



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



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The “Guidance to Develop Strategies and Action Plan on Multi-Hazard Impact-based Forecasting and Warning (IbFW) in Cambodia” has been developed under aegis of the World Food Programme (WFP) based on the outcome of the readiness assessment in Cambodia.

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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 Committee for Disaster Management (i.e. NDMO in Cambodia) 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 Cambodia to improve the institutional capacities of national stakeholders such as the Ministry of Water Resources and Meteorology (i.e. NMHS in Cambodia), the NCDM 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 Cambodia” has been developed that would guide relevant stakeholders and development partners to work collaboratively with national Government in implementing IbFW activities in Cambodia.

This guidance document is developed based on five pillars that are in line with the national priorities of Cambodia 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

This guidance document 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 Cambodia.

The guidance document for the development of MH-IbFW strategy and action plan in Cambodia 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 Cambodia. 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 Cambodia.

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
DHRW	Department of Hydrology and River Works
DOM	Department of Meteorology
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
MAFF	Ministry of Agriculture, Forestry and Fisheries
MH-IbFW	Multi Hazard Impact-based Forecasting and Warning
MoWRAM	Ministry of Water Resources and Meteorology
NCDM	National Committee for Disaster Management
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 Cambodia 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 Cambodia involved a number of Key Informant Interviews (KII's) and Focus Group Discussions (FGD's) and various consultations with the Ministry of Water Resources and Meteorology (MoWRAM), National Committee for Disaster Management (NCDM) and Ministry of Agriculture, Forestry and Fisheries (MAFF). The assessment formed a strong foundation for improving institutional capacities of national stakeholders such as the National Meteorological and Hydrological Services (i.e. MoWRAM), the National Disaster Management Office (i.e. NCDM) and the Ministry of Agriculture, Forestry and Fisheries (i.e. MAFF) so that the existing mechanism for impact-based forecasting information are improved for operational planning and decision-making.

The overall IbFW readiness assessment in Cambodia 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**).

Figure 1: Key Areas Considered for IbFW Readiness Assessment in Cambodia

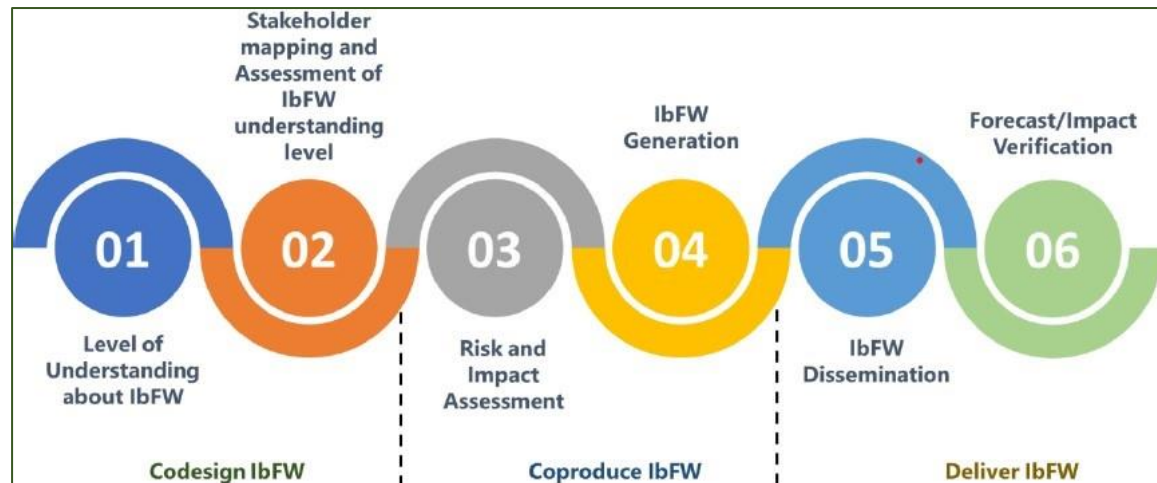
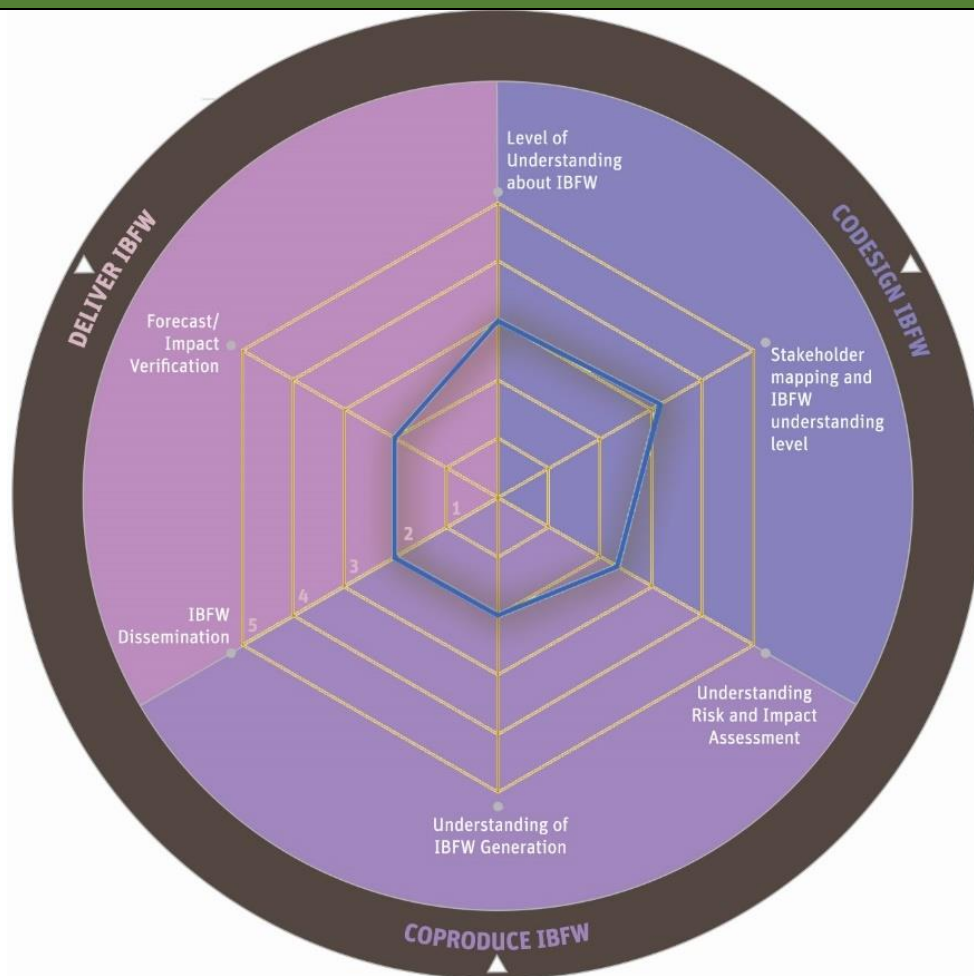


Figure (1) shows the results of overall IbFW readiness assessment in Cambodia.

Figure 2: Results of IbFW Readiness Assessment in Cambodia



(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)

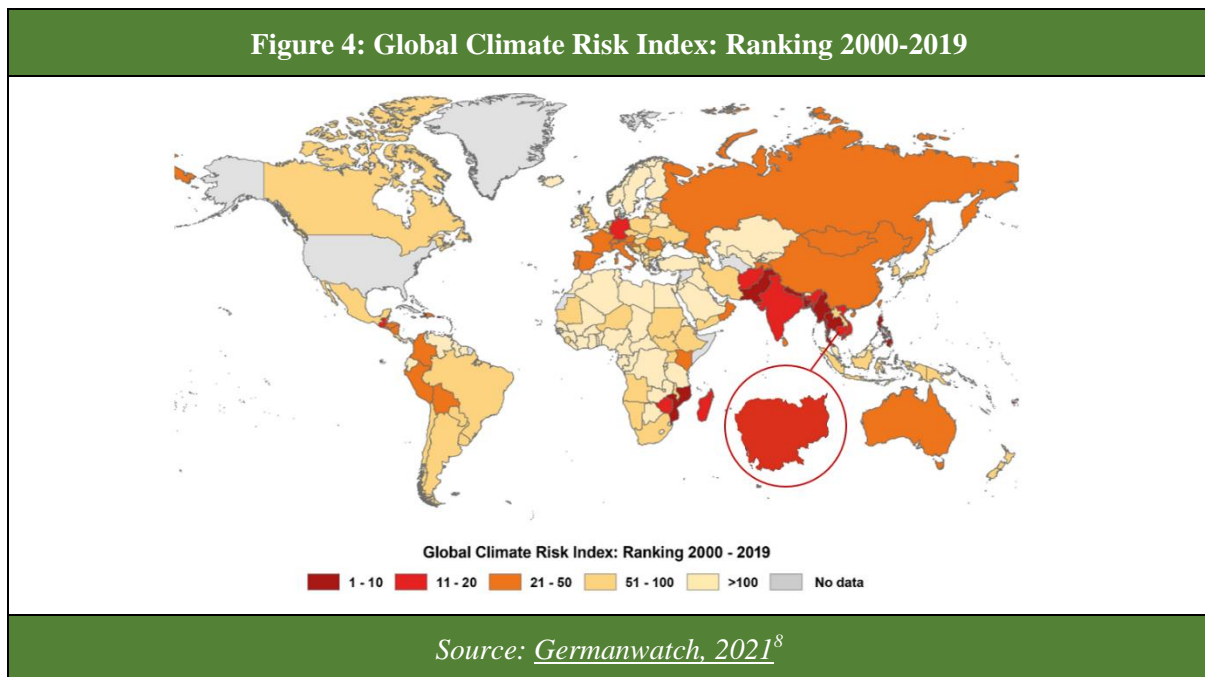
The overall assessment results (**Figure 2**) in the **codesign phase of IbFW** have shown that the level of knowledge and understanding about IbFW in Cambodia is medium (**Score of 3.0**) meaning there exist awareness about IbFW among the targeted agencies (DOM/MoWRAM, NCDM and MAFF). Similarly, in 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 three agencies identifying relevant partners such as the UNDP, WFP and People in Need (PIN) while also acknowledging that the stakeholders may have medium level of understanding on IbFW. Most of the engagements with development partners are project-based partnerships and collaborations. However, the overall results do not identify any other additional stakeholders.

The overall assessment results in the **coproduce phase of IbFW** have shown that the targeted agencies knowledge and understanding of risk and impact assessment as well as IbFW generations need to be enhanced considering its limited capacity (**Score of 2.0**). All three agencies have confirmed that national level risk assessment was not done, however, small scale assessments may have been done at provincial or district levels. In terms of forecast and warning generation, all the three agencies (DOM, NCDM, MAFF) have responded by saying that the current hazard forecast and warning information are being issued only for key hazards that includes floods, droughts, storms and lightning and such information are available on a daily and weekly basis. However, the integration of IbFW is lacking.

The overall assessment results in the **delivery phase of IbFW** have shown that the targeted agencies knowledge and skills need to be enhanced in IbFW dissemination and forecast verification (**Score of 2.0**). While DOM/MoWRAM is responsible for issuing forecast and warning information, the information sent out to NCDM and MAFF are still based on traditional weather forecasting and therefore, both these agencies receive information on weather conditions that are generic and does not clearly reflect the area of impact and its likely intensity. There are also other factors which further supplement to the existing challenges that includes limited knowledge of stakeholders in understanding the existing forecast and warning information in response to the hazard's occurrence, limited understanding of the required actions on preparedness at local level/end user level after the warning or forecast is issued and lack of interagency coordination mechanisms.

The final assessment results have highlighted limited capacity on IbFW in Cambodia in terms of knowledge, skills and competencies. 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 Cambodia 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 Cambodia.

Floods and droughts are major natural hazards in Cambodia, which is exacerbated by the country's high levels of exposure and susceptibility. Floods and drought are also recognized as potential natural hazards along with climate change in the Strategic National Action Plan for Disaster Risk Reduction ([NAP-DRR, 2014-2018](#)⁷). Several locational factors such as distinct geography, demographic trends, socio-economic factors, and limited adaptive capacities have an important role in determining the level of vulnerability; for example, the floodplains along the Mekong are more vulnerable to river floods, whereas mountain ranges (such as the Cardamom) are more susceptible to isolated landslides and flash flooding ([GFDRR, n.d.](#)). **Figure 4** represents Global Climate Risk Index Ranking from 2000-2019.



According to the 2022 INFORM Risk Index, Cambodia has a high degree of catastrophe risk, ranking 57th out of 191 nations ([EU, 2021](#)). This is mostly due to the country's high exposure and vulnerability to flooding ([GFDRR, n.d.](#)). Cambodia is highly vulnerable to flooding ([it is ranked equal 3rd in the world](#)), which includes riverine and flash floods ([EU, 2021](#)). Cambodia also has exposure to tropical cyclones and their associated hazards, and while the country's drought exposure is slightly lower than the global average, it is still a significant source of concern, as demonstrated by the severe drought that occurred in the country from 2015 to 2017. Cambodia's overall rating on the INFORM risk index is 4.6 (Medium to High), which compounded to some extent by a lack of coping capacity and higher susceptibility of the people. Many studies highlighted that Cambodia along with Bangladesh, and Vietnam are the countries with the largest proportional share of people and the highest percentage of GDP that is

⁷ NAP-DRR (2014-2018). URL: <https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2017/12/2014-national-action-plan-for-disaster-risk-reduction-nap-drr-2014-2018-english.pdf>

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

vulnerable to floods ([Kundzewicz, et al., 2014](#); [World Bank, 2015](#); [Willner, et al., 2018](#); [ADPC, 2019](#); [ADB, 2021](#)).

Section 3: Multi Hazard Impact-based Forecasting and Warning

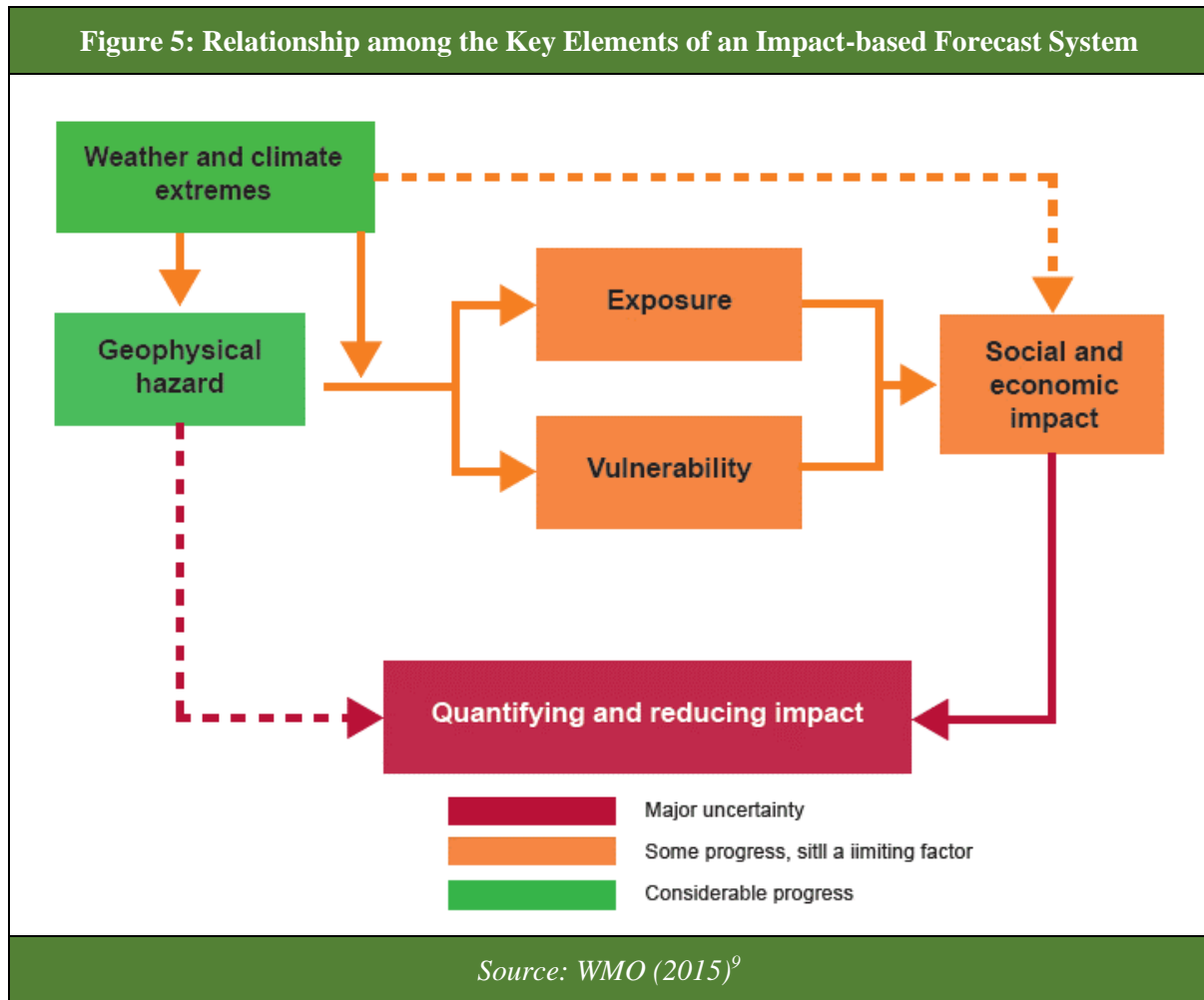
It is evident from Riskscape that each year the impacts of severe hydro-meteorological events in Cambodia give rise to multiple casualties and significant damage to property and infrastructure, with adverse economic consequence for communities, which can persist for many years. All this happens despite of precise forecasts of many of these severe events, with accurate warning information disseminated in a timely fashion by the MoWRAM and NCDM in Cambodia. 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. MoWRAM in Cambodia). Impact-based forecasts emphasize what a hazard will do rather than what a hazard will be. Achieving this requires MoWRAM 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 MoWRAM 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 NCDM 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.

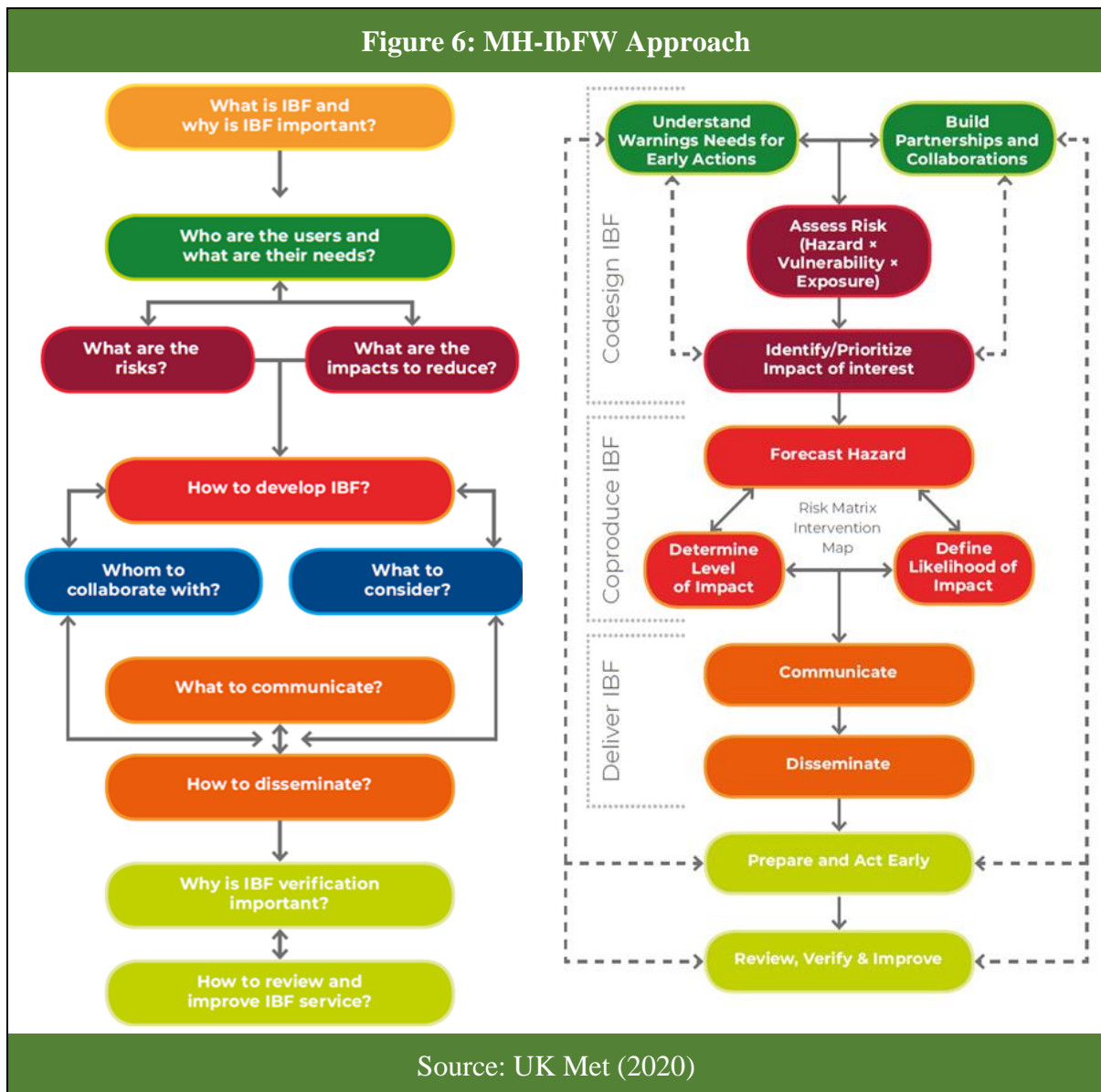


MH-IbFW is based on three main or primary components which can be further divided into secondary or sub-components. These three primary components of IbFW are suggested in guidelines developed by World Meteorological Organization (2015, 2021) and UK Met (2020). The brief description of the component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

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

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, Cambodia 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 in Cambodia

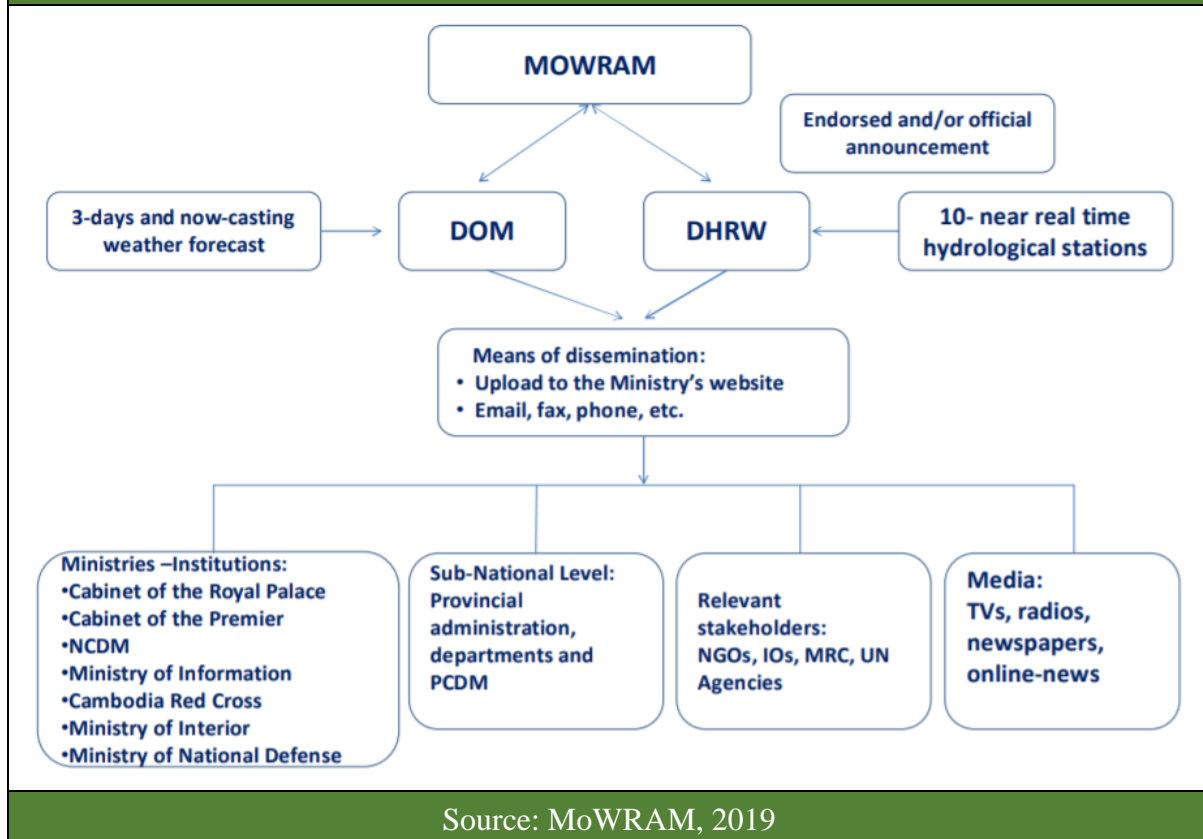
In Cambodia, Ministry of Water Resources and Meteorology (MoWRAM) is the mandated agency which directly engaged and deal with flood and drought monitoring, forecast and early warning. MoWRAM is designated National Meteorological and Hydrological Services (NMHS) in Cambodia. MoWRAM is the key producer of climate information in Cambodia. The Ministry of Agriculture, Fisheries, and Forestry (MAFF) is co-producer with value added information for agriculture and allied sectors. The National Committee for Disaster Management (NCDM) is also actively involved in flood and drought matters with the different mandate, roles and responsibilities. NCDM is mandated National Disaster Management Organisation (NDMO) in Cambodia. NCDM is also responsible for disaster management and impact assessment. The MoWRAM and its two key departments including Department of Meteorology (DoM) and Department of Hydrology and River Work (DHRW) are principally involved with meteorological and hydrological observation, forecasting, and early warning, as well as matters related water resources management, including the construction of physical infrastructure and the provision of large-scale pumping equipment when required. The Department of Meteorology (DOM) provides forecasts for heavy rain and flash flooding and storms as well as temperature. The Department of Hydrology and River Works (DHRW) is the main agency responsible for flood forecasting. **Figure 7** represents dissemination of hydro-meteorology forecasting and early warning information in Cambodia.

The DoM established in year 1999 under the MoWRAM is mandated to provide weather services including drought and flood monitoring and forecasting for Cambodia (Dutta et al., 2015). DoM is responsible for the operation and maintenance of all the meteorological observation and measurements, issuance of weather forecasts and severe weather warnings all over the country (Dutta et al., 2018). The weather information linked to crop yield monitoring/forecasting is very important for farmers to take key decisions regarding the management of their crops, livestock, soil, harvest, and equipment. DoM regularly update about impending extreme events and its direct and indirect impacts through its Provincial Department of Water Resources and Meteorology (PDoWRAM).

Weather observation network in Cambodia is consists of synoptic stations with manned observational equipment and manual rainfall stations. In Cambodia, weather observation network including forecast tool consist of meteorological stations, manual weather stations, rain gauges, one S-Band Weather RADAR, GTS connection, high performance servers, and a HIMAWARI weather satellite data reception and visualization station; while the hydrological observation network consists of various stations. MoWRAM provides climate data and information; Nowcasting; three-day, one-week, and seasonal forecasts; and severe weather warnings as a public weather service. MoWRAM receives the various meteorological data /information as well as early warning for any impending extreme event that occurred in the

region via the regional Global Telecommunication System (GTS) that linked from Thailand Meteorological Department (TMD), Bangkok. The forecast and early warning is provided to many users such as local authorities, NCDM, MAFF, Ministry of Information, Ministry of Defense, Cambodia Red-Cross, Media (TV, Radio, newspaper, through fax, telephone, email, and website).

Figure 7: Dissemination of Forecasting and Early Warning Information in Cambodia



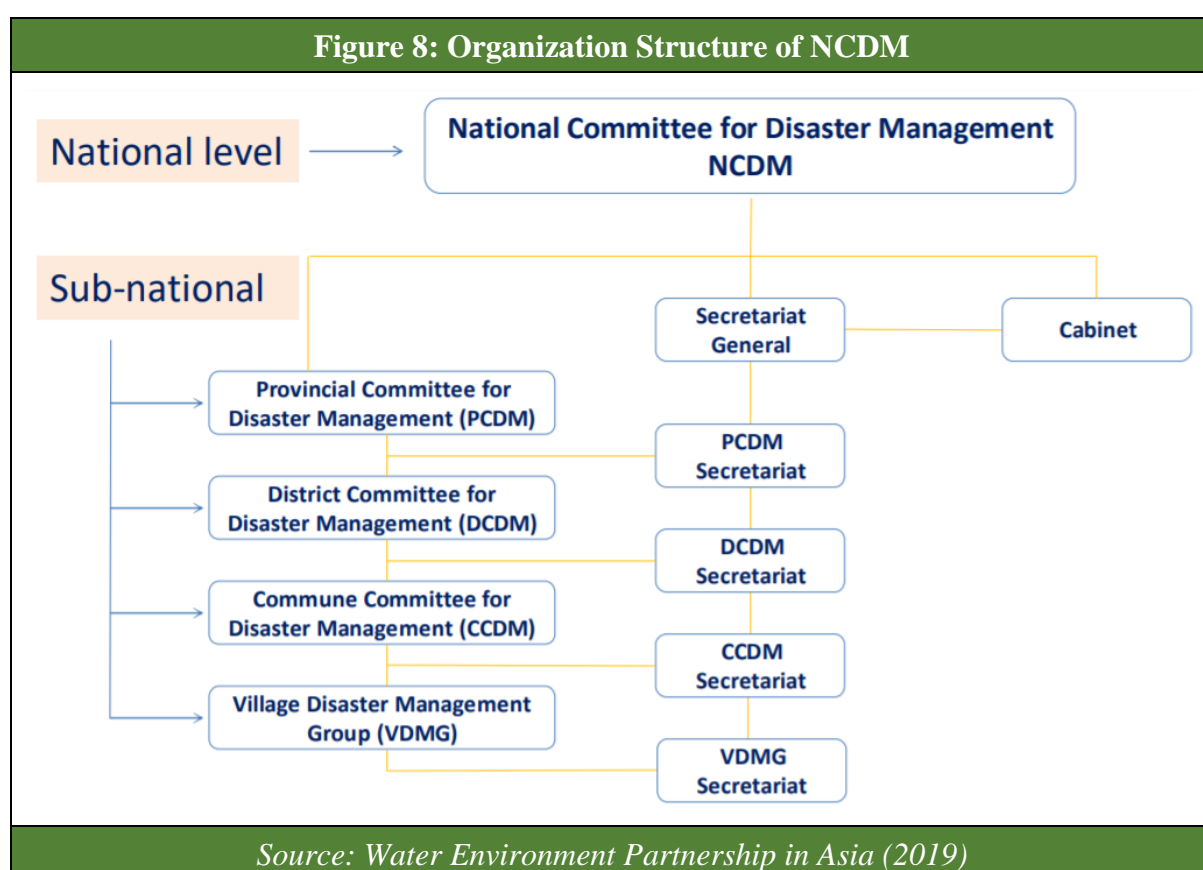
Source: MoWRAM, 2019

Department of Hydrology and River Work (DHRW) under MoWRAM, is responsible to manage and exchange hydrological information and issue forecasts and early warnings for possible floods and droughts to facilitate the timely adoption of mitigation measures. MOWRAM continuously engaged in the modernization of meteorological instruments and technology in Cambodia. The objective of this modernization is to enable the department to produce and broadcast weather forecasts to the relevant stakeholder. In this context, a Radar Station (TECHO SEN), has been established in Phnom Penh in year 2011. The station is operational since the April 2012 (<http://www.cambodiameteo.com>).

In terms of floods, the MoWRAM is in charge of pre-intervention measures such as early warnings, while the MAFF is in charge of post-intervention measures such as aiding with the restoration of rice fields following flood damage. The MoWRAM is also responsible for the establishment of Farmer Water User Committees (FWUCs), who are responsible for the management of water in their particular irrigation projects. A FWUC is not a government

agency, but rather a group of stakeholders who live in the region where an irrigation scheme is located who came together to create the organization.

NCDM is another important government organization that deals with disaster management in Cambodia. Early warning and evacuation are the responsibility of the line authorities (Provincial, district, and Commune Committee for Disaster Management) within this organization. Despite the fact that Cambodia appears to have different government departments dedicated to drought relief, there is typically coordination among the many authorities involved. Also created to perform specialized duties are intergovernmental organizations (IGOs). So, for example, in order to investigate and deal with the effects of climate change, the government issued Sub-Decree Number 35 in 2006, which established the National Climate Change Committee, which is presided over by the prime minister, chaired by a minister from the Ministry of Environment, and comprised of other high-ranking officials from relevant government agencies as members. Following the issuance of the sub-decree, working groups and task forces were created to provide technical assistance to the National Committee. **Figure 8** represent the organization structure of NCDM.



In terms of warning generation and dissemination, an extensive review conducted for MoWRAM found that it is mandated to produce and disseminate forecasts for the entire country. Flood monitoring, forecasting and warning information on the Mekong, the Bassac and the Tonle Sap mainstems is disseminated by the MoWRAM and the Department of Hydrology and River Works (DHRW). They disseminate information through daily bulletins,

emails and faxes to relevant line agencies, to be disseminated further to the public by radio, newspapers and public media networks. Department of Meteorology is responsible for monitoring the weather conditions in the country and region; for issuing weather forecasts and providing warnings on weather conditions to relevant agencies, including the NCDM, by phone, fax, email, web page, TV/radio, newspaper and SMS. The Provincial Department of Water Resources and Meteorology (PDoWRAM) at the local level further disseminates the warnings to communities (communes) through its networks by phone and radio-communication. On the other hand, NCDM provides a coordinating role in establishing and implementing early warning programmes as well dissemination of warning information. While MoWRAM acts as the source agency for observation, detection and warning formulation, the National Committee for Disaster Management (NCDM) remains as the central agency to disseminate the early warning information to the provincial committees for disaster management (PCDM), district committees for disaster management (DCDM), commune committees for disaster management (CCDM), the Cambodian Red Cross (CRC) and subsequently to the other entities of the last mile communication that are coordinated for emergency operations and response towards the early warning (Dutta et al., 2015).

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 Cambodia to improve the institutional capacities of national stakeholders such as the MoWRAM, the NCDM and sectoral agency such as 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 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. Overall assessment results from Cambodia have suggested limited capacity on MH-IbFW ranging from low (**Score of 2**) to medium (**Score of 3**). Therefore, it is recommended that an MH-IbFW strategy be developed together with an action plan highlighting the need for training and capacity building at institutional level so that existing capacities are enhanced on the use of MH-IbFW in Cambodia. This national level strategy and action plan has therefore, been developed taking into consideration the recommendations provided as an outcome of the readiness assessment of MH-IbFW in Cambodia. The strategy and action plan will guide the future implementation of MH-IbFW activities in the country.

5.1 Purpose and Objectives:

The **purpose** of this document is to introduce key priorities of MH-IbFW in Cambodia based on readiness assessment results and recommendations. The document outlines potential strategies and action plan for developing MH-IbFW for Cambodia. The document is targeted at MoWRAM, NCDM and sectoral institutions responsible for developing and operating existing early warning systems. MH-IbFW strategy and action plan of Cambodia highlights the

priority action for MoWRAM and NCDM and key sectoral institutions for the next ten years. The **objectives** of this decadal MH-IbFW strategy and action plan is:

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

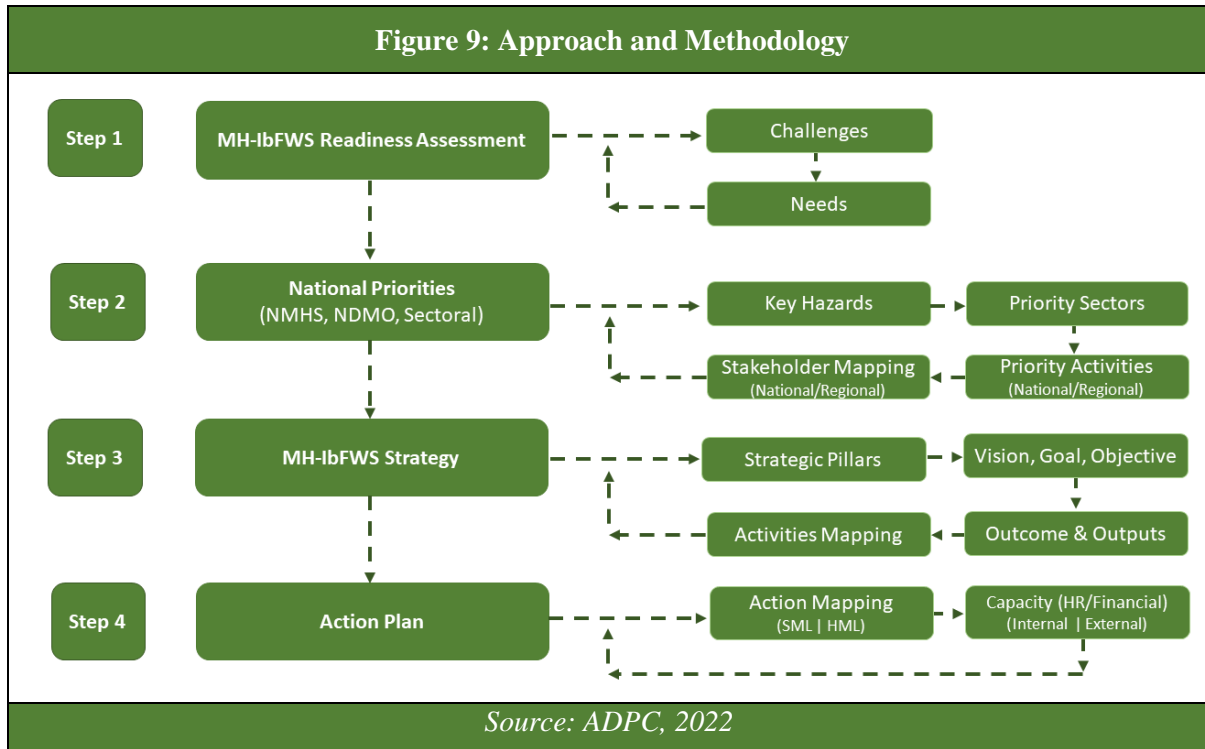
MH-IbFW strategy will guide MoWRAM and NCDM to engage credibly with the institutions, and individuals and development partners to contribute in more informed national and local decision-making, potentially saving lives and livelihoods. Further, enhancing capability builds a stronger platform for the country to manage the impacts of climate change and equipping Cambodia with valuable information to implement MH-IbFW strategy in phased manner. To see the benefits of MH-IbFW, Cambodia 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 Cambodia draws upon **international best practices** and is mindful of the operational constraints of information/data requirements, availability, collection, collation, and analysis at local level in Cambodia. 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 Cambodia.

Each year the impacts of severe hydro-meteorological events in Cambodia 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 MoWRAM and NCDM in Cambodia. 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 now 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, Cambodia 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 9** represents approach and methodology for MH-IbFW strategy development in Cambodia.



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 government, financiers and potential partner organizations. 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 organizations and will also help to introduce efficiency. The key elements, implementation phases and potential timeline of MH-IbFW are represented in **Table 3**.

Table 3: 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.	
	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 as well as 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, through 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 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 the 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, SOPs, Guidelines and MoUs	

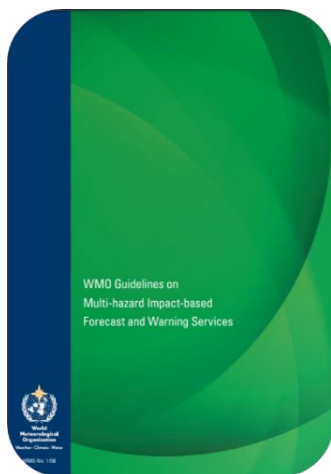
Table 3: MH-IbFW Key Elements, Phases and Timeline

Phase	Key Elements	Details	Potential Timeline
		Identify relevant approvals and funding needed to develop MH-IbFW Establish roles and responsibilities for partner organisations	

Sector 7: Current Practices

7.1: International Guidelines:

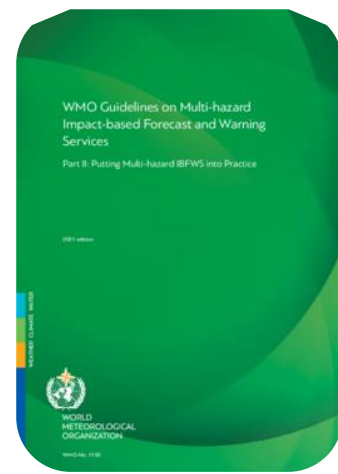
MH-IbFW Strategy for Cambodia is guided by key guidelines on climate services, early warning systems, and disaster risk management developed by various international and regional organisations. WMO and UK Met Office has developed an MH-IbFW Guidelines^{10 11 12} and MHEWS Checklist¹³ which can be further referred to keep track of what has already been developed and achieved and what needs to be developed for an effective MH-IbFW in Cambodia. The relevant international and regional guidelines such as “**Multi Hazard Impact-based Forecast and Warning**” (WMO, 2015), “**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

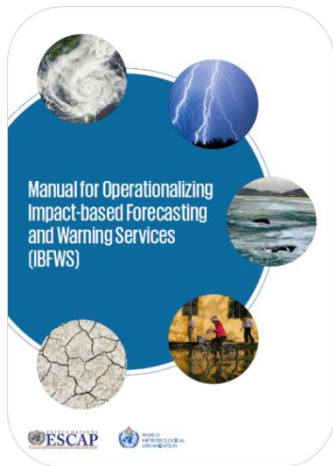
Other relevant guidelines such as “**Guidelines for Implementation of Common Alerting Protocol (CAP) – Enabled Emergency Alerting**” (WMO, 2013) can also be useful for MH-IbFW guidelines.

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

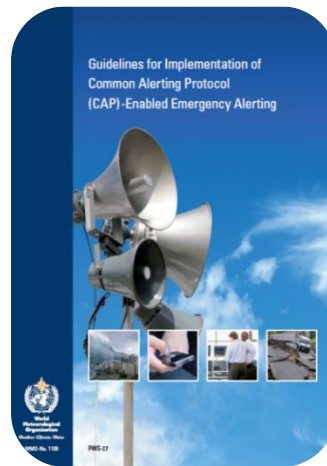
¹¹ WMO (2021), URL: https://library.wmo.int/?lvl=notice_display&id=21994#.YpwXpXZBxPZ

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

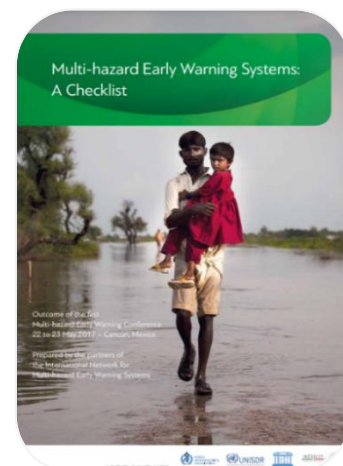
¹³ WMO (2017), URL: https://library.wmo.int/index.php?lvl=notice_display&id=20228#.Wri4cI4zMt8



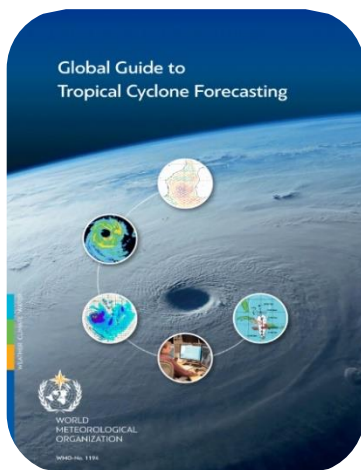
Source: UNESCAP, 2021



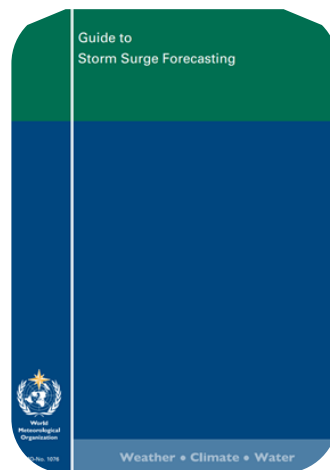
Source: WMO, 2013



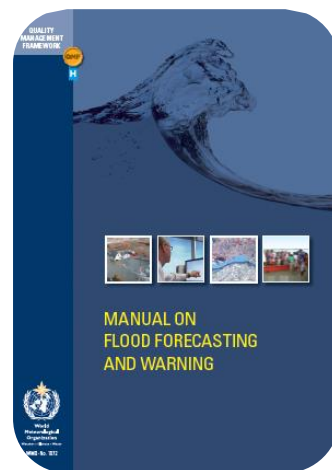
Source: WMO, 2017



Source: WMO, 2019



Source: WMO, 2011



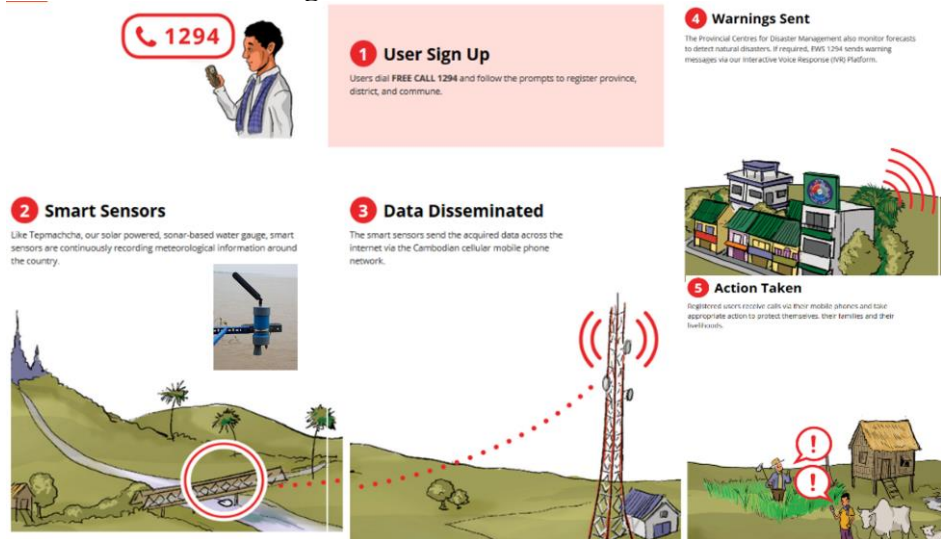
Source: WMO, 2011

7.2: National Level MHEWS Initiatives:

Early Warning System (EWS) 1294

EWS 1294 is a new initiative in Cambodia established in 2017 which alerts the public in advance of natural disasters that may occur in Cambodia. EWS 1294 is designed and developed by People-in-Need (PIN) that has been handed over to NCDM who now manages and operates the system (Figure (13)). Short code 1294 is a phone number that belongs to National Committee for Disaster Management (NCDM), given by Ministry of Posts and Telecommunications (MoPTC) and Telecommunication Regulator of Cambodia (TRC). An audio recording is delivered to the mobile phones of registered users in the affected areas when a natural disaster such as floods is detected or forecast, such as flash flooding. Three main mobile phone companies in Cambodia i.e. Smart Axiata Co., LTD; CamGSM. Co., LTD or called Cellcard and Metfone, provide its services for free for warning system and humanitarian purposes. **Figure 10** represents EWS 1294 platform.

Figure 10: EWS 1294 Platform

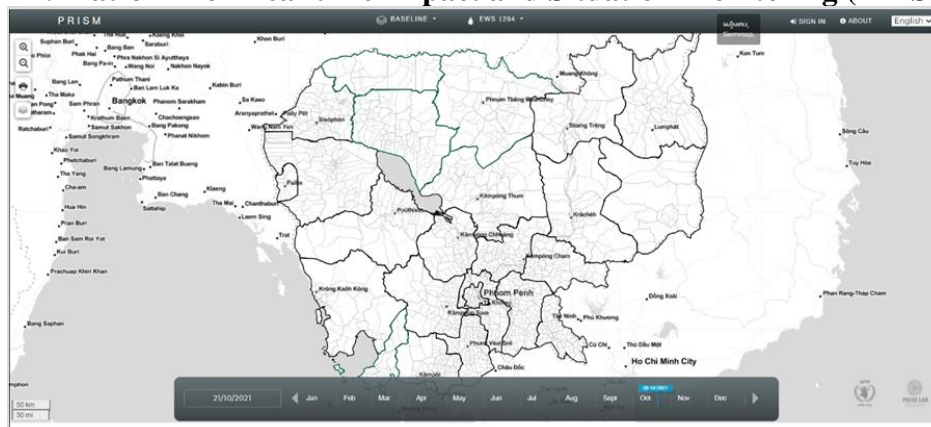


Source: <http://ews1294.info/en/how-it-works/>

Platform for Real-time Impact and Situation Monitoring (PRISM)

Platform for Real-time Impact and Situation Monitoring (PRISM)³⁰ has been developed to monitor the risk and impact of climate hazards in real time, the. For the first time, PRISM integrates satellite and other remote sensing data of climate-related hazards with data on socio-economic vulnerability to provide actionable climate risk information that helps those in need first. Droughts and floods, among other hazards, can be tracked over time using the maps' interactive features. Calculating the hazard's severity by administrative area is made easier with the use of graphs and tables (such as provinces and districts). Risk and effect indicators based on known vulnerabilities and exposure to hazards at any given time can also be generated automatically by the system. Mobile data collecting systems can be used in conjunction with PRISM. This gives customers the ability to see real-time data from affected locations, as well as hazard information supplied by the platform itself (PRISM, n.d.³⁰). **Figure 11** represents Platform for Real-time Impact and Situation Monitoring (PRISM) Tool.

Figure 11: Platform for Real-time Impact and Situation Monitoring (PRISM) Tool



Source: PRISM, n.d.¹⁴

¹⁴ Platform for Real-time Impact and Situation Monitoring (PRISM) Tool. URL: <https://www.prism-kh.info/>

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 forecast 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.

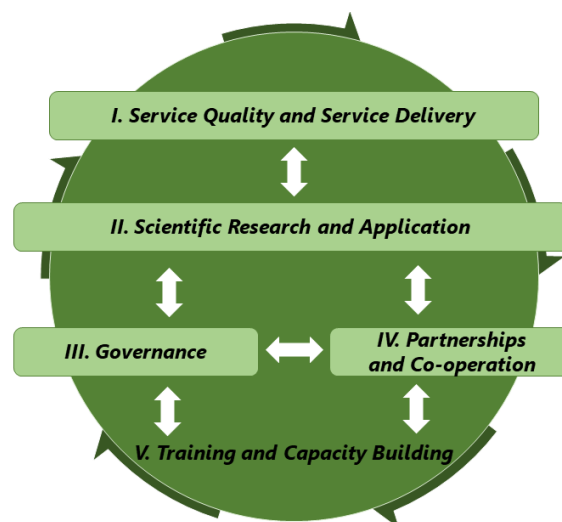
8.1 Vision: MH-IbFW Strategy has suggested the following Vision Statement for Cambodia.

MoWRAM and NCDM of the Cambodia 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 Cambodia developed based various national priorities, collated in following **five pillars (Figure 12)**:

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

Figure 12: MH-IbFW Strategic Pillars and Linkages



Source: ADPC, 2022

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** towards strengthening weather and climate observation, monitoring, forecasting and communication capacities in Cambodia. 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 the 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 and climate information	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
		<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 MoWRAM enhanced in generating, enhancing the quality of need-based climate products through innovative approaches	
<ul style="list-style-type: none"> • 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 Cambodia. 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 the 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 landslide
		<ul style="list-style-type: none"> • Establish threshold values that will cause drought, flooding, tropical cyclone, storm surge and landslide in Cambodia
		<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, flood and landslide
		<ul style="list-style-type: none"> • Undertake risk analysis incorporating hazard, exposure and vulnerability and 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 the 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 Cambodia. 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 Cambodia. The goal, outcome, outputs and high-level actions link with this pillar are represented in the 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 resilience planning at national and local levels and institutionalized people-centered MH-IbFW	Risk and evidence-based development polices and plans, investment programs developed at the national and local levels and the institutionalization of MH-IbFW facilitated and climate risk information in local policies, plans and budgets integrated	<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 (SOP) for MH-IbFW 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 MoWRAM, NCDM and sectoral institutions in Cambodia. The goal, outcome, outputs and high-level actions link with this pillar are represented in following table.

Goal: Enhancing Partnerships and Cooperation between MoWRAM, NCDM and Sectoral Institutions		
Outcome	Output	High-Level Actions
National Partnerships and Cooperation Enhanced	Partnership and cooperation enhanced between MoWRAM, and NCDM	<ul style="list-style-type: none"> • Preparation of National Framework for Climate Services (NFCS) for better Cooperation between MoWRAM, NCDM and sectoral institutions
		<ul style="list-style-type: none"> • National Climate Outlook forums to improve two-way communication between MoWRAM and users in all sectors

Goal: Enhancing Partnerships and Cooperation between MoWRAM, NCDM and Sectoral Institutions		
Outcome	Output	High-Level Actions
	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/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 implement the people-centered MH-IbFW and Forecast-based Early Actions (FbA) in Cambodia. 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 capacities in implementing a people-centered MH-IbFW and forecast-based early actions (FbA)	Capacities of MoWRAM, NCDM and Sectoral Institutions in co-design, co-produce and deliver the MH-IbFW products straightened in Cambodia	<ul style="list-style-type: none"> • Conduct a gap assessment on MH-IbFW of key national and local 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 for the four project sites
		<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 communication (IEC) materials on MH-IbFW including FbA and conduct advocacy and outreach starting in project sites
		<ul style="list-style-type: none"> • Expanding the use of MH-IbFW nationwide using scenarios

Section 9: Guidance on 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 Cambodia. 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** strengthening weather and climate observation, monitoring, forecasting and communication capacities in Cambodia. 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) ¹⁵ (S: 1-2, M: >2-5, L: >5)	Priority ¹⁶	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: MoWRAM, Cambodia, C: Internal (MoWRAM)
		Explore the use of non-traditional observations (eg: satellite data / reanalysis data) in areas where the conventional network is sparse through pilot activity	Short (1-2)	High	R: MoWRAM, Cambodia, 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: MoWRAM, Cambodia, 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: MoWRAM, Cambodia, C: Internal (MoWRAM)
	Capacity of MoWRAM	Conduct sectoral need	Short (1-2)	High	R: MoWRAM, Cambodia,

¹⁵ S: Short, M: Medium, L: Long

¹⁶ **First priority**; **Second priority**; **Third priority**

	enhanced in generating, enhancing the quality of need-based climate products through innovative approaches	assessment for climate products			C: External (Development Partners, Regional Institutions, Technical Partners)
		Implement pilot applications projects at national, sub-national and local level to demonstrate economic benefits of new and innovative climate products	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)

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

Goal: Generating comprehensive Weather and Climate informed Multi-hazard and Risk Information for MH-IBFW					
Outcome	Outputs	High-Level Actions	Timeframe (Years) ¹⁵ (S: 1-2, M: >2-5, L: >5)	Priority ¹⁶	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: NCDM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)
		Establish threshold values that will cause drought,	Short (1-2)	High	R: MoWRAM, Cambodia, R: NCDM, Cambodia,

		flooding, tropical cyclone, storm surge and landslide in Cambodia			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: NCDM, Cambodia, C: Internal (NCDM))
		Develop exposure database for key elements of exposure	Short (1-2)	High	R: NCDM, Cambodia, 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: NCDM, Cambodia, 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: NCDM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop the impact-based	Short (1-2)	High	R: MoWRAM, Cambodia,

		forecasting and warning system matrix for each hazard			R: NCDM, Cambodia, 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: MoWRAM, Cambodia, R: NCDM, Cambodia, 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: MoWRAM, Cambodia, R: NCDM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)
		Test and validate the impact and response tables	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, R: NCDM, Cambodia, 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: MoWRAM, Cambodia, R: NCDM, Cambodia, C: External (Development

					Partners, Regional Institutions, Technical Partners)
		Conduct simulations to test the MH-IbFW and calibrate knowledge and decision support system on a regular basis	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, R: NCDM, Cambodia, 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 Cambodia. The timeframe, priority, responsibility and capacity related high-level actions link with this pillar are represented in the 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)¹⁵ (S: 1-2, M: >2-5, L: >5)	Priority¹⁶	Responsibility (R)/ Capacity (C)
Climate risk information and MH-IbFW mainstreamed in development policy and planning, investment programming and resilience planning at national and local levels and institutionalized people-centered MH-IbFW	Risk and evidence-based development polices and plans, investment programs developed at the national and local levels and the institutionalization of MH-IbFW facilitated and climate risk information in local policies, plans and budgets integrated	Enhance existing manuals and guidelines on integrating MH-IbFW and FbA in national and local resilience planning processes	Short (1-2)	High	R: MoWRAM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop Standard Operating	Short (1-2)	High	R: MoWRAM, Cambodia,

		Procedures (SOP) MH-IbFW and FbA in national and local resilience planning processes			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: MoWRAM, Cambodia, C: Internal (MoWRAM) 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 MoWRAM, NCDM and sectoral institutions in Cambodia. 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 MoWRAM, NCDM and Sectoral Institutions					
Outcome	Output	High-Level Actions	Timeframe (Years)¹⁵ (S: 1-2, M: >2-5, L: >5)	Priority¹⁶	Responsibility (R)/ Capacity (C)
National Partnerships and Cooperation Enhanced	Partnership and cooperation enhanced between MoWRAM, and NCDM	Preparation of National Framework for Climate Services (NFCS) for better Cooperation between MoWRAM, NCDM and sectoral institutions	Short (1-2)	High	R: MoWRAM, Cambodia, C: Internal (MoWRAM) C: External (Development Partners, Regional Institutions, Technical Partners)
		National Climate Outlook forums to	Short (1-2)	High	R: MoWRAM, Cambodia,

		improve two-way communication between MoWRAM and users in all sectors			C: Internal (MoWRAM) 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: MoWRAM, Cambodia, R: NCDM, Cambodia, C: Internal (MoWRAM)
		Collaboration and dialogue between producers, co-producers and users	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, R: NCDM, Cambodia, C: Internal (MoWARM/ NCDM)
		Strengthen national inter-agency operational coordination mechanisms at the national level to implement MH-IbFW (Technical Working Groups)	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, R: NCDM, Cambodia, C: Internal (MoWRAM/ NCMD)
		Develop multi-stakeholder partnerships at the national and local levels for FbA and social protection	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, R: NCDM, Cambodia, C: Internal (MoWRAM/ NCDM)
		Encourage the development and open sharing of accurate risk information/ knowledge, provided as a	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, C: Internal (MoWRAM)

		regional public good			
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: MoWRAM, Cambodia, C: Internal (MoWRAM) C: External (Development Partners, Regional Institutions, Technical Partners)
		Establishment of Inter-country communication systems for establishing MH-IBFW and disseminating this information to users	Long (>5)	Low	R: MoWRAM, Cambodia, C: Internal (MoWRAM) C: External (Development Partners, Regional Institutions, Technical Partners)
		Establishment of a joint, multi-disciplinary, scientific sectoral working group	Long (>5)	Low	R: MoWRAM, Cambodia, R: NCDM, Cambodia, R: Sectoral Agencies C: Internal (MoWRAM/ NCDM) 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) ¹⁵ (S: 1-2, M: >2-5, L: >5)	Priority ¹⁶	Responsibility (R)/ Capacity (C)
Improved national and local capacities in implementing a people-centered MH-IbFW and forecast-based early actions (FbA)	Capacities of MoWRAM, NCDM and Sectoral Institutions in co-design, co-produce and deliver the MH-IbFW products straightened in Cambodia	Conduct a gap assessment on MH-IbFW of key national and local end-users	Short (1-2)	High	R: MoWRAM and NCDM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)
		Build gender-sensitive institutional and technical capacities to implement MH-IbFW.	Short (1-2)	High	R: MoWRAM, Cambodia, R: NCDM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)
		Develop localized impact tables and response tables for each hazard for the four project sites	Short (1-2)	High	R: MoWRAM, Cambodia, R: NCDM, Cambodia, 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: MoWRAM, Cambodia, R: NCDM, Cambodia, C: External (Development Partners, Regional Institutions,

					Technical Partners)
		Develop knowledge products and information, education and communication (IEC) materials on MH-IbFW including FbA and conduct advocacy and outreach starting in project sites	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, R: NCDM, Cambodia, C: External (Development Partners, Regional Institutions, Technical Partners)
		Expanding the use of MH-IbFW nationwide using scenarios	Medium (>2-5)	Medium	R: MoWRAM, Cambodia, 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 Services' (MoWRAMs) forecasts and warnings. Impact-based forecasts emphasize what a hazard will do rather than what a hazard will be. Achieving this, requires MoWRAMs 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 MoWRAMs and NCDM 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) already 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 NCDMs 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.

Cambodia 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. MoWRAM in Cambodia 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 MoWRAM need to upgrade in Cambodia.

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)**
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

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