as meeting the fundamental needs of the afflicted population. With the establishment of the National Disaster Management Committee (NDMC) in 1999, efforts have been steered towards more proactive, holistic, and risk reduction-oriented approaches. The NDMC serves as an inter-agency committee for disaster management from the national to the local level, and is focused on the entire disaster management cycle (Government of Lao PDR, 1999). Additionally, the NDMO was formed as the Secretariat of the NDMC as part of the order.

The National Disaster Management Committee (NDMC) was renamed the National Disaster Prevention and Control Committee (NDPCC) in 2011, with the Deputy Prime Minister and Minister of National Defense serving as head (NDMO, 2012).

Figure (8) represents Organization Structure of NDPCC, Lao PDR.

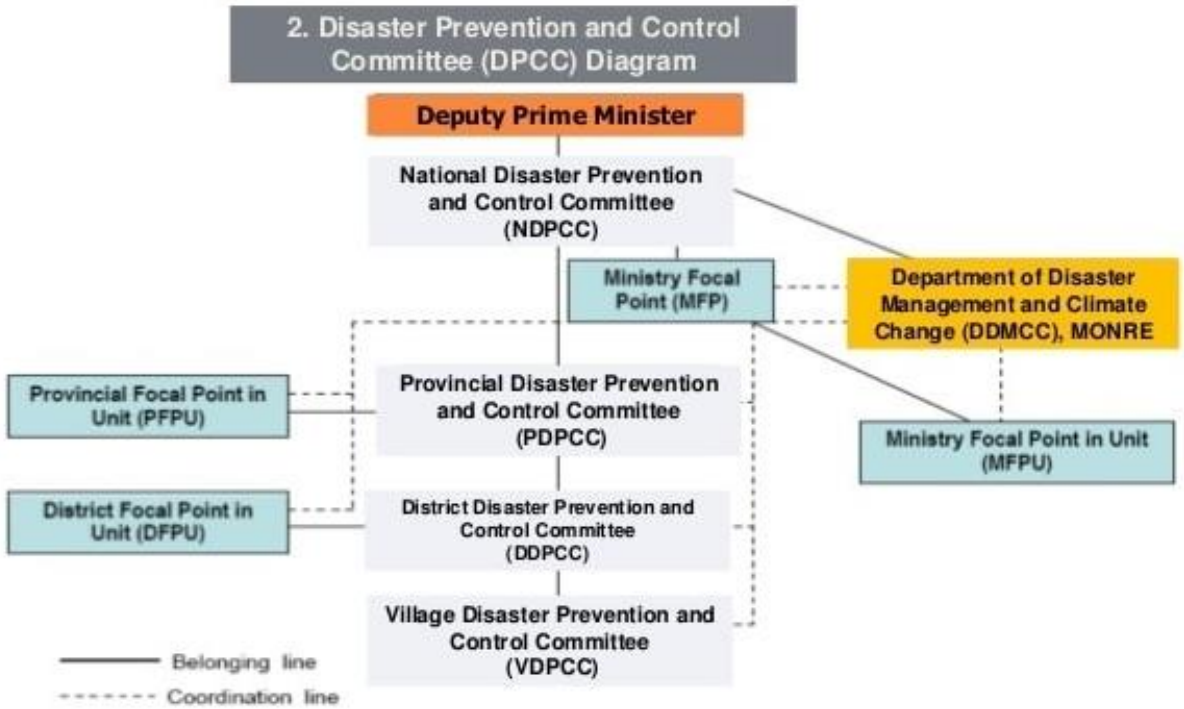


Figure (8): Organization Structure of NDPCC, Lao PDR (Source: MONRE, 2017)

DRM mechanisms have also been formed at the sub-national level in provinces, districts, and villages, resulting in a multi-tiered risk governance system for emergency management at the local level. It is composed of three components: Provincial Disaster Prevention and Control Committees (PDPCCs), District Disaster Prevention and Control Committees (DDPCCs), and Village Disaster Prevention and Control Committees, also known as Village Disaster

Prevention Units (VDPUCs) (VDPU). The Village Disaster Preparedness Unit (VDPU), which is the smallest unit for disaster risk management and the first line of defense in disaster response, is made up of representatives from community-based organizations (CBOs), traditional leaders, religious groups, and extension workers. Policies on disaster risk management, as well as the institutional architecture, have undergone revisions including transfer of duties and responsibilities. DRM duties were shifted from the Ministry of Natural Resources and Environment (MoNRE) to the newly-created Department of Disaster Management and Climate Change (DDMCC), with the Ministry of Labor and Social Welfare (MoLSW) role's reduced to reaction and relief only from 2013 to 2018. DDMC was entrusted with general data compilation and assessment throughout this time period, in its capacity as a national secretariat for the NDPCC, in order to report to the NDPCC on a timely basis for its decision, oversight, and action (DDMCC, 2015). The Ministry of Labour and Social Welfare (MLSW) has recently been tasked with redistributing DRM responsibilities at the national level including risk communication to stakeholders in Lao PDR.

Figure (9) represents EWS – Risk Communication mechanism by NDMO.

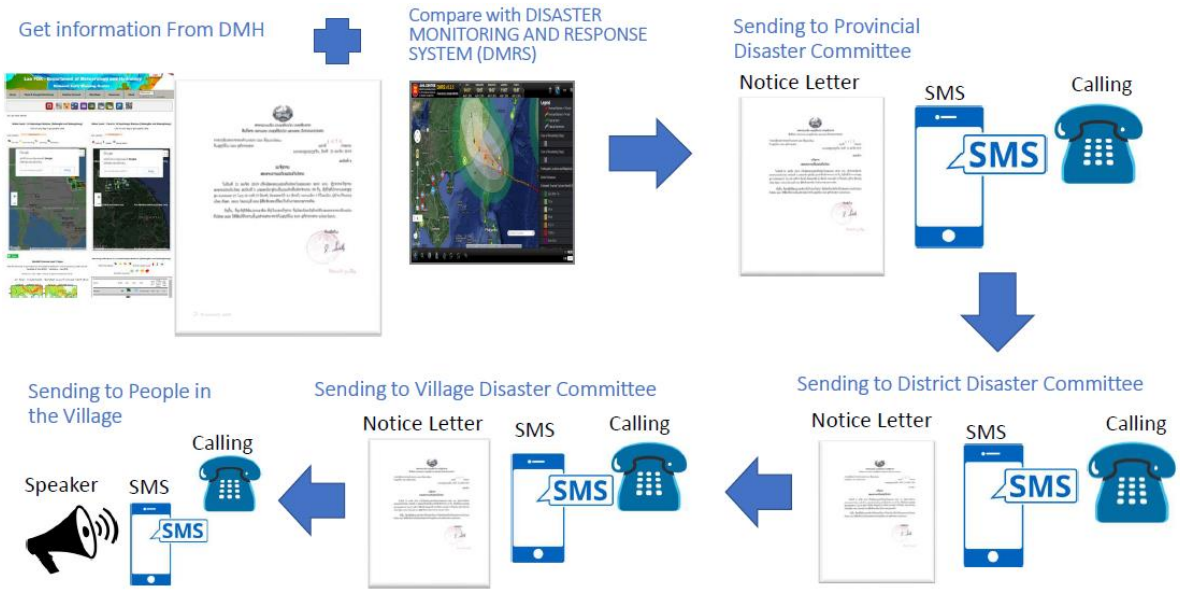


Figure (9): Risk Communication by NDMO (Source: NDPCC (2020))

The National Risk Profile of Lao PDR was developed by Asian Disaster Preparedness Center (ADPC) in 2010 to provide a comprehensive profile of the natural hazards and overall impacts on Lao PDR. It features maps of all hazard prone areas (based on historic disaster events), analysis and assessment of exposure, vulnerability and risks to people, property, and affected sectors including critical facilities, infrastructure and economic activities. The risk profile has

been extensively used to identify the risk priorities to guide national disaster risk reduction strategies (ADPC, 2010; ADPC, 2010).

Figure (10) represents National Risk Profile of Lao PDR Volume - 1 and Volume - 2. Volume 1 of National Risk Profile of Lao PDR presents hazard profile of Lao PDR, whereas Volume 2 of National Risk Profile of Lao PDR presents exposure, vulnerability and risk assessment.

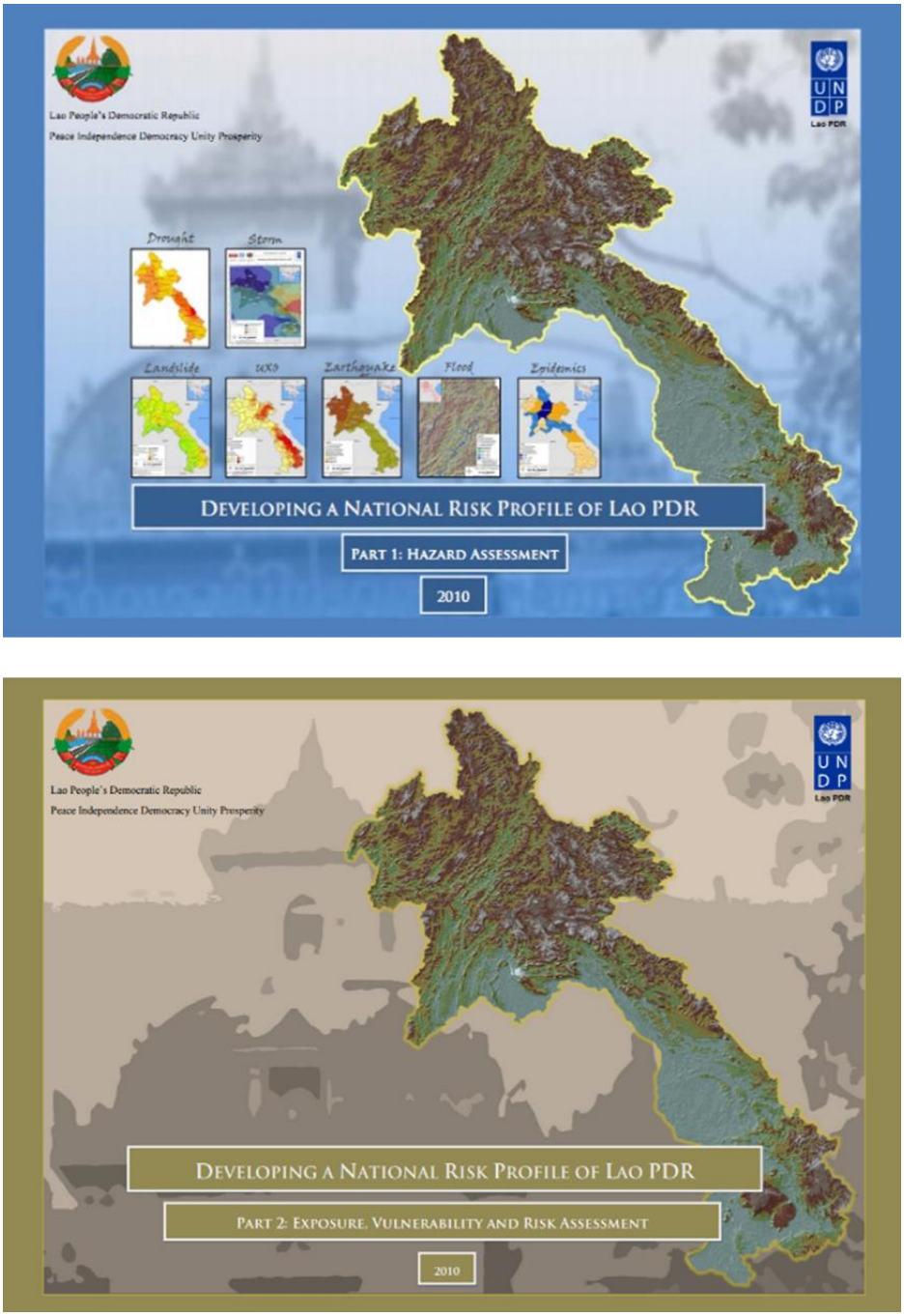


Figure (10): National Risk Profile of Lao PDR Volume - 1 and Volume – 2 (Source: ADPC, n.d.)

Section A: Introduction

Provincial Risk Profile and hazard maps have also been developed for the provinces of Saravanh, Sekong and Attapeu under the Operationalizing National Strategic Plan on Disaster Management (OSPDM) Project 2010-2012. Lao PDR National Assessment Report on Disaster Risk Reduction 2012 features disaster risk profile of the country, based on an initial analysis of DesInventar data to establish relationship between disasters and poverty, and includes a guide on mainstreaming DRR as part of poverty reduction (ADPC, 2012).

Figure (11) represents Lao PDR National Assessment Report on Disaster Risk Reduction 2012.

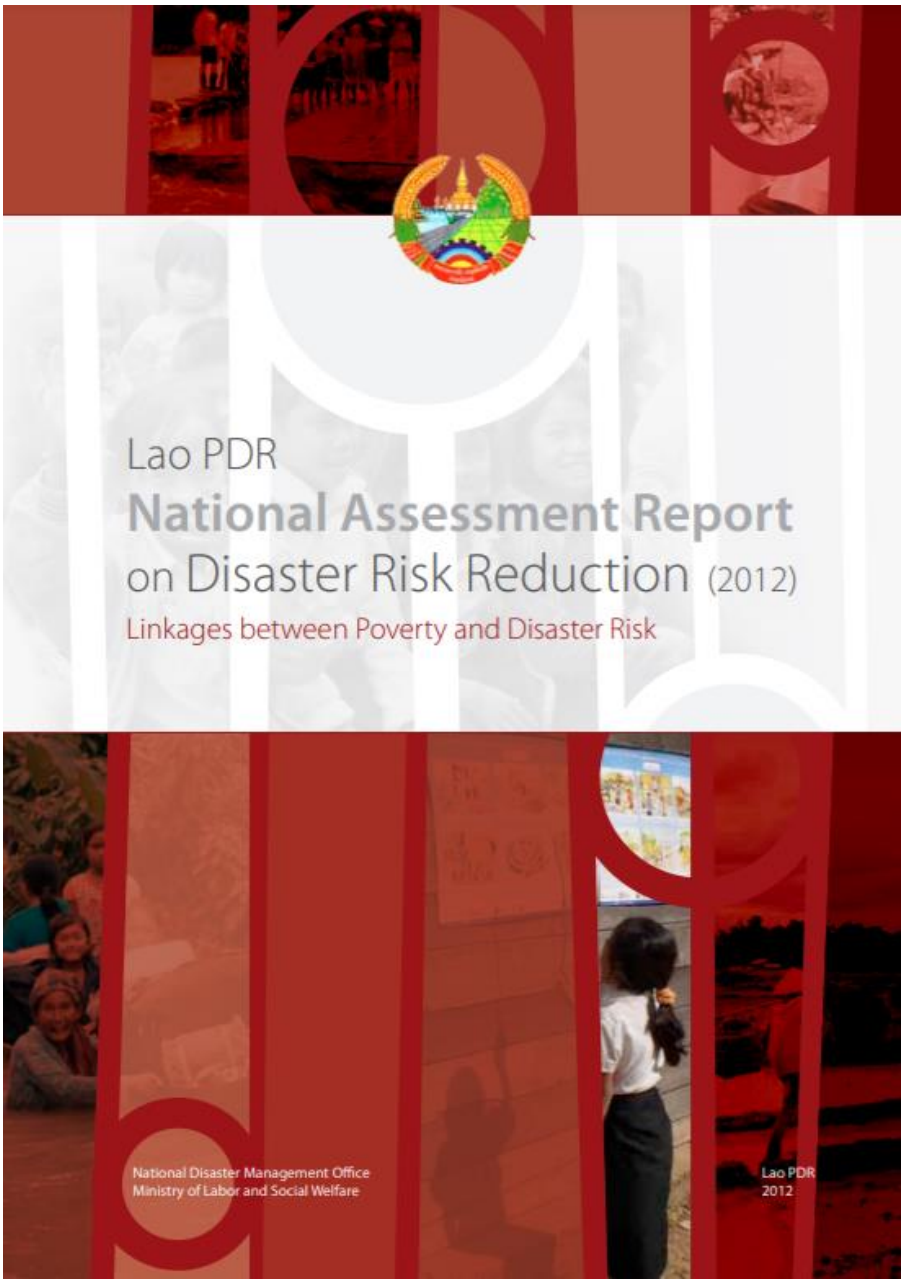


Figure (11): Lao PDR National Assessment Report on Disaster Risk Reduction 2012 (Source: ADPC, n.d.)

The DesInventar methodology, initiated by UNDP and UNISDR in Lao PDR since 2005, has evolved into an operational system for collecting historical disaster data, including loss database covering longer periods of time (NDMO, 2012). However, the Desinventar database has not been regularly updated (DDMCC, 2015). As the country has moved towards up-scaled DRR interventions across key development sectors, there is a need for a comprehensive database and quantifiable risk information for conducting sector specific risk assessments. For Lao PDR, the damage and loss data can be retrieved from the damage and loss database of "DesInventar" also called as a Disaster Information Management System (DIMS). DIMS (https://www.desinventar.net/) contains country-wise database of over 89 countries and Lao PDR is also included in the database. The datasets within DIMS are only available till 2012 for Lao PDR. It is worth to highlight here is that there is a major gap exists in the present state of baseline data for hazard, exposure, vulnerability, damage & loss, and risk analysis in order to increase the quality, quantity, and accessibility of datasets used for impact assessment and other DRM purposes. To address the information shortages for sectoral planners, more hazard inventories and risk assessment tools with more sector-specific exposure and vulnerability datasets need to be produced. The National Meteorological and Hydrological Services (NMHSs) are required necessary technical support, expertise, infrastructure, and human resources to provide accurate, timely, and usable climate predictions, products, and information. The Department of Meteorology and Hydrology (DMH) capacities has been strengthened in past by the World Bank and WMO to fulfill the increased demand for meteorological and environmental services as the nation faces more adverse climate effects.

5. Multi-stakeholder Initiatives for Drought and Floods

5.1 Strengthening Agroclimatic Monitoring and Information System (GEF/FAO)

Food and Agriculture Organization (FAO) with support from Global Environment Facility (GEF) under Least Developed Countries Fund (LDCF) currently implementing a project titled "Strengthening Agroclimatic Monitoring and Information Systems (SAMIS)" to improve adaptation to climate change and food security in Lao PDR. SAMIS is enhancing decision-making and planning capacity for the agricultural sector at national, sub-national and local levels in Lao PDR. Main objective of SAMIS project is to enhance capacities to gather, process, analyze, and share climatic and geospatial information so that these can be applied to agriculture planning and decision-making. Under SAMIS project, DMH is developing comprehensive agroclimatic monitoring and information capacity focused on boosting sustainable production by optimizing farmers and small-holders resilience against climate change. Using this information farmers will be able to take informed judgements about the most appropriate technologies and approaches in face of climate vagaries.

5.2 Laos Climate Services in Agriculture (LaCSA) System

Laos Climate Service for Agriculture (LaCSA) is a component of SAMIS project. The LaCSA system is significantly contributing about rainfall and temperature seasonal forecast as well as crop calendar to farmers on near real-time (with weekly bulletin), which will be very influential for making their decision on seasonal agriculture production such as selection of suitable crop species for cultivation in difficult condition of climate change. This will be able to ensure on more stable and sustainable production, higher productivity, improve food security, reduce the risk of disease and pest in Lao PDR.

Figure (12) represent Laos Climate Service for Agriculture (LaCSA).

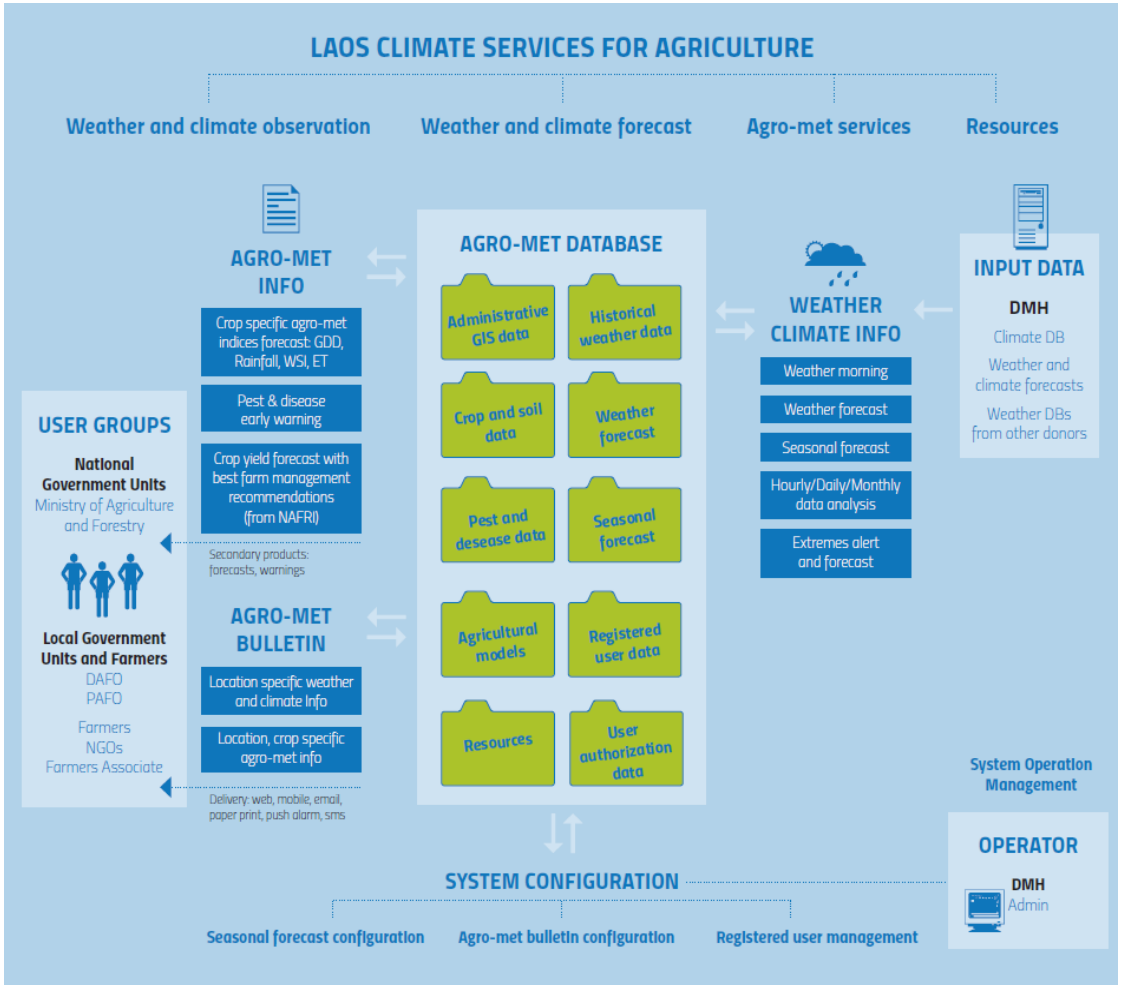


Figure (12): Laos Climate Services in Agriculture (LaCSA) (Source: FAO)

Advisory production chain and related activities under Strengthening agro-climatic monitoring and information systems (SAMIS) project are being implemented and monitored by the Department of Meteorology and Hydrology of the Ministry of Environment and Natural

Resources using GEF financing to improve adaptation to climate change and food security in Lao PDR.

Figure (13) represents Laos Climate Services in Agriculture (LaCSA) production chain.

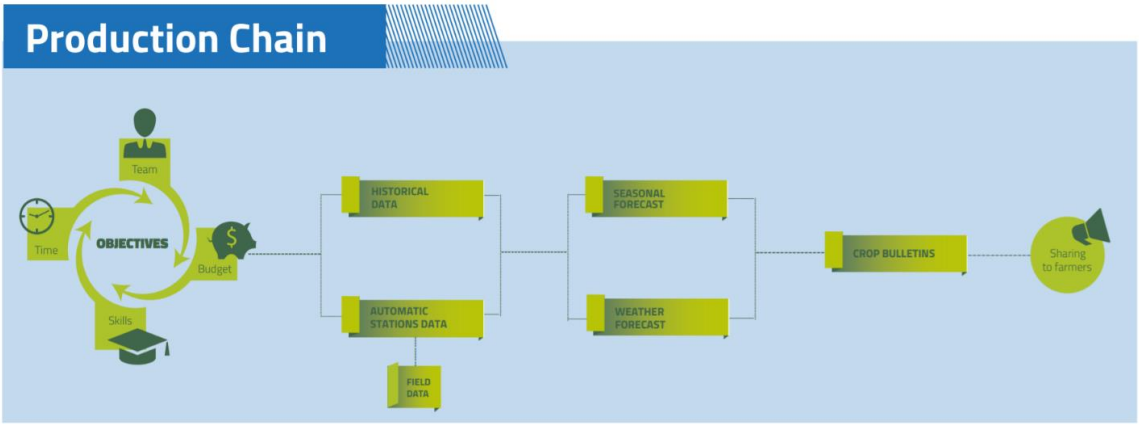


Figure (13): Production Chain under Laos Climate Services in Agriculture (LaCSA) (Source: FAO)
More details about LaCSA can obtained at: https://www.lacsa.net/mapView.do

5.3 LaCSA Weekly Weather Bulletin

Under Laos Climate Services in Agriculture (LaCSA) project, DMH issues weekly bulletin for all districts under 18 proviences. **Figure (14)** shows weekly weather bulletin of week 20 October to 26th October 2021 and forecast for week of 27 October to 02nd November 2021. More details about LaCSA can obtained at: https://www.lacsa.net/mapView.do

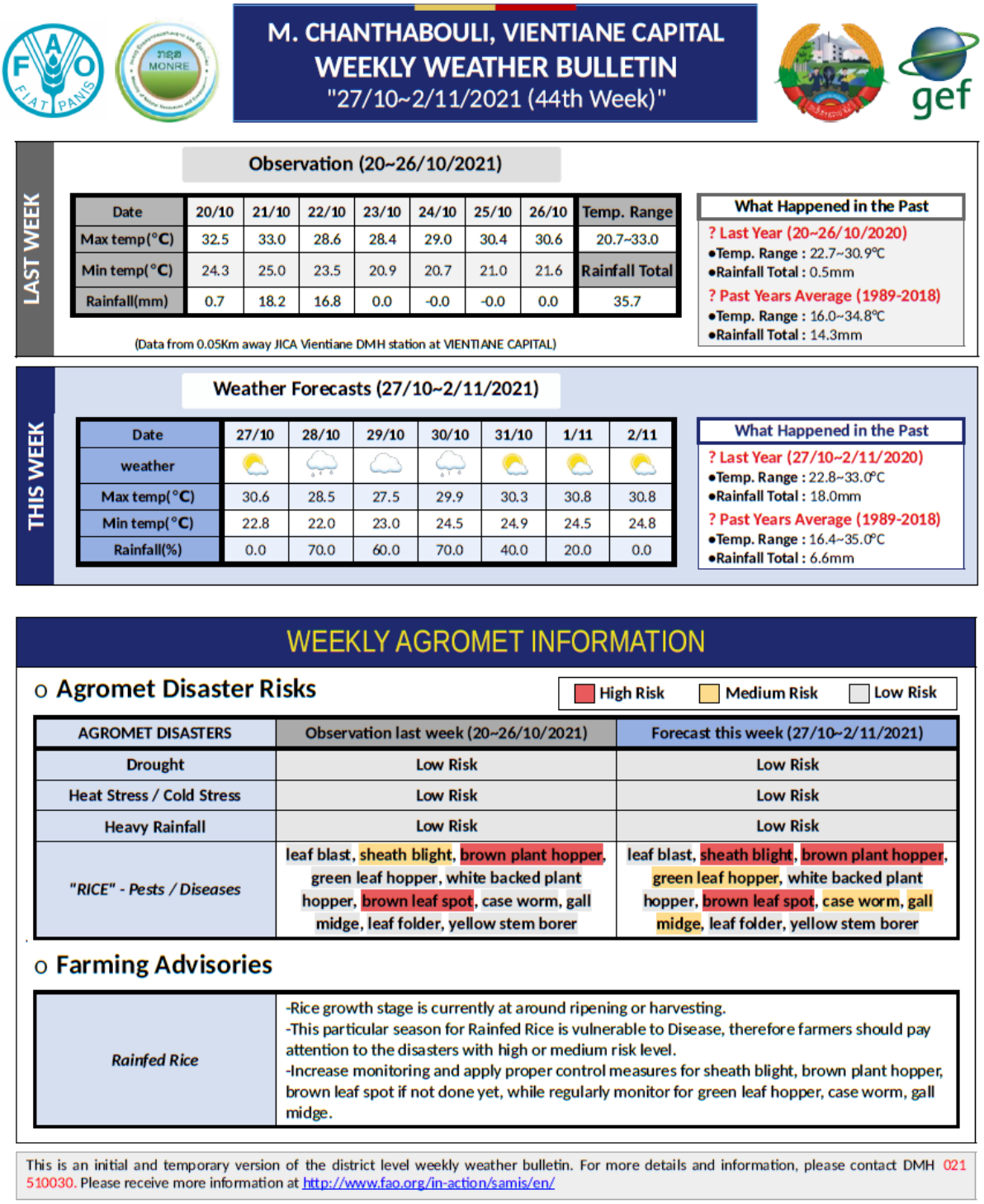
5.4 LaCSA Seasonal Forecast Bulletin

Under Laos Climate Services in Agriculture (LaCSA) project, DMH issues monthly seasonal agro-met bulletin for all 18 provinces. **Figure (15)** shows seasonal forecast bulletin for period of October to December 2021 for Vientiane provinces of Lao PDR. More details about LaCSA can obtained at: https://www.lacsa.net/mapView.do

6. Key Development Agencies in Lao PDR

Many international development organizations, such as the World Bank, Asian Development Bank (ADB), World Meteorological Organisation (WMO), Food and Agriculture Organisation (FAO), World Food Organisation (WFP), Japan International Cooperation Agency (JICA), Korea International Cooperation Agency (KOICA), Swiss Agency for Development and Cooperation (SDC), Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and Agence Française de Development (AFD) are active and involved in various flood and drought management projects in Lao PDR by providing financial and technical support to relevant ministries and agencies such as DMH and NDPCC etc.

Section A: Introduction



M. CHANTHABOULI, VIENTIANE CAPITAL
WEEKLY WEATHER BULLETIN
"27/10~2/11/2021 (44th Week)"

LAST WEEK

Observation (20~26/10/2021)

Date	20/10	21/10	22/10	23/10	24/10	25/10	26/10	Temp. Range
Max temp(°C)	32.5	33.0	28.6	28.4	29.0	30.4	30.6	20.7~33.0
Min temp(°C)	24.3	25.0	23.5	20.9	20.7	21.0	21.6	Rainfall Total
Rainfall(mm)	0.7	18.2	16.8	0.0	-0.0	-0.0	0.0	35.7

(Data from 0.05Km away JICA Vientiane DMH station at VIENTIANE CAPITAL)

What Happened in the Past
? Last Year (20~26/10/2020)
•Temp. Range : 22.7~30.9°C
•Rainfall Total : 0.5mm
? Past Years Average (1989-2018)
•Temp. Range : 16.0~34.8°C
•Rainfall Total : 14.3mm

THIS WEEK

Weather Forecasts (27/10~2/11/2021)

Date	27/10	28/10	29/10	30/10	31/10	1/11	2/11
weather							
Max temp(°C)	30.6	28.5	27.5	29.9	30.3	30.8	30.8
Min temp(°C)	22.8	22.0	23.0	24.5	24.9	24.5	24.8
Rainfall(%)	0.0	70.0	60.0	70.0	40.0	20.0	0.0

What Happened in the Past
? Last Year (27/10~2/11/2020)
•Temp. Range : 22.8~33.0°C
•Rainfall Total : 18.0mm
? Past Years Average (1989-2018)
•Temp. Range : 16.4~35.0°C
•Rainfall Total : 6.6mm

WEEKLY AGROMET INFORMATION

o Agromet Disaster Risks

High Risk | Medium Risk | Low Risk

AGROMET DISASTERS	Observation last week (20~26/10/2021)	Forecast this week (27/10~2/11/2021)
Drought	Low Risk	Low Risk
Heat Stress / Cold Stress	Low Risk	Low Risk
Heavy Rainfall	Low Risk	Low Risk
"RICE" - Pests / Diseases	leaf blast, sheath blight, brown plant hopper, green leaf hopper, white backed plant hopper, brown leaf spot, case worm, gall midge, leaf folder, yellow stem borer	leaf blast, sheath blight, brown plant hopper, green leaf hopper, white backed plant hopper, brown leaf spot, case worm, gall midge, leaf folder, yellow stem borer

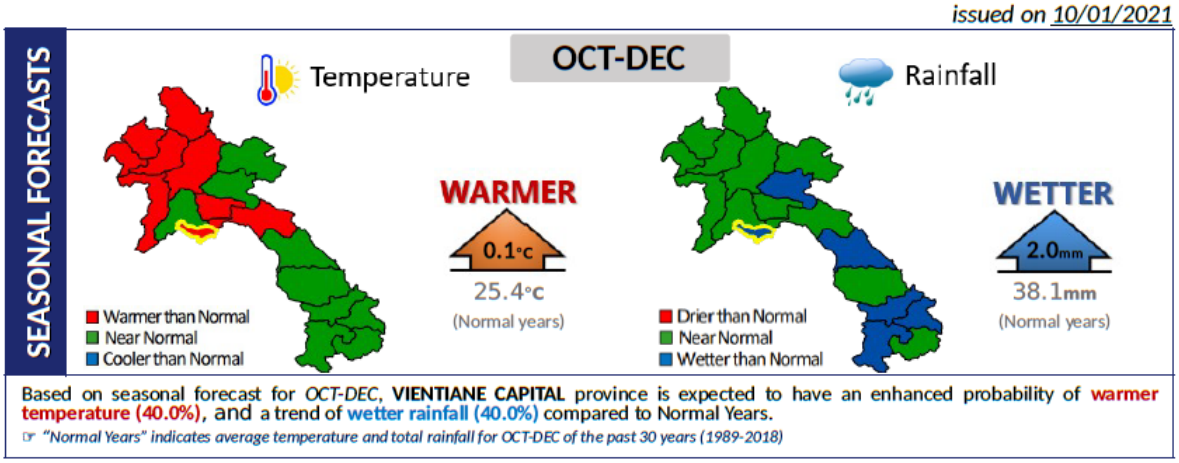
o Farming Advisories

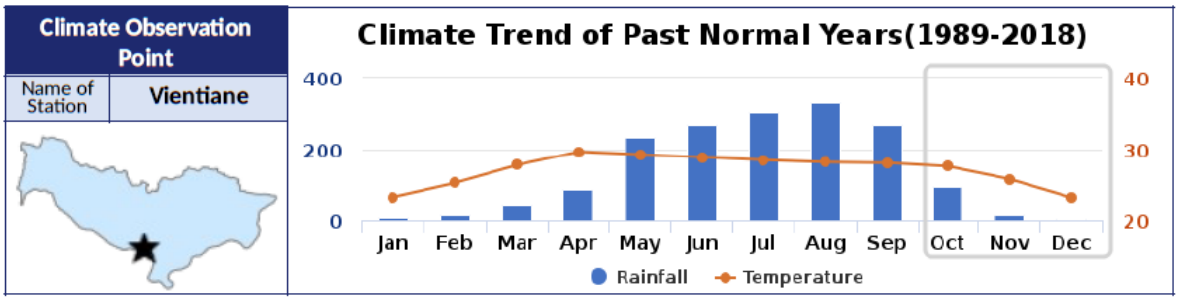
Rainfed Rice	-Rice growth stage is currently at around ripening or harvesting. -This particular season for Rainfed Rice is vulnerable to Disease, therefore farmers should pay attention to the disasters with high or medium risk level. -Increase monitoring and apply proper control measures for sheath blight, brown plant hopper, brown leaf spot if not done yet, while regularly monitor for green leaf hopper, case worm, gall midge.

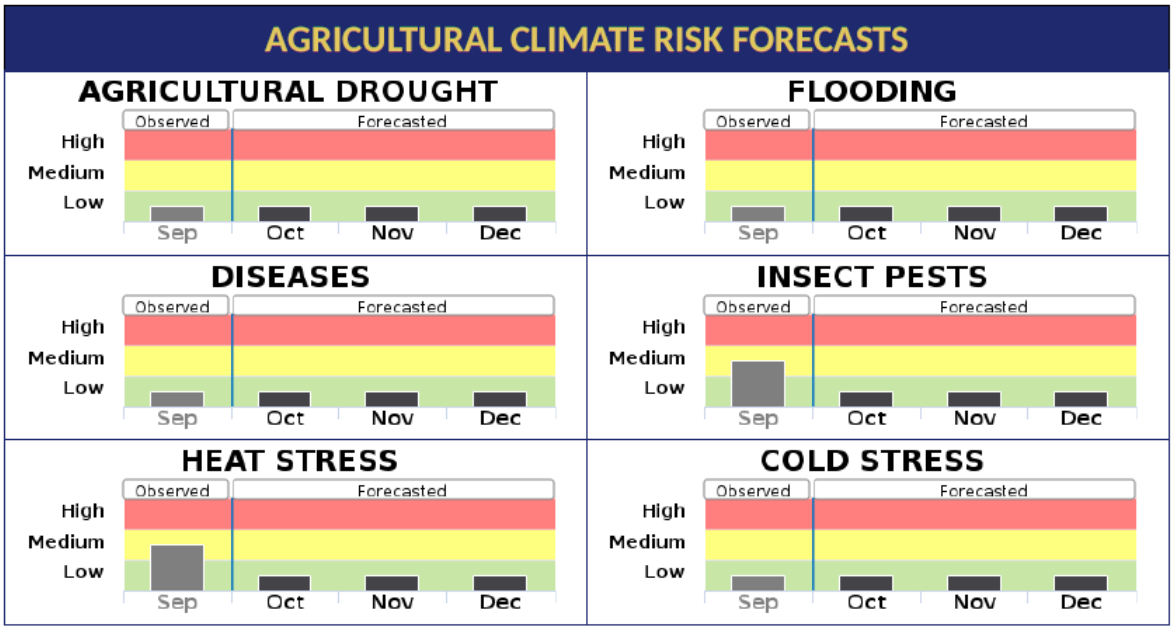
This is an initial and temporary version of the district level weekly weather bulletin. For more details and information, please contact DMH 021 510030. Please receive more information at http://www.fao.org/in-action/samis/en/

Figure (14): Weekly Weather Bulletin for Lao PDR (Source: LaCSA, n.d.)

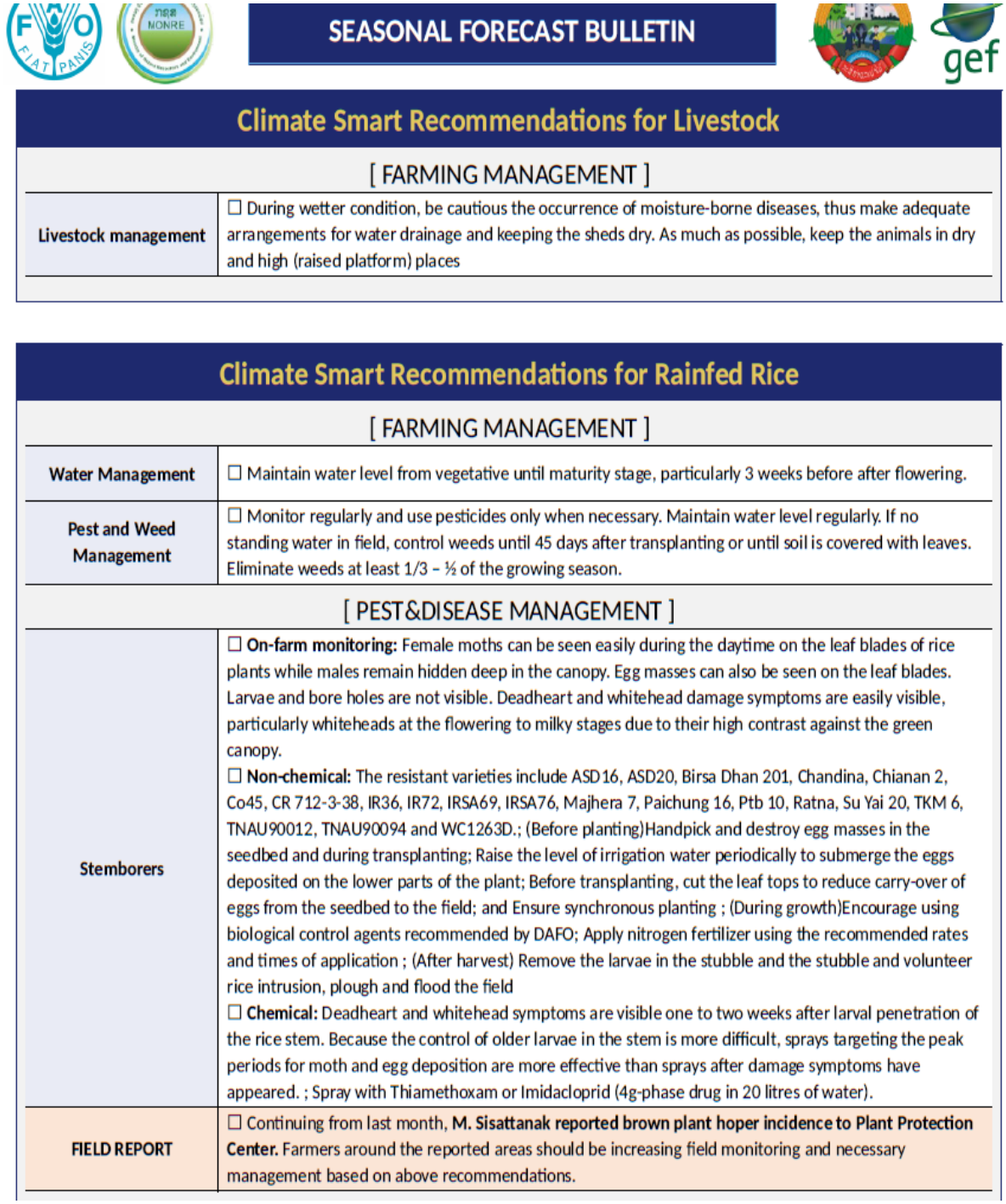
Section A: Introduction







Section A: Introduction



SEASONAL FORECAST BULLETIN

Climate Smart Recommendations for Livestock

[FARMING MANAGEMENT]

Livestock management	☐ During wetter condition, be cautious the occurrence of moisture-borne diseases, thus make adequate arrangements for water drainage and keeping the sheds dry. As much as possible, keep the animals in dry and high (raised platform) places

Climate Smart Recommendations for Rainfed Rice

[FARMING MANAGEMENT]

Water Management	☐ Maintain water level from vegetative until maturity stage, particularly 3 weeks before after flowering.
Pest and Weed Management	☐ Monitor regularly and use pesticides only when necessary. Maintain water level regularly. If no standing water in field, control weeds until 45 days after transplanting or until soil is covered with leaves. Eliminate weeds at least 1/3 – ½ of the growing season.

[PEST&DISEASE MANAGEMENT]

Stemborers	☐ **On-farm monitoring:** Female moths can be seen easily during the daytime on the leaf blades of rice plants while males remain hidden deep in the canopy. Egg masses can also be seen on the leaf blades. Larvae and bore holes are not visible. Deadheart and whitehead damage symptoms are easily visible, particularly whiteheads at the flowering to milky stages due to their high contrast against the green canopy. ☐ **Non-chemical:** The resistant varieties include ASD16, ASD20, Birsa Dhan 201, Chandina, Chianan 2, Co45, CR 712-3-38, IR36, IR72, IRSA69, IRSA76, Majhera 7, Paichung 16, Ptb 10, Ratna, Su Yai 20, TKM 6, TNAU90012, TNAU90094 and WC1263D.; (Before planting)Handpick and destroy egg masses in the seedbed and during transplanting; Raise the level of irrigation water periodically to submerge the eggs deposited on the lower parts of the plant; Before transplanting, cut the leaf tops to reduce carry-over of eggs from the seedbed to the field; and Ensure synchronous planting ; (During growth)Encourage using biological control agents recommended by DAFO; Apply nitrogen fertilizer using the recommended rates and times of application ; (After harvest) Remove the larvae in the stubble and the stubble and volunteer rice intrusion, plough and flood the field ☐ **Chemical:** Deadheart and whitehead symptoms are visible one to two weeks after larval penetration of the rice stem. Because the control of older larvae in the stem is more difficult, sprays targeting the peak periods for moth and egg deposition are more effective than sprays after damage symptoms have appeared. ; Spray with Thiamethoxam or Imidacloprid (4g-phase drug in 20 litres of water).
FIELD REPORT	☐ Continuing from last month, **M. Sisattanak reported brown plant hoper incidence to Plant Protection Center.** Farmers around the reported areas should be increasing field monitoring and necessary management based on above recommendations.

Figure (15): Seasonal Forecast Bulletin for Lao PDR (Source: LaCSA, n.d.)

7. New Initiative

7.1 National Early Warning System under The Greater Mekong Sub-Region (GMS) Flood and Drought Management and Mitigation Project (ADB)

DMH is establishing National Early Warning System (NEWS) under ABD supported project titled “Greater Mekong Sub-Region (GMS) Flood and Drought Management and Mitigation

Project". Under this project various key activities are being undertaken such as structural and non-structural measures to prepare for and manage disaster risks linked to floods and droughts. Project interventions such as: (i) enhance regional data and knowledge for the management of floods and droughts; (ii) upgrade or develop water management infrastructure; and (iii) prepare communities to manage disasters such as flood and drought and adapt to climate change. NEWS will provide reliable and timely hydro-meteorological information with an effective early warning system is essential to mitigate the losses from flood and drought disasters. To achieve this goal, DMH is enhancing its capacity by installing of the hydro-meteorological network, effective data transmission and management system, development of forecasting models, early warning and public awareness, as well as effective communication system are necessary.

Figure (16) shows National Early Warning System under GMS Project.

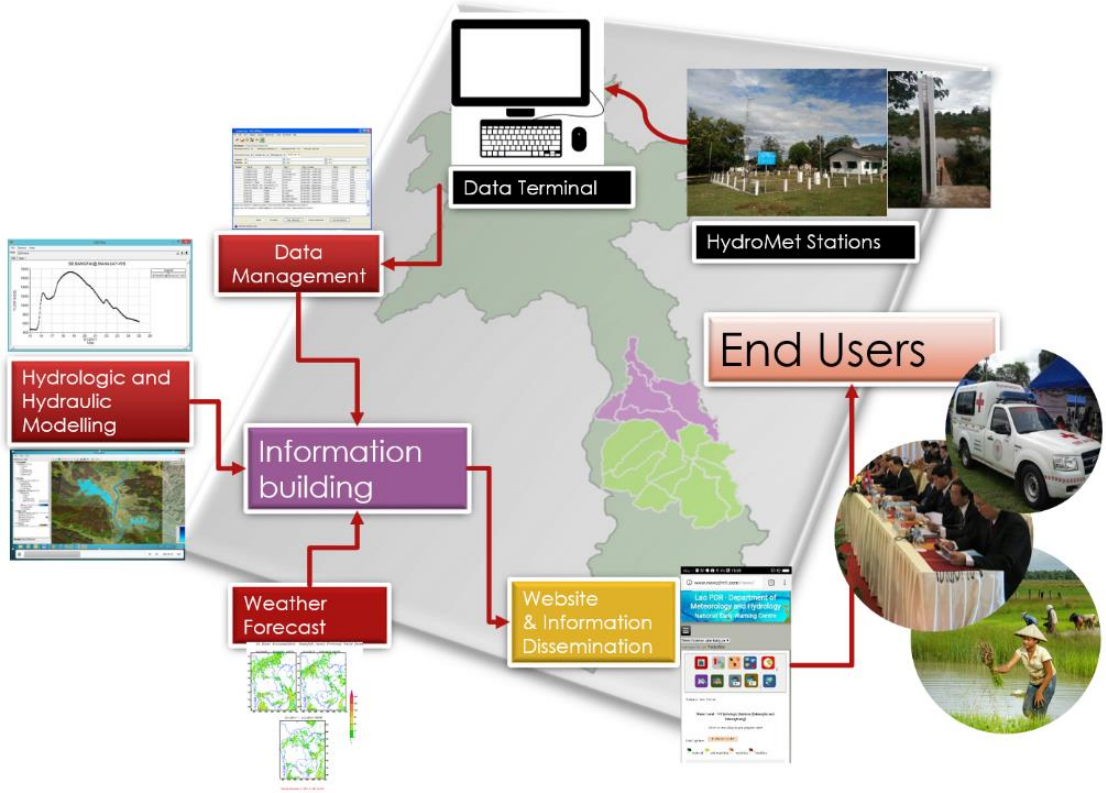


Figure (16): National Early Warning System under GMS Project (Source: DMH, ADB)

Under this project two priority basins for hydro-meteorological data collection and early warning system development: The Sebangfai and the Sebanghieng River Basins. These two basins are among the most flood affected river basins in Lao PDR.

8. Summary

Because to the recurrence of flooding, drought, and landslides in the Lao PDR, the establishment of an efficient early warning system has been given top priority and attention by national government. The Strategic Plan on Disaster Risk Management (2010) identified the development and establishment of early warning and information dissemination systems in all provinces and districts as a top objective. Later on, in order to put the plan into action, the process of Operationalization of Strategic Plan for Disaster Management (OSPDM) was launched in 2010, with one of the key components being the strengthening of the multi-hazard early warning system with integrated science, institutional, and social aspects, which was launched in 2010.

Since 2012, a consultation process for the development of a National Early Warning Strategy has been underway, with the goal of bridging communication gaps between relevant agencies and the general public (NDMO, 2012). MoNRE developed various documents (**Figure (17)**) in the past to support its EWS efforts such as:

- *National Strategy on Early Warning (EW)*
- *Standard Operating Procedures on Flood Early Warning (SOP)*
- *Community Based Flood Early Warning System (CBEWS)*

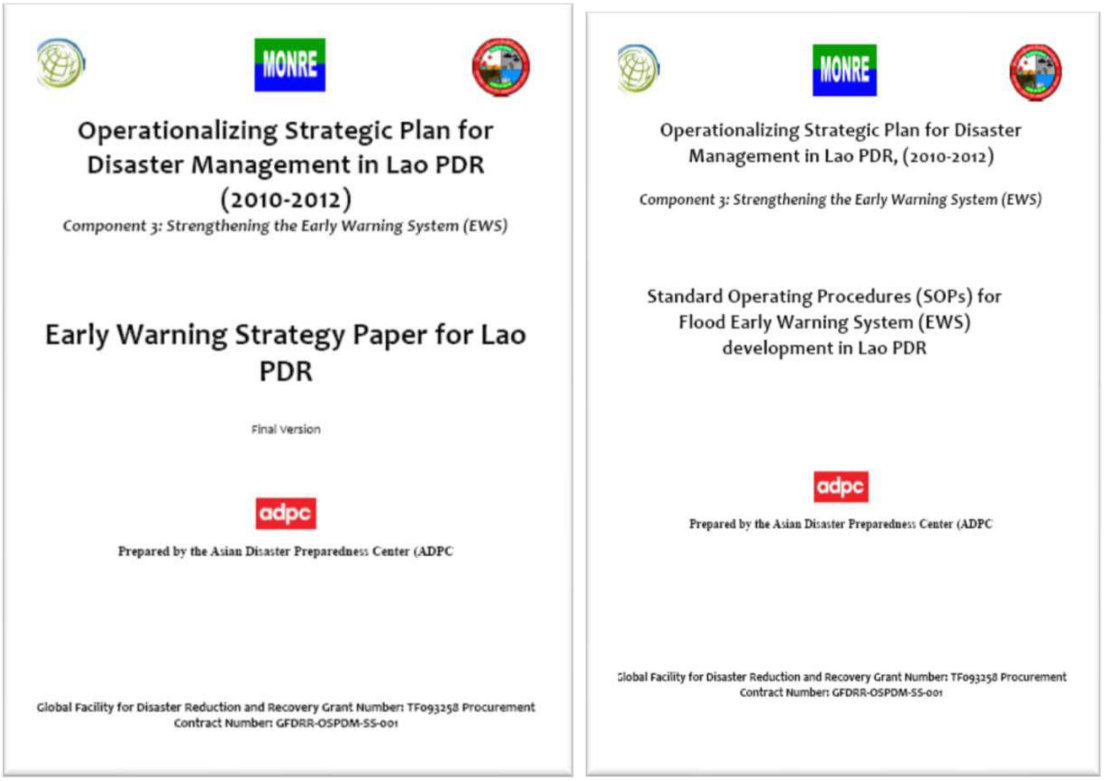


Figure (17): Risk Communication by NDMO (Source: NDPCC (2020))

Section A: Introduction

DMH in Lao PDR has to rely on external resources to fulfil its mandates and to respond the increasing national demands for services delivery as well as to cope with WMO strategic thrust and recommended framework. DMH also rely on external resources such as ODA from funding organizations, bilateral assistance from development partners and neighboring countries, to upgrade technical facilities and enhancement of following areas:

- Quality Management System (QMS) and Personnel Performance on Aeronautical Meteorology for the service to Aviation Safety;
- Data Communication Link via satellite for sharing data and early warnings with Vietnam and other neighboring countries;
- Strengthening the capacity in utilization of Severe Weather Forecast Demonstration Programme (SWFDP) which the designated Sub-Regional Center is located in Vietnam and hosted by NHMS of Vietnam;
- Assistance and Lesson learnt from Vietnam on techniques and setting-up National Early Warning Systems, including floods, drought, extreme weather and seasonal climate prediction and longer-term projection;
- Cooperation and assistance from Vietnam on earthquake monitoring stations and analysis, including seismicity study and mapping over Laos;
- Assistance and lesson learnt from Vietnam on operational techniques of Standard Weather and Climate messages encoding, decoding and instruments' calibration.

SECTION

B

APPROACH AND METHODOLOGY

SECTION B | Approach and Methodology

1. Background

A simplified rendition of the overall approach and methodology is presented in this section of the report. Various key elements of the Impact based Forecast and Warning (IbFW) readiness assessment were first outlined and defined and then a phase-wise procedure followed to achieve overall objective described in Terms of Reference (ToR). The methodology designed and used for the readiness assessment was based on international best practices of IbFW assessment and was mindful of the operational constraints due to COVID-19, information/data requirements, availability, collection, collation, and further analysis. The approach and methodology are tailor made for Lao PDR based on a wide range of discussion and existing secondary information and data and integrated them into a format that was discussed with client (i.e. WFP) consultation with national stakeholders. A systematic process was adopted to assess the readiness on IbFW in Lao PDR. IbFW readiness assessed, particularly with respect to the systems for hydro-meteorological hazards (mainly Floods, Cyclone, Drought) in the country.

Figure (18) represents approach and methodology of the IbFW readiness assessment.

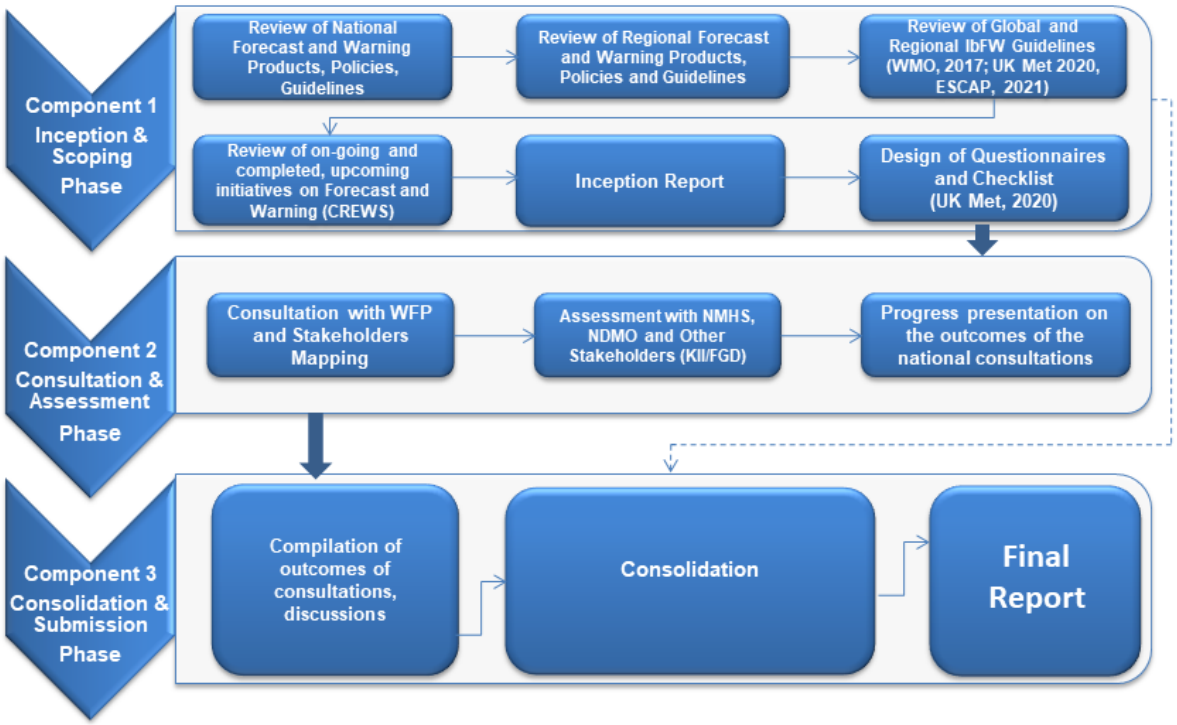


Figure (18): Approach and Methodology (Source: ADPC, 2022)

Natural hazards are becoming more and more intricate, complex and multi-faceted in these countries. It is evident from previous studies and various assessments that the Lower Mekong Countries especially Lao PDR are highly prone to various hydro-meteorological hazards

including floods, droughts, cyclones and lighting (ADPC, 2010). These countries are extremely vulnerable due to their unique geo-climatic setting in Southeast Asia.

NMHS in Lao PDR is mandated and accountable to provide weather forecast as well as warning to disaster management institutions (NDMO), and other stakeholders such as agriculture and water resources agencies. NDMO and other technical stakeholders are also mandated and accountable warning for dissemination, adding sector specific information, resource mobilization in the community, etc. Recognizing the fact that the frequency and severity of hydro-meteorological hazards is on the rise in changing climatic conditions, existing capacities of forecast and warning of NMHSs will not be sufficient in future. Unpredictability and increasing frequency of extreme hydro-meteorological events will clearly require significant improvement in the existing capacities of forecast and warning in near future linking with impacts on different elements (human, livestock, agriculture, key lifeline infrastructure, housing, business/livelihood) of society. Although, routine forecast and warning exist in these countries, however to convert into impact-based forecast and warning, they require timely upgradation and modernization of tools, technology as well as hiring of well-trained human resources.

In the existing IbFW readiness assessment, an attempt has been made to assess existing capacities and future needs related to IbFW of NMHSs, NDMO and other prioritised stakeholders in the project countries. IbFW readiness (capacities and needs) of national level agencies have been assessed through Key Informant Interviews (KII) and Focus Group Discussions (FGD) using structured questionnaires.

IbFW readiness assessment involved a systematic flow of understanding the forecast and warning structure at the regional, national, sub-national and local levels. It include institutional mechanism & their roles within the elements of IbFW; delivery of products & services by technical and disaster management agencies, as well as their coordination mechanism/operational cooperation; reviewing of existing mechanism of IbFW in Lao PDR; role of agencies in the IbFW and their integration in the disaster management organizations framework; discussion with stakeholders, the gaps & needs in the IbFW; capacities of institutions (technical agencies) engaged in IbFW; operational cooperation of technical agencies with the emergency departments/functionaries at the district and city levels (emergency management structure and response capabilities); current status and future needs of observation and monitoring capabilities; data management systems; seeking information on pre-computed assessment of risks for various intensity of hazards (risk assessment), hazard analysis and prediction capabilities (threat assessment/potential impact assessment); warning formulation/issuance of guidance and potential outlook/provision of actionable early warning information/warning products; decision making, generation of tailored risk information and dissemination of risk information to at-risk communities or hot-spot locations (risk

communication); information technology and telecommunication capabilities; preparation of response options; and institution/emergency responders & community response.

2. Reference Document

A number of IbFW guidelines have been developed in recent years by number of agencies such as WMO (2015), UK Met (2020) and UNESCAP (2021). The readiness assessment process has referred to a range of documents developed by these international and regional agencies.

Figure (19) represents international and regional guidelines on IbFW.

Source: WMO (2015) Source: MET Office, UK (2020) Source: UNESCAP (2021)

Figure (19): International and Regional Guidelines on IbFW

3. IbFW Readiness Assessment Matrix

IbFW readiness have been assessed based on an assessment matrix. This assessment matrix was developed by the ADPC technical team based on three primary components i.) Co-design, ii) Co-produce and iii) Deliver. These three primary components of IbFW are suggested in guidelines developed by World Meteorological Organization (2015) and UK Met (2020). Further these primary components were divided into secondary or sub-components of IbFW.

The brief description of the component and sub-component is given below **Table (2).**

Table (2): Key Component of IbFW

Component	Sub-components
Co-design	Understanding about IbFW
	Stakeholder mapping and assessment of IBFW understanding level
Co-produce	Understanding Risk and impact assessment

Section B: Approach and Methodology

	Understanding IBFW Generation
Deliver	IBFW Dissemination
	Forecast/Impact Verification

During consultation, ADPC used 58 main questions and 20 sub-questions for IbFW readiness assessment. These questions were added into matrix which was designed and developed based on key guiding questions and methodology provided in IbFW guidelines developed by UK Met (2020). These questions were translated into local language for ease of doing survey and further assessment.

Figure (20) represents IbFW approach and methodology.

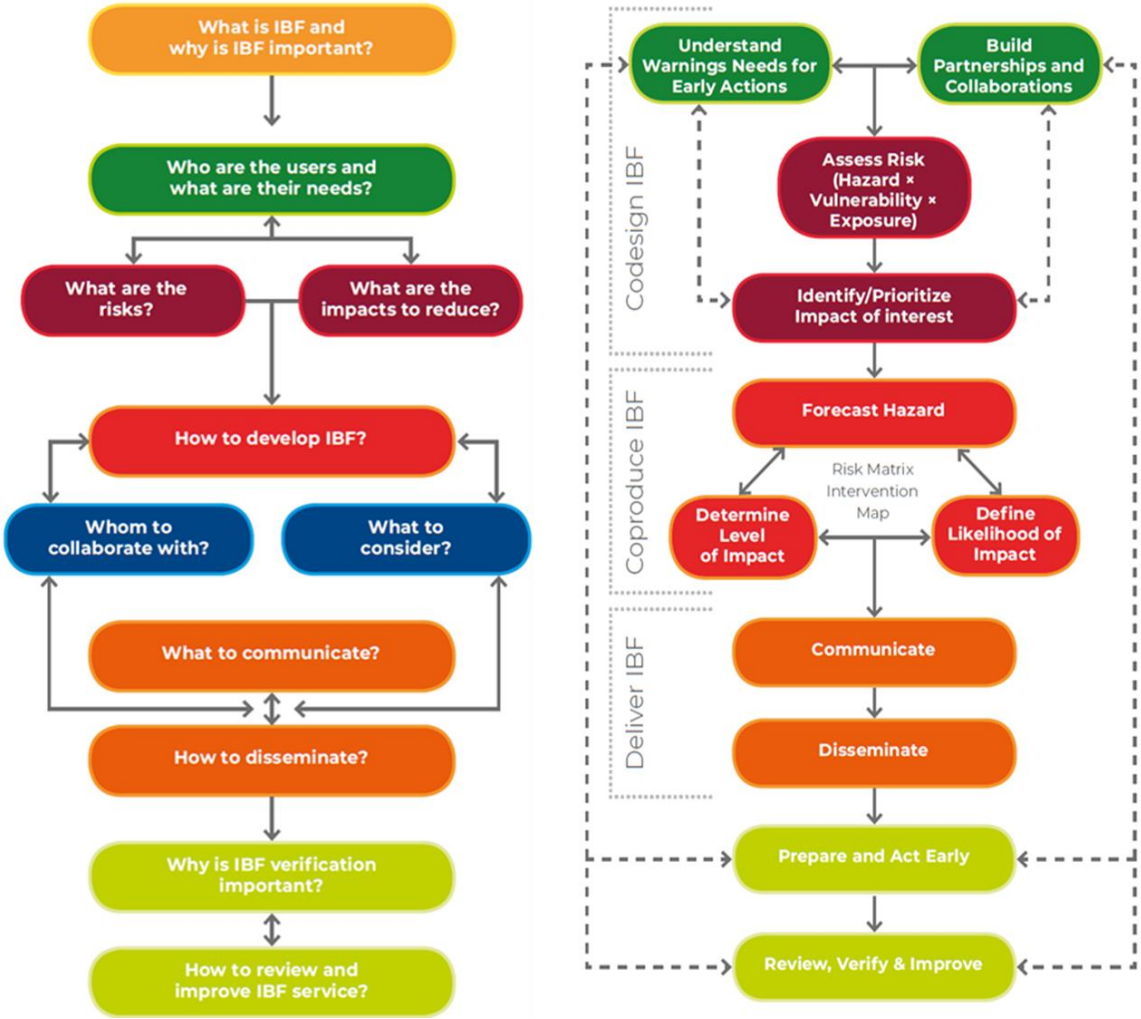


Figure (20): IbFW Approach and Methodology (Source: UK Met., 2020)

4. Ranking

Post consultation (KII and FGD), IbFW readiness have been assessed through a scoring system ranging from 0-5 with inputs from key representative and technical officials from NMHSs,

NDMO's and other stakeholders in Lao PDR. The scores were assigned by the subject experts based on their experiences, perceptions and opinions on existing IbFW at the national level in Lao PDR. The brief description of the scoring system is given below **Table (3).**

Table (3): Scoring system with the scale definitions		
Score	**Levels**	**Scale definition**
1	Very Low	Very Low Understanding and Capacity
2	Low	Low Understanding and Capacity
3	Medium	Medium Understanding and Capacity
4	High	High Understanding and Capacity
5	Very High	Very High Understanding and Capacity
Source: Dutta et al., 2015[14]		

It is very essential that these three component and sub-components coordinated across many agencies at national to local levels for entire system to work. Failure in one component or lack of coordination across them could lead to the failure of the whole system. The issuance of forecast and warnings is a national responsibility (NMHS); thus, roles and responsibilities of various other stakeholders for implementation of IbFW need to be clarified and reflected in the national to local regulatory frameworks, planning, budgetary, coordination, and operational mechanisms. MHEWS assessment was carried out with the national organizations. **Table (4)** represents list of stakeholders surveyed in the Lao PDR.

Table (4): List of stakeholders surveyed in Lao PDR		
Date	**Agency**	**Representative Expert/Specialist**
17 Dec. 2021to 30 Dec. 2021	National Disaster Management Office	Mr. Phonesavanh XAYSOMPHENG, Director Division of Disaster Prevention and Risk Reduction, NDMO, DSW, MoLSW
30 Dec. 2021 to 05 Jan. 2022	Ministry Agriculture and Forestry	Mr. Kynong KEOPASEUTH, Deputy Head of Planning Division, Department of Planning and Cooperation, MAF
05 Jan. 2022 to 07 Jan. 2022	Department of Meteorology and Hydrology, Ministry of Natural Resources and Environment	Mr. Viengxai Manivong, DDG, DMH, MoNRE and Team

[14] https://pdfs.semanticscholar.org/d98a/e6bcc548ad3ad7168a821ddf5d16d0b0daf4.pdf

Section B: Approach and Methodology

5. Limitations

The findings of this study have to be seen in light of some limitations and that could be addressed in future projects in the Southeast region.

- ADPC technical team members were not able to Lao PDR, due to COVID-19 related travel restrictions. Keeping the travel restrictions and time constraints, ADPC completed all regional and national consultations in hybrid mode;
- Due to COVID-19 related travel restrictions, all consultations were conducted by national staff, especially in a form of Key Informant Interviews (KII) and Focus Group Discussions (FGD) with NMHSs, NDMO's and national agencies. Necessary training was provided to national staff.
- The study originally planned in-country consultations and discussions with certain organizations and people (in KII and FGD mode). Due to the pandemic, ADPC technical team faced the problem of having limited access to these respondents. Due to this limited access, ADPC technical team redesigned/ restructured the consultation and discussion approaches and methods;
- ADPC technical team were only able to consult and discuss with nominated representatives of DMH, NDMO and MAF. In normal conditions, ADPC technical team allocate a full day or two for the discussion with NMHS to conduct INFWS assessment in KII and FGD mode;
- Verification of views and inputs are very crucial in qualitative assessment. There was limited opportunity to physically verify the views and inputs from representative respondents of DMH, NDMO and MAF on IBFW readiness assessment;
- There was no opportunity to discuss with other stakeholders such as development partners, INGOs/NGOs/CBOs or communities in Lao PDR;
- There was no opportunity to take field notes and review many key documents such as past/ongoing project reports, polices, acts, guidelines, plans which are not available in digital format or not available online;
- There was no opportunity to capture some traditional knowledge of communities on early warning in project countries;
- There was no opportunity to observe the IbFW infrastructure (including tools and technology) in Lao PDR;
- However, ADPC was in a unique position to timely hire local staff and align its approach and methodology during COVID-19 based on national protocol. ADPC regional team conducted virtual training on readiness assessment matrix for national staff before the assessment.
- ADPC national staff have prior in-depth knowledge and understanding of forecast and warning and related components in Lao PDR and also have previous experience of implementation of early warning and hydro-meteorological systems projects in the country.

Section C: Results and Discussion

SECTION

C

RESULTS AND DISCUSSION

SECTION C | Result and Discussion

C.2 | Lao PDR

1. Overall Assessment

Department of Meteorology and Hydrology (DMH) is the mandated agency under the Ministry of Natural Resources and Environment (MoNRE) for forecast and warning. It is responsible for the collection and analysis of hydro-meteorological data and the provision of water supply conditions, weather forecasts, and issuing early warning. DMH releases this information at their website as well as in weekly and seasonal bulletins. DMH has an institutional linkage from National level to Provincial Office of Natural Resources and Environment (PoNRE) at the provincial level and to District Office of Natural Resources and Environment (DoNRE) at the district level to the villages respectively. They disseminate the warning information through hard copy, TV, radio, Newspaper, WhatsApp and Facebook. They issue three types of warnings according to water level and forecasted rainfall, which are normal stage (green color), alarm stage (yellow color) and flood warning (red color). The potentiality of disaster resulting from the flood warning stage will be different from place to place due to various conditions.

Food and Agriculture Organization (FAO) with support from Global Environment Facility (GEF) under Least Developed Countries Fund (LDCF) is currently implementing a project titled “Strengthening Agroclimatic Monitoring and Information Systems (SAMIS)” to improve adaptation to climate change and food security in Lao PDR. SAMIS is enhancing decision-making and planning capacity for the agricultural sector at national, sub-national and local levels in Lao PDR. Main objective of SAMIS project is to enhance capacities to gather, process, analyze, and share climatic and geospatial information so that these can be applied to agriculture planning and decision-making. Under SAMIS project, DMH is developing comprehensive agroclimatic monitoring and information capacity focused on boosting sustainable production by optimizing farmers and small-holders in building resilience against climate change. Using this information, farmers will be able to take informed judgements about the most appropriate technologies and approaches in the face of climate vagaries.

Laos Climate Service for Agriculture (LaCSA) is a component of SAMIS project. The LaCSA system will significantly contribute about rainfall and temperature seasonal forecast as well as crop calendar to farmers on near real-time (with weekly bulletin), which will be very influential for making their decision on seasonal agriculture production such as selection of suitable crop species for cultivation in difficult condition of climate change. This will also ensure a more stable and sustainable production, higher productivity, improve food security, reduce the risk of disease and pest in Lao PDR. Advisory production chain and related activities under Strengthening Agroclimatic Monitoring and Information Systems (SAMIS) project are being implemented and monitored by the Department of Meteorology and Hydrology (DMH) of the

Ministry of Environment and Natural Resources (MoNRE) using GEF financing to improve adaptation to climate change and food security in Lao PDR.

In terms of impact-based forecasting and warning, institutions have a limited knowledge and low to medium capacity in this regard. There is no impact-based forecasting and warning system in place yet within DMH.

The overall IbFW readiness assessment in Lao PDR was carried out based on six key areas that includes:

i. Level of Understanding about IbFW
ii. Stakeholder Mapping and Assessment of IbFW Understanding Level
iii. Risk and Impact Assessment
iv. IbFW Generation
v. IbFW Dissemination
vi. Forecast/Impact Verification

While (i) and (ii) has been categorized as Codesign Phase, (iii) and (iv) has been categorized as Coproduce Phase and (v) and (vi) has been categorized as Delivery Phase (**Figure (21)**).

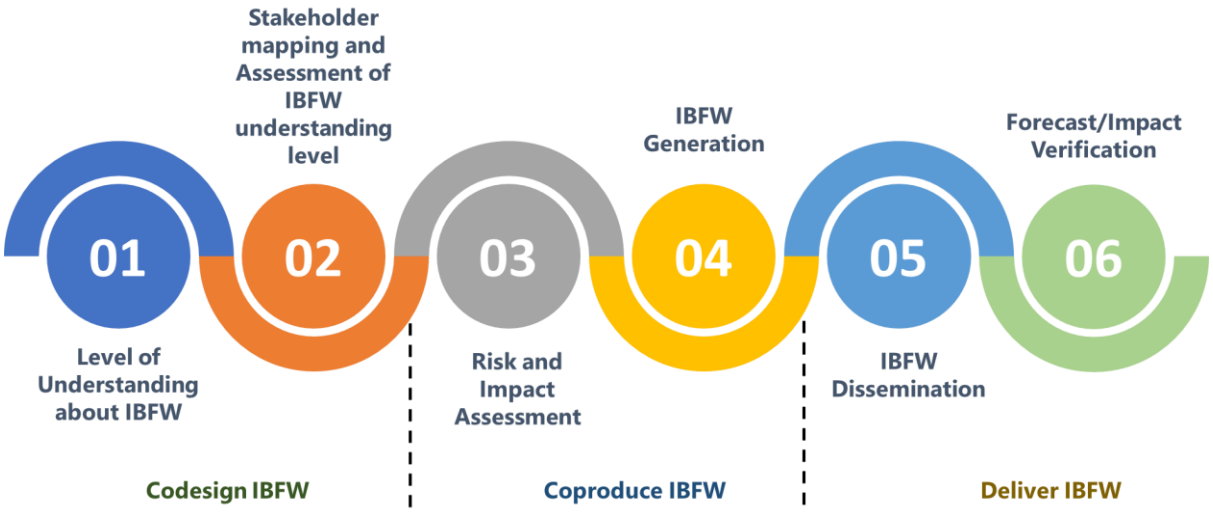


Figure (21): Key Areas Considered for IbFW Readiness Assessment in Lao PDR.

The overall assessment results in the **codesign phase of IbFW** have shown that the level of knowledge and understanding about IbFW in Lao PDR is medium (**Score of 3.0**) meaning there exist awareness about IbFW among the targeted agencies (DMH, NDMO and MAF). Similarly, in terms of stakeholders mapping and assessment of IbFW understanding level, once again the overall assessment result was found to be medium (**Score of 3.0**) with DMH and NDMO

already working collaboratively with various stakeholders from Government to International Organizations. While DMH is engaged with Government entities such as MoNRE, PDoNRE, DDoNRE and all members of disaster management committees, it is also working collaboratively with UN agencies (WFP, FAO, etc.) and Intergovernmental Organizations (ADPC, RIMES, etc.). Similarly, NDMO is working collaboratively with the Center for Disaster Management Committee (CDMC) in 13 sectors as well as with PDMC, DDMC and VDMC.

The overall assessment results in the **coproduce phase of IbFW** have shown that the targeted agencies have low level knowledge and understanding of risk and impact assessment as well as IbFW generations (**Score of 2.0**). While DMH and MAF is not aware of any country-level risk assessment, however, NDMO did risk assessment through a joint project with ADPC and UNDP in 2010 which is currently being updated through an ADB supported project on "Supporting Adaptation Decision Making for Climate Resilient Investments". In terms of forecast and warning generation, all the three agencies (DMH, NDMO, MAF) have responded by saying that the current hazard forecast and warning information are being issued only for key hazards that includes floods, droughts, and landslides. The forecast information currently being generated is through traditional forecasting models and lacks integration of IbFW. DMH is responsible to provide forecast information to NDMO which is received on a daily basis. For MAF, they receive information on weather forecast three months in advance from the National Agro-met system of Lao PDR that includes the information from MAF itself and the Laos Climate Services for Agriculture (LaCSA) system.

The overall assessment results in the **delivery phase of IbFW** have shown that the targeted agencies have low level knowledge and skills in IbFW dissemination and forecast verification (**Score of 2.0**). While DMH is responsible for issuing forecast and warning information, the information sent out to NDMO and MAF are still dependent on traditional weather forecasting and therefore, the information received by NDMO and MAF is more generic giving only weather conditions but does not clearly reflect the area of impact and its likely intensity. However, on a daily basis, DMH sends out the weather forecast to NDMO while MAF recives the weather forecast information through their LaCSA systsm. **Figure (22 and 23)** shows the overall IbFW Readiness in Lao PDR.

Section C: Results and Discussion

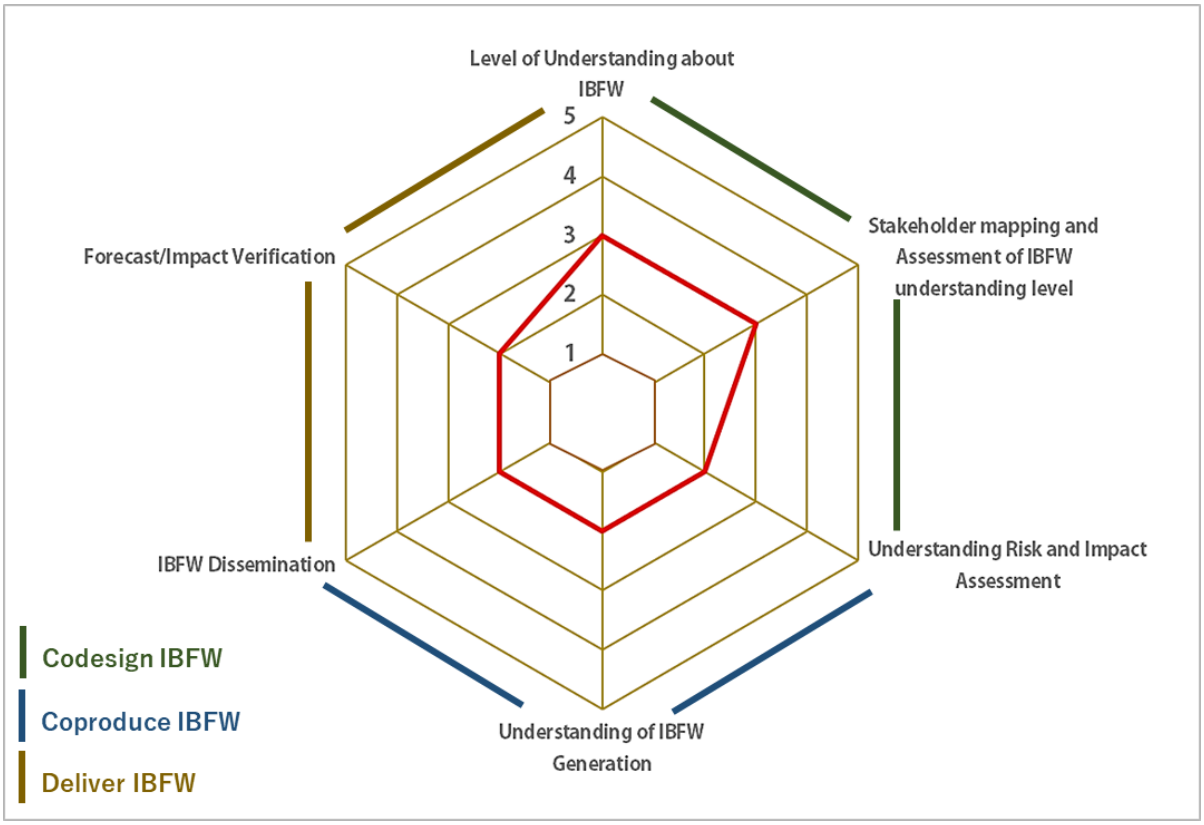


Figure (22): Overall IbFW Readiness in Lao PDR. (Scale: 1-Very Low (Very low understanding and capacity); 2-Low (Low understanding and capacity); 3-Medium (Medium understanding and capacity); 4-High (High understanding and capacity); 5-Very High ((Very high understanding and capacity)

Section C: Results and Discussion

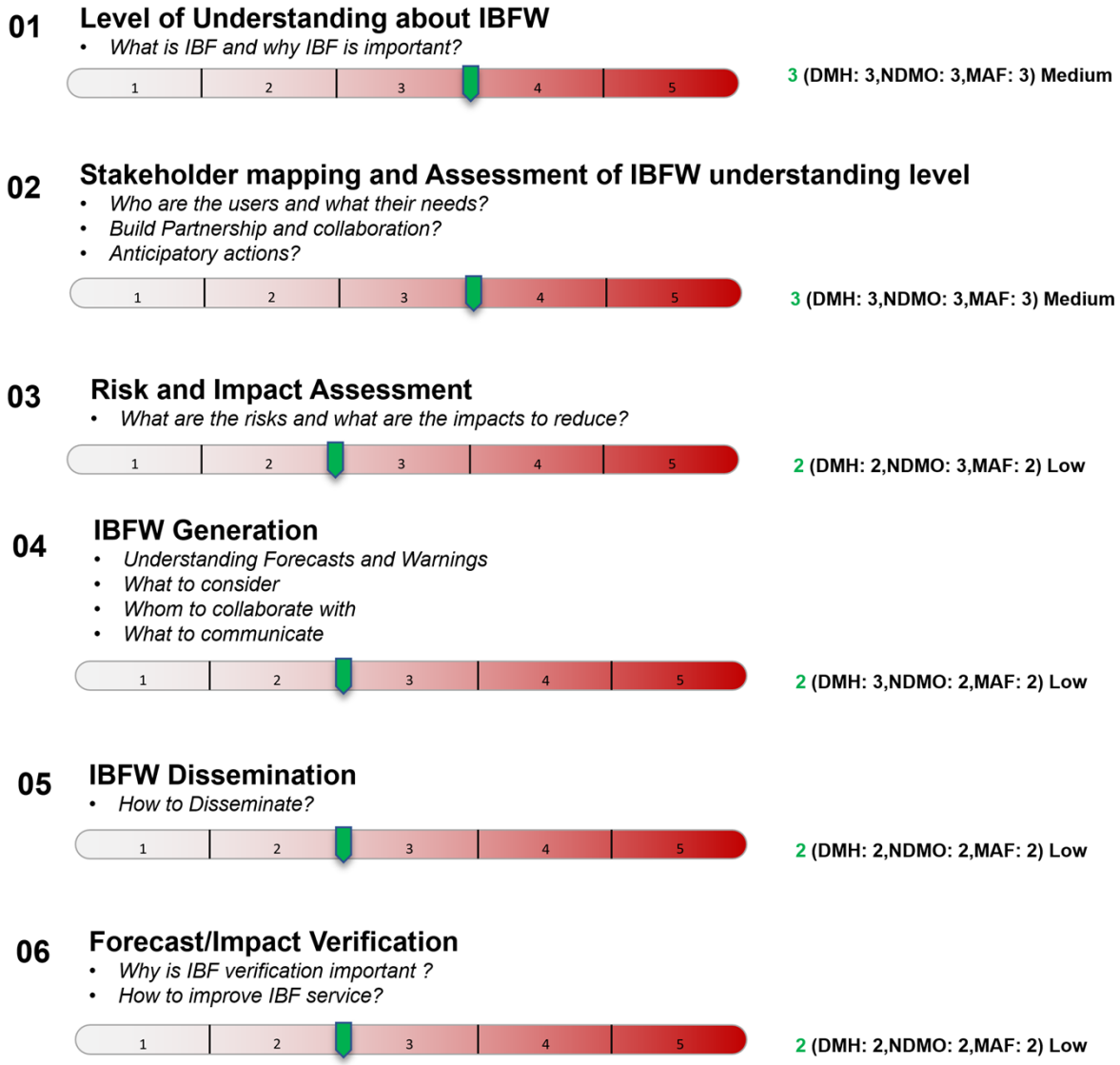


Figure (23): Overall IbFW Readiness in Lao PDR based on the overall scores from the agencies. (Scale: 1-Very Low (Very low understanding and capacity); 2-Low (Low understanding and capacity); 3-Medium (Medium understanding and capacity); 4-High (High understanding and capacity); 5-Very High ((Very high understanding and capacity)

2. Agency-wise Assessment:

2.1. Department of Meteorology and Hydrology (DMH)

The overall assessment results in the **codesign phase of IbFW** have shown that the level of knowledge and understanding about IbFW within DMH is medium (**Score of 3.0**) meaning there exist awareness about IbFW within DMH. Similarly, in terms of stakeholders mapping and assessment of IbFW understanding level, the overall assessment result was found to be medium (**Score of 3.0**) with DMH working closely with different Government entities such as MoNRE, PDoNRE, DDoNRE and all members of disaster management committees as well as with the UN and Intergovernmental Organizations. Most of the engagements with development

partners are project-based partnerships and collaborations. However, DMH also has official mandates to engage with international agencies such as the WMO and others.

The overall assessment results in the **coproduce phase of IbFW** have shown that DMH have low level (**Score of 2.0**) knowledge and understanding of risk and impact assessment whereas they have medium level understanding of IbFW generations (**Score of 3.0**). DMH is not aware of any national level or pilot scale risk assessment being done in Lao PDR but they consider it to be very important for their work. Similarly, in terms of forecast and warning generation, DMH issues forecast and warning information for key hazards in Lao PDR that includes floods, droughts and landslides and such information are generated on a daily basis. The information is then shared with NDMO for their awareness and dissemination. However, the integration of IbFW is lacking.

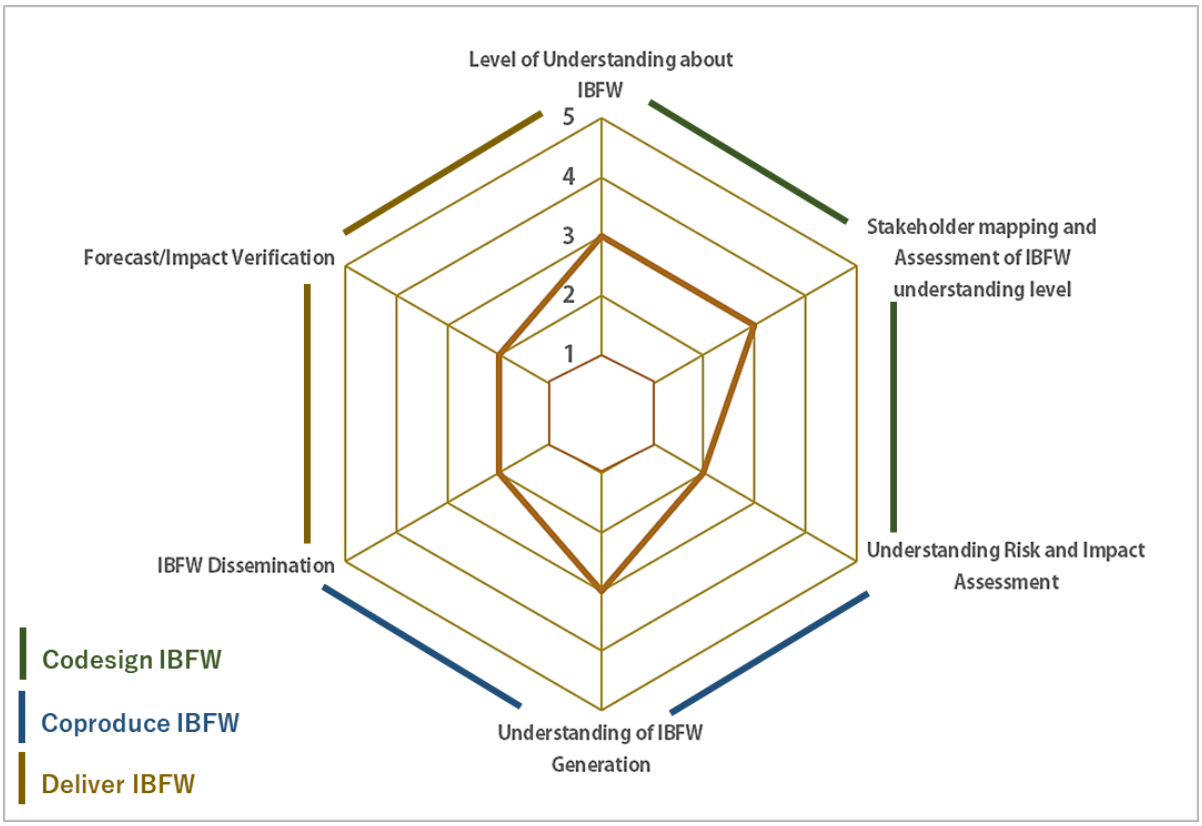


Figure (24): Overall IbFW Readiness within DMH. (Scale: 1-Very Low (Very low understanding and capacity); 2-Low (Low understanding and capacity); 3-Medium (Medium understanding and capacity); 4-High (High understanding and capacity); 5-Very High ((Very high understanding and capacity)

The overall assessment results in the **delivery phase of IbFW** have shown that DMH have low level knowledge and skills in IbFW dissemination and forecast verification (**Score of 2.0**). While DMH is responsible for issuing forecast and warning information, the information sent out to NDMO is still based on traditional weather forecasting. Therefore, DMH agree that

integration of IbFW would be essential for improving the accuracy of information dissemination and warning. **Figure (24)** shows the overall IbFW Readiness of DMH.

2.2. National Disaster Management Organization (NDMO)

The overall assessment results in the **codesign phase of IbFW** have shown that the level of knowledge and understanding about IbFW within NDMO is medium (**Score of 3.0**) meaning there exist awareness about IbFW amongst its staff. Similarly, in terms of stakeholders mapping and assessment of IbFW understanding level, the overall assessment result was found to be medium (**Score of 3.0**) with NDMO working very closely with the Government specifically with CDMC, PDMC, DDMC and VDMC. However, the overall results did not identify any other additional stakeholders.

The overall assessment results in the **coproduce phase of IbFW** have shown that NDMO have medium level (**Score of 3.0**) knowledge and understanding of risk and impact assessment and low-level knowledge on IbFW generations (**Score of 2.0**). NDMO has already conducted national level risk assessment through a joint project with ADPC and UNDP in 2010. Presently, the Risk Profiles are being updated through a project supported by Asian Development Bank (ADB) titled “Supporting Adaptation Decision Making for Climate Resilient Investments”. However, NDMO has limited knowledge on IbFW generation and is also not directly within their organizational mandate.

The overall assessment results in the **delivery phase of IbFW** have shown that NDMO have low level knowledge and skills in IbFW dissemination and forecast verification (**Score of 2.0**) as it is not within their scope of work. DMH is responsible for issuing forecast and warning information which is then sent to NDMO for further dissemination and decision-making. However, NDMO suggests that IbFW should be integrated in order for DMH to generate more improved forecast and warning information that would help in better planning and preparedness. **Figure (25)** shows the overall IbFW Readiness of NDMO.

Section C: Results and Discussion

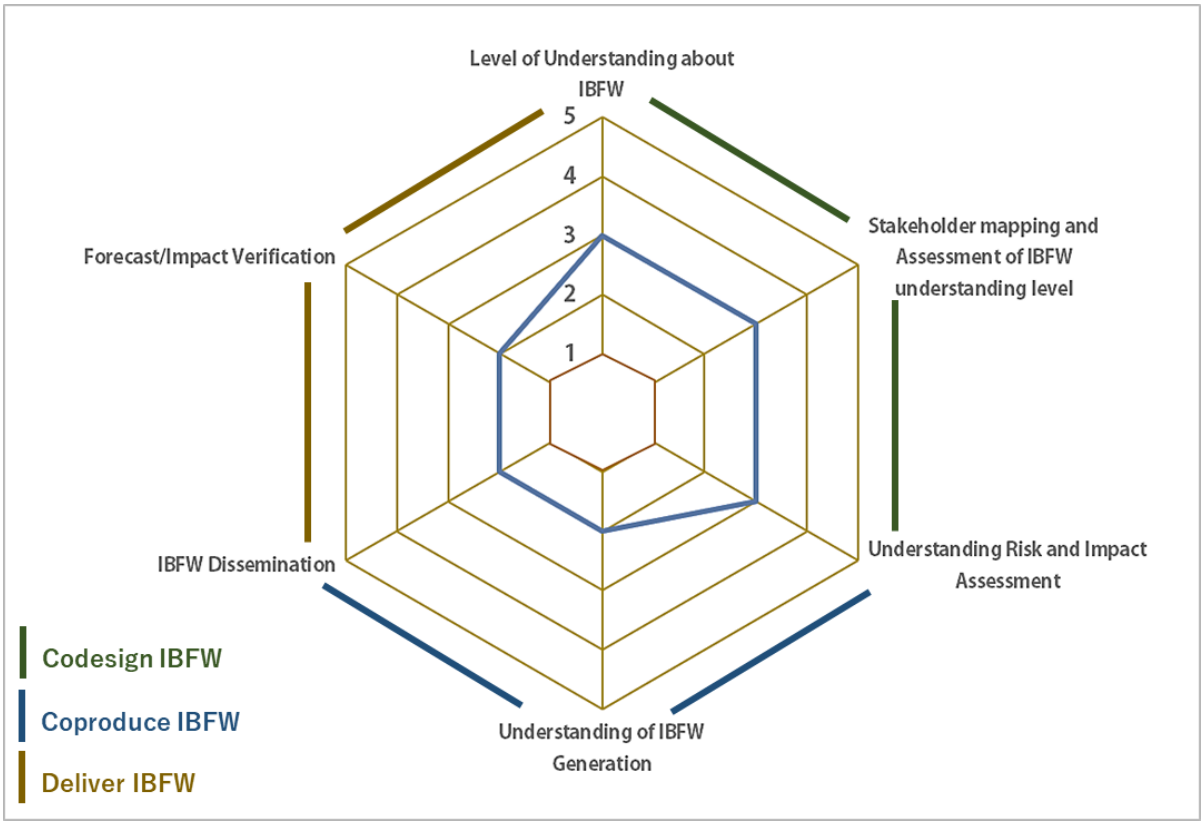


Figure (25): Overall IbFW Readiness within NDMO. (Scale: 1-Very Low (Very low understanding and capacity); 2-Low (Low understanding and capacity); 3-Medium (Medium understanding and capacity); 4-High (High understanding and capacity); 5-Very High ((Very high understanding and capacity)

2.3. Ministry of Agriculture and Forestry (MAF)

The overall assessment results in the **codesign phase of IbFW** have shown that the level of knowledge and understanding about IbFW within MAF is medium (**Score of 3.0**) meaning there exist awareness about IbFW amongst its staff. Similarly, in terms of stakeholders mapping and assessment of IbFW understanding level, the overall assessment result was found to be medium (**Score of 3.0**) with MAF working closely with development partners. Most of the engagements with development partners are project-based partnerships and collaborations. However, the overall results did not identify the names of the stakeholders.

The overall assessment results in the **coproduce phase of IbFW** have shown that MAF have low (**Score of 2.0**) level knowledge and understanding of risk and impact assessment as well as IbFW generations. MAF is not directly involved in any risk assessment related work but they are working with UNDP on post-disaster impact assessment. They are not engaged in any direct IbFW activity.

The overall assessment results in the **delivery phase of IbFW** have shown that MAF have low level knowledge and skills in IbFW dissemination and forecast verification (**Score of 2.0**) as it

is not within their scope of work. MAF gathers their forecast information through LaCSA system that provides 3-hour weather forecast, 7-day weather forecast and seasonal weather forecast together with weekly and monthly agro-met bulletins. This information is used for agricultural planning and decision-making purposes. **Figure (26)** shows the overall IbFW Readiness of MAF.

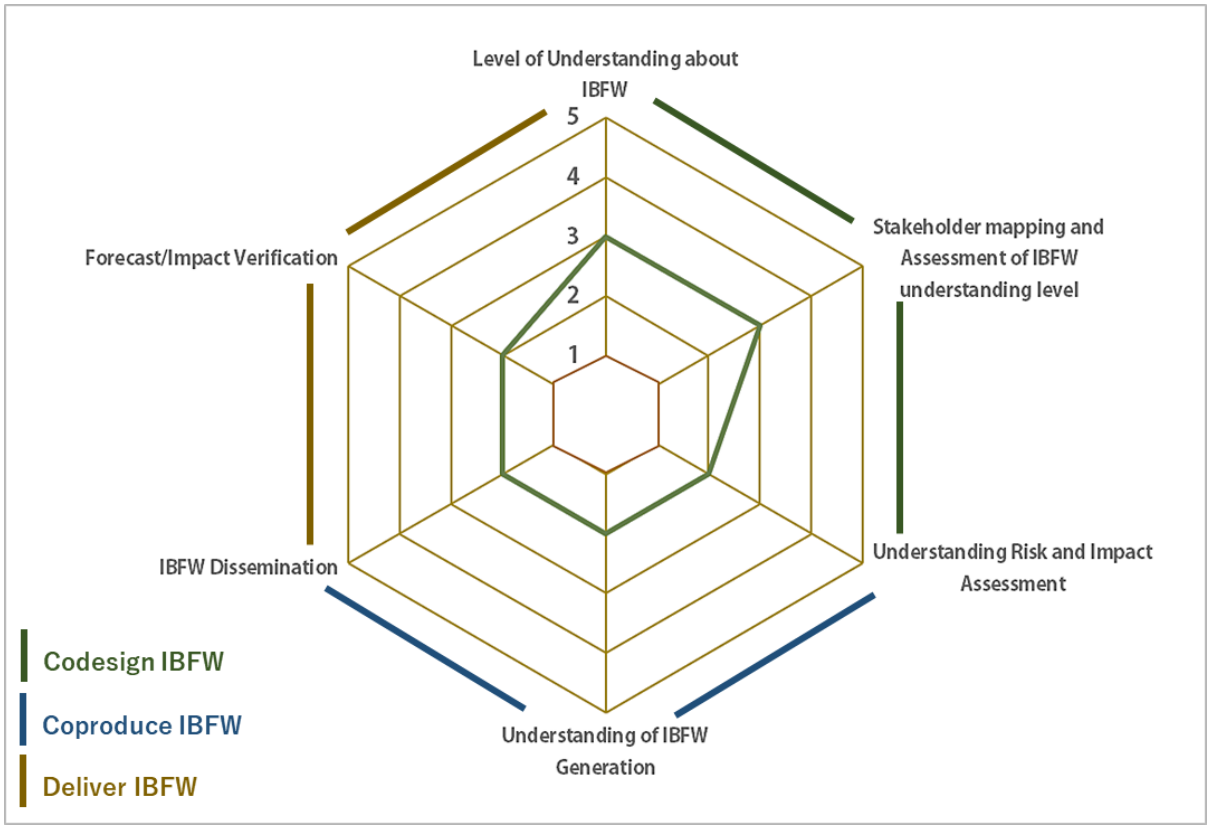


Figure (26): Overall IbFW Readiness within MAF. (Scale: 1-Very Low (Very low understanding and capacity); 2-Low (Low understanding and capacity); 3-Medium (Medium understanding and capacity); 4-High (High understanding and capacity); 5-Very High ((Very high understanding and capacity)

3. Component-wise Assessment:

3.1. Level of Understanding about IbFW

Level of understanding about IbFW amongst institutions in Lao PDR is medium **(Score of 3.0).** The institutions in Lao PDR have good understanding about "what the weather and impending hazard will be", compare to "what the weather will do". The institutions have basic understanding about IbFW from various international and regional trainings events and workshops, which they have participated in the recent past. The institutions understand that inclusion of impact on humans, livelihoods/businesses, infrastructure and agriculture makes impact-based forecasting unique among other traditional forecasts and warnings. Although, traditional forecasts and early warnings system exist in these countries, there is no functional IbFW at this juncture in Lao PDR. Mandated institutions in Lao PDR haven't produced any

IbFW products. Lao PDR also doesn't have any national level guidelines and Standard Operating Procedure (SOP) on IbFW. Department of Meteorology and Hydrology (DMH) is a mandated agency under the Ministry of Natural Resources and Environment (MoNRE), which is responsible for the collection and analysis of hydro-meteorological data and the provision of water supply conditions, weather forecasts, and issuing early warning. According to DMH, the traditional weather forecasts and warnings provides only general information about the weather pattern in Lao PDR. Therefore, IbFW can provide clearer information, that is accurate, precise with clarity and thereby bringing more confidence to the warnings being issued to the public. IbFW can also help focus on an area that is expected to have impacts. NDMO is the mandated agency to manage disaster and associated activities in Lao PDR. According to NDMO, Lao PDR established Disaster Management Law in 2019. NDMO consider that traditional forecasts and future IbFW mechanism will fall under the same Disaster Management Law (No.71/NA, dated July 24, 2019). However, NDMO observes that there are few differences when it comes to IbFW compared to traditional weather forecast, such as a.) Information incorporated into IbFW may be more detailed, such as being able to identify the extent of the impact, where the effect of actual impact may be monitored in terms of severity that includes population, animals and other elements in the area at risk; b.) Communications systems for transmitting and dissemination information may be more advanced allowing the mandated agencies to send and receive information at the shortest possible time; c.) It will also enhance the technical skills of NDMO staff. On the other hand, MAF is the mandated agency to ensuring food security, producing comparative and competitive potential agricultural commodities, developing clean, safe and sustainable agriculture and shift gradually to the modernization of a resilient and productive agriculture economy, linking with rural development contributing to the national economic basis. MAF consider, IbFW as more advance information with clear, precise and accurate impact details on basic infrastructures, agricultural production, livelihood of communities as well as informing about when and what areas within the district maybe affected and so on. (**Refer to Figure (23)**)

3.2. Stakeholder Mapping and Assessment of IBFW Understanding Level

Understanding about stakeholders and about their likely roles within IbFW amongst institutions is at medium level in Lao PDR **(Score of 3.0).** According to institutions (especially DMH and NDMO), identification of stakeholders and stakeholder mapping have been done in Lao PDR. However, some institutions (such as MAF) haven't identified stakeholders and mapping exercise is not been initiated. Lao PDR built a simplistic national government structure to guide the country's disaster risk reduction and emergency management. There are two main ministries that directly involve in traditional forecast and warning, which are Ministry of Natural Resources and Environment (MoNRE) and the Ministry of Agriculture (MAF). In general, DMH sends hydro-meteorological information (weather forecast, precipitation and water level) to relevant departments under MAF and to DMH at the provincial and district

levels respectively. DMH has a mandated institutional linkage from National level to Provincial Office of Natural Resource and Environment (PoNRE) at the provincial level and to District Office of Natural Resources and Environment (DoNRE) at the district level to the villages respectively. Similarly, MAF also represents Department of Agriculture (DOA), National Agriculture, Forestry, and Rural Development Research Institute (NAFRI), Department of Livestock and Fisheries (DOLF), Department of Agricultural Land Development (DALaM) as per government mandate. The general mandate of DOA is to manage and develop the crop sector by focusing on improvement of productivity through technical innovation and crop improvement in line with clean agriculture for food security and commodity production. They also have specific mandates such as management of the agricultural inputs (registration for seeds, fertilizers, pesticides and farms), development of legislations related to management of the crop sector (Laws, degrees, regulations, guidelines, manuals etc.). DOLF is also responsible for the protection, promotion, and sustainable production, use and management of livestock and aquaculture resources in Laos. The livestock sector plays an important role in the livelihood of farmers. (**Refer to Figure (23)**).

3.3. Risk and Impact Assessment

DMH, NDMO and MAF shows a strong understanding of the cascading hazards especially in their related field of works. However, there is a need to exchange the experiences and knowledge among the three institutions to develop a comprehensive understanding of cascading hazards therefore, allowing them to be aware of another area of possible impacts outside their scope of works.

According to the assessment results, floods and storm are the most dominant hazards that creates a severe impact to settlements, agriculture, social and economic sectors in Lao PDR. The results also show that NDMO is well aware of the importance of the vulnerable group such as elderly, children, disabled people and pregnant women while DMH is more aware of the people who live in the risk area such as along the river or hilly areas and MAF considers farmers as the most vulnerable group who are also impacted from the disasters. This shows that three organizations should have a capacity building to raise up awareness on gender inclusive into their decision-making and strategic planning to leave no one behind which will enhance the IbFW accordingly.

Regarding to the availability of exposure and vulnerability data in Lao PDR, the results have shown that there are no impacts data related to historical climate records that are georeferenced and maintained. The capacity building on collecting impacts data, pre- and post-processing data including data management and how to relate impacts and extreme climate events are needed to build up their capacity. This also tends to support IbFW development in Lao PDR.

The analysis shows that there is a lack of understanding about risk assessment **(Score of 2.0)** especially the definition of vulnerability which includes physical, environmental, social and economic vulnerability dimensions. Therefore, basic level training on risk and vulnerability assessments should be provided to DMH and MAF and intermediate level for NDMO as they have the mandate to assess risks for disaster risk management. (**Refer to Figure (23)**).

3.4. IbFW Generation

Department of Meteorology and Hydrology (DMH) is the mandated agency in Lao PDR to develop and issue weather and climate forecasts. With the current capacity of DMH in producing traditional weather forecasts, there is a potential to further improve its capacity to support IbFW. DMH has the confidence to make such changes within a short period of time if they receive proper guidance and financial supports from external agencies. LaCSA platform developed under SAMIS project helps DMH to bring the traditional weather forecast into the next level that includes generation, integration and dissemination. MAF is also directly benefited from this platform. However, DMH requires an improvement on risk and impact assessment. Most of the necessary data for risk and impact assessment can be accessed from NDMO, MAF and other relevant agencies. Since the co-development engagement between agencies is also weak at the moment, so it is important to improve the co-data sharing, coordination and collaboration among the relevant agencies to better produce an IbFW. There is also a great potentiality for both NDMO and MAF to convert their existing traditional weather forecast which is usually received from DMH and update such forecasts information from LaCSA platform to IbFW level by improving their existing capacity. Based on the assessment, overall IbFW generation component in Lao PDR requires attention and capacity enhancement to meet the much-needed IbFW standards and sub-components **(Score of 2.0)**. (**Refer to Figure (23)**).

3.5. IbFW Dissemination

Understanding about IbFW dissemination amongst institutions is low in Lao PDR **(Score of 2.0).** Institutions (apart from DMH) have basic understanding about dissemination of existing traditional forecast and warning in the country. Use of social media for information dissemination is legal in accordance with the Disaster Management Law. Currently, DMH disseminate the warning information through hard copy, TV, radio, Newspaper, WhatsApp and Facebook. They issue three types of warnings according to water level and forecasted rainfall, which are normal stage (green color), alarm stage (yellow color) and flood warning (red color). Regarding IbFW, institutions suggested that (a) visuals should include infographics, pictures and photos, (b) word choices should be simple and understandable and (c) color schemes should be based on standard guidelines defined by WMO or by the national agencies in the country. In terms of issues related to dissemination flow, DMH highlighted that sometimes the warning does reach the areas at risk quite late. Therefore, DMH suggested that this gap needs

to be addressed in the near future. MAF too highlighted the issue with the dissemination flow wherein the Ministry sends notice to the provinces and the districts to collect data on the impacts and needs after the disaster event and then submit a report which normally is not submitted on time therefore leading to considerable delays. MAF highlighted that budget limitation on data collection at provincial and district levels is another critical issue. In terms of receiving feedbacks from stakeholders engaged in dissemination flow, the major feedback has been the language being too technical through the entire communication channel from national to local levels. Generally, the feedbacks received are also not documented as has been informed by all three agencies. (**Refer to Figure (23)**).

3.6. Forecast/Impact Verification

DMH, NDMO and MAF are currently trying to perform the verification on the forecast after each event and seasonally which is a good initiative. However, collecting, collating and archiving the required data for the verification process i.e., historical forecasts, historical observations and historical data on disaster impacts are still weak. Whereas collecting and archiving historical meteorological observation are progressing well over the years, it is noticed that there are no proper scientific methodology/approach in place for forecast and impact verifications. It is therefore, recommended to pay the much-needed attention on improving capacities for verification process, evaluation and forecast skill assessment for all three agencies in Lao PDR **(Score of 2.0)**. (**Refer to Figure (23)**).

SECTION

D

RECOMMENDATIONS

Section D: Recommendation

SECTION D | RECOMMENDATIONS

D.1 | Lao PDR

1.1. Level of Understanding about IbFW

- While there has been awareness about IbFW for all three targeted institutions in Lao PDR, practical applications of IbFW is lacking.
- Therefore, strengthening the capacity of mandated agencies through training and specialized courses would help broaden their knowledge and skills to implement IbFW in Lao PDR.

1.2. Stakeholder Mapping and Assessment of IBFW Understanding Level

- In terms of stakeholder engagements, institutions in Lao PDR are aware about "who-is-who" in the country, but due to the absence of appropriate guidelines or SOPs on IbFW, there is always a lack of understanding about the potential role of the stakeholders and their level of engagements within the Government entities.
- Therefore, it is recommended that SOPs are developed, standard terms of references (ToRs) for stakeholders are identified according to the level of engagements with the Government.

1.3. Risk and Impact Assessment

- While Lao PDR has done country-level risk assessment, however, the results show that there are no impact level data related to historical climate record available as yet. Therefore, capacity building on collecting such data, pre- and post-processing the data including data management and how to relate impacts and extreme climate events are essential. This will help support overall IbFW development in Lao PDR.
- The assessment results also show the lack of understanding of risk assessment especially at the theoretical level that includes the definition of vulnerability based on physical, environmental, social and economic vulnerability dimensions. For this to be achieved, a basic conceptual level training should be provided to DMH and MAF while advanced level training be provided for NDMO as they have mandate to assess risks for disaster risk management further.

1.4. IbFW Generation

- The assessment results make it clear that DMH requires an improvement on risk and impact assessment. However, they have limited access to data from NDMO, MAF and other relevant agencies. Therefore, it is recommended that the co-development engagement between agencies be strengthened by improving the co-data sharing, coordination and collaboration among the relevant agencies to produce better IbFW.

- Overall IbFW generation component in Lao PDR requires attention and capacity enhancement to meet the required IbFW standards and subcomponents.

1.5. IbFW Dissemination

- In terms of issues related to dissemination flow, the existing gaps needs to be identified so that information flow in a timely manner.
- Standard Operating Procedures (SOPs) and guidelines for data collection and reporting be introduced for timely collection of required data and information.
- Budget allocation for data collection be enforced.

1.6. Forecast/Impact Verification

- The assessment results have shown that all three institutions have limited capacity on collecting, collating and archiving the required data for the verification process that includes historical forecasts, historical observations and historical data on disaster impacts. Therefore, it is recommended that training on data collection and reporting be provided to strengthen their data collection skills by following appropriate guidelines and formats.
- Whereas collecting and archiving historical meteorological observation are progressing well over the years, it is noticed that there are no proper scientific methodology/approach in place for forecast and impact verifications. It is therefore, recommended to pay the much-needed attention on improving capacities for verification process, evaluation and forecast skill assessment for all three agencies in Lao PDR.

D.2 | Overall Recommendation for Lao PDR

- Capacity building is a key to enhance the skills and knowledge on IbFW in Lao PDR;
- Develop guidelines on IbFW before establishing a full-fledged IbFW system;
- Set up integrated IbFW portal (model);
- Establish inter-agency coordination mechanism;
- Establish data sharing agreements between agencies;
- Identify the overlapping roles between the agencies to maintain data consistencies and reliable flow of information;
- Arrange specialized courses so that knowledge and skills of staff engaged in forecasting and warning is enhanced;
- Organize training atleast from basic to intermediate level to the institutions so that staff understands the methods and approaches of IbFW and apply it appropriately;

Section D: Recommendation

- Provide funding support not only through donor funds but also bringing in CSR funding to procure required resources to support IbFW.
- Develop IBFW strategy that would guide the future design and implementation of IBFW activities in Lao PDR

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Annex 1: Readiness Assessment Matrix

ANNEX

1

READINESS ASSESSMENT MATRIX

Annex 1: Readiness Assessment Matrix

ANNEX 1.1 | Readiness Assessment Matrix

SECTION - I: Assessment of the understanding about IBFW

1. What is Impact-based Forecasting and warning (IBFW)?	
2. How is it different from traditional weather forecast and warning?	
3. Why is it Impact-based Forecasting (IBFW) important?	

SECTION - II: Stakeholders mapping and Assessment of IBFW understanding level?

4. Have you identified and mapped stakeholders for Impact-based Forecast and Warning (IBFW) chain (national to local)? ☐ Yes ☐ No	
5. Can you provide the names of these identified IBFW stakeholders? ☐ Yes ☐ No. If yes, please provide the names of these stakeholders.	☐ MoWRAM ☐ MAFF ☐ NCDM ☐ UNDP ☐ WFP ☐ PIN ☐ GIZ ☐ Other
6. Can you categorize these identified stakeholders in to the following categories? Please follow the listed users order.	☐ disaster risk knowledge ☐ detection, monitoring and forecasting of the hazards and possible consequences ☐ warning dissemination and communication ☐ preparedness and response capability ☐ governance
7. Can you rate the level of understanding about IBFW amongst identified stakeholders? (Scale of 1 – 5)	☐ 1: very low ☐ 2: low ☐ 3: medium ☐ 4: high ☐ 5: very high
8. What is your working and information sharing mechanism with these identified stakeholders	☐ Partnerships ☐ Collaborations

Annex 1: Readiness Assessment Matrix

SECTION - III: Understanding Forecast and Warnings

9. What are the key natural hazards in your country?	☐ Flood ☐ Storm ☐ Drought ☐ Lightening ☐ Other
10. For which hazards forecast and warning information are currently being generated and issued?	☐ Flood ☐ Storm ☐ Drought ☐ Lightening ☐ Other
11. What is frequency of the forecast and warning information are currently being issued?	☐ Hourly ☐ Daily ☐ Weekly ☐ Dekadal (15-20 days) ☐ Monthly ☐ Seasonally ☐ Other
12. How forecast and warning information are currently being used in decision making and practices?	
13. What are key challenges do stakeholders face while using the existing the forecast and warning information?	
14. Have you conducted any hazard, exposure, vulnerability and risk assessment?	
15. Is there any impact information added in the existing the forecast and warning information?	
16. How can be existing forecasts and warnings information can be improvised which can provide appropriate information to enable informed decision-making and trigger action?	
17. How long will it take to embedded impact information in existing forecast and warning and produce and disseminate the impact-based forecast or warning?	☐ Short Term (1-6 months) ☐ Medium Term (6-12 months ☐ Long Term (more than a year ☐ Other

Annex 1: Readiness Assessment Matrix

18. At what spatial or administrative scale do stakeholders need forecast and warning information in order to act effectively?	☐ National ☐ Provincial ☐ District ☐ Commune ☐ Village
19. How much time will it take for stakeholders to process the information and prepare for early actions?	☐ 1-6 hours ☐ 6-12 hours ☐ 12-24 hours ☐ More than 24 hours ☐ Others

SECTION - IV: Understanding Risk and Impact Assessment

20. What is the existing mechanism of lifting the warning?	
21.1. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of Heavy Rainfall?	☐ primary impacts ☐ secondary impacts
21.2. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of Low Rainfall?	☐ primary impacts ☐ secondary impacts
21.3. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of High Temperature?	☐ primary impacts ☐ secondary impacts
21.4. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of Low Temperature?	☐ primary impacts ☐ secondary impacts
21.5. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of High Wind?	☐ primary impacts ☐ secondary impacts
21.6. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of Storm Surge?	☐ primary impacts ☐ secondary impacts
21.7. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of Lightning?	☐ primary impacts ☐ secondary impacts
21.8. What are the 'Cascading Hazards' and 'Expected primary and secondary impacts' of Fog?	☐ primary impacts ☐ secondary impacts

Annex 1: Readiness Assessment Matrix

22. Which hazard have maximum impacts on housing, livelihoods, business, critical infrastructure, etc.?	☐ Flash flood ☐ Storm/Typhon/Cyclone ☐ Drought ☐ Land slide ☐ Others
23. Which group of society affected the most?	☐ ID poor 1 & 2 ☐ Vulnerable people ☐ Indigenous people ☐ Elderly ☐ Handicapped ☐ Children ☐ Others
24. Which hazard and impacts are the most complicated and difficult to deal with?	☐ Flash flood ☐ Storm/Typhon/Cyclone ☐ Drought ☐ Land slide ☐ Others
25. What are the key sectors affected by the most due to these impacts (Agriculture, Water, Transport, Health, Tourism, Energy, etc.)?	☐ Agriculture ☐ Water ☐ Transportation ☐ Health ☐ Tourism ☐ Energy (Electricity cut off) ☐ Others
26. Have you archived the historical climate data and impact records?	☐ Yes ☐ No
27. What is the duration for the historical climate data and impact records are archived?	☐ Monthly ☐ Quarterly ☐ Semester ☐ Annually ☐ Others
28. What is the quality of the historical climate data and impact records?	☐ Accuracy ☐ Good quality ☐ Frequency updating ☐ Up to date
29.1. What was (a) the frequency (b) the magnitude (related to return period) and (c) geographic distribution of impacts of the DROUGHT hazard?	

Annex 1: Readiness Assessment Matrix

29.2. What was (a) the frequency (b) the magnitude (related to return period) and (c) geographic distribution of impacts of the FLOOD hazard?	
30. What are the key vulnerabilities?	
31. What are the vulnerability indicators that are related to the identified hazards and impacts?	
32. What are the key elements of exposures?	
33. What is the quality and availability of data for vulnerability and exposure assessments?	
34. Have you Identified impact levels from hazard thresholds? If yes, what are the hazards that thresholds have developed?	
35.1 Is there any future climate change projections data are available at national and local scale?	
35.2. If yes, provide some details of available GCMs, scenarios, time periods and resolution of data.	

SECTION - V: Understanding IBF and Warning Generation

36. Have you conducted any impact assessment using those climate change projections? if yes, Name those studies?	
37.1. How many staff are engaging in the process of IBF development and dissemination?	
37.2. What are the expertise areas of staff engaging in the process of IBF development and dissemination?	
38. Is this number of staff sufficient for catering the demand? if not, how many staff are you expecting?	

Annex 1: Readiness Assessment Matrix

39. What are the tools/software do you use to produce Impact-based forecast and warning?	
40. Which existing forecasts and warnings can be adapted to meet the user requirements of impact-based forecast services?	
41. Select the content of existing impact-based forecasts and warnings	
42. What capabilities are needed to produce the impact-based forecasts and warnings that will meet the user requirements?	

SECTION - VI: Partnerships and collaboration

43. Do you have any current pilot project that IBF is testing? If yes, what projects?	
44.1. Have you identified potential partners and collaborators who should be engaged with in developing IBFs?	
44.2. Who are they?	
45. What support are you expecting from them?	

SECTION - VII: IBF Dissemination

46. Which language(s) preferred by the stakeholders in your country for forecasts and warnings?	☐ Simple ☐ Laymen ☐ Technical/Mix
47. How do stakeholders access forecasts and warnings?	
48. How should the information be presented?	☐ What visuals, ☐ What word choices, and ☐ What color schemes?
49. Which mode stakeholders preferred for the forecasts and warnings?	☐ Television ☐ Social Media ☐ Newspaper ☐ SMS

Annex 1: Readiness Assessment Matrix

50. How impact levels can be communicated to support decision-making and action?	
51. What is the IBF dissemination flow in your country? (Hint: Draw a flow diagram of institutes/people in a separate paper)	
52. Are there any known issues and challenges in the dissemination flow? If yes, what are those?	
53.1 Are you receiving any feedback from stakeholders who are involved in this dissemination flow? If yes, what are those feedbacks?	
53.2 Are you documenting these feedbacks for future references?	
54. Did you have any business continuity plans and measures during any failures of normal dissemination channels?	

SECTION - VIII: Forecast/Impact Verification

55.1. Are you usually performing a forecast/impact verification?	
55.2. How frequent do you usually perform the verification?	☐ After each event ☐ Seasonally ☐ Annually
56. Are you regularly collection, collating and archiving following data?	☐ Historical forecasts ☐ Historical observations ☐ Historical data on disaster impacts
57. What kind of benefit do you get from verification process to improve the IBF?	
58. What are the key challenges you are facing when producing impact-based forecasting?	

Annex 1: Readiness Assessment Matrix

ANNEX 1.2 | Readiness Assessment in Lao People's Democratic Republic (Responses)

Assessment of Understanding about IbFW

In order to assess the understanding of impact-based forecasting of the targeted institutions, three specific definitions have been posed to the institutes as given in table.

Table (1) represents the accepted definitions of IbF

Sr. No.	IBF Definitions	Institutions		
		DMH	NDMO	MAF
1.	Impact-based forecasting drives actions which save lives and protect property and livelihoods	√	√	√
2.	Impact-based forecasting provides information on the level of risk a hazard poses to a specific area	√	√	√
3.	Impact-based forecasts and warnings provide an assessment of the forecast weather or climate hazard and an assessment of the possible impacts, including when, where and how likely the impacts are	X	√	X

Perception about Impact-Based Forecasting and Warning (IBFW) and traditional weather forecasting:

According to the targeted institutions perspective, the following responses have been received:

DMH Perspective

1. The traditional weather forecasts and warnings provides general information about the weather and its likely impacts to lives and properties of vulnerable people mostly local communities.
2. Traditional weather forecast is not specific to a specific area and cannot tell when an event in that area may happen.
3. Impact-Based Forecasting and Warning (IBFW) will be able to provide clearer information, that is accurate, precise with clarity and thereby bringing more confidence to the warnings being issued to the public. It will also help focus on an area that is expected to have impacts.
4. Enhance technical skills of DMH staff.

NDMO Perspective

1. According to NDMO, going by their existing Disaster Management Law, they consider traditional forecasts and IBFW mechanism to be the same considering that both terms will fall under the Disaster Management Law No. 71 /NA, Dated 24th June 2019 like in the law identifies that Disaster management committee consists of:

Annex 1: Readiness Assessment Matrix

a. Center Disaster Management Committee (CDMC)
b. Provincial Disaster Management Committee (PDMC)
c. District Disaster Management Committee (DDMC)
d. Village Disaster Management Committee (VDMC)

2. However, NDMO observes the following differences when it comes to IBFW compared to traditional weather forecast:
    a. Information incorporated into IBFW may be more detailed, such as being able to identify the extent of the impact, where the effect of actual impact may be monitored in terms of severity that includes population, animals and other elements in the area at risk;
    b. Communications systems for transmitting and dissemination information may be more advanced allowing the mandated agencies to send and receive information at the shortest possible time.
    c. Enhance technical skills of NDMO staff.

MAF Perspective

1. Normally in the past and present situation, MAF receives warning bulletins through social media such as WhatsApp, Facebook, etc. Such warning bulletins are received during the rainy season and also during the event of an expected disaster containing information such as name of the province or provinces that are likely to be affected, type of disaster and its duration.
2. The bulletins are issued to the Department of Agriculture and Forestry in the provinces who in turn sent out official notifications to the districts that are likely to be affected. The districts then assign staff to the at-risk villages to warn the communities and prepare for disaster response.
3. However, MAF observes the following differences when it comes to IBFW compared to traditional weather forecast:
    a. Information used in the warnings through IBFW may have more clarity, precise and accurate to identify potential impacts on basic infrastructures, agricultural production, livelihood of communities as well as informing about when and what areas within the district maybe affected and so on;
    b. IBFW will provide advanced tools and technologies for improved warning generation and dissemination for at-risk areas before the event allowing stakeholders to prepare in advance for the incoming disaster;
    c. Enhance technical skills of MAF staff.

Annex 1: Readiness Assessment Matrix

Table (2) Importance of Impact-Based Forecasting and Warning (IBFW)

DMH	NDMO	MAF
Able to identify the area of occurrence of a disaster event and informed the vulnerable communities effectively through clear, precise and accurate warning generation and information.	Will help all stakeholders to identify the extent and location of likely to be affected areas allowing sufficient time to prepare and plan for response.	Will help provide in advance clear, accurate and precise warning information on areas that maybe affected by floods and droughts, therefore, allowing authorities to plan and determine measures to prepare and respond to mitigate the damages and losses in the agricultural production.
Improve DMH's confidence in issuing warnings	Improve NDMO's confidence in recognizing the warnings received from DMH for preparedness and response	Improve MAF's confidence in effectively using the warning information for preparedness and response to minimize risk to agricultural sector.

Stakeholder Mapping

Stakeholders Mapping and Identification for IbFW from National to Local Levels

When asked about stakeholder mapping and identification, DMH and NDMO has mentioned that stakeholders have been identified and mapped but for MAF, they haven't done stakeholder mapping exercise.

Table (3) Stakeholder Mapping and Identification

Agency Name	Stakeholders	
	Government	**International**
DMH	MoNRE, PDoNRE, DDoNRE and all members of disaster management committees Potential Stakeholders: Ministry of Labour and Social Welfare (MoLSW), Ministry of Defense, Ministry of Public Work and Transport, Ministry of Agriculture and Forestry (MAF), Ministry of Public Health.	UN agencies (WFP, FAO, etc.) and Intergovernmental Organizations (ADPC, RIMES, etc.)
NDMO	Center Disaster Management Committee members (CDMC): 13 sectors include, i. Deputy PM -President ii. Minister of Labour and Social Welfare Deputy iii. Vice Minister of National Defense - member iv. Vice Minister of Finance - member	

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	v. Deputy Head of Office of PM - member vi. Vice Minister of Public Health - member vii. Vice Minister of Agriculture and Forestry - member viii. Vice Minister of Public Work and Transport -member ix. Vice Minister of Education and Sport - member x. Vice Minister of Information, Culture and Tourism - member xi. Vice Minister of Natural Resource and Environment xii. Vice Minister of National Security xiii. Vice President of Youth Union Provincial Disaster Management Committee (PDMC) District Disaster Management Committee (DDMC) Village Disaster Management Committee (VDMC)	
MAF	None	None

Level of Understanding about IbFW amongst Stakeholders

Based on the assessment results, when asked to rate the level of understanding and knowledge about IBFW of different stakeholders, all three agencies, DMH, NDMO and MAF have put the score at 3 meaning medium level understanding (**Figure (1)**).

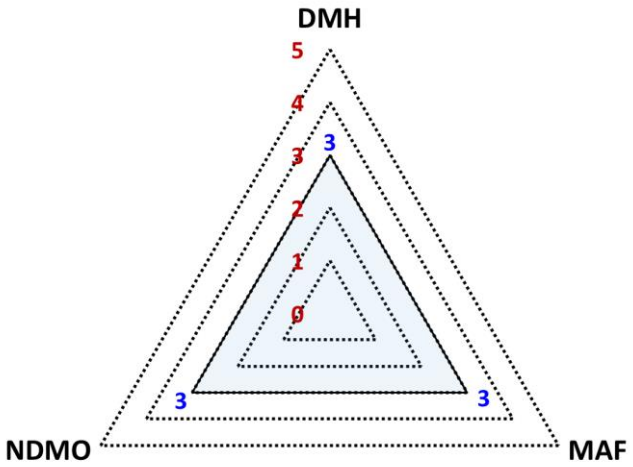

Figure (1): Radar chart showing the level of understanding and knowledge about IBFW of different stakeholders through the scores provided by DMH, NDMO and MAF. (Scale: 1-Very Low; 2-Low; 3-Medium; 4-High and 5-Very High)

Annex 1: Readiness Assessment Matrix

Working Relationships with the Stakeholders

In terms of working relationships with the different stakeholders, all three agencies have identified the relationships as follows.

Table (4) Stakeholder Relationships

Sr. No.	Stakeholder Relationships	Institutions		
		DMH	NDMO	MAF
1	Government Mandate	√	√	√
2	Memorandum of Understanding (MoU)	X	X	X
3	Project-based Partnerships and Collaborations	√	√	√
4	Contracts	X	X	X
5	Others	X	X	X

Understanding Forecast and Warnings

Table (5) List of Key Natural Hazards in Lao PDR

Sr. No.	Key Hazards	Institutions		
		DMH	NDMO	MAF
1	Floods	√	√	√
2	Flash Floods	√	√	X
3	Riverine Floods	√	X	X
4	Droughts	√	√	√
5	Cold Wave	√	X	X
6	Earthquakes	√	√	X
7	Landslides	√	√	√
8	Pest	X	√	√

Among the identified hazards, it appeared that floods, droughts and landslides are key hazards for all three agencies.

Hazards Forecast and Warning Information that are Currently being Generated and Issued

Department of Meteorology and Hydrology (DMH)

There are two forms of warning information that DMH issues:

- **Normal Warning** which is issued as a daily weather forecasts through TV, National Radio, Facebook, WhatsApp groups and so on.
- **Severe Warning** issued in case of potential severe weather conditions such as storms, tropical cyclones, flooding, and so on. DMH issue warning bulletin/ official letter every 3 hours.
- In terms of **forecast**, DMH provides forecast at 1-day, 7-days, 1-month and 3-months. The forecast information after 7-days is further summarized for next 7-days.

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National Disaster Management Office (NDMO)

- NDMO receives daily weather information from DMH
- Hazards forecast and warning are being generated and issued during the rainy season when there is a likely possibility of windstorms, floods (flash floods and riverine floods) and landslides.
- NDMO sends out the warning bulletin from DMH and the official letter from the Secretariat of Disaster Management Office (SDMO) to the Provincial Disaster Management Committee (PDMC) for preparedness and planning.

Ministry of Agriculture and Forestry (MAF)

- MAF receives weather forecast information three months ahead from the National Agro-met system of Lao PDR that includes the information from MAF itself and the Laos Climate Services for Agriculture (LaCSA) system.
- LaCSA provides weather service for 3-hourly forecast; 7-day forecast and Seasonal forecast.
- LaCSA also provides Agro-met bulletins both weekly and monthly.

Table (6) Frequency of Forecast and Warning Information Issued

Agency	Frequency of Forecast and Warning Information Issued					
	Hourly	Daily	Weekly	Dekadal	Monthly	Seasonal
DMH	X	√	X	X	X	X
NDMO	X	√	X	X	X	X
MAF	X	X	X	X	X	√

Forecast and Warning Information Presently being used for Decision-Making

Department of Meteorology and Hydrology (DMH)

- Forecast and warning information are being used by all sectors that includes water resources management, dam management, agriculture planning, public works and transportation, tourism and implementation of disaster response from national to local levels;
- Forecast and warning information are also being used for preparing plans for minimizing disaster impacts on people's livelihoods;
- Forecast and warning information are also being used for adopting measures to prevent unexpected damages and losses to crops;
- Forecast and warning information are also used for emergency response planning to climate change;

National Disaster Management Office (NDMO)

NDMO receives the forecast and warning information from DMH which is then reviewed by the Secretariat of the Disaster Management Organization (SDMO). The information is then

shared or notified to all stakeholders from national to municipality levels for preparedness and response to potential disaster conditions. The notification sent out to all stakeholders includes the warning bulletin from DHM.

The information in the warning bulletin is used to identify the overall coping measures and also act as a guidance all stakeholders on the actions to be taken such as:

- Closely monitor the situation as reported by DMH through television, radio and other social media as well as coordinate with the Secretariat of Central Disaster Management Committee;
- Nominate a committee to closely monitor water levels along the river banks;
- Preparedness and response plans to cope with situations such as expected landslides, floods and strong windstorms;
- Send out warning messages to the local population living in at-risk areas to receive information and be careful, keeping important things, pets in safe places, prepare, prevent and deal with potential events in time.

Ministry of Agriculture and Forestry (MAF)

- Forecast and warning information are used for agricultural production planning such as planning for livestock, planning for water storage including supplying water and determining measures to deal with potential hazard events.
- Relate the forecast and warning information to stakeholders through WhatsApp, Web site, television, Radio, etc.

Key Challenges Stakeholders Face while using Forecast and Warning Information

Department of Meteorology and Hydrology (DMH)

- The forecast and warning information uses excessive technical terms making it difficult to understand;
- The forecast and warning information are mostly generic and lacks specific information;
- The frequency of the issue of warnings does not meet the needs of stakeholders appropriately;
- Access to the information source remains limited;
- Stakeholders do not have too much time to watch TV;
- DMH issues several warning bulletins, but the stakeholders may not be aware of all the bulletins resulting in communication gap and misunderstandings.

National Disaster Management Office (NDMO)

- In general, there are no challenges while using the existing forecast and warning information. When NDMO is notified, each level of stakeholders is alerted starting from province to the district and from district to the villages and the communities.

Annex 1: Readiness Assessment Matrix

- Mostly the information received from DMH provides an overall information about the potential disaster event and the likely to be affected provinces and locations. It does not specifically inform NDMO the extent of the area that will actually be affected. Therefore, the province and district estimate the area likely to be affected according to their experience.

Ministry of Agriculture and Forestry (MAF)

- Locals still has less experience in coping with disaster events;
- Local authorities and residents, who are living in the risk areas, still believe on their past experiences such as there had not been any severe impacts with no losses and damages, so they tend not to implement the warning in advance;
- Lack of awareness of local people on the impact of disasters and climate change;
- Although the district sends staff to the at-risk villages for information dissemination, but still some people tend not to evacuate before the disaster event.

Hazard, Exposure, Vulnerability and Risk Assessment

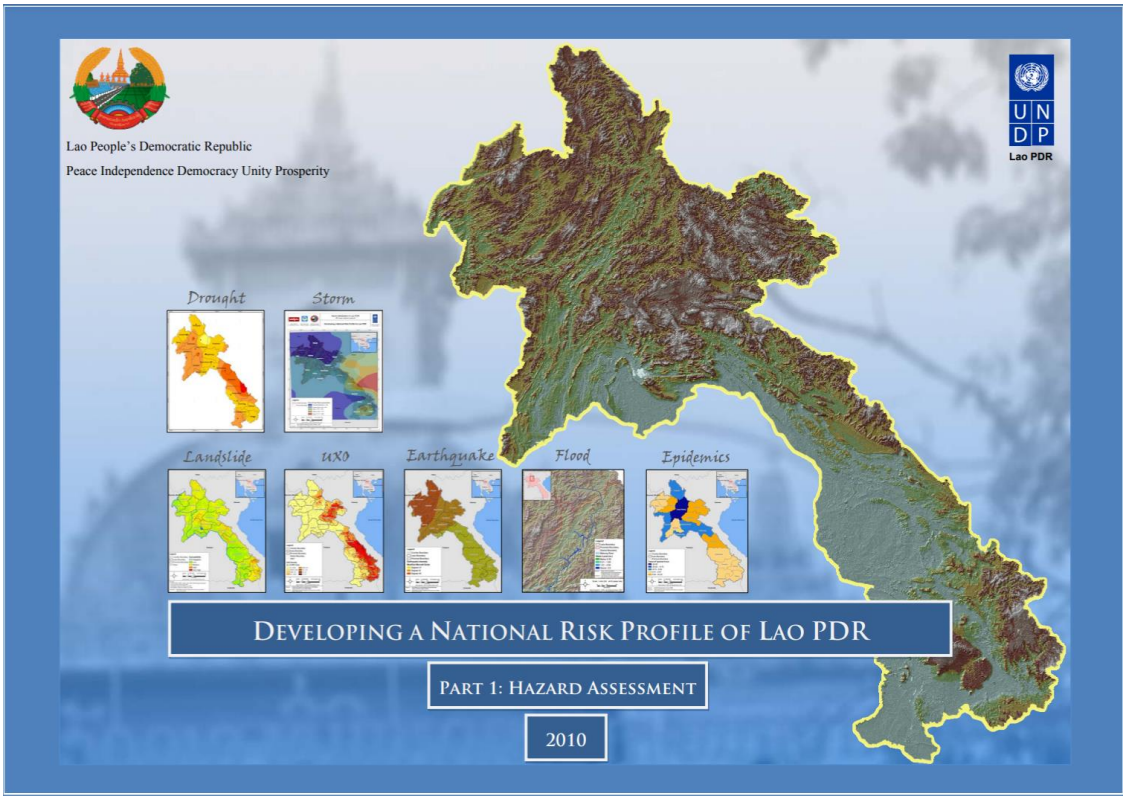
Department of Meteorology and Hydrology (DMH)

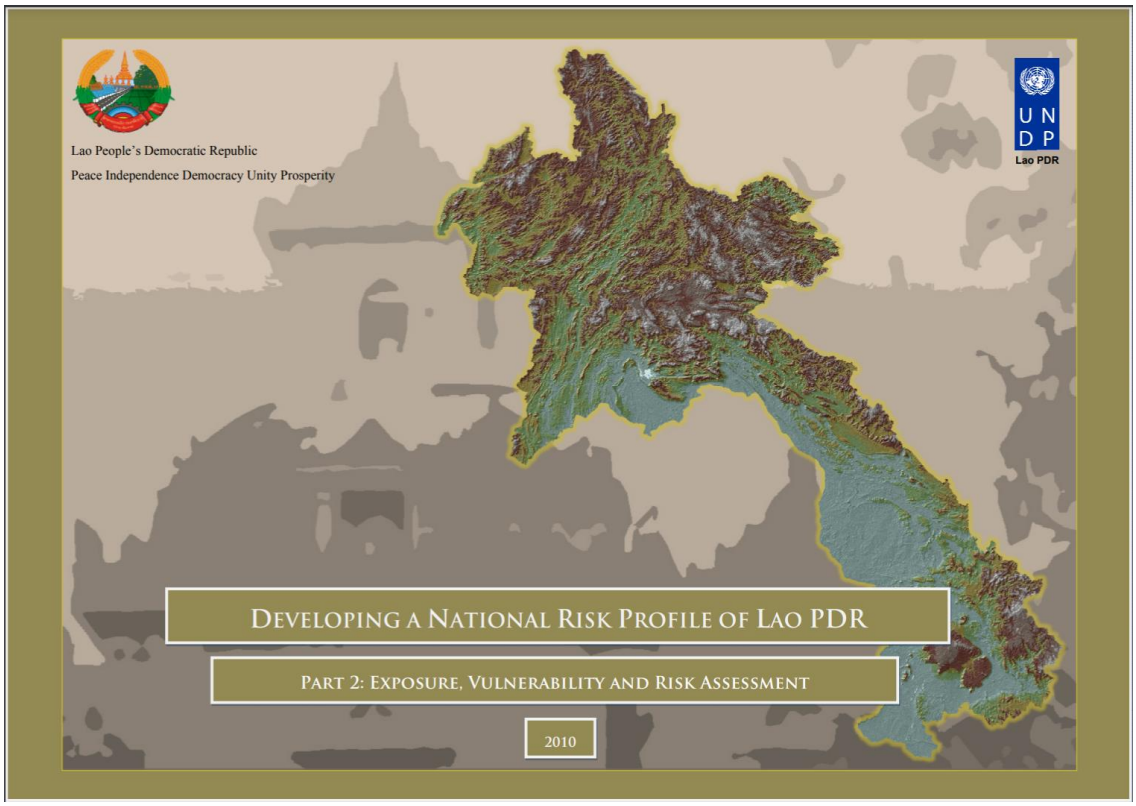
- Never did any risk/impact assessment but they consider it to be very important for their work.

National Disaster Management Office (NDMO)

- NDMO did the risk/impact assessment through a joint project with ADPC and UNDP in 2010;
- Presently, risk profile is being reviewed and updated through a project supported by Asian Development Bank (ADB) titled “Supporting Adaptation Decision Making for Climate Resilient Investments”.

Annex 1: Readiness Assessment Matrix





Annex 1: Readiness Assessment Matrix

Ministry of Agriculture and Forestry (MAF)

- Never did any risk/impact assessment but they are working with UNDP on post-disaster impact assessment.

Need for Improving the Existing Forecasts and Warning Information for Informed Decision-Making and Triggering Action

Department of Meteorology and Hydrology (DMH)

- Increase the accuracy of information to improve the reliability of warning information for the users;
- Increase the frequency of alerts issued as much as possible;
- Provide forecast and warning information including alerts in a simple and understandable to all people;
- Increase the communication channels to disseminate the warning information so that it reaches the last mile at the shortest possible time.

National Disaster Management Office (NDMO)

- Data on weather extremes and hazards with affected area extent and locations should be recorded yearly and analyzed so that it can help in re-estimating the potential impacts from similar events in the future;
- Setting up tools and technologies related to IBFW would bring about improvement in forecast and warnings;
- Need of a joint program between DMH, SDMO and MAF on data review such as hazards data like storms, floods, and droughts as well as analyze the severe impacts across the country;
- Currently, SDMO has country-level risk profiles (risk maps);
- Lao Disaster Information (LAODI) has been developed from Disenventar while DMH and MAF have their own database, therefore, if these data can be linked, it will help enable informed decision-making and trigger impactful actions;
- Need to develop provincial and district level risk profiles/hazard maps.

Ministry of Agriculture and Forestry (MAF)

- The existing forecast and warning information should be updated/improved in order to make it more accurate, precise, clear and area specific;

Need to install early warning system and early warning center at district level, especially in the risk areas. The engagements with the district need to be further improved as they have enormous experiences on who, where and what is likely to be affected by a specific disaster event providing more precise, accurate and clear information about the expected impacts.

Annex 1: Readiness Assessment Matrix

Time Needed to Embed Impact Information in Existing Forecast and Warning to Produce and Disseminate IbFW

Table (7) Time to Embed Impact Information

Sr. No.	Period (months)	Institutions		
		DMH	NDMO	MAF
1	Short-term (1-6 months)	X	√	X
2	Medium-term (6-12 months)	√	X	X
3	Long-term (more than a year)	X	X	√

Administrative Scale at which impact-based forecasting and warning (IBFW) is Needed

Table (8) Need of IbFW at Country-Level

Sr. No.	Administrative Level	Institutions		
		DMH	NDMO	MAF
1	National	X	X	X
2	Provincial	X	X	X
3	District	X	√	√
4	Village/Commune	√	X	X
5	Municipalities	X	X	X

Time Taken by Stakeholders to Process Information and Prepare Early Actions

Table (9) Time to Embed Impact Information

Sr. No.	Time for Early Action	Institutions		
		DMH	NDMO	MAF
1	1-6 hours	X	X	X
2	6-12 hours	X	X	√
3	12-24 hours	√	X	X
4	> 24 hours	X	√	X

Existing Mechanisms to Lift Warning

According to DMH, mechanisms to issue warnings are available but mechanisms to lift the warning is not available. NDMO and MAF too have mentioned that there is no mechanism to lift the warning in a post-disaster situation.

Annex 1: Readiness Assessment Matrix

Understanding Risk and Impact Assessment

Cascading Hazards due to Weather Conditions and its Impacts

Table (10a) Cascading Hazards and its Impacts

WC	DMH		
	H	PI	SI
Heavy Rainfall	Heavy rain, tropical storm, Flash flood, Riverine flood	Weather extreme; Impact to the Dams	Dam release causing flooding
Low Rainfall	Drought and hot weather	Extreme weather conditions, water shortages	Direct effects on agriculture, electricity production, fisheries and water transport
High Temperature	Drought, wild fire	Affects livelihood Easy outbreak of diseases Impact on health	None
Low Temperature	Very cold conditions	Impact on agricultural production by slowing down crop growth, impact on human health and livestock; and easy outbreak of Pest	None
Strong Winds	Storms/cyclones	Damage to houses and other physical structures, loss of lives and property and other utilities	Communication cut-off, increase investments in rehabilitation, more funds to revive economic damage
Storm Surge	Lao PDR is not affected by storm surge	None	None
Lightening	Severe electrocution	Kills people, animals, damages trees, residential fire, etc. air transport affected	None
Fog	Deep haziness, coldness and poor visibility	Impact on land, water and air transportation, occurrence of accidents, impact on agricultural crops	None

Abbreviations: Weather Conditions (WC); Hazards (H); Primary Impacts (PI); Secondary Impacts (SI)

Annex 1: Readiness Assessment Matrix

Table (10b) Cascading Hazards and its Impacts

WC	NDMO		
	H	PI	SI
Heavy Rainfall	Flood and Landslides	Damage to agricultural areas, houses, school buildings, roads, livestock, utilities, water systems as well as loss of life	Food insecurity, no income, increased poverty, etc.
Low Rainfall	Drought	Lack of drinking water, crop damage, less agricultural production	Food insecurity, increased cost of living, lack of access to clean water, loss of livelihood
High Temperature	Drought	Lack of drinking water, crop damage, less agricultural production	Food insecurity, increased cost of living, lack of access to clean water, loss of livelihood
Low Temperature	Cold weather	Damage to crops, loss of animal life mostly in North of the country	None
Strong Winds	Storms/Cyclones	Damage to housing, schools, electricity, and other vulnerable assets	Lack of housing, schools, high family expenses, increased poverty, lack of access to livelihood
Storm Surge	Lao PDR is not affected by storm surge	None	None
Lightening	Severe electrocution	Death of human and animals	None
Fog	None to report	None	None

Abbreviations: Weather Conditions (WC); Hazards (H); Primary Impacts (PI); Secondary Impacts (SI)

Table (10c) Cascading Hazards and its Impacts

WC	MAF		
	H	PI	SI
Heavy Rainfall	Flood	Impact on production/product/yield, damage to crops, livestock and irrigation	Impact on Food security, reduced income, impact on access to clean water, impact on livelihoods, more budget requirement from the Government
Low Rainfall	Drought	Not enough water supply (drinking and daily use), crop yield reduced, increased pest infestations, rise in animal diseases	Decreased productivity, food insecurity, decreased income and increase in

Annex 1: Readiness Assessment Matrix

			family expenses, increased poverty
High Temperature	Hot weather	Affects crops and livestock	Affects livestock nutrition and affects crop growth
Low Temperature	Cold weather	Affects crop cultivation and reduction in livestock feed	Agricultural productivity is reduced
Strong Winds	Storms/Cyclones	Damage to agriculture (crops, vegetables and fruits)	Reduction in income and livelihood and impacts on the local economy
Storm Surge	Lao PDR is not affected by storm surge	None	None
Lightening	No information is available	None	None
Fog	Very cold weather	Direct effects on crop and livestocks	

Abbreviations: Weather Conditions (WC); Hazards (H); Primary Impacts (PI); Secondary Impacts (SI)

Hazards and its Impacts

In terms of maximum hazard impacts on housing, livelihood, business, critical infrastructure, etc., all three agencies have identified floods, droughts, landslides, tropical storms/cyclones, lightening and earthquakes to have direct impacts. All three agencies have identified that the most affected groups of society include, the farming communities, elderly people, disabled people and pregnant women. In terms of area of impacts, mostly people living along the river banks and mountainous areas are the most affected. All three agencies have also identified the following hazards that they found it difficult and complicated to handle and that includes floods, droughts, landslides, tropical storms/cyclones, lightening and earthquakes. In terms of the direct effects on key sectors, agriculture, water, transport and electricity are found to be directly impacted by hazards.

Climate Data Archive and its Availability

All three agencies appear to have maintain climate data archives for their work.

Table (11) Climate Data Availability

Sr. No.	Climate Data Archive	Institutions		
		DMH	NDMO	MAF
1	Historical Climate Data Records Maintained	√	√	√
2	Does not Maintain Historical Climate Data Records	X	X	X

Annex 1: Readiness Assessment Matrix

DMH has maintained historical climate data since 1970 onwards and the data is available in Excel file format. NDMO has maintained historical climate data since 2000 onwards and the data is available in Excel file format and document format. MAF has maintained historical climate data since 2000 onwards and the data is available in Excel file format. Data mostly includes rainfall, temperature and sunshine hours that is collected from DMH. Some data is also available through MAF website of National Agri-Food Statistics System[15].

Climate Data Quality

In terms of climate data quality, all three agencies (DMH/NDMO/MAF) has put the quality score between 2-3 meaning 'low' to 'medium' quality when asked to measure in the scale of 1-5. DMH and MAF has given the score of 3 (medium) while NDMO has given the score of 2 (low). Average score from all three agencies is 2.7 (low) (**Figure (2)**).

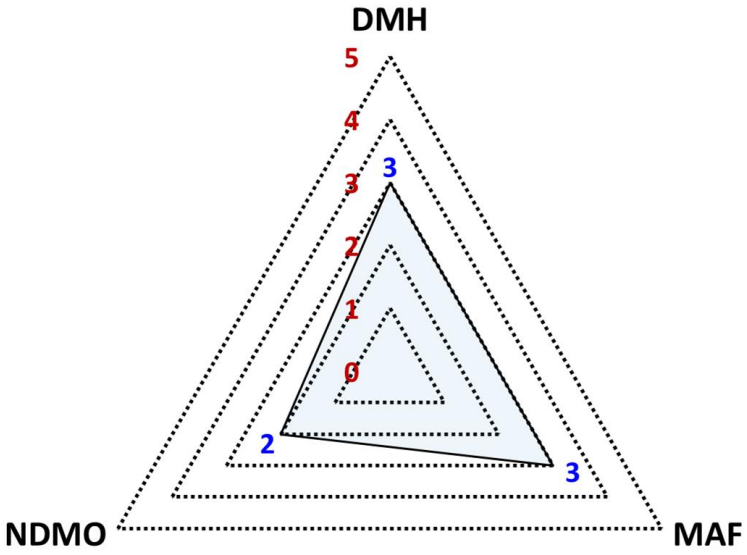


Figure (2): Radar chart informing about climate data quality through the scores provided by DMH, NDMO and MAF. (Scale: 1-Very Low; 2-Low; 3-Medium; 4-High and 5-Very High)

Impacts of Specific Hazards in terms of Frequency, Magnitude and Geography

Table (11a) Hazards Impacts in Terms of Frequency, Magnitude and Geography

Sr. No.	Drought Hazard			
	Agencies	Frequency	Magnitude (return period)	Geography
1	DMH	Every 3-5 years	< 1700 mm rainfall	Whole country
2	NDMO	No data available	No data available	No data available

[15] http://casdopc-maf.la/home/main;jsessionid=AF1CEDB175C9AF0EE740F51BB2506F38

Annex 1: Readiness Assessment Matrix

3	MAF	Every year since 2008	Based on total areas affected and value of losses incurred	Northern/Central/Southern regions

Table (11b) Hazards Impacts in Terms of Frequency, Magnitude and Geography

Sr. No.	Flood Hazard			
	Agencies	Frequency	Magnitude (return period)	Geography
1	DMH	Normal floods: every year Major floods: every 1.5-2 years	No data available	Mekong River Basin, Central and Southern areas
2	NDMO	Becoming more frequent	No data available	Regular flooding in whole country
3	MAF	Every year in the Northern, Central and Southern parts	Based on total areas affected, damages occurred and value of losses incurred	Northern/Central/Southern regions

Key Challenges Identified based on the Key Hazards

Department of Meteorology and Hydrology (DMH)

- Early warning system does not cover all areas;
- Budget used for disaster response is not enough;
- Environmental management does not provide detailed conservation measures;
- People living in disaster prone areas have less knowledge on preparedness and response as well as knowledge on warning information.

National Disaster Management Office (NDMO)

- Physical structure such as residential areas, utilities, livestock are at direct risk to disasters;
- Economic impact is severe post-disaster situation specially in agricultural sector, livestock, retail trade, personal properties including telephones, mobile phones, TVs, and so on;
- Social impact includes effects on people living in at-risk areas such as elders, children, pregnant women, and so on.
- Absence of warning services such as loud speakers, social protection systems, awareness and understanding.

Annex 1: Readiness Assessment Matrix

- Environmental impacts include impact on water harvesting, drainage, sanitation, access to clean water and contamination.

Ministry of Agriculture and Forestry (MAF)

- Direct impacts on agricultural areas such as rice fields;
- Impact on livestock, vegetable crops, fisheries;
- Impact on irrigation channel.

Quality and Availability of Data for Vulnerability and Exposure Assessments

In terms of data quality for vulnerability and exposure assessment, all three agencies (DMH/NDMO/MAF) has put the quality score between 2-3 meaning 'low' to 'medium' quality when asked to measure in the scale of 1-5. DMH and NDMO has given the score of 3 (medium) while MAF has given the score of 2 (low). Average score from all three agencies is 2.7 (Low) (**Figure (3)**).

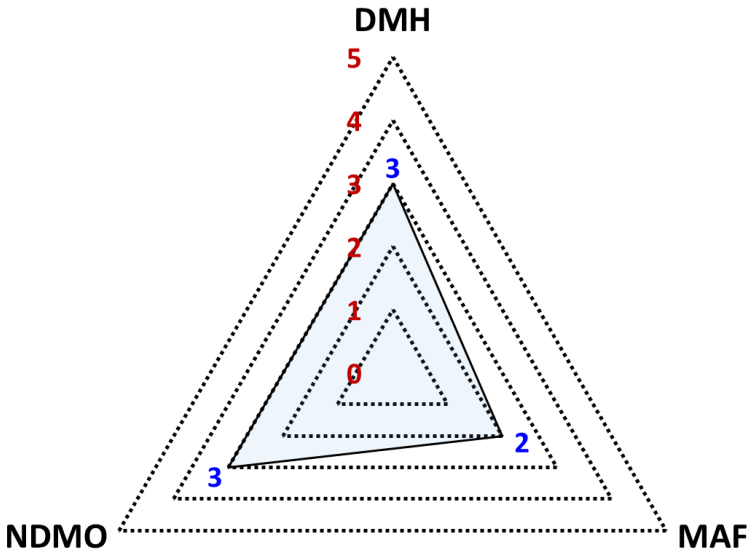


Figure (3): Radar chart informing about quality and availability of risk assessment data through the scores provided by DMH, NDMO and MAF. (Scale: 1-Very Low; 2-Low; 3-Medium; 4-High and 5-Very High)

Hazards for which Threshold Levels Have Been Developed

DMH follows the thresholds as defined by the Mekong River Commission flood warning zones along the Mekong river.

NDMO follows the existing thresholds from the country-level risk profile.

MAF follows the color thresholds as defined by the Department of Irrigation. Three color categories have been defined that includes

- Green color refers to Safety level;
- Yellow color refers to risk level;

Annex 1: Readiness Assessment Matrix

- Red color refers to danger level.

Availability of Future Climate Projections Data from National to Local Levels

Table (12) Future Climate Scenario Data

Sr. No.	Future Climate Scenario Data				
	Agencies	Yes	No	Response	Impact Assessment using Climate Projections
1	DMH	√		Currently using only forecast information through Lao Climate Service for Agriculture (LaCSA) system	None
2	NDMO		√	Not applicable	Not applicable
3	MAF		√	GCM has not been used, instead only LaCSA system has been used	None

Understanding IBFW Generation

Staff Engagement for IBF Development and Dissemination

Table (13) Staff Engagements

Sr. No.	Staff Engagement for IBF Development and Dissemination			
	Agencies	Staff (Number)	Expertise	Staff Sufficiency
1	DMH	15	Meteorology and Hydrology	Not sufficient; Need over 50 staff to conduct forecasting and dissemination for the whole country
2	NDMO	Not aware	Not aware	No staff and capacity
3	MAF	Not aware	Not aware	Have enough staff but needs IBFW knowledge through capacity building

Current use of Tools/Platforms for Impact-Based Forecasting and Warning (IBFW)

Tools/Data being used by DMH

- Meteorological satellites; Meteorological radar; Numerical Weather Prediction (NWP); Meteorological station; Geological Station; Monitoring analyzing system, weather mapping; Meteorological and Radar satellite images; Model of weather forecasts and flood forecasts; GIS;

- Providing weather information to Lao Climate Services for Agriculture (LaCSA) (3-hour forecast; 7-day forecast and Seasonal Forecast) https://www.lacsa.net/mapView.do

Tools/Data being used by NDMO

- No tools/software's are being used. But receives the required information from DMH

Tools/Data being used by MAF

- Using weather information to Lao Climate Services for Agriculture (LaCSA);
- Need for warning center at district level for appropriate agricultural planning.

Existing Forecasts and Warnings to be Adapted to Meet User Requirements of IbF Services

DMH: Update/improve the equipment/tools for monitoring, analysis, forecasting and warning information dissemination

NDMO:

- Update the forecasting and warning system to disseminate information which are up-to-date, fast, clear and easy to access for all stakeholders.
- Time-to-time revisions and analysis of warning information is required and the staff capacity should be enhanced.

MAF: A weather warning center has been operational at the National Agriculture and Forestry Research Institute (NAFRI) which may require further upgradation on its forecast and dissemination process.

Content of Existing Impact-Based Forecasts and Warnings

All the three agencies have been asked to identify the contents related to IbFW which have already been included in their existing forecast and warning based on the given six criteria's (**Figure (4)**):

i. Time and date of expected impacts
ii. Location of impacts
iii. Severity and likelihood of impacts
iv. Types of impact
v. Hazard information
vi. Advice and guidance on what actions to take

Annex 1: Readiness Assessment Matrix

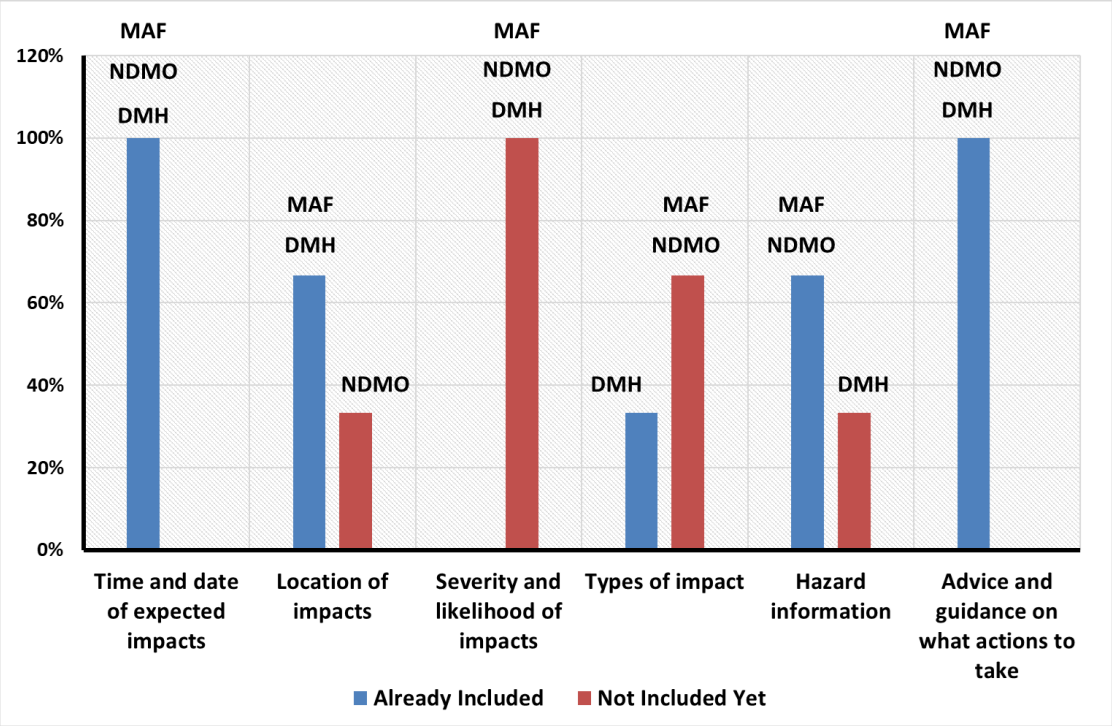


Figure (4) represents various content in existing IbFW

The result suggests that all three agencies (DMH/NDMO/MAF) have included the criteria's (i) and (vi) appropriately. DMH also included criteria's (ii) and (iv). Similarly, NDMO included the criteria (v) while MAF included the criteria's (ii) and (v).

Capabilities needed to produce IbFW to Meet User Requirements

- DMH will require additional tools related to IBFW, surface weather maps, upper weather maps, satellite images, radar images, updated Numerical Weather Prediction models, storm trackers, tools for flood forecasts as well as training and capacity building of DMH staff which is critical. Focus areas for capacity building should include meteorology, disaster management, remote sensing and Information Technology
- NDMO is not sure about their requirements since they are getting information from DMH.
- MAF wants improved forecast and warning capacity and time-to-time Agro-met information.

Annex 1: Readiness Assessment Matrix

Current Pilot Project where IBF is being Tested

Table (14) IbF Pilot Projects in Lao PDR

Sr. No.	Agency	Yes	No
1	DMH		√
2	NDMO		√
3	MAF	√	

Partnership and Collaboration

Identified Potential Partners and Collaborators to be Engaged in Developing IBFs

Table (15) Potential Partners in Lao PDR

Sr. No.	Agency	Yes	No	Potential Partners
1	DMH	√		MoNRE, MoEM, MAF, MoLSW, MoICT. ADB, FAO, WMO
2	NDMO	√		ADB, WB, INGO (ADPC and others), NGO, CSOs
3	MAF	√		FAO and WFP

Expectations from Partner Agencies

- DMH: Funding support to install and deploy new tools for forecasting and warnings and capacity building for national and local staffs.

- NDMO: Support the project partner with DMH on strengthening capacity on IBFW for staff who are in charge of forecast and warning from national to district levels.
- MAF: Needs support for installation of an early-warning system at district level that would help alert the villagers/communities in time while also helping the district to get access to at-risk zones faster than the provincial authorities as first responders. NDMO would also need support for development of village disaster risk reduction plans and strengthen provincial and district capacity about the importance of forecasting and warning information.

IbFW Dissemination

Access to Forecast and Warnings for Stakeholders

Use of social media in accordance with the Disaster Management Law for information dissemination. Social media includes Facebook, Twitter, WhatsApp, etc. Other medium should include newspaper, radio, television, fax and YouTube.

Annex 1: Readiness Assessment Matrix

Language(s) Preferred by Stakeholders for Forecasts and Warnings

Table (16) Preferred Languages for IBFW in Lao PDR

Sr. No.	Agency	Simple/laymen	Technical	Mix (Simple & Technical)
1	DMH	Not applicable	Not needed for Public	√
2	NDMO	√	Not needed for Public	Not applicable
3	MAF	√	Not needed for Public	Not applicable

Presentation of Information to Stakeholders and the General Public

All three agencies have been asked about the presentation of information that is to be disseminated to the public based on visuals, color schemes and word choices. All of them responded that (a) visuals should include infographics, pictures and photos, (b) word choices should be simple and understandable and (c) color schemes should be based on standard guidelines defined by WMO or by the national agencies in the country.

Specific suggestions from MAF includes,

a) **Visuals:** Some pictures containing impact information from floods, droughts and other hazard events to make the local people understand it easily;
b) **Word Choices:** Some simple to understand language on the impact information for local people who are living in risk areas would be very useful;
c) **Color Schemes:** Maps which shows impact levels by color schemes such as **Green** referring to safety with no impact; **Yellow** referring to warning about possible impact and the need for preparation to minimize such impacts; and **Red** referring to the dangers and possible effects.

IbFW Dissemination Flow at the Institutional Level

For DMH, they follow the following 3-steps:

1) Study the vulnerabilities and impacts of a particular area;
2) Analyze, forecast and warn;
3) Disseminate the warning information

For MAF their flow of information is similar to the traditional forecast and warning dissemination as given through the figure below (**Figure (5)**):

Annex 1: Readiness Assessment Matrix

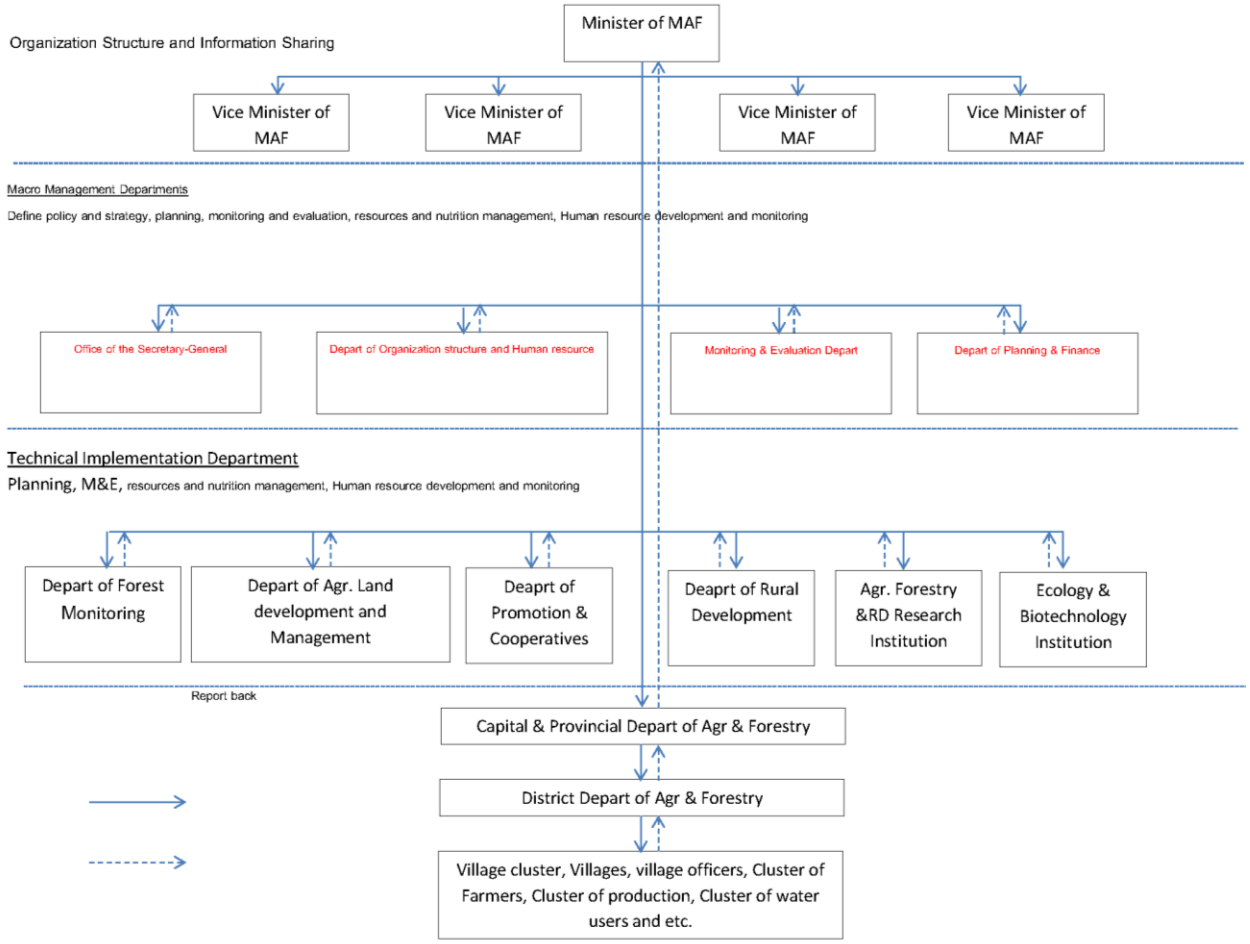


Figure (5) represents the institutional flow of information within MAF

In terms of issues related to dissemination flow, DMH highlights that sometimes the warning does reach the areas at risk quite late. Therefore, this gap needs to be addressed. For NDMO, there are no related issues. MAF too highlights the issue with the dissemination flow wherein the Ministry sends notice to the provinces and the districts to collect data on the impacts and needs after the disaster event and then submit a report which normally is not submitted on time therefore leading to considerable delays. Lastly, budget limitation on data collection at provincial and district levels is another critical issue. In terms of receiving feedbacks from stakeholders engaged in dissemination flow, the major feedback has been the language being too technical through the entire communication channel from national to local levels. Generally, the feedbacks received are also not documented as has been informed by all three agencies. With regards to Business Continuity Plans (BCPs), DMH approach is through regular consultations while NDMO and MAF does not have any such plans.

Annex 1: Readiness Assessment Matrix

Forecast/Impact Verification

Table (17) Forecast/Impact Verification

Sr. No.	Agency	Yes	No	Frequency of Verification
1	DMH	√		After each event
2	NDMO		√	After each event
3	MAF	√		After each event/Annually

Table (18) Collecting, Collating and Archiving Data

Sr. No.	Agency	Historical Forecasts	Historical Observations	Historical Data on Disaster Impacts
1	DMH	√	√	√
2	NDMO	Not applicable	Not applicable	√
3	MAF	Not applicable	Not applicable	√

Table (19) Benefits from Verification Process to Improve IBF

Sr. No.	Agency	Benefits from Verification Process
1	DMH	Help improve the quality of forecast and warning and build confidence of the users or stakeholders in using forecast and warning information
2	NDMO	Not applicable
3	MAF	• Provide knowledge on the impact information through precise and accurate assessment of damage and losses; • Help estimate appropriate recovery needs, such as plant and animal species, pesticides, vaccines to incorporate into the post-disaster recovery plan

Key Challenges Faced while Producing Impact-based Forecasting

- Need for accurate and good quality data for analysis;
- The tools used to forecast previously only and overview of the overall scenario which sometimes makes it difficult to carry out response measures.

Annex 2: Meetings with Agencies

ANNEX

2

MEETINGS WITH THE AGENCIES

Annex 2: Meetings with Agencies

ANNEX 2 | List of Agency Contacts with whom the Survey Has been Conducted

List of stakeholders surveyed in Lao PDR		
Date	**Agency**	**Representative Expert/Specialist**
29 October 2021	Department of Meteorology and Hydrology (DMH)	Project briefing meeting attended by DMH officials and staff
17 Dec. 2021to 30 Dec. 2021	National Disaster Management Office (NDMO)	Mr. Phonesavanh XAYSOMPHENG, Director Division of Disaster Prevention and Risk Reduction, NDMO, DSW, MoLSW
30 Dec. 2021 to 05 Jan. 2022	Ministry Agriculture and Forestry (MAF)	Mr. Kynong KEOPASEUTH, Deputy Head of Planning Division, Department of Planning and Cooperation, MAF
05 Jan. 2022 to 07 Jan. 2022	Department of Meteorology and Hydrology, Ministry of Natural Resources and Environment (DMH)	Mr. Viengxai Manivong, DDG, DMH, MoNRE and Team
17 January 2022	DMH NDMO MAF FAO WFP	Results sharing workshop attended by officials and staff of all three agencies

Annex 3: Standards and Guidelines

ANNEX

3

STANDARDS AND GUIDELINES

Annex 3: Standards and Guidelines

ANNEX 3 | Standards and Guidelines

Standards and Guidelines	Year
General Standards and Guidelines	
Natural Hazard Awareness and Disaster Risk Reduction-OECD Policy Handbook, 2010	2010
WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services	2015
Multi-hazard Early Warning Systems: A Checklist	2017
Disaster Risk Knowledge	
Guidelines on the Definition and Monitoring of Extreme Weather and Climate Events	2015
Guidance for Recording and Sharing Disaster Damage and Loss Data	2015
Detection, Monitoring and Forecasting of the Hazards and Possible Consequences	
Guidelines on early warning systems and application of nowcasting and warning operations	2010
WMO Manual on the Global Data-processing and Forecasting System: Annex IV to the WMO Technical Regulation	2017
WMO step-by-step Guidelines for Establishing a National Framework for Climate Services,	2018
Manual on Marine Meteorological Services - Volume I	2018
Warning Dissemination and Communication	
WMO Guidelines on Improving Public Understandings of and Response to Warnings	2002
WMO Guidelines on Cross-Border Exchange of Warnings	2003
WMO Guidelines on Weather Broadcasting and the Use of Radio for Delivery of Weather Information	2005
WMO Guidelines on Communicating Forecasting Uncertainty	2008
WMO Guidelines on International and Cross-border collaboration in the warning process	2011
WMO Guidelines for Implementation for Common Alerting Protocol (CAP) Enable Emergency Alerting	2013
Preparedness and Response Capability	
WMO Guidelines on Integrating Severe Weather Warnings into Disaster Risk Management	2005

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WMO Guidelines in Quality Management Procedures and Practices for Public Weather Services	2005
WMO Public Weather Services Strategy for Developing Public Education and Outreach	2006
WMO Guidelines in capacity building strategies in Public Weather Services	2007
UNISDR Disaster prevention for schools: guidance for education sector decision-makers	2008
UNISDR School emergency and disaster preparedness: guidance notes	2010
WMO Guidelines for Creating a Memorandum of Understanding and a Standard Operating Procedure between a National Meteorological or Hydrological Service and a Partner Agency	2012
WMO Guide to Implementation of Education and Training Standards in Meteorology and Hydrology, volume I - Meteorology	2015
Other Key Guidelines	
Guide to Climate Watch System Early Warning against Climate Anomalies and Extremes	2006
Guide to Drought Monitoring and Early Warning: Concepts, Progress, and Future Challenges	2006
Guide to Flood Forecasting and Warning	2011
Guide to Management of Flash Floods	2012
Guide to Agricultural Meteorological Practices	2012
Standardized Precipitation Index User Guide	2012
Handbook of Drought Indicators and Indices	2016
Guide to Use of Climate Predictions to Manage Risks	2016
Guidelines on Nowcasting Techniques	2017
Guide to Storm Surge Forecasting	2018
Step-by-step Guidelines for Establishing a National Framework for Climate Services	2018
Global Guide to Tropical Cyclone Forecasting	2019

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