



Guidance to Develop Strategy and Action Plan on Multi-Hazard Impact-based Forecasting and Warning (IbFW) in Lao PDR



Guidance to Develop Strategies and Action Plan on Multi-Hazard Impact-based Forecasting and Warning (IbFW) in Lao People's Democratic Republic

Final Document

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The team includes Dr. Rishiraj Dutta, Mr. Lalit Kumar Dashora, Mr. Susantha Jayasinghe and Ms. Chinaporn Meechaiya from ADPC.

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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. 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, National Disaster Management Office (i.e. NDMO in Lao PDR) 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 PDR to improve the institutional capacities of national stakeholders such as the Department of Meteorology and Hydrology, Ministry of Natural Resources and Environment (i.e. NMHS in Lao PDR), 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. Based on the outcome of the readiness assessment, a ““Guidance to develop strategies/action plan on Multi-Hazard Impact-based Forecasting and Warning (IbFW) in Lao PDR” has been developed that would guide relevant stakeholders and development partners to work collaboratively with national Government in implementing IbFW activities in Lao PDR.

This guidance document is developed based on five pillars that are in line with the national priorities of Lao PDR that includes,

- I. Service Quality and Service Delivery
- II. Scientific Research and Application
- III. Governance
- IV. Partnerships and Co-operation
- V. Training and Capacity Building

The strategy sets out priority areas in a matrix and activities that can be undertaken both at the national and regional levels. The priorities and actions are supported by a set of institutional partnerships that will bring together donor agencies, development partners, international and regional organizations to support weather, climate, water and hydrological services in Lao PDR.

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institutional partnerships that will bring together donor agencies, development partners, international and regional organizations to support weather, climate, water and hydrological services in Lao PDR.

The guidance document for the development of MH-IbFW strategy and action plan in Lao PDR draws upon international best practices on impact-based forecasting and warning and is mindful of the operational constraints of information/data requirements, availability, collection, collation, and analysis at local level in Lao PDR. The actual process will be considerably more complex, because of data availability and other challenges than described in this document. In practice, a number of working assumptions will have to be made to assess the multi hazard, exposure, vulnerability and risk and their impacts in Lao PDR.

There are several guiding principles and key elements, which make up an effective MH-IbFW. Traditional forecasts and warnings have focussed heavily on the hazard forecast, with much less focus on other elements of warning services. In MH-IbFW, the focus is on all elements.

At this juncture, operational MH-IbFW are being established in many countries on full scale or pilot basis, bringing hazard and risk knowledge to those most at risk from the devastating impacts of hydrometeorological hazards. As a result, key lessons, best practice and recommendations are emerging from countries who are finding solutions to successfully implement each element of MH-IbFW.

First key lesson is the importance of formalising roles, responsibilities and accountabilities of partnership and collaborating institutions within MH-IbFWS. Legal frameworks, Memorandums of Understanding and Standard Operating Procedures all help organisations contributing towards an effective MH-IbFW to understand and execute their respective roles and responsibilities whilst eliminating duplication of effort, ambiguity and inefficiency.

Partnerships and collaboration are required throughout the development and operational delivery of MH-IbFW. Expertise and capability from a range of disaster management organisations and service providers can be leveraged to greatly enhance the effectiveness of IBFWS, from forecast accuracy to timely dissemination.

Second key lesson is ensuring that MH-IbFW are user-centred – putting the needs of those who will be using the forecast or warning at the heart of impact-based forecasting and warning services. Successful MH-IbFW invest time and resources to understand what the users need from MH-IbFW and how the service can be developed to ensure that warning information is presented and disseminated in ways that make the warnings easy to access, easy to understand and easy to use. A recommendation emerging from countries employing MH-IbFW is to start simply. Several countries have taken a pilot project approach to developing MH-IbFW by selecting a priority hazard to focus on and making use of existing organisational and local hazard and risk knowledge.

In addition, seeking continual feedback from users during development allows the IBFWS to improve iteratively until a minimum viable service is achieved that meets the needs of those using the service. The MH-IbFW can then become operational and be expanded to include more hazards. Transitioning hydrometeorological warnings to impact-based forecasting and warning services brings together expertise and organizational capability to provide vital hazard and risk information in easy-to-use formats with advice on what to do to reduce the impact of climate and weather-related disasters. MH-IbFW effectively deliver warning information in good time to enable the people and communities most at risk to make decisions and act to protect life, property and livelihoods. The result is reduced impact and reduced socio-economic cost of disasters.

Abbreviations

ADPC	Asian Disaster Preparedness Center
CREWS	Climate Risk and Early Warning Systems
DMH	Department of Meteorology and Hydrology
FbA	Forecast-based Early Actions
FGD	Focus Group Discussions
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
IbFW	Impact-based Forecasting and Warning
KII	Key Informant Interviews
MAF	Ministry of Agriculture and Forestry
MH-IbFW	Multi Hazard Impact-based Forecasting and Warning
MoNRE	Ministry of Natural Resources and Environment
NDMO	National Disaster Management Office
NMHS	National Meteorological and Hydrological Services
SOP	Standard Operating Procedure
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
WFP	World Food Programme
WMO	World Meteorological Organization

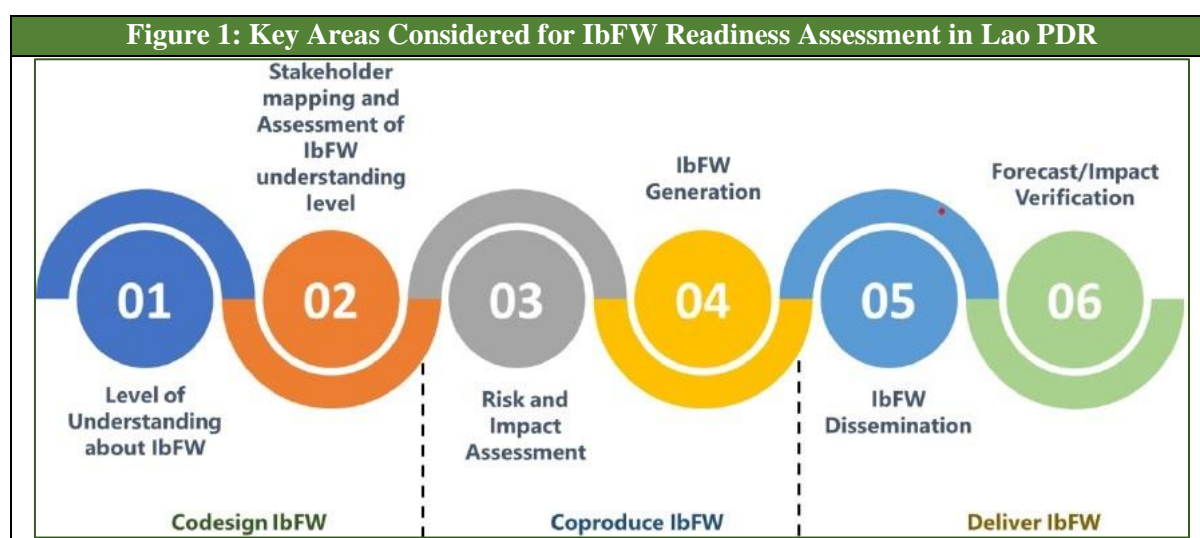
Section 1: Background

Asian Disaster Preparedness Center (ADPC) and the United Nations World Food Programme (WFP), under a cooperation agreement between the two organizations, have conducted a readiness assessment of Impact-based Forecasting and Warning (IbFW) in Lao PDR during year 2021-2022. The Readiness Assessment was carried out to provide a better understanding of the current capacities and challenges related to IbFW implementation by key institutions and how the expertise of ADPC and WFP can be leveraged to further strengthen and enhance such capacities at individual and organizational levels.

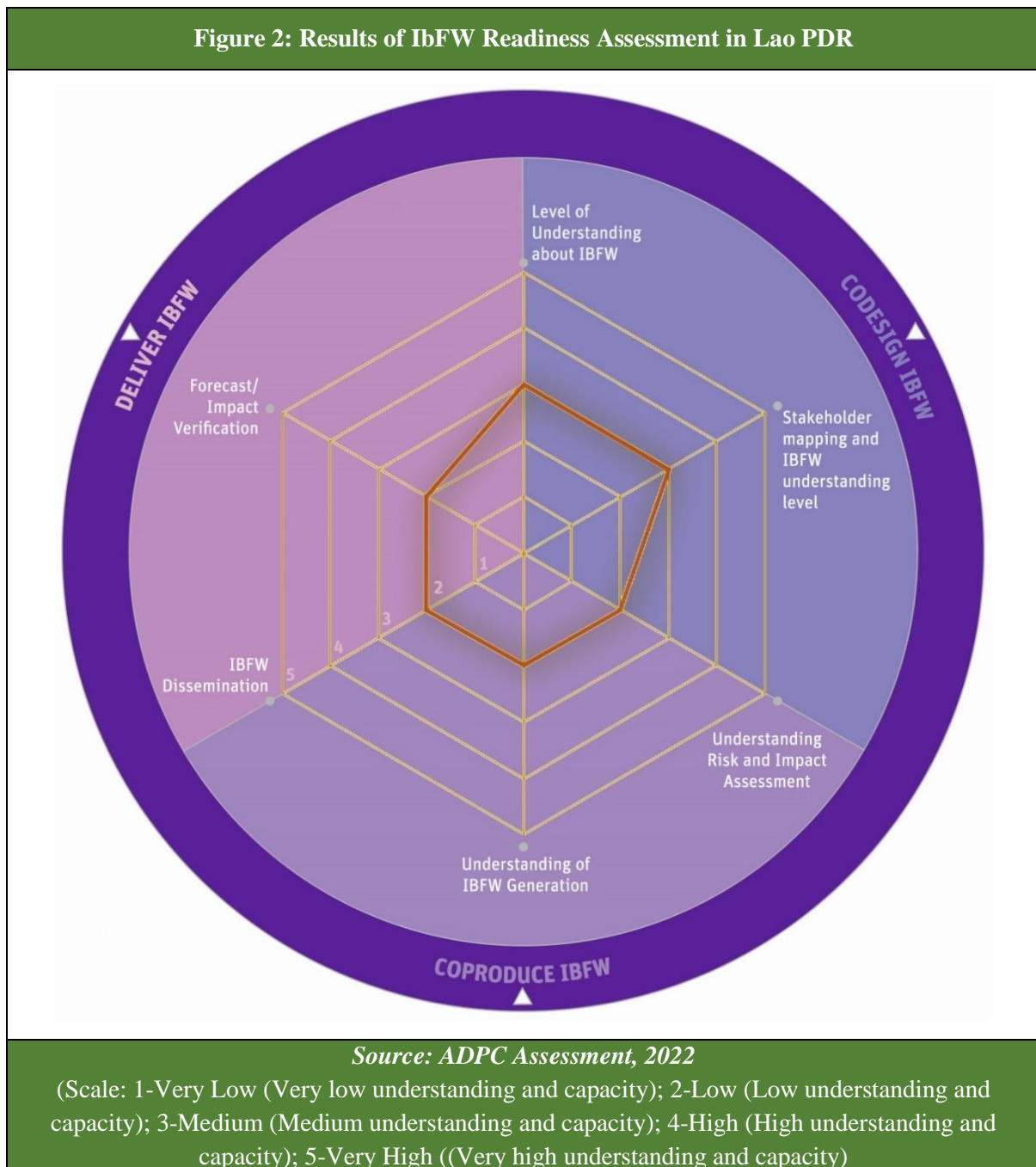
The readiness assessment process in Lao PDR involved a number of Key Informant Interviews (KII's) and Focus Group Discussions (FGD's) and various consultations with the Department of Meteorology and Hydrology (DMH), Ministry of Natural Resources and Environment (MoNRE), Division of Disaster Prevention and Risk Reduction, National Disaster Management Office (NDMO), Department of Social Welfare (DSW), Ministry of Labor and Social Welfare (MoLSW) and Planning Division, Department of Planning and Cooperation, Ministry of Agriculture and Forestry (MAF). The overall IbFW readiness assessment in Lao PDR was carried out based on the following six key areas defined under international and regional guidelines of IbFW including;

- (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 Co-design Phase, (iii) and (iv) has been categorized as Co-produce Phase, and (v) and (vi) has been categorized as Delivery Phase (**Figure 1**).



The assessment formed a strong foundation for improving institutional capacities of national stakeholders such as the National Meteorological and Hydrological Services (i.e. DMH, MoNRE), the National Disaster Management Office (i.e. NDMO) and other sectoral institutions such as Ministry of Agriculture and Forestry (i.e. MAF) so that the existing mechanism for impact-based forecasting information are improved for operational planning and decision-making. **Figure 2** shows the results of overall 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.


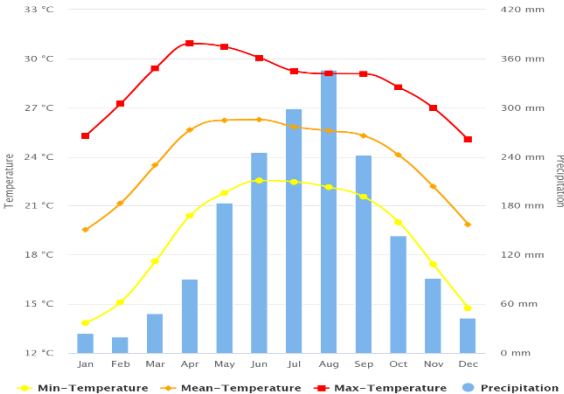
The overall assessment results in the **coproduce phase of IbFW** have shown that the targeted agencies have low level knowledge and understanding of risk and impact assessment as well as IbFW generations (**Score of 2.0**). While DMH and MAF is not aware of any country-level risk assessment, however, 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 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 are 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 receives the weather forecast information through their LaCSA system.

The final assessment results have highlighted limited capacity on IbFW in Lao PDR in terms of knowledge and skills. The overall recommendation suggests to develop IbFW strategy, action plan, training and capacity building at institutional level enhancing the capacity on the use of IbFW in Lao PDR including establishing IbFW within relevant institutions in the country. Therefore, as part of the recommendations provided based on the outcome of the readiness assessment of IbFW, strategy will be developed that would guide the future implementation of IbFW activities in Lao PDR.

Section 2: Lao PDR Riskscape

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.). **Table 1** represents a ready reckoner of Riskscape of Lao PDR.

Table (1): Ready Reckoner of Riskscape of Lao PDR	
Capital: Vientiane	<p style="text-align: center;">Figure 3.1: Geographical Location</p>  <p style="text-align: center;">Source: United Nations, n.d.¹</p> <p style="text-align: center;">Figure 3.2: Monthly Climatology of Mean-Temperature and Precipitation in Lao PDR from 1991-2000</p> <p style="text-align: center;">Monthly Climatology of Min-Temperature, Mean-Temperature, Max-Temperature & Precipitation 1991-2020 Lao PDR</p>  <p style="text-align: center;">Source: The World Bank²</p>
Location: 19.8563° N, 102.4955° E	
Geographical Area: 236,800 km ²	
Number of Provinces: 18	
Number of Districts: 142	
Population: 72,75,556 ³	
Male: 3,651,794 Female: 3,623,762	
WMO Region: II Asia	
NMHS: Department of Meteorology and Hydrology (DMH), Ministry of Natural Resources and Environment (MoNRE), Government of Lao PDR, WMO Member: July 1955 ⁴	
NDMO: National Disaster Management Office	
Germanwatch Global Climate Risk Index: Climate Risk Index Score: 55.17 ⁵ Climate Risk Index Rank: 45	
INFORM Country Profiles: INFORM Risk Index: 4.1 ⁶ INFORM Risk Rank: (79) ⁷ INFORM Risk Class: Medium INFORM Hazard and Exposure Index: 3.4 INFORM Vulnerability Index: 3.4 INFORM Lack of Coping Capacity: 6.0	

¹ United Nations (n.d.). URL: <https://www.un.org/Depts/Cartographic/map/profile/laos.pdf>

² The World Bank (n.d.). URL: <https://climateknowledgeportal.worldbank.org/country/lao-pdr/climate-data-historical>

³ The World Bank (n.d.). URL:

<https://data.worldbank.org/indicator/SP.POP.TOTL?locations=LA>

⁴ WMO (n.d.), https://contacts.wmo.int/all_members/details_all_members/?id=7d1074ca-816a-e811-a959-000d3a38c9b5

⁵ Germanwatch (2021). URL:

https://germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf

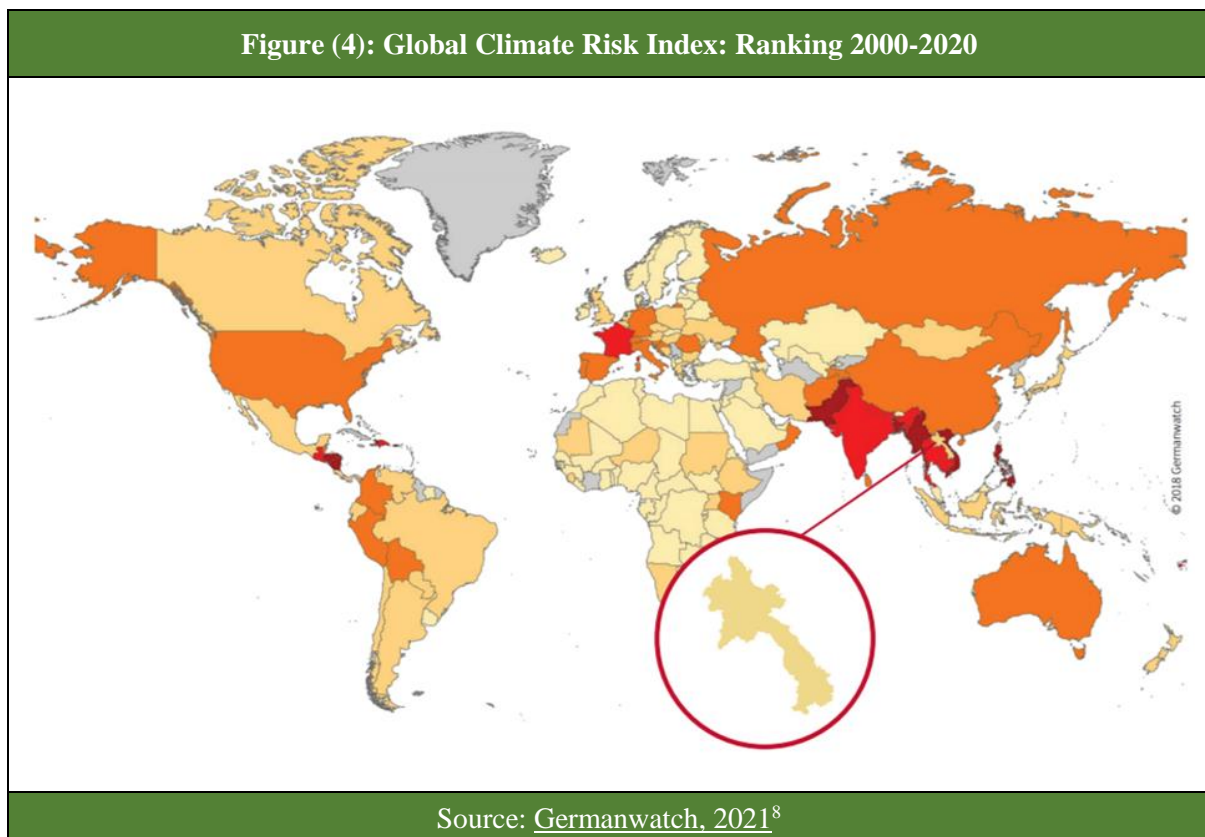
⁶ European Union (2021). Inform Risk Index-2022 <https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Results-and-data/moduleId/1782/id/433/controller/Admin/action/Results>

⁷ European Union (2021). Inform Risk Index-2022 <https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Profile>

In the Lao PDR, 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 prone to fluvial flooding (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. **Figure 4** represents Global Climate Risk Index Ranking from 2000-2019.



⁸ 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

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 compared to the other parts of 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 vary with locations. The limited coping capability of Lao PDR, as well as the susceptibility of the country's people to multi hazards, 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 percent of GDP, and approximately 70-80 percent 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.

Section 3: Multi Hazard Impact-based Forecasting and Warning

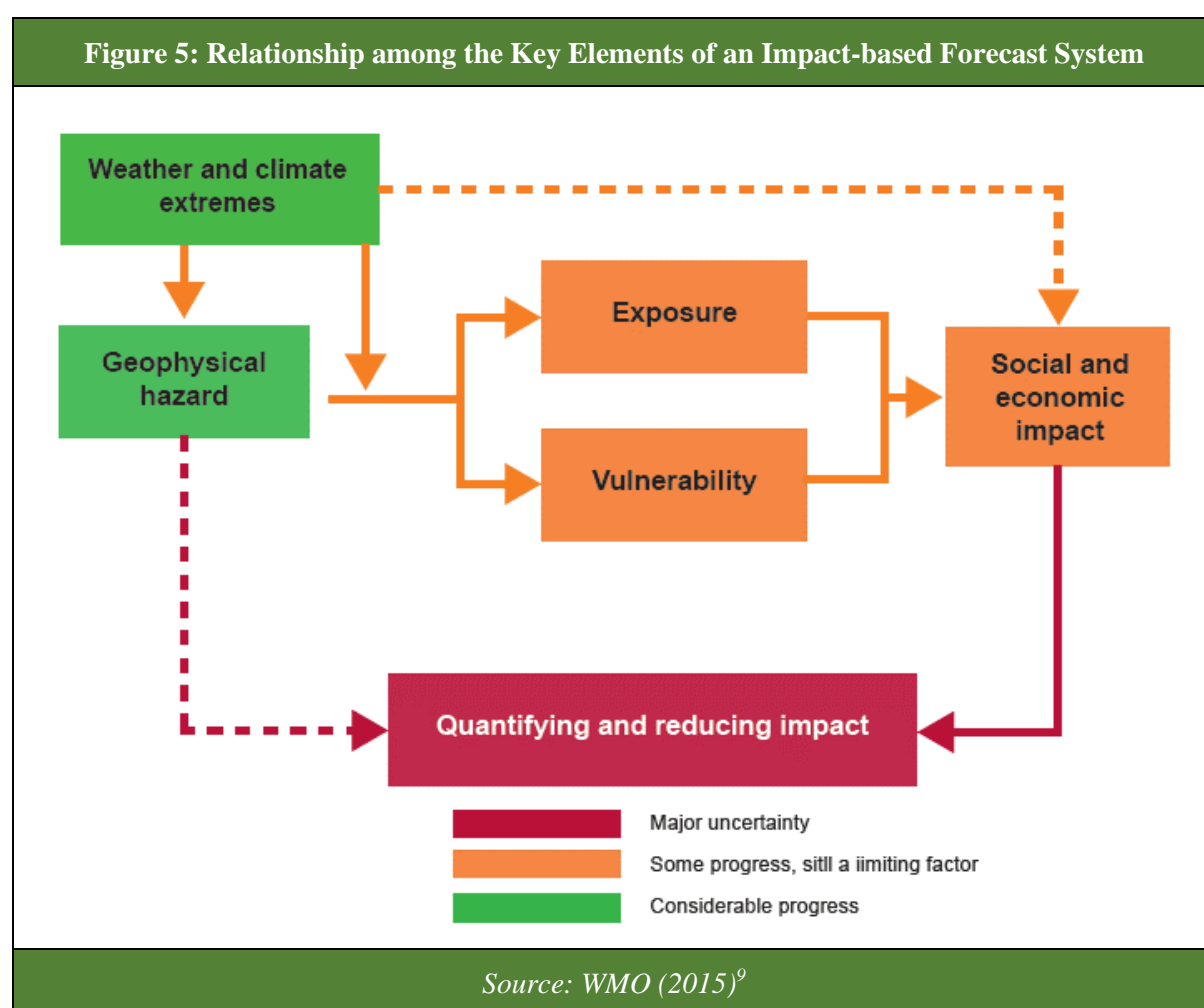
It is evident from Riskscape that each year the impacts of severe hydro-meteorological events in Lao PDR give rise to multiple casualties and significant damage to property and infrastructure, with adverse economic consequence for communities, which can persist for many years. All this happens despite of precise forecasts of many of these severe events, with accurate warning information disseminated in a timely fashion by the MoNRE and NDMO in Lao PDR. The reasons for this apparent disconnect lie in the gap between forecasts and warnings of a hazard events and an understanding of their potential impacts. In a simple way to explain, there is a realization of what the hazard might be, however there is frequently a lack of understanding of what the hazard might do. If this gap is to be filled, then an all-encompassing approach to observing, modelling and predicting severe hydro-meteorological events, and the consequent cascade of hazards through to impacts, is needed.

To overcome this situation, requires a multi-disciplinary, multi-sectoral and multi-layered approach to access the best possible science, and the optimum services, to manage multi-hazard events today, and to provide the best possible evidence base on which to make the costly decisions on infrastructure investments to protect the population in the future.

MH-IbFW have been identified as a high priority by WMO to increase the relevance and utility of forecasts and warnings issued by the NMHS (i.e. MoNRE in Lao PDR). Impact-based forecasts emphasize what a hazard will do rather than what a hazard will be. Achieving this requires MoNRE to increase their emphasis on delivering impact-based forecast and warning

services. Development partners supported and WMO-led modernization efforts already emphasize service delivery. Moving beyond hazard forecasting is a significant step-up, requiring effective partnerships with many different government agencies, as well as volunteer organizations and non-Governmental organizations, which have access to relevant data—this is perhaps one of the most difficult things to achieve. This is where development partners have a larger role, through its convening power, to bring together many of the actors and stakeholders to help MoNRE and disaster management agencies create the necessary partnerships and data sharing arrangements, and to encourage other development partners to support this approach.

Impact-based forecasting and warning services focus on translating meteorological and hydrological hazards into sector- and location-specific impacts, and the development of sectoral responses to mitigate those impacts. By focusing on impacts, it is expected that NDMO will provide a better understanding of the hazards to which people are exposed, and that people and communities will more likely take appropriate action to protect their lives and livelihoods. **Figure 5** represents the relationship between key elements of an impacts forecast system.



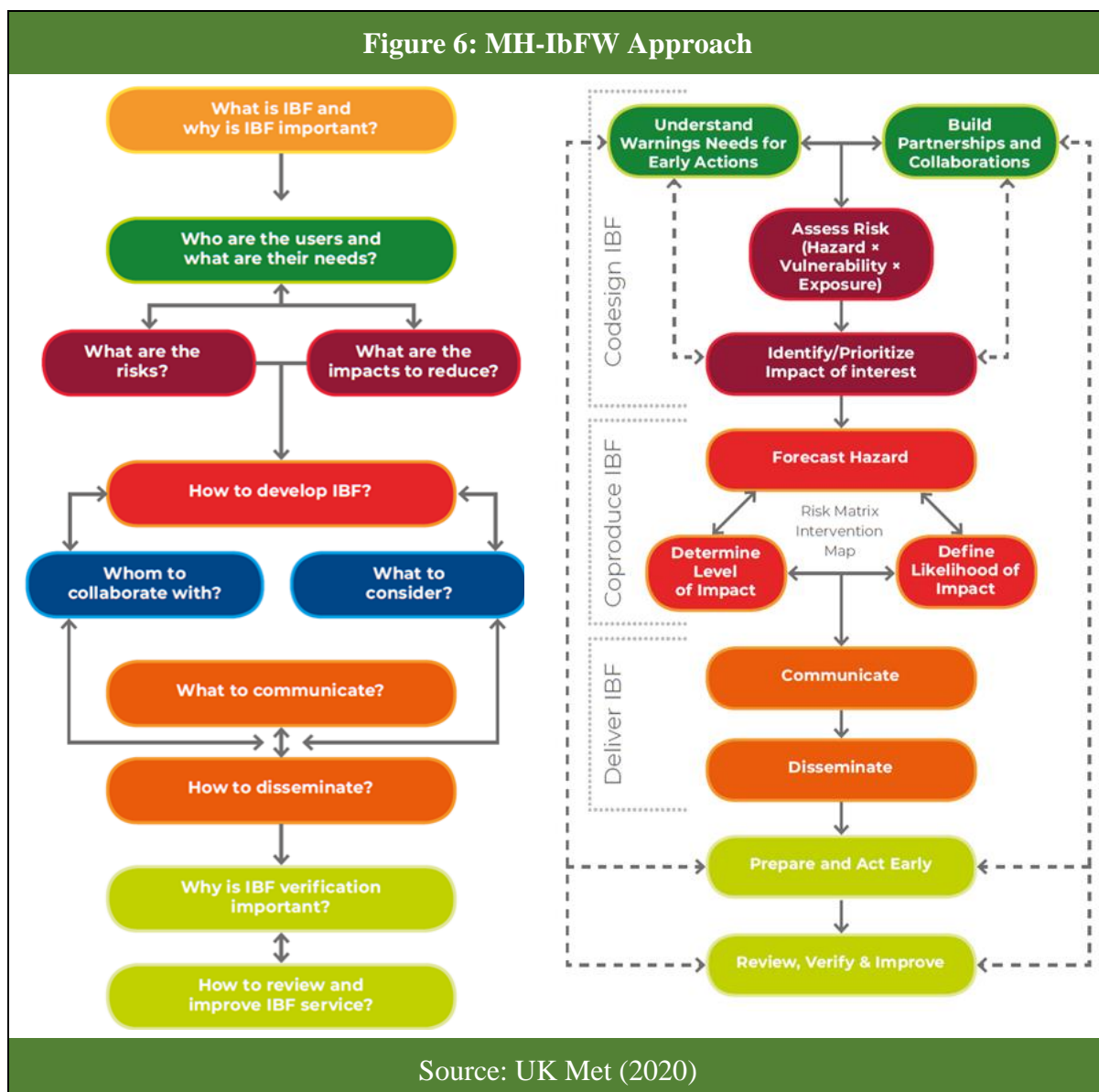
⁹ WMO Guidelines - 1150 (2015), “WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services”.

MH-IbFW is based on three main or primary components which can be further divided into secondary or sub-components. These three primary components of IbFW are suggested in guidelines developed by World Meteorological Organization (2015, 2021) and UK Met (2020). The brief description of the component and sub-component is given below **Table 2**.

Table 2: Key Component of IbFW	
Component	Sub-component
Co-design	Understanding about IbFW
	Stakeholder mapping and assessment of IBFW understanding level
Co-produce	Understanding Risk and impact assessment
	Understanding IBFW Generation
Deliver	IBFW Dissemination
	Forecast/Impact Verification

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. **Figure 6** represents the MH-IbFW approach.

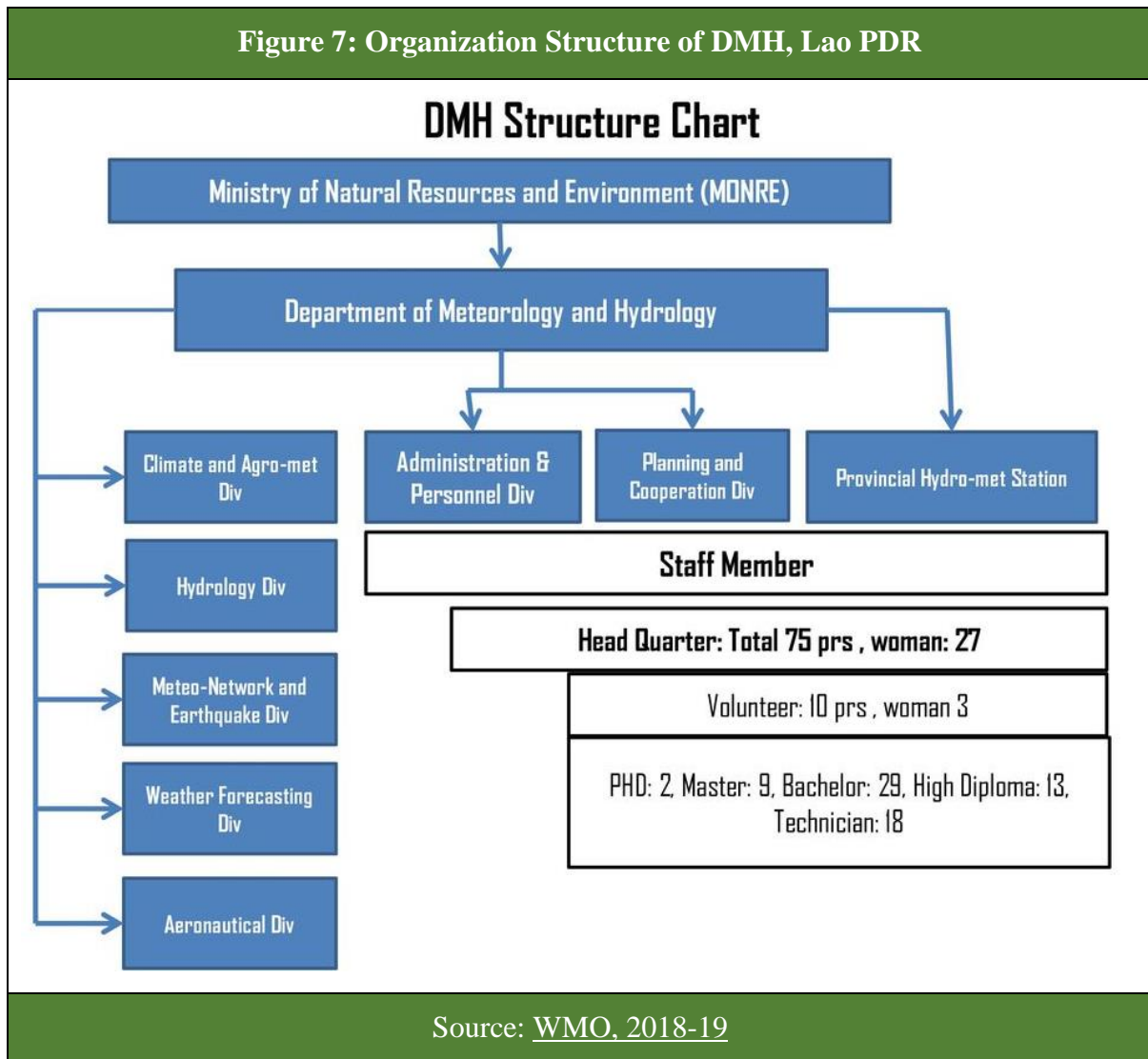
It is evident from above **Figure 6**, that linking hazards and potential impacts allows MH-IbFW to present vital risk information which can improve decision-making and anticipatory actions taken by governments, disaster risk reduction agencies, businesses, communities and individual members of the public. Effective MH-IbFW also provide advice and guidance on what actions users can take to further reduce the socio-economic cost of weather and climate related hazardous events. To realise the benefits of MH-IbFW, Lao PDR must bring together and maximise existing expertise in a range of disciplines, including hazard forecasting and risk assessment, whilst looking to develop or establish new techniques and methods to successfully deliver effective MH-IbFW.



Section 4: Existing Monitoring and Forecasting and Policy Setup 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 7** represent the organization structure chart of DMH in Lao PDR.

Figure 7: Organization Structure of DMH, Lao PDR

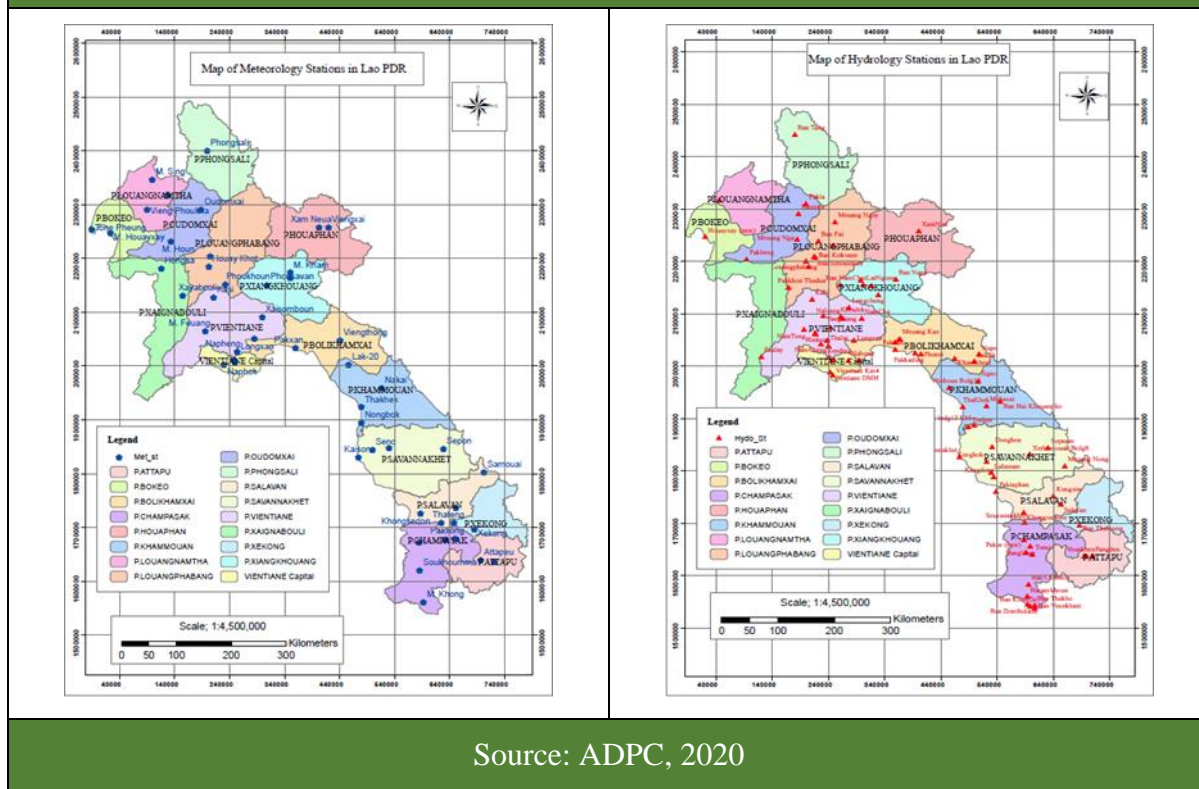


4.1 Existing Monitoring and Forecast Capacity:

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 8** represents locations of meteorological stations (left) and hydrological stations (right) in Lao PDR.

DMH 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. DMH selected Sebangfai as a pilot site to run hydrodynamic model, simulating water level forecast and usually run 2 times during monsoon season.

Figure 8: Locations of Meteorological Stations (left) and Hydrological Stations (right) in Lao PDR



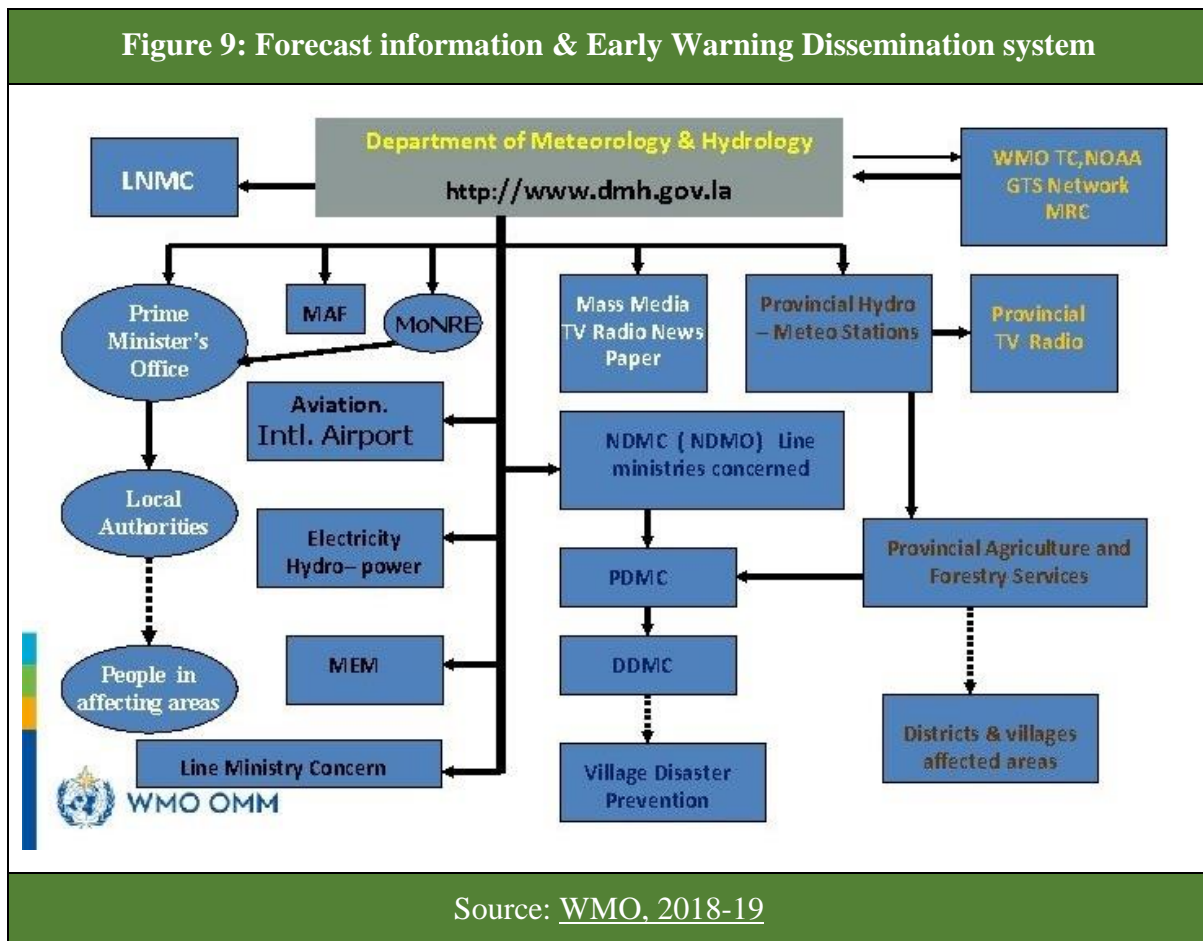
Source: ADPC, 2020

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.

4.2 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 9: Forecast information & Early Warning Dissemination system



Source: WMO, 2018-19

4.2 DRM Policy Setup in Lao PDR

In the past Disaster Risk Management (DRM) in Lao PDR had a primary focus on response and relief, to meet basic needs of affected population. Efforts have been steered towards more proactive, holistic and risk reduction-oriented approaches, with the establishment of National Disaster Management Committee (NDMC) in 1999, which serves as an inter-agency committee for DRM from national to local level, focused on the whole of DRM cycle (Government of Lao PDR, 1999). The NDMO was also established under the decree as the Secretariat to the NDMC.

In 2011, NDMC was renamed to National Disaster Prevention and Control Committee (NDPCC), with Deputy Prime Minister, Minister of National Defense as chair (NDMO, 2012). DRM structures in Lao PDR have also been established at sub-national level in provinces, districts and at the villages, which form a multi-tier risk governance for emergency management. The system comprises of Provincial Disaster prevention and control committees (PDPCCs), District Disaster prevention and control committees (DDPCCs), and Village Disaster Prevention and Control Committees (VDPCCs), or Village Disaster Prevention Units (VDPU). The composition of Village Disaster Preparedness Unit (VDPU) as smallest unit for DRM and front liners for response includes representatives of community-based organization (CBOs), traditional leaders, religious organizations and extension workers (Oxfam, 2012).

DRM policies and the institutional framework have undergone adjustments and reallocation of roles and responsibilities. From 2013-2018, DRM functions were transferred to a newly-created Department of Disaster Management and Climate Change, under the Ministry of Natural Resources and Environment (MoNRE), while the role of Ministry of Labor and Social Welfare (MLSW) was limited to response and relief. During this period, as a national secretariat for NDPCC, DDMC was tasked with overall data compilation and assessment for reporting to the NDPCC on timely basis for its decision, supervision and action (DDMCC, 2015). Recently, at national level, DRM mandates are reassigned to Ministry of Labour and Social Welfare (MLSW) (Abbott, 2018).

First concrete step for comprehensive DRR planning was the Disaster Management Country Strategy, which is a long term, phased master plan for DRR. Based on evaluation of experience and lesson learned of NDMC and MLSW, the strategy outlines its goals, and implementation approaches for 2005, 2010 and 2020, including the budget for operations. To roll out the strategy, continued support has been provided since 2010 to develop and implement action plans. Line ministries also play significant roles in DRM. Ministry of Public Works and Transport, Ministry of Agriculture and Forestry, and the Ministry of Natural Resources and Environment are the key once.

In 2009, the government undertook the National Adaptation Programme of Action to Climate Change (NAPA) project with plans to establish an early warning system for priority flood prone areas in Lao PDR aiming to also improve and expand meteorology, hydrological networks and weather monitoring systems.

The Early Warning Standard Operating Procedures (SOPs), 2017 were developed to provide a concise list of major tasks to be executed by concerned agencies responsible for early warning. This combines the elements of technology-based hazard monitoring and weather forecasts, by the Department of Meteorology and Hydrology (DMH), through its National Early Warning Centre (NEWC), early warning dissemination through multi-tier mechanisms facilitated by each respective DRM agency – the NDMC, Provincial Disaster Management Committees and Office (PDMC), District Disaster Management Committees and Offices (DDMC), and response actions of the government functionaries and community. Continued effort to enhance technical capacity and people-centered early warning is underway to develop a fully

functioning and systematic early warning system for all major hazards (The Government of Lao PDR, 2017) (**Table 3**).

Table 3: DRM Policy Setup in Lao PDR				
Name of Document	Type of Document	Scope	Implementation Responsibility	Purpose
National Strategy on Disaster Risk Reduction (NSDRR) 2021-2030	Strategy	National	Ministry of Labor and Social Welfare	The NSDRR consists of a vision and goals for 2030, seven key strategies and twelve objectives. Each of these objectives also sets out the priority focus areas for implementation from 2021-2030.
Law on Disaster Risk Management Law 2019 (No. 15/2019)	Law	National	NDMO	This law sets the country's disaster risk management legal framework.
Decree on Climate Change (2019) (321/2019)	Decree	National	MoNRE	This document sets general rules to enable mitigation and adaptation actions within the country.
Law on Meteorology and Hydrology (2017) (No. 36/NA).	Law	National	MoNRE	This Law defines principles, rules, and measures on the management, monitoring and evaluation of meteorological and hydrological activities in order to ensure that the work in this field is expanded, modernized, effective and efficient. It aims to prevent and reduce the impacts of natural disasters on lives and properties of the state, public and individuals. Its purpose is also to ensure a timely and accurate data provision that can be integrated at a regional and international level, which will contribute to the national socio-economic growth in line with the green and sustainable development and national security.

Law on Water and Water Resources (Amended) (2017)	Law	National	MoNRE	The Water and Water Resources Law provides for the principles, regulations, and measures for water resource management in the Lao People's Democratic Republic, aiming to improve the sustainability of Lao's water resources. The new provisions have been added on water rights and use, including waste-water discharge permits, wetlands and water-resources protection, ground-water management, and river-basin management.
Early Warning Strategy and Early Warning Standard Operating Procedures (SOPs) (2017)	SOP	National	MoNRE	It is expected that these strategic, legal, and operational documents will help clarify the roles and responsibilities of DMH, strengthen the institutional arrangements, and streamline operational collaboration in the provision of hydro-met and early warning services
Environmental Protection Law (2013 version)	Law	National	MoNRE	This law defines the principles, regulations and measures related to management, monitoring protection, control, preservation and rehabilitation of the environment, as well as mitigation of anthropogenic impacts and pollutions
National Strategy on Climate Change of the Lao PDR 2010 and Climate Change Action Plan (2013 – 2020)	Strategy	National	MoNRE	The objective of the strategy is to secure a future where the Lao PDR is capable of mitigating and adapting to changing climatic conditions in a way that promotes sustainable economic development, reduces poverty, protects public health and safety, enhances the quality of Lao PDR's natural environment, and advances the

				quality of life for all Lao people.
Inter-Agency Contingency Plan (IACP) (2013/2014)	Plan	National	National Disaster Management Office	Supporting the government in guaranteeing effective and timely emergency response by defining roles and providing guidelines for coordination
Prime Minister's Decree 220 (2013)	Decree	National	Department of disaster Management and Climate change (DDMCC)	Establishes the Department of Disaster Management and Climate Change under the ministry of Natural Resources and Environment.
National Strategy on Climate Change of the Lao PDR (2010)	Strategy	National	The government of Lao PDR and, relevant Sectoral department	Outlines the objectives and direction for addressing climate change in Lao PDR across sectors, in consideration of SDGs and CCA.
Periodical Strategic Plan on Disaster Risk Management	Plan	National	National Disaster Management Office	Articulates a DRM strategy, direction and priority actions based on lessons learned in the past.
Prime Minister's Decree No. 373 (2011)	Decree	National	National disaster Prevention and Control Committee	Re-establishing the National Disaster Prevention and Control Committee (NDPCC) and NDRMP to serve as a foundation for multi-sectoral DRM in the country.
The National Adaptation Programme Of Action to Climate Change (NAPA) (2009)	Plan	National	National Environment Committee	In 2009, the government undertook the National Adaptation Programme Of Action to Climate Change (NAPA) project with plans to establish an early warning system for priority flood prone areas in Lao PDR aiming to also improve and expand meteorology, hydrological networks and weather monitoring systems
The Prime Minister's	Decree	National	National disaster Management	To create a comprehensive disaster management institution with authority

Decree No 158 (1999)			Committee (NDMC)	reaching from the national level to villages, with set goals up to 2020
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Section 5: Rationale for Development MH-IbFW Guidance

As highlighted in previous section, ADPC in partnership with WFP has conducted a readiness assessment of MH-IbFW in Lao PDR to improve the institutional capacities of national stakeholders such as the DMH, MoNRE, the NDMO and the sectoral institutions (MAF) so that the existing mechanism for impact-based forecasting information are improved for operational planning and decision-making. The readiness assessment was carried out to provide a better understanding of the current capacity and gaps on MH-IbFW implementation of these institutions and how the expertise of ADPC and the WFP can be leveraged to further strengthen and enhance such capacities at individual and organizational levels. Readiness assessment results from Lao PDR have observed limited capacity on MH-IbFW ranging from low (**Score of 2**) to medium (**Score of 3**).

The overall recommendation suggests that MH-IbFW strategy and action plan are developed and more training and capacity building are identified at the institutional level to enhance the existing capacities on the use of MH-IbFW in Lao PDR. Hence, this national level strategy and action plan have been developed on the basis of the recommendations provided as an outcome of the readiness assessment of MH-IbFW which in turn would help guide the future implementation of MH-IbFW activities in Lao PDR.

3.1 Purpose and Objectives:

The **purpose** of this guidance document is to introduce key priorities of MH-IbFW in Lao PDR based on **readiness assessment** results and recommendations and also priorities identified in National Strategy on Disaster Risk Reduction (NSDRR) 2021-2030. The guidance document outlines potential strategies and action plan for developing MH-IbFW for Lao PDR. The document is targeted at DMH, MoNRE, NDMO and sectoral institutions responsible for developing and operating existing early warning systems. MH-IbFW strategy and action plan of Lao PDR highlights the priority action for DMH, MoNRE and NDMO and key sectoral intuitions.

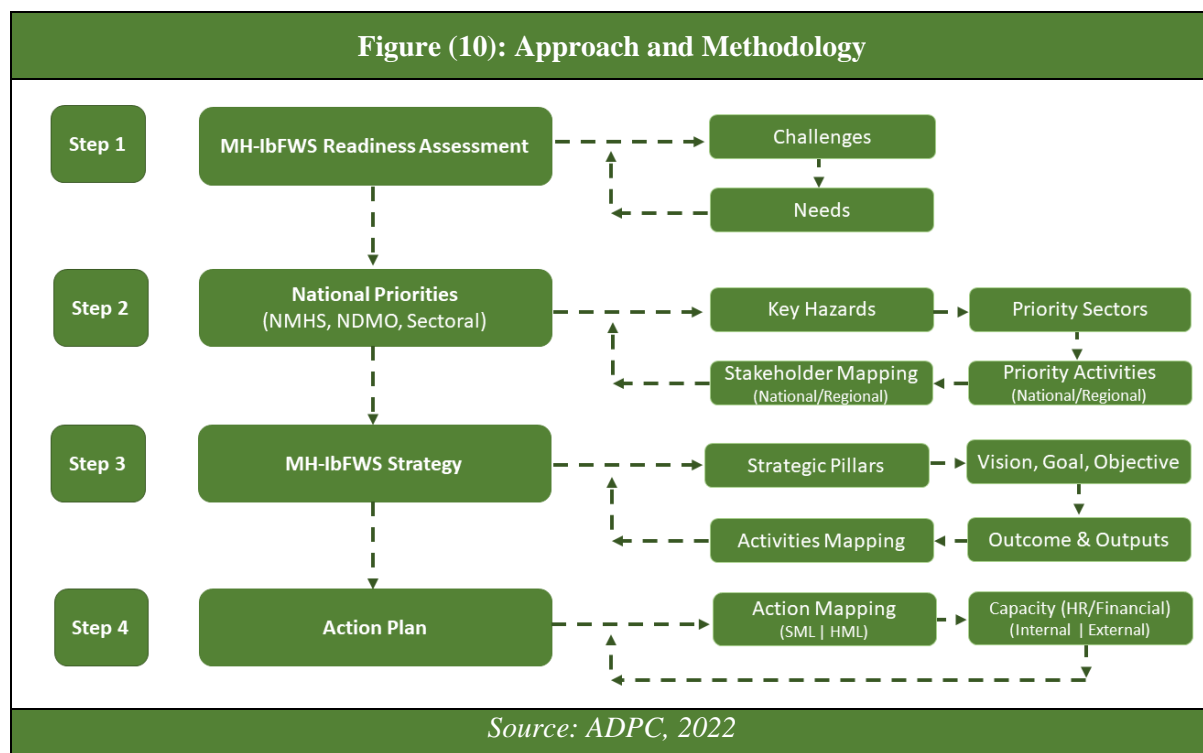
The key **objectives** of this MH-IbFW strategy and action plan is:

- *to address the challenges and critical needs identified during IbFW readiness assessment in Lao PDR, and*
- *to enable institutions and individuals in Lao PDR to better anticipate and respond to hydrometeorological hazards and other related extreme events and their associated impacts.*

MH-IbFW strategy will guide DMH, MoNRE and NDMO to engage credibly with the institutions, and individuals and development partners to contribute in more informed national and local decision making, potentially saving lives and livelihoods. Further, enhancing capability builds a stronger platform for the country to manage the impacts of climate change and equipping Lao PDR with valuable information to implement MH-IbFW strategy in phased manner. To see the benefits of MH-IbFW, Lao PDR must bring together and maximize existing expertise in a range of disciplines, including hazard forecasting and risk assessment, whilst looking to develop or establish new techniques and methods to successfully deliver effective MH-IbFW.

Section 6: Approach and Methodology

A simplified rendition of the overall approach and methodology of MH-IbFW strategy development is presented in this section. The approach and methodology for MH-IbFW strategy development in Lao PDR draws upon international best practices and is mindful of the operational constraints of information/data requirements, availability, collection, collation, and analysis at local level. The actual process will be considerably more complex, because of data availability, various assessments and other operational challenges than described in this section. In practice, a number of working assumptions need to be made to assess the hazard, exposure, vulnerability and risk to develop impact matrix for different hazards in Lao PDR. Each year the impacts of severe hydro-meteorological events in Lao PDR give rise to multiple casualties and significant damage to property and infrastructure, with adverse economic consequence for institutions and individuals, which can persist for many years. All this happens despite of precise forecasts of many of these severe events, with accurate warning information disseminated in a timely fashion by the DMH, MoNRE and NDMO in Lao PDR. The reasons for this apparent disconnect lie in the gap between forecasts and warnings of a hazard events and an understanding of their potential impacts. In a simple way to explain, there is a now realization of what the hazard might be, however there is frequently a lack of understanding of what the hazard might do. If this gap is to be filled, then an all-encompassing approach to observing, modelling and predicting severe hydro-meteorological events, and the consequent cascade of hazards through to impacts, is needed. To overcome this situation, Lao PDR requires a multi-disciplinary, multi-sectoral and multi-layered approach to access the best possible science, and the optimum services, to manage multi-hazard events today, and to provide the best possible evidence, based on which to make the costly decisions on infrastructure investments to protect the population in the future. **Figure 10** represents the approach and methodology for MH-IbFW strategy development in Lao PDR.



The initial stages of MH-IbFW strategy development focused on understanding what hazards and impacts are of concern to which province, institutions and individuals, what information needs to be included within an impact-based forecast or warning and what additional capacity partner organisations will need to develop and operate MH-IbFW. The next steps are then, mapping of resources for developing MH-IbFW needed from the government, financiers and potential partner organisations. Any legal frameworks, mandates or memorandums of understanding should ideally be in place for the organisations that will be responsible for developing and delivering MH-IbFW. This will help clarify and confirm the roles and responsibilities of the different organisations and will help to introduce efficiency. The key elements, implementation phases and potential timeline of MH-IbFW represented in **Table 4**.

Table 4: MH-IbFW Key Elements, Phases and Timeline			
Phase	Key Elements	Details	Potential Timeline
Phase I	Hazard forecasting	Focusing development of hazard forecasting on the hazards of most concern to those at risk. Investing in hazard forecasting capability to produce more accurate hazard forecasts.	Short Term (1-2 Years)
	Risk assessments	Understanding the relationships between hazards and impacts. Assessing the vulnerability and exposure of populations and assets. Combining this knowledge with the hazard forecast to identify who will be impacted, how severe the impacts will be and when the impacts will hit.	

Table 4: MH-IbFW Key Elements, Phases and Timeline

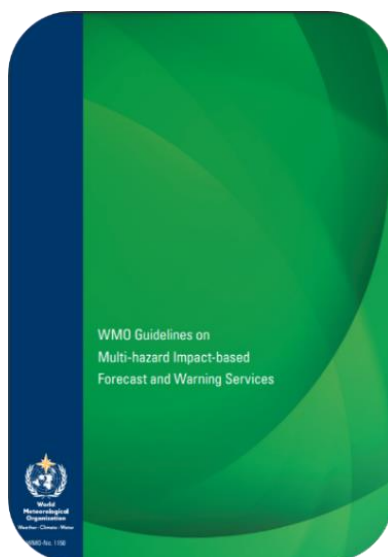
Phase	Key Elements	Details	Potential Timeline
	User-centred MH-IbFW	Putting the users at the heart of all aspects of MH-IbFW. Listening to the needs of the people and organizations who use forecasts and warnings and designing MH-IbFW around those needs.	
	Impact-based forecast and warning products	Producing forecasts and warnings which are based on the needs of the people using them. Forecasts and warnings are clear, easy to use and contain vital hazard and risk information that enables all users to act.	
Phase II	Dissemination and Communication	Getting forecasts and warnings to all users. Making use of a range of appropriate methods to reach all those at risk, from TV, radio, social media and cell broadcasting to flags and sirens.	Medium Term (>2-5 Years)
	Preparedness and Response	Increasing the understanding of the implications of hazard and risk to preparedness and response strategies and actions. Incorporating impact-based forecasts and warnings and action advisories into disaster risk reduction preparedness and response activities. Linking warning levels with predefined actions.	
	Review	Reviewing the effectiveness of MH-IbFW to share, adopt and replicate best practice and drive improvements. Learning from experience and adapting.	
	Training and Capacity Building	Improving understanding of hazards and risks across all disaster risk reduction sectors and the public. Understanding how forecast and warning information can be used to make effective, life and asset saving decisions. Sharing advice and guidance on what can be done to reduce the impact of disaster.	
Phase III	Partnerships and collaboration	Working together across all necessary sectors to develop, design and deliver effective MH-IbFW, from forecasting the hazard to driving effective decision-making and disaster response.	Long Term (>5 Years)
	Governance	Putting in place legal frameworks, mandates, SOP, Guidelines, and MoUs, identify relevant approvals and funding needed to develop MH-IbFW, Establish roles and responsibilities for partner organisations	

Section 7: Current Practices

7.1 International Guidelines

MH-IbFW Strategy for Lao PDR is guided by key guidelines on climate services, early warning systems, and disaster risk management developed by various international and regional organisations. WMO and UK Met Office has developed an MH-IbFW Guidelines^{10 11 12} and MHEWS Checklist¹³ which can be further referred to keep track of what has already been developed and achieved and what needs to be developed for an effective MH-IbFW in the country.

The relevant international and regional guidelines such as the “**Multi Hazard Impact-based Forecast and Warning**” (WMO, 2015, 2021), “**Multi-hazard Early Warning System – A Checklist**” (WMO, 2017), “**The Future of Forecasts: Impact-Based Forecasting for Early Action**” (UK Met, 2020), and recently published manual titled “**Operationalizing Impact-based Forecasting and Warning Services**” (UNESCAP, 2021) are useful for further linkages.



Source: WMO, 2015



Source: UK Met, 2020



Source: WMO, 2021

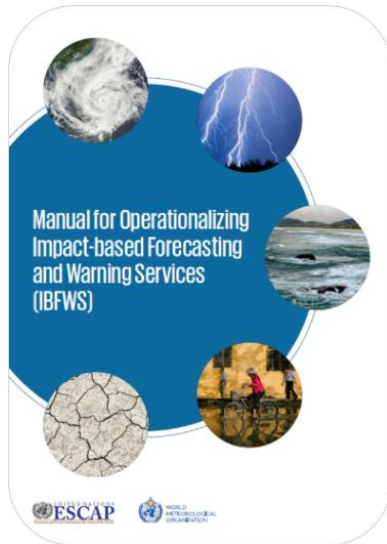
Other guidelines such as “**Guidelines for Implementation of Common Alerting Protocol (CAP) – Enabled Emergency Alerting**” (WMO, 2013), **Global Guide to Tropical Cyclone Forecasting** (2019), “**Guide to Storm Surge Forecasting**” (2011), “**Manual on Flood Forecasting and Warning**” (2011) can also be useful for MH-IbFW guidelines.

¹⁰ WMO (2015), URL: https://library.wmo.int/index.php?lvl=notice_display&id=17257#.YpwXfnZBxPY

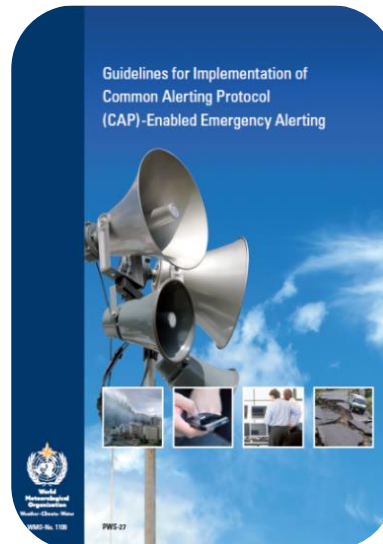
¹¹ WMO (2021), URL: https://library.wmo.int/?lvl=notice_display&id=21994#.YpwXpXZBxPZ

¹² UKMet (2020), URL: <https://www.forecast-based-financing.org/wp-content/uploads/2020/09/Impact-based-forecasting-guide-2020.pdf>

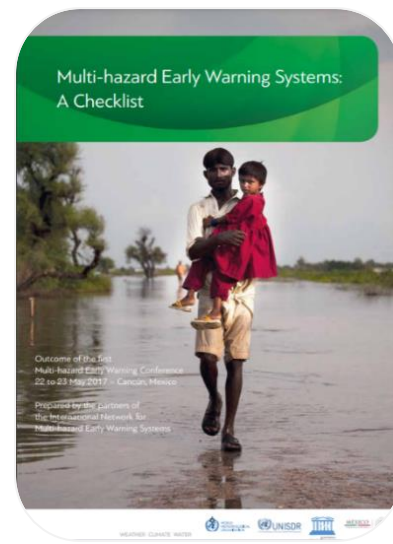
¹³ WMO (2017), URL: https://library.wmo.int/index.php?lvl=notice_display&id=20228#.Wri4cI4zMt8



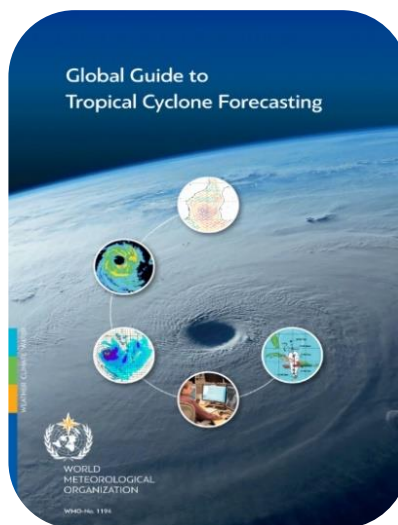
Source: UNESCAP, 2021



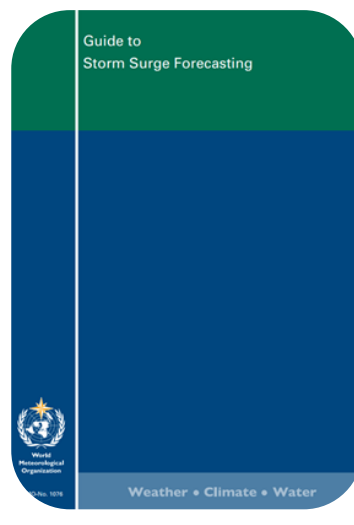
Source: WMO, 2013



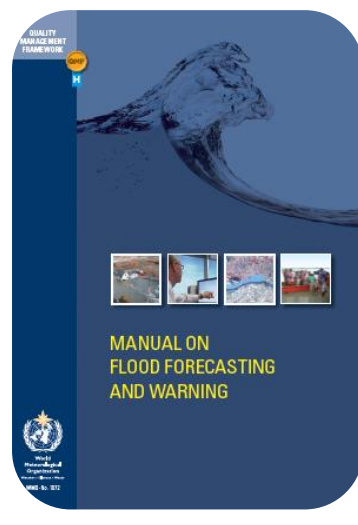
Source: WMO, 2017



Source: WMO, 2019



Source: WMO, 2011



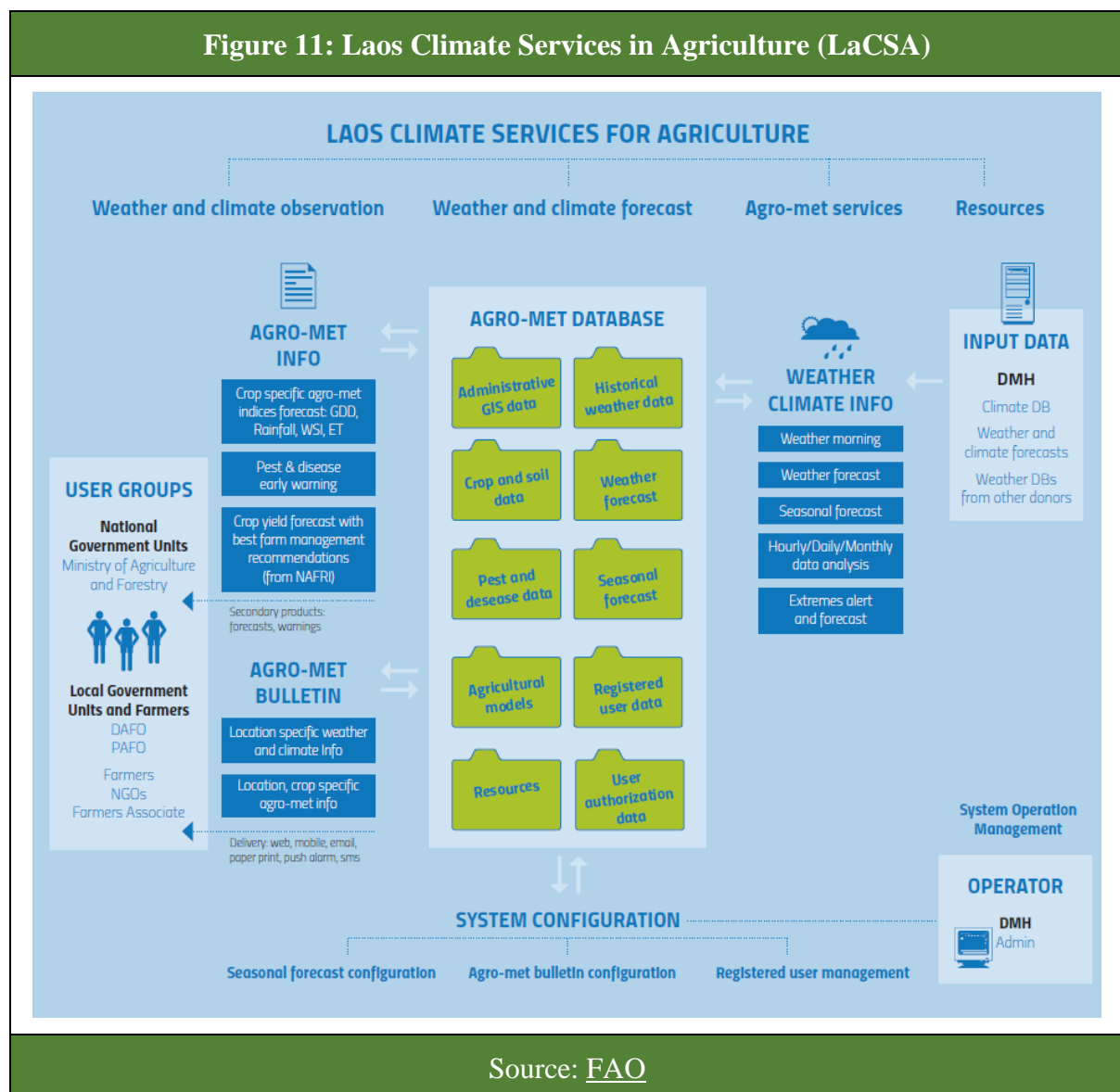
Source: WMO, 2011

7.2 National Level MHEWS Initiatives

Strengthening Agroclimatic Monitoring and Information System (SAMIS): 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.

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 11** represents **Laos Climate Services in Agriculture (LaCSA)**.



Section 8: Guidance to Develop MH-IbFW Strategy

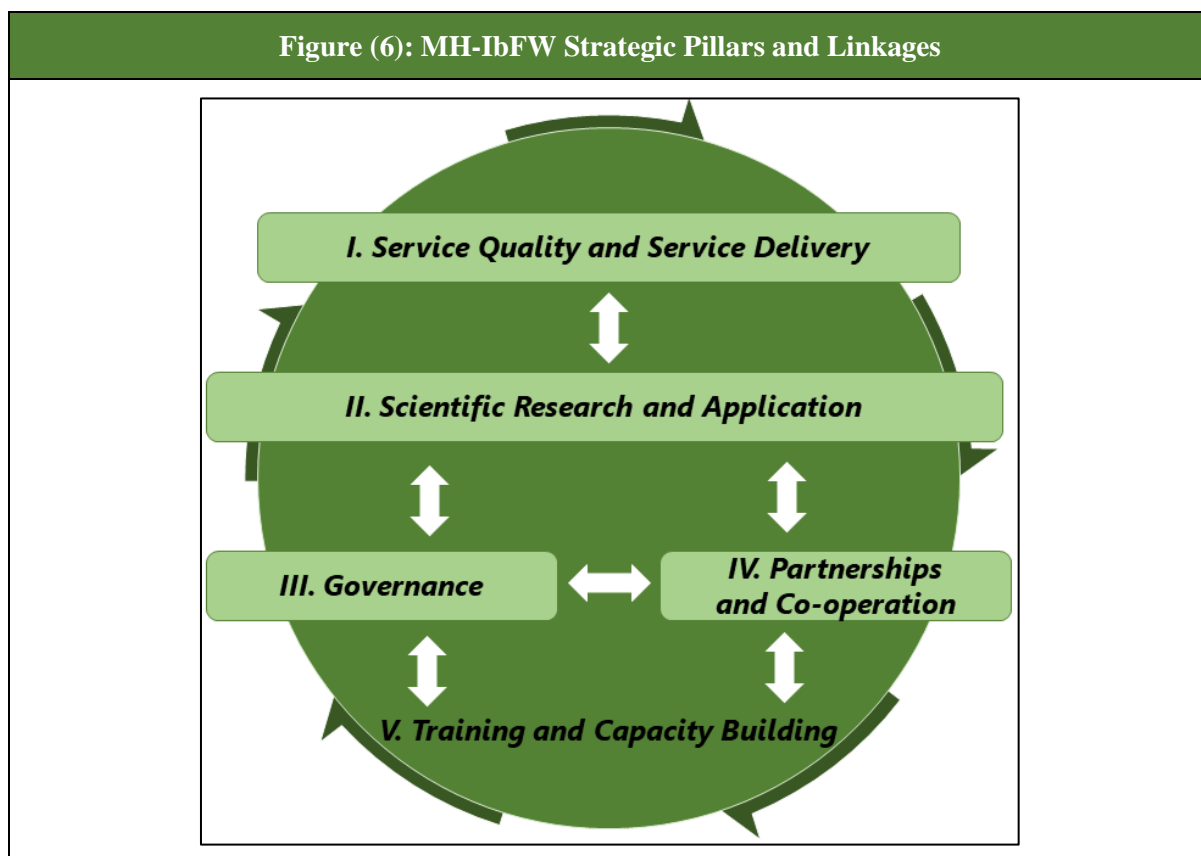
MH-IbFW Guidance to develop strategy provide a comprehensive information, built around various stages and products based on the needs of the **institutions and individuals** who will use the forecasts and warnings. Traditional forecast and warning products describe what the weather will *be*, but MH-IbFW describe what the weather will *do* – linking the forecasted hazard to potential impacts. Linking hazards and potential impacts allows MH-IbFW to present vital risk information which can improve decision-making and anticipatory actions taken by governments, disaster risk reduction agencies, businesses, communities and individual members of the public. This effective MH-IbFW strategy provide an advice and guidance on what informed actions **institutions and individuals** can take to further reduce the socio-economic cost of weather and climate related hazardous events.

8.1 Vision: MH-IbFW Strategy has suggested the following Vision Statement for Lao PDR.

DMH, MoNRE and NDMO of the Lao PDR provide relevant IbFW services to institutions and individuals to make informed decisions for their safety, socio-economic well-being, prosperity and sustainable livelihoods.

MH-IbFW strategy for Lao PDR developed based various national priorities, collated in following five pillars. In line with the overall vision and objective of this MH-IbFW strategy, ‘Service Quality and Service Delivery’ and ‘Scientific Research and Application’ is identified as assigned high priority pillars.

- I. Service Quality and Service Delivery
- II. Scientific Research and Application
- III. Governance
- IV. Partnerships and Co-operation
- V. Training and Capacity Building



8.2 Matrix of Outcomes, Outputs and High-Level Actions:

Pillar I: Service Quality and Service Delivery:

First pillar of MH-IbFW Strategy focused on the **Service Quality and Service Delivery** on strengthening weather and climate observation, monitoring, forecasting and communication capacities in Lao PDR. The high-level actions proposed under this pillar support expansion and upgradation of the existing hydrometeorological network covering multiple climate-induced hazards (tropical cyclone, fluvial and pluvial floods, landslide, storm surge, and heat waves) based on the readiness assessment. The goal, outcome, outputs and high-level actions link with this pillar are represented in following table.

Goal: Strengthening Weather and Climate Observation, Monitoring, Forecasting and Communication Capacities		
Outcome	Outputs	High-Level Actions
Observational network & climate data management capacities strengthened for generation of weather	Observational, monitoring, forecasting network strengthened	<ul style="list-style-type: none"> Support to rehabilitate silent stations and assess, upgrade existing observation networks and install new networks
		<ul style="list-style-type: none"> Explore the use of non-traditional observations (eg: satellite data / reanalysis data) in areas where the conventional network is sparse through pilot

and climate information		<ul style="list-style-type: none"> • Value addition to indigenous weather forecast knowledge as well as traditional risk management practices
	State-of-the-art national climate data management center (for collection, collation, storage and analysis) established	<ul style="list-style-type: none"> • Establishment of high-quality climate data storage facility which is readily available for research, modelling and prediction purpose
	Capacity of DMH, MoNRE enhanced in generating, enhancing the quality of need-based climate products through innovative approaches	<ul style="list-style-type: none"> • Conduct sectoral need assessment for climate products • Implement pilot applications projects at national, sub-national and local level to demonstrate economic benefits of new and innovative climate products

Pillar II: Scientific Research and Application:

Second pillar of MH-IbFW Strategy focused on **scientific research and applications** generating comprehensive weather and climate informed multi-hazard and risk information for MH-IbFW in Lao PDR. The workflow to develop MH-IbFW needs four fundamental inputs including hazard, exposure, vulnerability and risk. The goal, outcome, outputs and high-level actions link with this pillar are represented in following table.

Goal: Generating comprehensive Weather and Climate informed Multi-hazard and Risk Information for MH-IbFW		
Outcome	Outputs	High-Level Actions
MH-IbFW established and supported by knowledge products and decision support system through scientific research and applications	Science-based multi-hazard weather and climate risk information is generated and impact matrix developed	<ul style="list-style-type: none"> • Generate probabilistic hazard maps for key hazards including drought, flooding, tropical cyclone, storm surge and landslides
		<ul style="list-style-type: none"> • Establish threshold values that will cause drought, flooding, tropical cyclone, storm surge and landslide in Lao PDR
		<ul style="list-style-type: none"> • Generate national probabilistic weather forecasts for heavy rainfall and severe wind using numerical weather prediction (NWP) at the national level
		<ul style="list-style-type: none"> • Develop exposure database for key elements of exposure
		<ul style="list-style-type: none"> • Update/develop vulnerability and fragility curves for structures/ buildings for tropical cyclone, storm surge, floods and landslides
		<ul style="list-style-type: none"> • Undertake risk analysis incorporating hazard, exposure and vulnerability and

Goal: Generating comprehensive Weather and Climate informed Multi-hazard and Risk Information for MH-IbFW		
Outcome	Outputs	High-Level Actions
		assess socio-economic and gender vulnerability to identify potential impacts from extreme weather events
		<ul style="list-style-type: none"> • Develop the impact-based forecasting and warning system matrix for each hazard
		<ul style="list-style-type: none"> • Develop/update early warning protocols from hazard to impact-based using collaborative approaches
		<ul style="list-style-type: none"> • Develop and adopt national policy framework on MH-IbFW to guide the implementation of national government, local government units and all stakeholders nationwide
		<ul style="list-style-type: none"> • Test and validate the impact and response tables
		<ul style="list-style-type: none"> • Develop a knowledge and decision support system to support the implementation of MH-IbFW
		<ul style="list-style-type: none"> • Conduct simulations to test the MH-IbFW and calibrate knowledge and decision support system on a regular basis

Pillar III: Governance

Third pillar of MH-IbFW Strategy focused on **Governance**, mainstreaming of Climate Risk Information and MH-IbFW in Development Policy and Planning, Investment Programming and Resilience Planning in Lao PDR. Mainstreaming of MH-IbFW Strategy in development planning processes especially for priority sectors at national and local levels will be useful for overall climate and disaster risk management in Lao PDR. The goal, outcome, outputs and high-level actions link with this pillar are represented in following table.

Goal: Mainstreaming of Climate Risk Information and MH-IbFW in Development Policy and Planning, Investment Programming and Resilience Planning		
Outcome	Outputs	High-Level Actions
Climate risk information and MH-IbFW mainstreamed in development policy and planning, investment programming and	Risk and evidence-based development polices and plans, investment programs developed at the national and local levels and the institutionalization of MH-	<ul style="list-style-type: none"> • Enhance existing manuals and guidelines on integrating MH-IbFW and FbA in national and local resilience planning processes
		<ul style="list-style-type: none"> • Develop Standard Operating Procedures (SOPs) for MH-IbFW

resilience planning at national and local levels and institutionalized people-centered MH-IbFW	IbFW facilitated and climate risk information in local policies, plans and budgets integrated	and FbA in national and local resilience planning processes
		<ul style="list-style-type: none"> • Develop risk informed plans and integration of MH-IbFW into annual budgets

Pillar IV: Partnerships and Cooperation

Fourth pillar of MH-IbFW Strategy focused on **Partnerships and Cooperation**, enhancing partnerships and cooperation between DMH, MoNRE, NDMO and sectoral institutions in Lao PDR. Partnerships are critical to the successful implementation of this Strategy. To be effective, the Strategy must be clearly linked with the work of other government departments and agencies, technical partners, civil society and NGOs, and the private sector, and work in concert with other global and regional frameworks. It will also be essential to partner with organizations that will help DMH, MoNRE and NDMO keep pace with rapidly changing technology in the earth science industry. The goal, outcome, outputs and high-level actions link with this pillar are represented in following table.

Goal: Enhancing Partnerships and Cooperation between DMH, MoNRE, NDMO and Sectoral Institutions (MAF)		
Outcome	Output	High-Level Actions
National Partnerships and Cooperation Enhanced	Partnership and cooperation enhanced between DMH, MoNRE and NDMO	<ul style="list-style-type: none"> • Preparation of National Framework for Climate Services (NFCS) for better Cooperation between DMH, MoNRE, NDMO and sectoral institutions
		<ul style="list-style-type: none"> • National Climate Outlook forums to improve two-way communication between DMH, MoNRE and users in all sectors
	National partnership and cooperation enhanced for MH-IbFW to different sectors	<ul style="list-style-type: none"> • Support initiatives that engage users in climate/risk data collection, interpretation and dissemination
		<ul style="list-style-type: none"> • Collaboration and dialogue between producers, co- producers and users
		<ul style="list-style-type: none"> • Strengthen national inter-agency operational coordination mechanisms at the national level to implement MH-IbFW (Technical Working Groups)
		<ul style="list-style-type: none"> • Develop multi-stakeholder partnerships at the national and local levels for FbA and social protection
	<ul style="list-style-type: none"> • Encourage the development and open sharing of accurate risk information/ 	

Goal: Enhancing Partnerships and Cooperation between DMH, MoNRE, NDMO and Sectoral Institutions (MAF)		
Outcome	Output	High-Level Actions
		knowledge, provided as a regional public good
Regional Partnerships and Cooperation Enhanced	Regional partnership and cooperation enhanced for MH-IbFW to different sectors	<ul style="list-style-type: none"> Promote regional users' networks to share knowledge on climate products and services
		<ul style="list-style-type: none"> Establishment of Inter-country communication systems for establishing MH-IbFW and disseminating this information to users
		<ul style="list-style-type: none"> Establishment of a joint, multi-disciplinary, scientific sectoral working group

Pillar V: Training and Capacity Building

Fifth pillar of MH-IbFW Strategy focused on enhancing **Training and Capacity Building**, to develop national technical capacities within DMH, MoNRE and NDMO and to implement the people-centered MH-IbFW and Forecast-based Early Actions (FbA) in Lao PDR. The goal, outcome, outputs and high-level actions link with this pillar are represented in following table.

Goal: Implementation of a People-centered MH-IbFW and Forecast-based Early Actions (FbA)		
Outcome	Output	High-Level Action
Improved national and local technical capacities in implementing a people-centered MH-IbFW and forecast-based early actions (FbA)	Technical Capacities of DMH, MoNRE, NDMO and Sectoral Institutions in co-design, co-produce and deliver the MH-IbFW products straightened in Lao PDR	<ul style="list-style-type: none"> Conduct a capacity, need and gap assessment on MH-IbFW of key national and local producer, co-producer and end-users
		<ul style="list-style-type: none"> Build gender-sensitive institutional and technical capacities to implement MH-IbFW.
		<ul style="list-style-type: none"> Develop localized impact tables and response tables for each hazard
		<ul style="list-style-type: none"> Develop early action protocols applicable to project sites including shock-responsive social protection
		<ul style="list-style-type: none"> Develop knowledge products and information, education and

Goal: Implementation of a People-centered MH-IbFW and Forecast-based Early Actions (FbA)		
Outcome	Output	High-Level Action
		communication (IEC) materials on MH-IbFW including FbA and conduct advocacy and outreach • Expanding the use of MH-IbFW nationwide using scenarios

Section 9: Guidance to Develop MH-IbFW Action Plan

IbFW Strategy Action Plan is developed in such a way that it guides the implementation of high-level actions and linked activities and sub-activities with given priority and timeframe in Lao PDR. Action plan also highlights the key responsibilities (institutions/individuals) and capacities (external and internal). Action planning highlights the step-by-step process that what needs to be done, when it needs to be done, by whom it needs to be done, what capacities need to implement and what resources or inputs are needed or available to do it.

Pillar I: Service Quality and Service Delivery:

First pillar of MH-IbFW Strategy focused on the **Service Quality and Service Delivery** on strengthening weather and climate observation, monitoring, forecasting and communication capacities in Lao PDR. The timeframe, priority, responsibility and capacity related high-level actions link with this pillar are represented in following table.

Goal: Strengthening Weather and Climate Observation, Monitoring, Forecasting and Communication Capacities					
Outcome	Outputs	High-Level Actions	Timeframe (Years) ¹⁴ (S: 1-2, M: >2-5, L: >5)	Priority ¹⁵	Key Responsibilities (R)/ Capacity (C)
Observational network & climate data management capacities strengthened for generation of weather and climate information	Observational, monitoring, forecasting network strengthened	Support to rehabilitate silent stations and assess, upgrade existing observation networks and install new networks	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR,)

¹⁴ S: Short, M: Medium, L: Long

¹⁵ **First priority**; **Second priority**; **Third priority**

		Explore the use of non-traditional observations (eg: satellite data / reanalysis data) in areas where the conventional network is sparse through pilot	Short (1-2)	High	R: DMH, MoNRE Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Value addition to indigenous weather forecast knowledge as well as traditional risk management practices	Short (1-2)	High	R: DMH, MoNRE Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
	State-of-the-art national climate data management center (for collection, collation, storage and analysis) established	Establishment of high-quality climate data storage facility which is readily available for research, modelling and prediction purpose	Medium (>2-5)	Medium	R: DMH, MoNRE Lao PDR, C: Internal (DMH, MoNRE, Lao PDR)
	Capacity of DMH, MoNRE enhanced in generating, enhancing the quality of need-based climate products through innovative approaches	Conduct sectoral need assessment for climate products	Short (1-2)	High	R: DMH, MoNRE Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Implement pilot applications	Medium (>2-5)	Medium	R: DMH, MoNRE Lao PDR,

		projects at national, sub-national and local level to demonstrate economic benefits of new and innovative climate products			C: External (Development Partners, Regional Institutions, Technical Partners)
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Pillar II: Scientific Research and Application:

Second pillar of MH-IbFW Strategy focused on **scientific research and applications** generating comprehensive weather and climate informed multi-hazard and risk information for MH-IbFW in Lao PDR. The timeframe, priority, responsibility and capacity related high-level actions link with this pillar are represented in following table.

Goal: Generating comprehensive Weather and Climate informed Multi-hazard and Risk Information for MH-IBFW					
Outcome	Outputs	High-Level Actions	Timeframe (Years) ¹⁴ (S: 1-2, M: >2-5, L: >5)	Priority ¹⁵	Responsibilities (R)/ Capacity (C)
MH-IbFW established and supported by knowledge products and decision support system through scientific research and applications	Science-based multi-hazard weather and climate risk information is generated and impact matrix developed	Generate probabilistic hazard maps for key hazards including drought, flooding, tropical cyclone, storm surge and landslide	Short (1-2)	High	R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Establish threshold values that will cause drought, flooding, tropical cyclone, storm surge and landslide in Lao PDR	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions,

					Technical Partners)
		Generate national probabilistic weather forecasts for heavy rainfall and severe wind using numerical weather prediction (NWP) at the national level	Short (1-2)	High	R: NDMO, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR)
		Develop exposure database for key elements of exposure	Short (1-2)	High	R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Update/develop vulnerability and fragility curves for structures/ buildings for tropical cyclone, storm surge, flood and landslide	Short (1-2)	High	R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Undertake risk analysis incorporating hazard, exposure and vulnerability and assess socio-economic and gender vulnerability to identify potential impacts from extreme weather events	Short (1-2)	High	R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop the impact-based forecasting and	Short (1-2)	High	R: DMH, MoNRE, Lao PDR,

		warning system matrix for each hazard			R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop/update early warning protocols from hazard to impact-based using collaborative approaches	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop and adopt national policy framework on MH-IbFW to guide the implementation of national government, local government units and all stakeholders nationwide	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Test and validate the impact and response tables	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)

		Develop a knowledge and decision support system to support the implementation of MH-IbFW	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Conduct simulations to test the MH-IbFW and calibrate knowledge and decision support system the system on a regular basis	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)

Pillar III: Governance

Third pillar of MH-IbFW Strategy focused on **Governance**, mainstreaming of Climate Risk Information and MH-IbFW in Development Policy and Planning, Investment Programming and Resilience Planning in Lao PDR. The timeframe, priority, responsibility and capacity related high-level actions link with this pillar are represented in following table.

Goal: Mainstreaming of Climate Risk Information and MH-IbFW in Development Policy and Planning, Investment Programming and Resilience Planning					
Outcome	Output	High-Level Actions	Timeframe (Years)¹⁴ (S: 1-2, M: >2-5, L: >5)	Priority¹⁵	Responsibility (R)/ Capacity (C)
Climate risk information and MH-IbFW mainstreamed in development policy and planning, investment programming	Risk and evidence-based development polices and plans, investment programs developed at the national and local levels and the institutionalization	Enhance existing manuals and guidelines on integrating MH-IbFW and FbA in national and	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, C: External (Development Partners, Regional Institutions,

and resilience planning at national and local levels and institutionalized people-centered MH-IbFW	of MH-IbFW facilitated and climate risk information in local policies, plans and budgets integrated	local resilience planning processes			Technical Partners)
		Develop Standard Operating Procedures (SOP) MH-IbFW and FbA in national and local resilience planning processes	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop risk informed plans and integration of MH-IbFW into annual budgets	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR) C: External (Development Partners, Regional Institutions, Technical Partners)

Pillar IV: Partnerships and Cooperation

Fourth pillar of MH-IbFW Strategy focused on **Partnerships and Cooperation**, enhancing partnerships and cooperation between DMH, MoNRE, NDMO and sectoral institutions in Lao PDR. The timeframe, priority, responsibility and capacity related high-level actions link with this pillar are represented in following table.

Goal: Enhancing Partnerships and Cooperation between DMH, MoNRE, NDMO and Sectoral Institutions					
Outcome	Output	High-Level Actions	Timeframe (Years) ¹⁴ (S: 1-2, M: >2-5, L: >5)	Priority ¹⁵	Responsibility (R)/ Capacity (C)
National Partnerships and Cooperation Enhanced	Partnership and cooperation enhanced between DMH, MoNRE, and NDMO	Preparation of National Framework for Climate Services (NFCS) for better Cooperation between DMH, MoNRE, NDMO and sectoral institutions	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR) C: External (Development Partners, Regional Institutions, Technical Partners)
		National Climate Outlook forums to improve two-way communication between DMH, MoNRE and users in all sectors	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR) C: External (Development Partners, Regional Institutions, Technical Partners)
	National partnership and cooperation enhanced for MH-IbFW to different sectors	Support initiatives that engage users in climate/risk data collection, interpretation and dissemination	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR)
		Collaboration and dialogue between producers, co-producers and users	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR)

		Strengthen national inter-agency operational coordination mechanisms at the national level to implement MH-IbFW (Technical Working Groups)	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR)
		Develop multi-stakeholder partnerships at the national and local levels for FbA and social protection	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR)
		Encourage the development and open sharing of accurate risk information/ knowledge, provided as a regional public good	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR)
Regional Partnerships and Cooperation Enhanced	Regional partnership and cooperation enhanced for MH-IbFW to different sectors	Promote regional users' networks to share knowledge on climate products and services	Long (>5)	Low	R: DMH, MoNRE, Lao PDR, C: Internal (DMH, MoNRE, Lao PDR) C: External (Development Partners, Regional Institutions, Technical Partners)
		Establishment of Inter-country communication systems for	Long (>5)	Low	R: DMH, MoNRE, Lao PDR,

		establishing MH-IBFW and disseminating this information to users			C: Internal (DMH, MoNRE, Lao PDR) C: External (Development Partners, Regional Institutions, Technical Partners)
		Establishment of a joint, multi-disciplinary, scientific sectoral working group	Long (>5)	Low	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, R: Sectoral Agencies C: Internal (DMH, MoNRE, Lao PDR) C: External (Development Partners, Regional Institutions, Technical Partners)

Pillar V: Training and Capacity Building

The timeframe, priority, responsibility and capacity related high-level actions link with this pillar are represented in following table.

Goal: Implementation of a People-centered MH-IbFW and Forecast-based Early Actions (FbA)					
Outcome	Output	High-Level Actions	Timeframe (Year)¹⁴ (S: 1-2, M: >2-5, L: >5)	Priority¹⁵	Responsibility (R)/ Capacity (C)
Improved national and local technical capacities in implementing a people-centered MH-IbFW and forecast-based	Technical Capacities of DMH, MoNRE, NDMO and Sectoral Institutions in co-design, co-produce and deliver	Conduct a capacity, need and gap assessment on MH-IbFW of key national and local end-users	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)

early actions (FbA)	the MH-IbFW products straightened in Lao PDR				
		Build gender-sensitive institutional and technical capacities to implement MH-IbFW.	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop localized impact tables and response tables for each hazard	Short (1-2)	High	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop early action protocols applicable to project sites including shock-responsive social protection	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop knowledge products and information, education and communication (IEC) materials on MH-IbFW	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, R: NDMO, Lao PDR, C: External (Development Partners, Regional

		including FbA and conduct advocacy and outreach			Institutions, Technical Partners)
		Expanding the use of MH-IbFW nationwide using scenarios	Medium (>2-5)	Medium	R: DMH, MoNRE, Lao PDR, C: External (Development Partners, Regional Institutions, Technical Partners)

Section 10: Summary

MH-IbFW have been identified as a high priority by WMO and member countries to increase the relevance and utility of their National Meteorological and Hydrological Service (NMHS) forecasts and warnings. Impact-based forecasts emphasize what a hazard will do rather than what a hazard will be. Achieving this requires NMHS in Lao PDR i.e. DMH, MoNRE to increase their emphasis on delivering impact-based forecast and warning services.

Moving beyond hazard forecasting is a significant step-up, requiring effective partnerships with many different government institutions, individual as well as volunteer organizations and non-Governmental organizations, which have access to relevant data—this is perhaps one of the most difficult things to achieve. This is where the international organisation (like World Bank, WMO, WFP) and regional institutions (like ADPC) has a larger role, through its convening power, to bring together many of the actors and stakeholders to help DMH, MoNRE and NDMO to create the necessary partnerships and data sharing arrangements, and to encourage other development partners to support this approach.

The World Bank supported and WMO-led efforts under the Climate Risk and Early Warning Systems (CREWS) have already been emphasizing to enhance the capacities of national and regional stakeholders/institutions to provide more timely and precise forecasts and warnings.

MH-IbFW focus on translating meteorological and hydrological hazards into sector- and location-specific impacts, and the development of sectoral responses to mitigate those impacts. By focusing on impacts, it is expected that NDMOs will provide a better understanding of the hazards to which people are exposed, and that people and communities will more likely take appropriate action to protect their lives and livelihoods.

Lao PDR is prone to various hydro-meteorological hazards including cyclones, floods, and storm surges. These hazards are becoming more and more intricate, complex and multi-faceted. DMH, MoNRE in Lao PDR is mandated and accountable to provide short- and long-range

weather forecast as well as early warning to institutions and individuals. Recognizing the fact that the frequency and severity of hydro-meteorological hazards is on the rise in changing climatic conditions, existing capacities and technologies at DMH, MoNRE need to upgrade in Lao PDR.

Further Reading

Further detail on how to design and develop IbFWS is available in the following recommended documents.

- **Guidelines on Multi-Hazard Impact-based Forecast and Warning Services (2015)**
Source: World Meteorological Organization
URL: https://library.wmo.int/doc_num.php?explnum_id=7901
- **Multi-Hazard Early Warning: A Checklist (2017)**
Source: World Meteorological Organization
URL: https://library.wmo.int/doc_num.php?explnum_id=4463
- **The Future of Forecasts: Impact-based Forecasting for Early Action (2020)**
Source: UK Met Office
URL: <https://www.forecast-based-financing.org/wp-content/uploads/2020/09/Impact-based-forecasting-guide-2020.pdf>
- **Guidelines on Multi-Hazard Impact-based Forecast and Warning Services: Part II: Putting Multi-hazard IBFWS into Practice (2021)**
Source: Source: World Meteorological Organization
URL: https://library.wmo.int/doc_num.php?explnum_id=10965
- **Manual for Operationalizing Impact-based Forecasting and Warning Services (IBFWS) (2021)**
Source: UNESCAP
URL: <https://www.unescap.org/kp/2021/manual-operationalizing-impact-based-forecasting-and-warning-services-ibfws>

Other Key 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
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

For more information, please contact :

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