Deltares

Development of a Multi-Hazard Platform for forecasting Local level climate extremes and physical hazards for Iskandar Malaysia

Inception report

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Summary

This report describes the detailed workplan for the project "Development of a Multi-Hazard Platform for forecasting local level climate extremes and physical hazards for Iskandar Malaysia". In this report we present the overall approach and detailed task descriptions and deliverables. The purpose of this report is to present a detailed approach and inform key stakeholders about the process and main goals and outputs of the project.

The project consists of 4 phases or tasks:

- Inception phase that gave rise to the underlying work plan.
- Functional and technical design of a multi-hazard platform.
- Prototype development and financing needs assessment.
- Capacity building and knowledge product development.

The outcome of this project will be that local authorities and key stakeholders in Iskandar Malaysia have a better understanding of needs, benefits, and costs of having a multi-hazard platform for their region, and how such a system could work and can be operated. The prototype will also provide users with hands-on experience using such a platform.

Contents

1 Introduction

The Climate Technology Centre and Network (CTCN), being the operational arm of the United Nations Framework Convention on Climate Change, received and awarded a request from Malaysia to provide Technical Assistance (TA) on Development of a Multi-Hazard Platform for forecasting Local level climate extremes and physical hazards for Iskandar Malaysia. The objective of the TA is to enable Iskandar Malaysia to take early actions to mitigate climate risk through a decision support system designed in an inclusive manner and based on the understanding of the local level climate extremes and their impacts by integrating them into a prototype Multi-Hazard Platform (MHP) focusing on coastal hazards.

Coastal areas in Malaysia are largely affected by various hazards (floods, droughts, erosion, etc.) affecting its growing population and increasing number of assets. Combined with climate change and sea level rise, these hazards threaten the fast-growing coastal developments in Malaysia.

The TA will deliver a prototype decision support tool which will demonstrate how a multi-hazard platform for five zones of Iskandar Malaysia can help address growing climate change risks of this important coastal economic zone.

The overall goal of the project is to (1) develop technical specifications to design and integrate information on local climate extremes and hazard risks in a multi-hazard platform (MHP) for Iskandar Malaysia (IM), (2) develop a prototype and establish the financing requirements to operationalize the MHP for IM, and (3) improve local capacities in implementing a people-centred forecasting system using social innovation.

In this project, commissioned to Deltares, we will capacitate the Iskandar Regional Development Authority in the development of a prototype of the multi-hazard platform. There are basically 4 main tasks in the project, preceded by an inception phase:

1) Task 1: Inception phase to deliver a detailed workplan.
2) Task 2: The functional and technical design of a multi-hazard platform.
3) Task 3: The development of a prototype of the multi-hazard platform.
4) Task 4: Improve local capacities in implementing a people-centred forecasting system.

In the inception phase we have worked out in more detail the workplan and established the form of communication between our team and IRDA. We also started with the data collection process, which includes the collection of relevant reports and information on data portals.

After approval of the workplan delivered in the inception phase we will start in Task 2 with making a functional design of the multi-hazard platform. A functional design describes the functionalities that should be included in a multi-hazard platform. This will be a joint effort between our team, IRDA and potential other stakeholders. Based on a literature review and the information collected from key stakeholders, an overview of the current situation and the desired situation will be made. From here we can derive risk information requirements, that can be used as input for the functional design of the system. Based on the functional design, a technical design will be made. The technical design covers more details, for example on data requirements, hydrodynamic and hydrological modelling, etc. In Task 2 we will also start with the collection of existing, and development of missing hazard and risk information. This includes determining the return periods for specific coastal hazards and risk, preparing the related hazard and risk maps, and deriving threshold values for early warning and response.

This information is required as input for the functional design and can later be used as direct input to the multi-hazard platform.

In Task 3 a prototype of the multi-hazard platform will be developed. The functional and technical design are used as input for the prototype, but the prototype shall not be fully covering all elements from the functional and technical design. An implementation plan, including a rough cost estimate for the development of a fully functioning prototype will be developed in parallel to demonstrate how the prototype can be upscaled.

In Task 4 we will focus on improving local capacities through a workshop, training sessions and the development of knowledge products. These knowledge products will be designed in close collaboration with key stakeholders and shall be made fit to local conditions. The prototype developed in Task 3 will be used as input for the capacity building and knowledge product development.

A schematic representation of the project is shown in Figure 1-1.

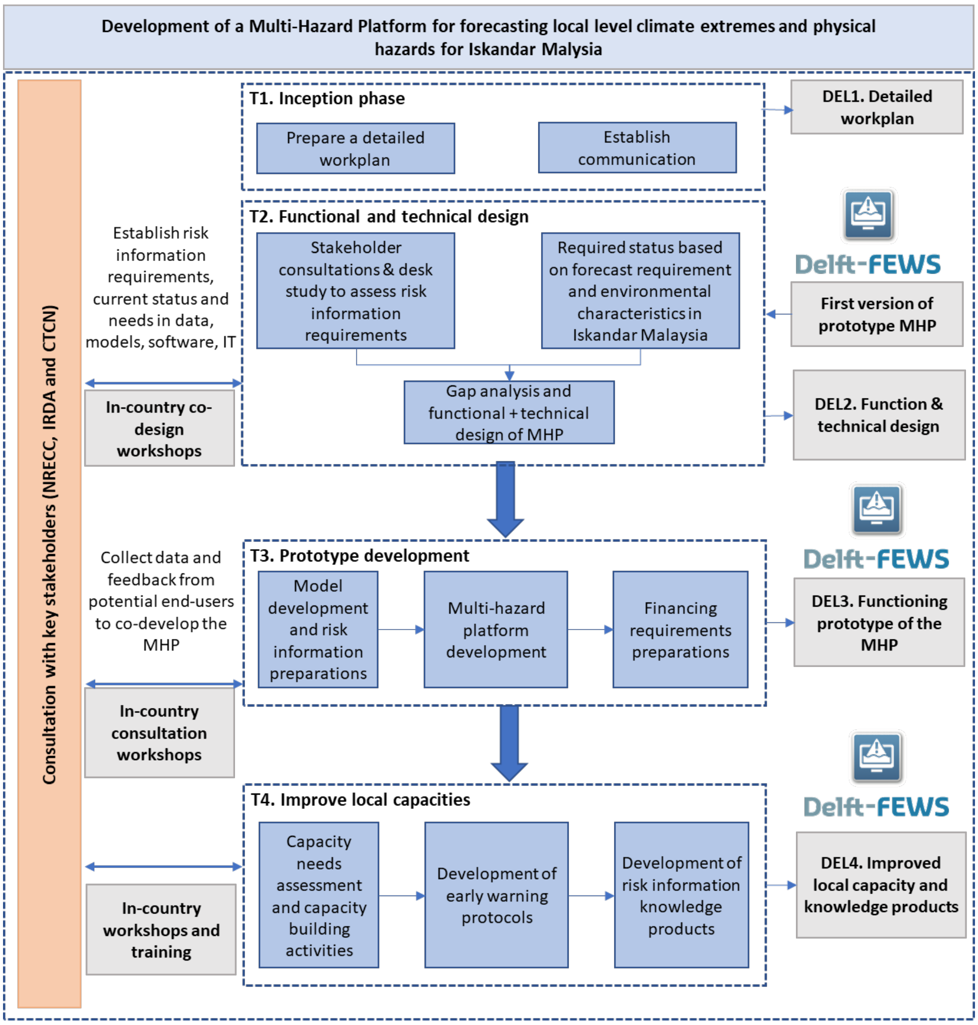


Figure 1-1 Schematic overview of the project components.

1.1 Team

The project will be implemented by Deltares and its subconsultant the Universiti Teknologi Malaysia (UTM). In Table 1-1 the members of the core team are presented including their role in the project and the location where they are currently stationed. The team will be supported by a team of experts presented in Table 1-2. If needed, additional non-key experts will be added to the team.

Table 1-1 Core team of key experts.

Name	Role	Organization	Based in
Tjitte Nauta	Project director (new position)	Deltares	The Netherlands
Mark Hegnauer	Project manager / Senior climate and DRR expert (I1 + I2)	Deltares	Singapore
Hélène Boisgontier	Geographical Information System expert-GIS data modeller (I1)	Deltares	Singapore
Christian Ligouri	Information Technology expert (I4)	Deltares	Indonesia
Nor Eliza Alias	Coastal climate data coordination and stakeholder engagement expert (N1)	UTM	Malaysia
Halimah Mohd Yusof	Gender expert (N2)	UTM	Malaysia

Table 1-2 Support team

Name	Role	Organization	Based in
Kasturi Devi Kanniah	Project support	UTM	Malaysia
Rizka Akmalia	Flood risk modelling expert (support)	Deltares	Indonesia
Bas Stengs	Multi-hazard platform expert (support)	Deltares	The Netherlands

1.2 Country focal points

The project aims to form a good basis to implement a full functioning multi-hazard platform for Iskandar Malaysia in the future, based on the lessons learned of the current project outcome, including the MHP prototype. To this end, the project will be implemented for and in close collaboration with the Iskandar Regional Development Authority (IRDA), who is the project proponent and NRECC, the national designated entity. Within the project, we will liaise with both organizations, where IRDA is our day-to-day contact for the collection of information and data. NRECC will be an important stakeholder in the project to make sure the approach fits Malaysia standards.

IRDA is expected to play a very active role in the project in terms of:
- Giving feedback and reviewing the deliverables;
- Collecting local data and providing access to relevant data sets and reports;
- Communicate with key-stakeholders and invite them to the workshops;
- Take a leading role in the organization of the workshops (planning, venue, etc.). Deltares will take the lead for the content of the workshops.

NRECC is expected to be present during the workshops and provide feedback on the deliverables of the project.

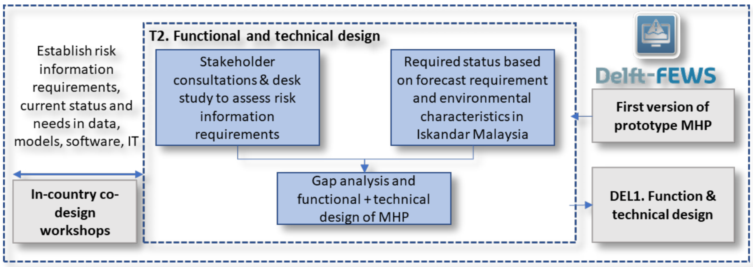
2 Tasks

In this Chapter we will outline the expected outputs of the projects and the activities that will deliver these outputs.

2.1 Task 1: Inception phase and detailed workplan

The current report describes the workplan in detail, which is Deliverable 1.2: detailed workplan. The detailed workplan, as can be read in this document, contains more in-depth information on how the project will be implemented, what will be done in the different activities and how this relates to the overall planning of the project.

2.2 Task 2: Develop technical specifications to design and integrate information on local climate extremes and hazard risks in a multi-hazard platform (MHP) for Iskandar Malaysia (IM)



The first main step in the project is to make a functional and technical design of a multi-hazard platform for Iskandar Malaysia and to collect and develop base information that can be used as input to the multi-hazard platform.

The functional design shall describe which hazards and which functionalities should be included in a multi-hazard platform for Iskandar Malaysia. This information can be collected through a desk-study and literature review, but we will also conduct a stakeholder consultation workshop to collect relevant information about the requirements for a multi-hazard platform. Examples of the type of information required to make a functional design are listed below:

- Which hazards are to be included in a multi-hazard platform (i.e., this project and in consecutive follow-up projects)?
- Which hazard information is already available to be used in the platform?
- What real-time data can be used as input to the multi-hazard platform?
- Which stakeholders shall be maintaining and/or using the platform?

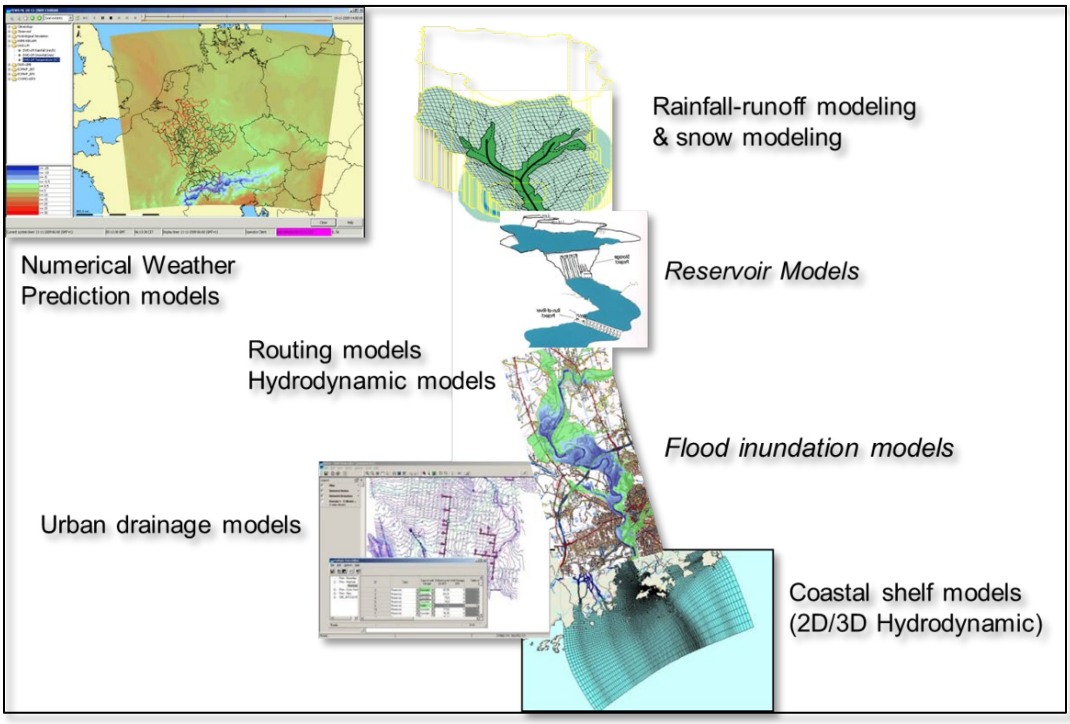


Figure 2-1 Overview of different components in a multi-hazard flood early warning system.

Based on the functional design, a technical design can be made. A technical design will describe how certain functionalities can and will be developed in the platform. A technical design shall provide more detailed information about the platform, for example about the model output, model resolution, data sources and availability, etc. The technical design will be used as a blueprint for output 2, the development of a prototype of the multi-hazard platform.

Specifically for coastal hazards such as floods and coastal erosion we will also start in this phase with the collection and development of relevant threshold values and generate hazard and risk information for selected return periods (e.g. 1/2, 1/5, 1/10, 1/25 and 1/100 year). For this, we will make use of Deltares open-source models such as Delft3D FM, SFINCS, Wflow and FIAT.

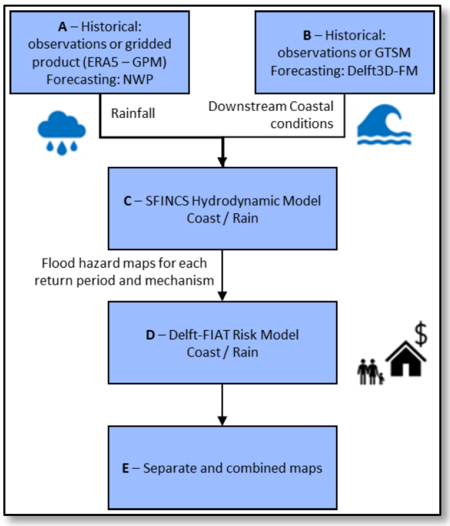


Figure 2-2 Approach for developing multi-hazard flood risk maps using Delft3D FM, SINFCS and FIAT.

In the end, the different steps and tools will be used to develop a MHEWS for Iskandar Malaysia. The Delft-FEWS platform will be used for the collection, processing, and analysis of the data and to run the integrated models. The Delft-FEWS platform will also be used to visualize the information and as such will in the basis be the Graphical User Interface (GUI) for the MHP. Different models can be used to simulate (flood) hazards. These models will be integrated in the Delft-FEWS based MHP. Delft-FIAT is a tool to prepare static risk information that can be used as input to the MHP to update this risk information with real-time information.

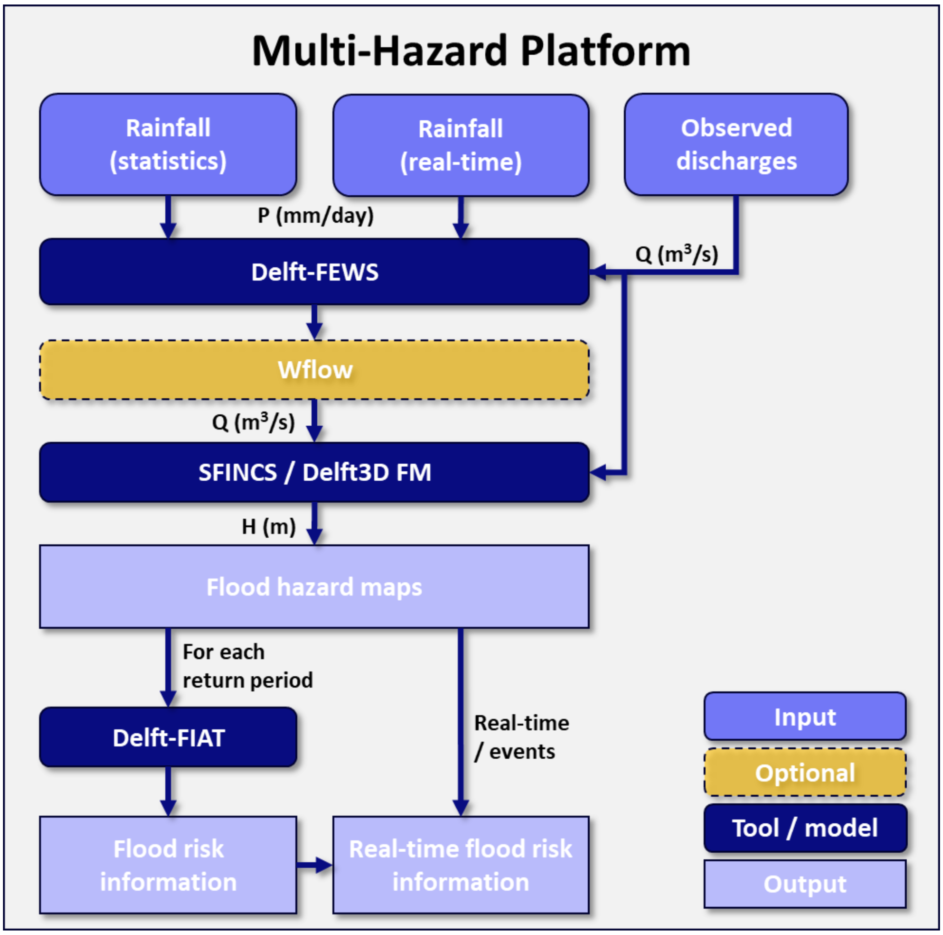


Figure 2-3 Schematic overview of the proposed MHP components and their connections. A more detailed design will be presented in the next phase of the project as part of the functional and technical design phase.

A more detailed description of the activities for Task 1 to develop the functional and technical design can be found in the following sections. A simplified overview of the tasks and outputs is presented in the table below.

Table 2-1 Summary table of the activities and expected outputs.

Activity	Expected output
Literature review and stakeholder consultation workshop to collect relevant data and information	• Chapter in the report describing the functional and technical design of the Multi-Hazard Platform
Select the hydrometeorological and hazard models based on the climatic conditions of the selected five local authorities in Iskandar Malaysia	• Chapter on data collection and analysis • Recommendation on hazard models

Establish threshold values for climate induced coastal hazards in IM	• Chapter on derived threshold values for climate induced coastal hazards
Generate probabilistic hazard maps for IM or the selected five local authorities in IM	• Chapter describing method and results for preperation of probabilistic hazard maps
Design localized hazard forecasting integrated into the MHP for IM	• Report describing the functional and technical design of the Multi-Hazard Platform, including chapters of activities 2.1 – 2.3 and 2.5.
Update/develop vulnerability curves for different types of infrastructure and demography in IM (e.g. buildings in the economic zones of IM)	• Chapter on methodology and results for updating vulnerability curves for different types of infrastructure.

2.2.1 Activities

Activity 2.1: Select the hydrometeorological and hazard models based on the climatic conditions of the selected five local authorities in Iskandar Malaysia

We will start with a literature review and data collection on existing risk information, data, and models available for Iskandar Malaysia. This desk study will be accompanied with a stakeholder workshop in which we would like to engage with key stakeholders on their needs regarding hazard related risk-based information, how this information is currently being used and what the main gaps are in terms of required risk information. The information gathered through the desk study and stakeholder consultation should also provide sufficient information to determine the functional (what type of information, for which stakeholders, etc.) and technical (what frequency and at what resolution) requirements of the multi-hazard platform.

To speed up the process and engage with the stakeholders in a more visual manner, we will already start preparing an initial version of the prototype for the multi-hazard platform. Past projects have demonstrated that presenting a working example visually can catalyse more meaningful discussions with stakeholders. For the development of the prototype, we will use the Delft-FEWS platform, an open-source platform for data and model integration. An example of such prototype (or demonstrator) can be found in Figure 2-4 where we show a prototype development for the HydroMET service in Lao PDR. Delft-FEWS was selected a software platform because of the open character, being able to incorporate many different data sources and models and can be configured to the needs of the users. Delft-FEWS has been implemented in many countries around the world, including among others The Netherlands, Australia, the USA, the UK, and Singapore for their operational and multi-hazard forecasting requirements. Based on the requirements stated in the terms of reference, the Delft-FEWS platform fits the criteria well. Other advantages of the Delft-FEWS platform include the low licensing costs (free) and scalability of the solution from stand-alone desktop application to running in the cloud.

Delft-FEWS platform

Protecting people means making the right decisions, at the right time, and with the right information. In the world of water, doing your job effectively requires knowledge of what the future holds, whether it's about droughts, floods, reservoirs, or water quality. Delft-FEWS is the state-of-the-art Flood forecasting and Early Warning System that helps you anticipate the future.

https://www.deltares.nl/en/software-and-data/products/delft-fews-platform

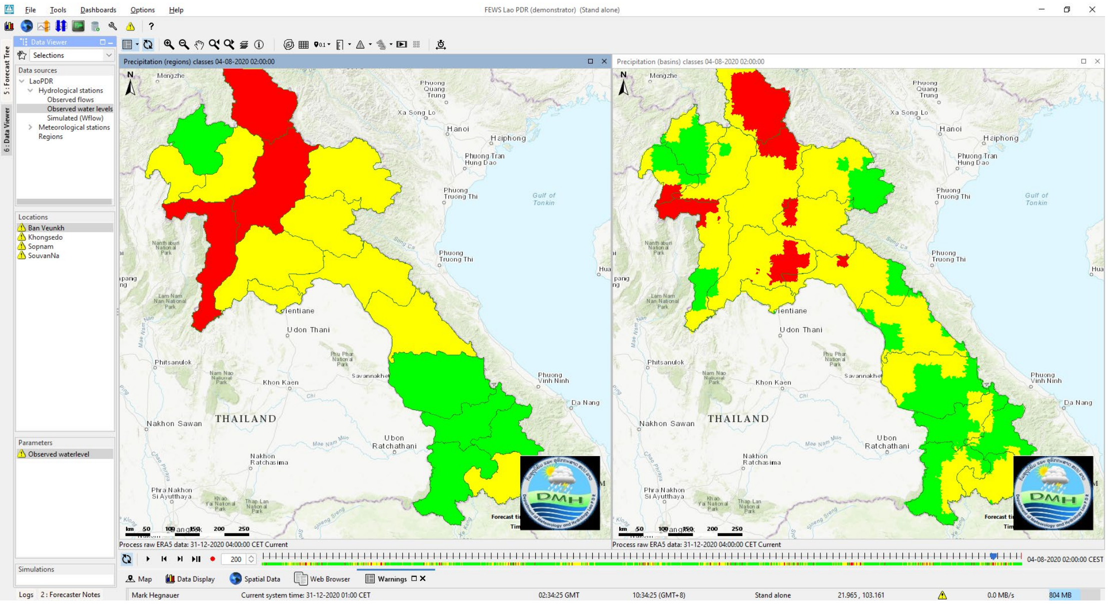


Figure 2-4 Example of a prototype (or demonstrator) Early Warning System in Lao PDR using Delft-FEWS.

Activity 2.2: Establish threshold values for climate induced coastal hazards in IM
A key element in a hazard and risk information system is knowing the thresholds values for the hazards and risks. These threshold values are typically derived from observation data, accompanied with statistical analysis and in some cases, modelling. In this activity, we will collect relevant data from observation stations in the region of interest (if available), accompanied with relevant global datasets. Based on the collected data, in combination with other relevant (contextual) data, the thresholds values will be derived. Typically for coastal water levels or rainfall stations, thresholds are related to 1/2, 1/5-, 1/10-, 1/25- and 1/100-year return periods. This will also be done as a starting point in this study to demonstrate how this information can be derived and used in the consecutive steps.

As stated before, we will start developing the prototype system already at the start of the project. The collected data will be integrated into the prototype system and the threshold values can be added as well in the output figures. An example of the use of threshold values in Delft-FEWS is shown in Figure 2-5 and Figure 2-6.

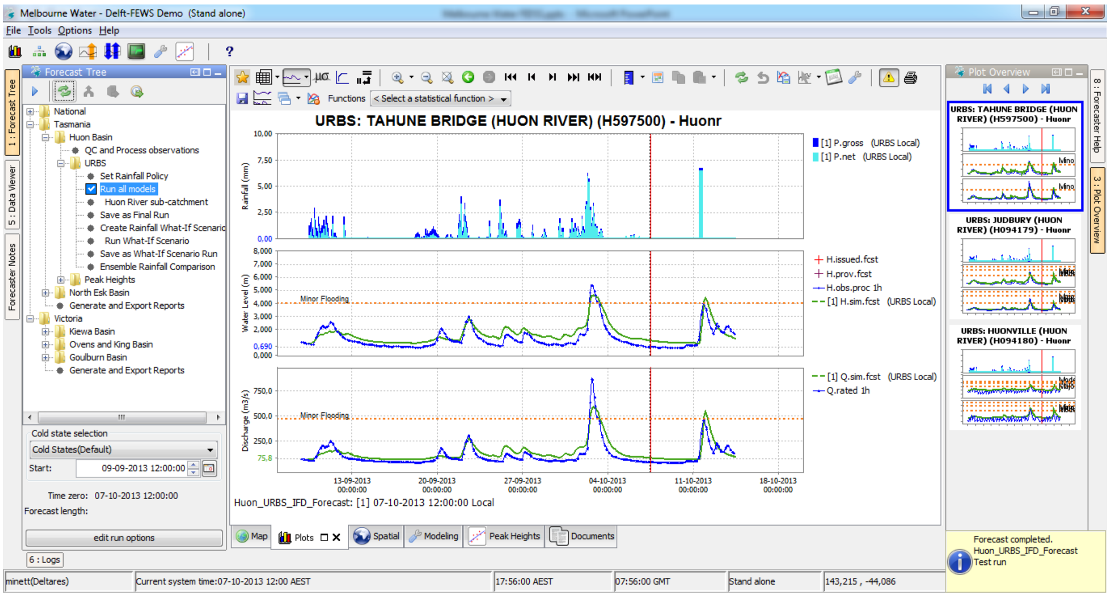


Figure 2-5 Example from Australia showing how threshold values derived from historical information can be used as warning levels (red dotted lines) in the figures.

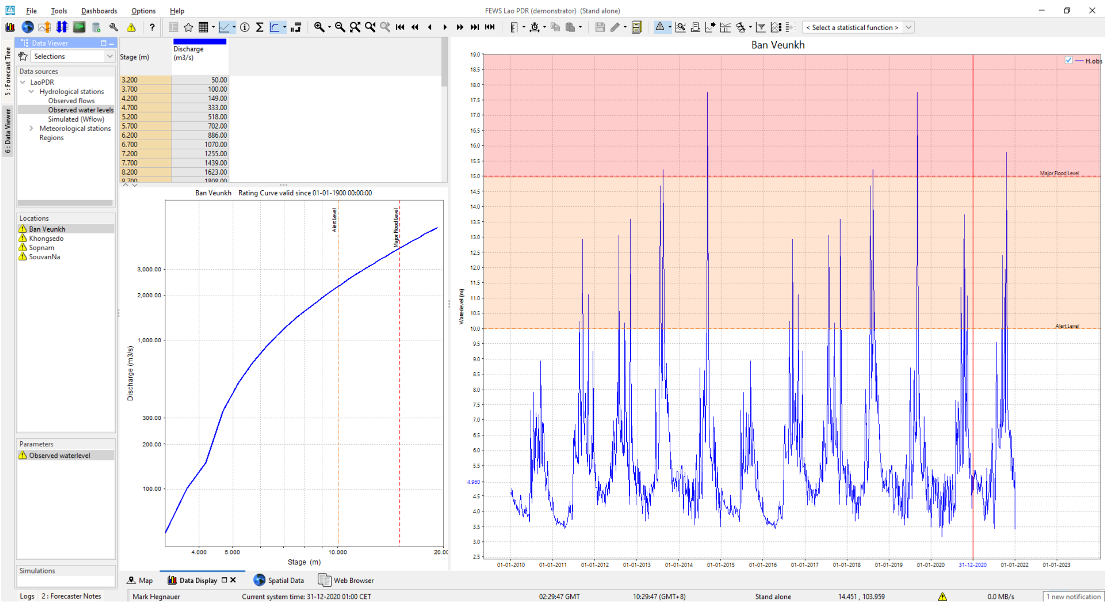


Figure 2-6 Example from a Laos prototype system showing how threshold values derived from historical information can be used as warning levels (coloured areas) in the figures.

Activity 2.3: Generate probabilistic hazard maps for IM or the selected five local authorities in IM

In this activity we will try to collect available flood maps for the selected return periods, or if not available, we will generate the flood maps based on our open-source modelling frameworks (Wflow, Deflt3D FM and SFINCS). The advantage of using this software is the relatively low licensing cost (free) and the open-source code, which is a requirement under this contract. The models are also designed to work seamlessly with global, regional, and local data, making these models very suitable for applications in data scares environments and for quick model setup and testing (e.g., for the development of a prototype).
The idea is to combine the information of Activity 2.2 with available or generated flood maps to generate the flood hazard information. We will do this for different (flood) hazards, including coastal flood hazard, pluvial flood hazard and pluvial flood hazard. Where

applicable, the combined hazard maps can also be generated for selected return periods. An example of the expected type of output is shown in Figure 2-7, which shows the different flood maps for only coastal floods (left panel), only pluvial floods (middle panel) and combined fluvial-pluvial floods (right panel). Validated hazard maps can be utilized for many purposes, including for planning, emergency preparedness and response.

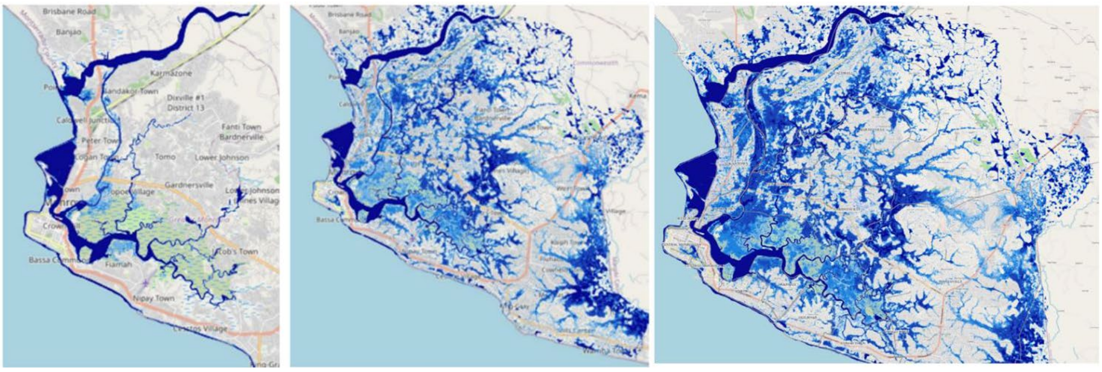


Figure 2-7 Example of hazard maps for a specific return period for coastal (left), pluvial (centre) and combined pluvial-coastal-riverine (right) floods.

Delft3D Flexible Mesh
The Delft3D Flexible Mesh Suite (Delft3D FM) is the successor of the Delft3D 4 Suite. Like Delft3D 4, the Delft3D FM Suite can simulate storm surges, hurricanes, tsunamis, detailed flows and water levels, waves, sediment transport and morphology, water quality and ecology, and can handle the interactions between these processes.

https://www.deltares.nl/en/software-and-data/products/delft3d-flexible-mesh-suite

SFINCS
SFINCS is a new fast numerical model to simulate 2D compound flooding dynamically for large scale coastal systems, within a fraction of the time required by our 1D2D models. Compound flooding during extreme events can result in significant property damage and loss of life. Early warning systems and multi-hazard risk analysis can reduce these impacts. However, traditional approaches either do not involve relevant physics or are too computationally expensive to do so for large stretches of coastline. The SFINCS model (Super-Fast INundation of CoastS) is a new reduced-complexity engine recently developed by Deltares, that is capable of simulating compound flooding including a high computational efficiency balanced with good accuracy.

https://www.deltares.nl/en/software-and-data/products/sfincs

Wflow
Water managers need insight into the available water resources within their catchments in both the short and long-term, especially in the face of climate change. Whilst at the same time they are struggling with a lack of reliable data. Wflow enables users to simulate all catchment hydrological processes even in data scarce environments. Thus empowering them with the information and knowledge about their water resources and climate risks, and leading to smarter planning.

https://www.deltares.nl/en/software-and-data/products/wflow-catchment-hydrology

Activity 2.4: Design localized hazard forecasting integrated into the MHP for IM
The information from activities 2.1 - 2.3 can be integrated into the multi-hazard early warning platform to help stakeholders better understand the hazards and risks and relate them to current or forecasted hydro-climatological conditions. For this, the hazard and risk information need to be linked to operational data streams of water level and rainfall observations and forecasts.

In this activity we will develop a plan (or functional design) on how to integrate this information into the proposed multi-hazard early warning platform. A good understanding of the hazard is crucial for this activity. As an example, knowing how quickly a (flash)flood will propagate through the system can support the responsible agencies to derive monitoring and warning protocols tailored to the local situation. A warning protocol based on observed water level data in a system where the downstream city will flood within 30 minutes after a certain upstream water level threshold is reached is not a useful protocol. In such cases, it might be better to derive protocols derived from observed, or even forecasted rainfall data. This will create the required lead time for the responsible organization to act. These protocols are different for different types of hazards and typically also depend strongly on the institutional setting.

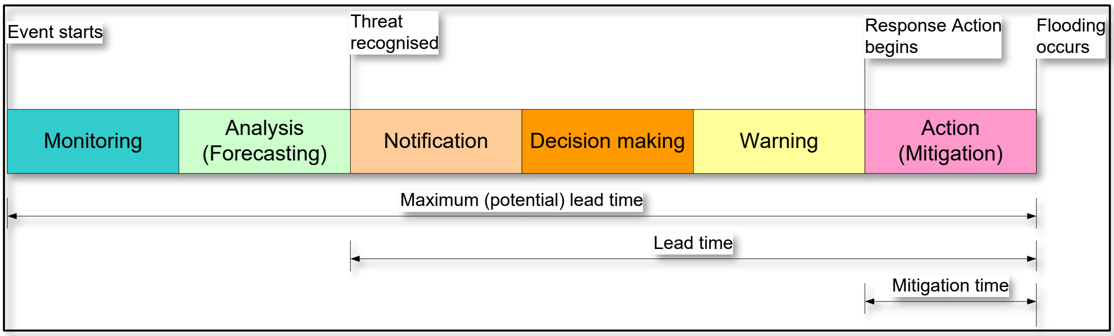


Figure 2-8 Schematic overview for deriving the required lead time for action.

The creation of the protocols is a combination of understanding the hazard (Activities 2.1 – 2.3), the required time for decision making process and the actual time required for taking the mitigation actions. The latter two elements (decision making process and time for mitigation) require the input from key stakeholders. Therefore, we will organize a stakeholder workshop to interact with the stakeholders and to collect the relevant information.

For this step we will also investigate which datasets and techniques can be used to optimize the forecasting capabilities of the proposed system, incl. elements like big data analysis and ensemble forecasting.

Activity 2.5: Update/develop vulnerability curves for different types of infrastructure and demography in IM (e.g., buildings in the economic zones of IM)
A crucial element in any risk assessment is to assess the actual people and assets (critical infrastructure, houses, etc.) at risk. For this the flood hazard maps are typically overlayed with detailed land use maps to calculated how much the different types of land are affected by the hazard. For this assessment we will make use of the open-source Delft-FIAT, the Deltares Flood Impact Assessment Toolbox. In Figure 2-9 a conceptual overview of Delft-FIAT is shown. Basically, for every pixel on the flood map, the land use is determined from a detailed land use map. If this land use type for example is “residential”, for this specific pixel the maximum potential damage is derived from a database. This maximum potential damage occurs at a certain water depth. If the water depth of the flood is below this threshold, the actual damages is less. To calculate this, so-called depth-damage curves are used that related the actual damage to the simulated water depth. This is down for all pixel in the map and for each flood map to calculate the total annual expected damages. This is crucial information to determined vulnerable areas and prioritize actions.

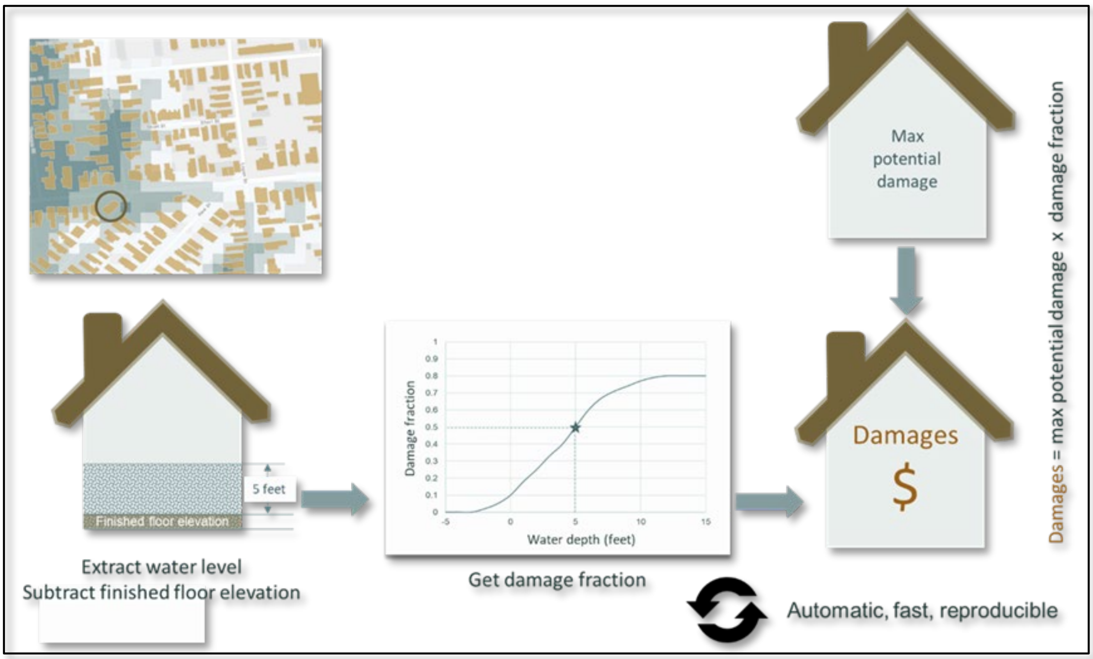


Figure 2-9 Conceptual framework of the Flood Impact Assessment Tool (Delft-FIAT).

Delft-FIAT
When it comes to floods, decision-makers have tough choices to make. Which interventions should they invest in, and when? How long will those interventions maintain a certain level of service for the community? Which intervention should have priority? Are interventions impacting different sectors of the community equitably? Delft-FIAT is a fast, flexible, Python-based tool to rapidly assess direct economic impacts to buildings, utilities, and roads for user-input flood maps.

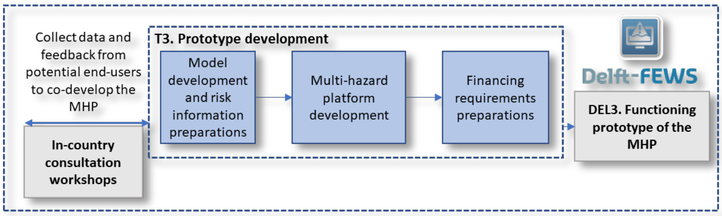
https://www.deltares.nl/en/software-and-data/products/delft-fiat-flood-impact-assessment-tool

2.2.2 Deliverables

The following deliverables will be generated for Task 2:

ID	Description	Type
D2.1	Functional design report: A report well covering the approach and methodology used, data and information collected including the raw data and information, lessons learnt and outcomes of the activity in terms of: • Data analytics. • Threshold values. • Hazard maps. • Probabilistic risk maps.	REPORT
D2.2	Technical design report: A report and working tools covering the approach and methodology used, data and information collected including the raw data and information, lessons learnt and outcomes of the activity in terms of: • Localized weather forecasting using numerical weather data. • Vulnerability curves.	REPORT

2.3 Task 3: Develop a prototype and establish the financing requirements to develop the MHP for IM



Task 3 will provide the functional and technical requirements for the multi-hazard platform. Already in Task 2 we will have a first version of the prototype, which in Task 3 will be extended with additional data and workflows. The prototype shall provide the stakeholders with an insight of how such a multi-hazard platform can look like, how it can be used and what is required to further develop and maintain such a system in the future. And although a multi-hazard platform can be extended to support multiple hazard types (floods, droughts, erosion, etc,), in the development of the working prototype we will focus on the flood hazard component. The proposed activities are described in more detail in the next sections.

2.3.1 Activities

Activity 3.1: Develop a knowledge and decision support system for the establishment of prototype of MHP for IM
Based on the specifications drawn from Task 2, example workflows for multi-hazard information generation will be configured into the platform. This includes workflows that will import data from the identified sources, display and process data and feed into hazard models to simulate flood hazards. The design of the workflows will be done in close collaboration with the key stakeholders. For this we will organize a consultation workshop to collect valuable feedback from the potential user of the system.

The prototype will be developed using our open-(source) software products. This includes the software for the platform (Delft-FEWS) and the underlying models (Wflow, SFINCS and Delft3D FM). To support the usage of the prototype by the end users, we will prepare a concise user manual and training materials.

Users can avail of the platform once it is delivered and continue using the MHP also after the project finalization, once they have accepted the standard terms and conditions for the use of the Deltares software. These terms and conditions will be shared. The number of users of the MHP is not limited. However, it is highly recommended to keep track of the users. During the delivery of the system, we will make a list of users that have received and installed the MHP. It is up to IRDA to maintain the list, also after the project finalization. Support and maintenance of the prototype is not included in the project. We advise to arrange this only if users and stakeholders want to develop the prototype further into a fully functional and operational platform.

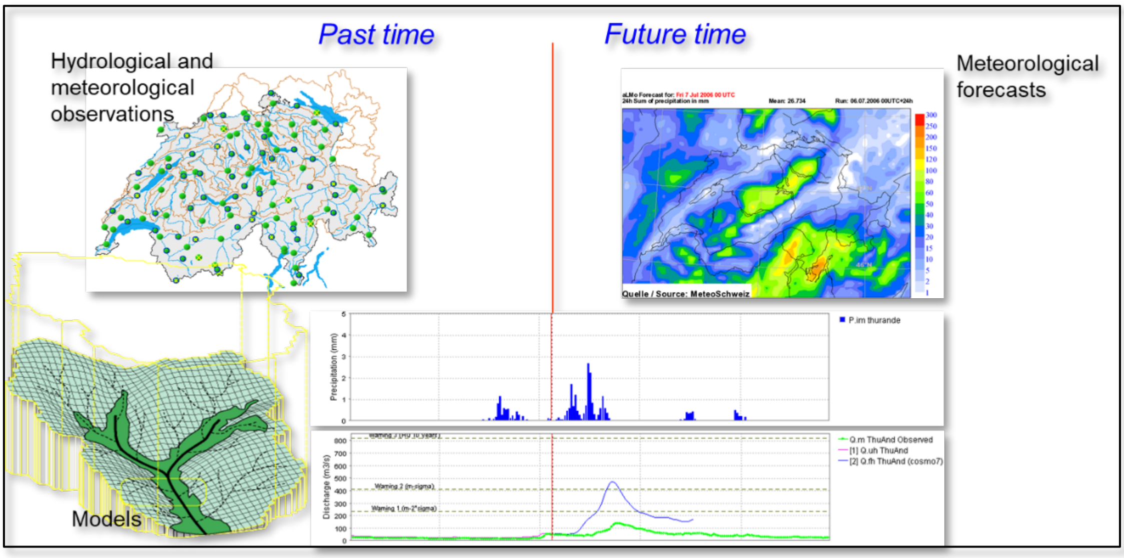


Figure 2-10 Example workflow of collecting observed data, collecting meteorological forecast data and combining this to run a model to forecast water levels into the (near) future.

Activity 3.2: Assess the financing needs to develop the fully operational MHP
Based on the specifications drawn from Task 2 to develop an MHP, financing needs will be assessed. Financing requirements will cover several aspects, such costs related to the development, testing, upgrading, and maintaining a fully operational MHP for IM (in follow-up projects). As we have extensive experience in the development and implementation of such systems, we will also address typical issues that might arise, such as capacity building to develop the skills at all levels of running such a system operationally. It is our strong view that technically developing such a system is only a small element in the process of improving flood resilience, as also indicated in Figure 2-11. This means that as part of the financing needs assessment we will also address the capacity requirements to build, operate and maintain the system. This assessment will be conducted as part of Task 4 (Activity 4.1: "Conduct a gap assessment on the MHP with impact-based forecasting"), but we believe it is best to connect Activity 4.1 to Activity 3.2. Potential sources of funding (including domestic and international climate finance) and possible financing mechanisms will be reviewed in closed consultation with the key stakeholders.

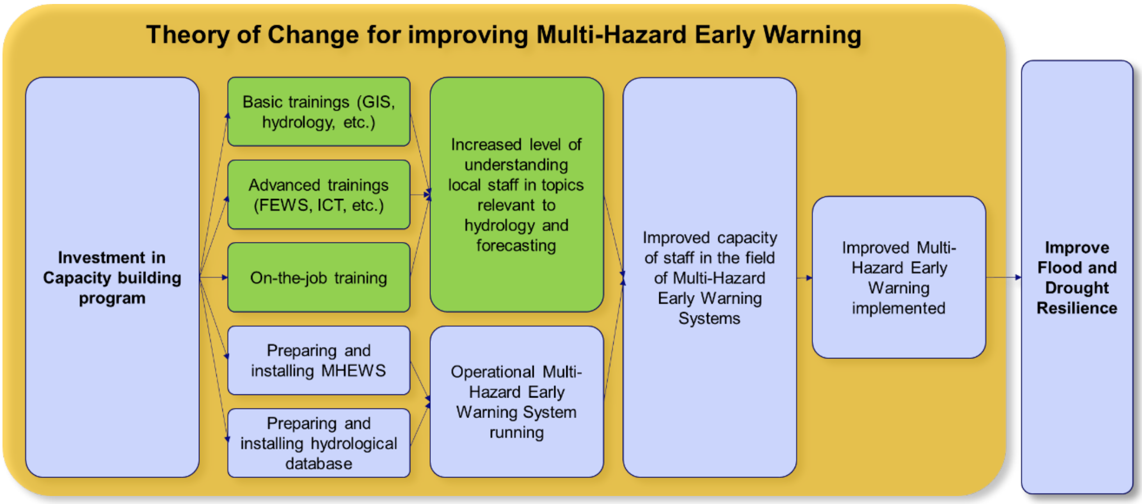


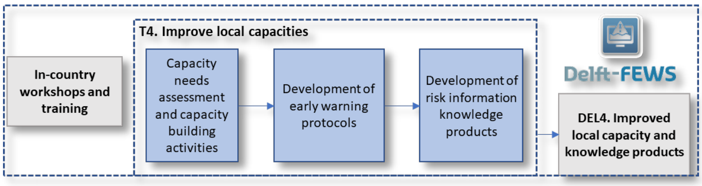
Figure 2-11 Example theory of change for improving flood and drought resilience through the development of a multi-hazard early warning platform and capacity building.

Activity 3.3: Conduct a stakeholder consultation
At least one combined stakeholder workshop will be conducted for all 5 zones to run through the prototype of the multi-hazard platform to seek feedback and inputs on how to make the MHP fully operational with impact-based forecasting and receive their feedback.

2.3.2 Deliverables

ID	Description	Type
D3.1	Working tool as a prototype of the MHP with user manual	TOOL + MANUAL
D3.2	Report on financing needs and input to the funding proposal	REPORT
D3.3	Minutes of the stakeholder workshop	MINUTES OF MEETING
D3.4	Stakeholder consultation report	REPORT

2.4 Task 4: Improve local capacities in implementing a people-centred forecasting system using social innovation



The goal of this final task is to go beyond the technical aspect of the MHP towards capacity building and institutional steps to move towards an impact-based forecasting MHP.
Different target groups will be defined during a gap assessment and a gender-sensitive capacity building plan will be prepared to increase local understanding of impact-based forecasting and early warning. Several materials including training modules, early action plans, knowledge products and communication factsheets will be prepared. Using this material, different workshops will be conducted for several targeted groups to raise awareness and build institutional and technical capacities.

2.4.1 Activities

Activity 4.1: Conduct a gap assessment on the MHP with impact-based forecasting
A capacity needs assessment will be conducted to determine the existing capabilities and available resources needed to implement a people-centred MHP with impact-based forecasting (including forecast-based financing and early actions). The needs assessment will include a definition of the targeted groups to be considered. As stated before, we will try to link this activity also to the financing requirements assessment in Activity 3.2 as we understand that capacity building at institutional level can be a considerate investment as well.

Activity 4.2: Build gender-sensitive institutional and technical capacities to implement the MHP with impact-based forecasting
Based on the results of the capacity needs assessment, a gender-sensitive capacity building plan will be developed for targeted groups. The developed prototype will be used as guidance for the training sessions and workshops. In the workshops and training sessions we will address the different stakeholders and users of the system to increase their understanding of impact-based forecasting and early warning (including early actions and forecast-based financing).

Activity 4.3: Develop early action protocols applicable to 5 authorities including shock-responsive social protection
Based on the available risk information, early action protocols will be derived for 5 authorities in Iskandar Malaysia. These protocols will help understand what to do at which moment in time and based on which information. The protocols should also help responsible organizations to better communicate and understand each other in times of a hazard occurring. The protocols shall be based on available real-time information from the multi-hazard platform. As the system will only be a prototype, the protocols shall use the information available in the prototype to demonstrate how such a system could work in combination with the early action protocols.

Title: Implementation of forecast and warning options			
SOP ID: A323	**Date:** 27/08/2019	**Version Nr.:** 1.0	
Division: National Centre for Hydromet Forecasting			
SOP preparation	Mr. B. Stengs	Signature:	Date: 01/06/2019
SOP approval	Mr/Mrs Y	Signature:	Date:
Description of procedure:	This SOP describes the implementation of forecast and warning options.		
Reference docs.:	-		
Links to other SOPs:	• SOP ID A320 – Forecasting Procedure 3.2.0: Start forecasting duty • SOP ID A321 – Forecasting Procedure 3.2.1: Collection and processing of information and data • SOP ID A322 – Forecasting Procedure 3.2.2: Analysis and assessment of current situation		
Frequency of SOP:	Depending on the organizational schedule		
Update SOP:	Depending on change in Circulars or change in software		
List of definitions / acronyms	Not applicable		

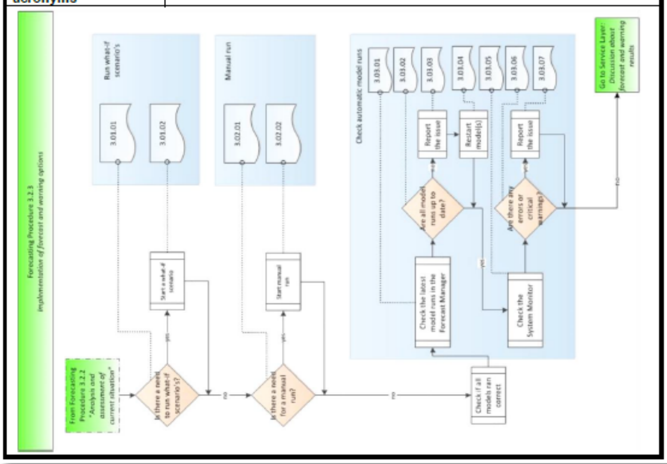


Figure 2-12 Example of a protocol for early action.

Activity 4.4: Develop knowledge products and information, education and communication (IEC) materials on the MHP with impact-based forecasting
In this activity we will develop several example products that can be used for communication of hazard information. As we are working with a prototype, the knowledge products will only be used as examples of how such products can be used once the prototype would be operationalized. For this activity we will organize a stakeholder workshop in which we will use existing knowledge products used in other countries as a guidance for the development of the example products for Iskandar Malaysia. In Figure 2-13 some examples of existing knowledge products connected to operational Early Warning Systems based on Delft-FEWS.

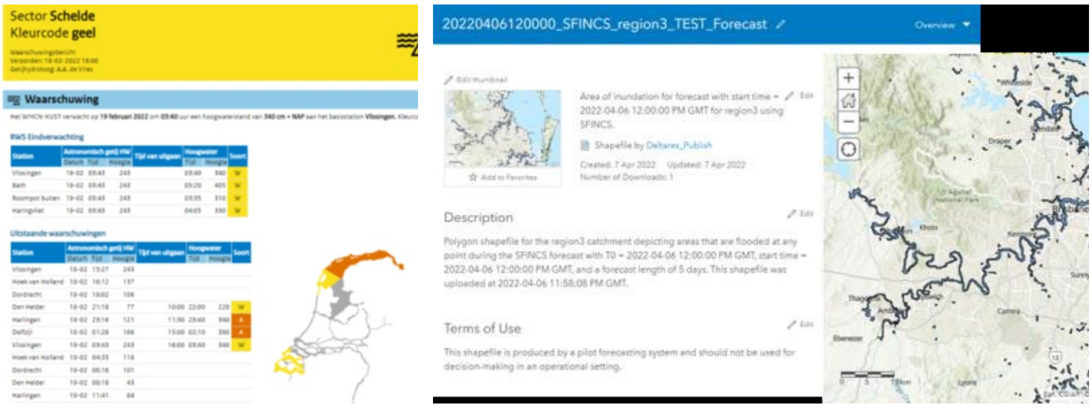


Figure 2-13 Example knowledge products for the communication of hazard information. On the left a bulletin used for communication with the public, on the right detailed forecasted flooded areas that can be used as real-time input for emergency response units.

2.4.2 Deliverables

ID	Description	Type
D4.1	Report on capacity gap assessment on the MHP with impact-based forecasting	REPORT
D4.2	Report on capacity building plan mainstreaming gender	REPORT
D4.3	Report on social early action protocols and shock responsive social protection	REPORT
D4.3	Factsheets and communication materials on MHEWS and response	FACTSHEETS + EXAMPLE BULLETINS

3 Data requirements

To successfully implement the project, local information and datasets are required. In Table 3-1 an overview of the requested data is summarised. This list will be updated during the functional and technical design phase and based on preliminary inputs from key stakeholders. During the 1st stakeholder meeting, we will also discuss more in-depth the availability of the data and the alternative data sources that can be used.

Table 3-1 List with required data.

Dataset	Preferred file-format	Alternative source
Formal flood maps / flood risk information	GIS (GeoTIFF)	-
Formal statistics of rainfall, discharge, water level	Report	-
Formal flood damage curves	Report	Global flood depth-damage functions
Digital elevation data	GIS (GeoTIFF)	MeritHYDRO
Landuse / landcover map	GIS (GeoTIFF, shapefile)	ESA Worldcover
Building footprint map	GIS (GeoTIFF, shapefile)	World Settlement Footprint or Open Street Map
Road network data	GIS (shapefile)	Global Roads Inventory Project or Open Street Map
Rainfall data (grids)	NetCDF	GPM / ERA5
Rainfall data (stations) – locations and timeseries	CSV	-
Temperature data (grids)	NetCDF	ERA5
Temperature data (stations) – locations and timeseries	CSV	-

4 Planning

The total duration of the project is 15 months[1]. The timeline for the project is shown in Figure 4-1. In the planning we have proposed moments for the delivery of draft reports, final reports, and workshops. The exact timing of the workshops will be decided in close consultation with NRECC, IRDA, CTCN, and other local key stakeholders. For reference, the overview of the deliverables is presented in Table 4-1.

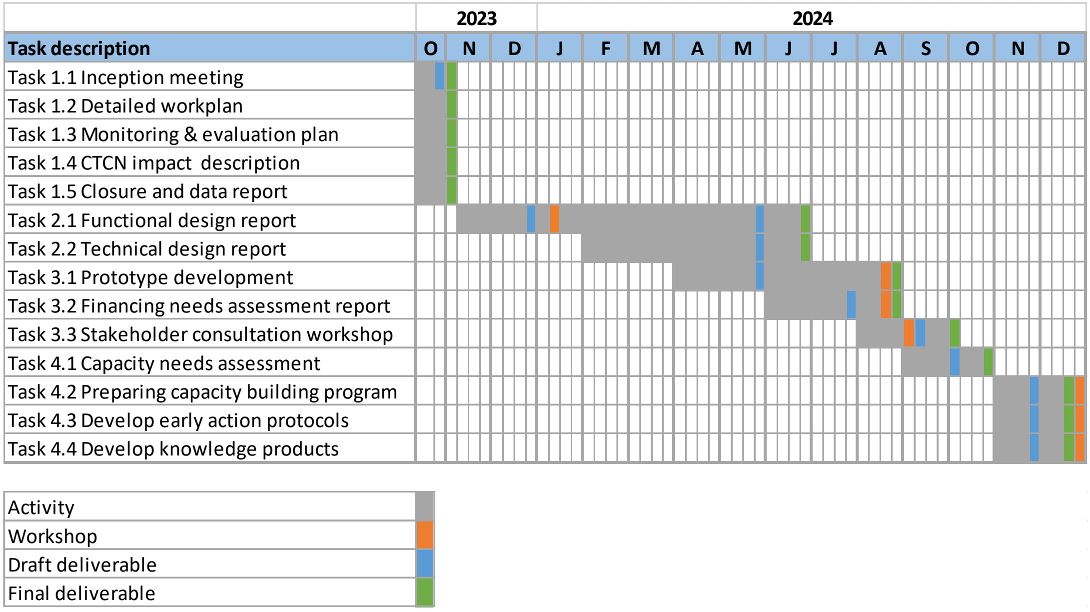


Figure 4-1 Planning timeline of the project.

Table 4-1 Summary of the deliverable and the final delivery date.

ID	Description of the deliverable	Type of product	Month from start	Date
D1.2	Detailed workplan	REPORT	2	DEC '23
D2.1	Functional design report	REPORT	9	JUN '24
D2.2	Technical design report	REPORT	9	JUN '24
D3.1	Working MHP prototype + user manual	TOOL + MANUAL	11	AUG '24
D3.2	Report on financing needs	REPORT	13	AUG '24
D3.3	Minutes of the stakeholder workshop	MINUTES	14	SEP '24
D3.4	Stakeholder consultation report	REPORT	14	SEP '24
D4.1	Report on capacity gap assessment	REPORT	15	OCT '24
D4.2	Report on gender sensitive capacity building plan	REPORT	16	DEC '24
D4.3	Report on social early action protocols	REPORT	17	DEC '24
D4.3	Factsheets and communication materials on MHEWS	FACTSHEETS	18	DEC '24

[1] In the contract (page 36) the table mentions 18 months. Hence, in our original planning we used this table as guiding timeline. Although we do think the project can be executed in 15 months, we want to highlight this discrepancy in the contract at the start, as we might be in need for project extension if things are not going according to the adjusted timeline of 15 months.

5 Organization

5.1 Workshops & training sessions

We foresee to organize 4 stakeholder workshops, each which its own focus:

- **Workshop 1:** Hazard and risk information requirements (1 day);
- **Workshop 2:** Prototype demonstration and training (2 days);
- **Workshop 3:** Stakeholder consultation workshop and training (2 days);
- **Workshop 4:** Final workshop and training (2 days).

The locations & venues for the workshops will be selected and arranged by IRDA. The associated costs for hosting the workshops (venue, catering, etc.) shall be at the expense of IRDA.

5.1.1 Workshop 1: Hazard and risk information requirements

In this workshop the goal is to collect valuable input from key stakeholders on their current operations, the requirements, and the gaps in terms of data, models, tools, and protocols. This information will be used to make the functional and technical design of the MHP.

Workshop 1 links to activities 2.1 – 2.5.

5.1.2 Workshop 2: Prototype demonstration and training

In this workshop we will demonstrate the prototype of the MHP. The prototype will not be finalized at this stage, so the purpose of this workshop is to gather feedback which can be used for the final delivery of the prototype. The workshop will be accompanied by a 1-day training in the use of the MHP and to show examples of MHP around the world that can be of inspiration to the stakeholders to define their needs and requirements more clearly.

Workshop 2 links to activities 3.1 and 3.2.

5.1.3 Workshop 3: Stakeholder consultation workshop and training

In this workshop we will demonstrate the final prototype to the stakeholders. This workshop will also be used as a starting point for Task 4 to collect information from the key stakeholders in terms of the capacity to use, run and maintain a MHP and to start to co-design and develop the early action protocols and knowledge products.

Workshop links to activities 4.1 – 4.4.

5.1.4 Workshop 4: Final workshop

In this workshop we will present the final outcomes of the project and discuss and plans for further developments of the MHP into an operational multi-hazard platform for Iskandar Malaysia.

Workshop 4 is scheduled at the closure of the project and review the work done in activities 2.1 – 4.4.

5.2 Review process

We propose to follow a simple review process where CTCN. NRECC and IRDA provide their comments on the draft deliverables within 2 weeks of receiving the deliverable. For the convenience of collecting the feedback, Deltares will prepare an online shared table in which

CTCN. NRECC and IRDA can jointly add their comments. If desired, a separate table for each organization can be provided for.

To formalize the role and to assure stakeholder buy-in, IRDA proposes a formal review process of the key deliverables (inception phase and final reports), which we agree to. To this end, we propose the organization of a Steering Committee and a Technical Committee. The Steering Committee will review key documents and deliverables to assure the project goes in the right direction.

The first Steering Committee meeting is planned for 1st of February 2024. The Technical Committee meetings will be scheduled once the plan has been approved and the timeline of the project is formalized.

5.3 Risk mitigation

5.3.1 Data availability

Within this project we need local information and data to produce the required outputs. In case local data cannot be made available, or is not existing, we will use global or regional open data instead. For most datasets we already have identified open datasets that can be used. Data availability will also be discussed during the 1st stakeholder workshop.

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