D4.6 A generic, Multilanguage smartphone app

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Document Information

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Deliverable	Number	D 4.6	Title	Overview of prototypes in D4.6
Work Package	Number	WP4	Title	Flood Forecasting and Early Warning Systems for Coastal Regions

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Abstract (for dissemination, 100 words)	Pearl has provided several life applications in which new methodologies and tools have been explored and applied for effective dissemination of flood information, during the warning stage, during the event and in the aftermath of the event. We have developed prototypes that provide new data sources, e.g. crowd sourcing observations, easy accessible shelter, flee-routing information and forecasted water levels, which are crucial for authorities during crisis management. The technologies have been created in a way that both citizens and authorities can use the tools in multiple ways: as an early warning system, as a flood information platform and as an evacuation guide.
Keywords	smartphone, app, tracking, crowdsourcing, GIS, forecasts, evacuation information, citizen routing, shelter

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Disclaimer

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Summary

Within Pearl Task 4.5 several partners focussed on prototypes where new methodologies, concepts and tools for effective dissemination of early warnings were developed. This document is the associated deliverable (D4.6) and contains an overview of the prototypes that have been created within Pearl.

Several smartphone and web based technologies have been developed in this task. These prototypes of partners HydroLogic Research (HR), DHI and UNESCO-IHE contain functionalities such as:

- Creation of flood observation messages that include images, Pearl knowledge based categories and geo locations.
    - Data available by a web service (API).
- Data acquisition
    - Forecasted rainfall and sea water levels.
    - Flood forecasting.
- Evacuation information
    - Shelter locations.
    - Routing to shelters.
    - Shelter information like status and contacting information.
- Request emergency assistance.

The technologies have been applied to specific case-study areas of the Pearl project and are disseminated as prototypes through the usual channels e.g. Play Store, websites and portals.

The developed technologies are further described in this deliverable and show advances of methodologies, concepts and tooling, which can be used as effective early warning channels. This includes showcases of new information sources such as crowd sourcing social data, flood levels, forecast data, object data (shelters) and more. These sources can be used by citizens and authorities in early warning and during flooding situations. The tools also provide interactions with the data, making it possible to observe posts of other users, and numerical forecasts to evaluate whether user-locations are prone to flooding and eventually evacuation routing options in case of floods.

Contents

List of figures

Abbreviations

D4.6	Deliverable 4.6 A generic, Multilanguage smartphone app.
HR	Pearl Consortium member HYDROLOGIC RESEARCH B.V.
UNESCO- IHE	Pearl consortium member UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION -UNESCO
API / Web API	Application Programming Interface / API as a web-service
NHC	National Hurricane Center

Glossary

Pearl Detective	Multilanguage smartphone application created by HydroLogic Research, used as tool to send crowdsourcing information to the platform.
FloodReadyQ	Prototype for public flood communication using a smartphone app created by HydroLogic Research.
EvacuAPP	Evacuation application created by UNESCO-IHE.
Water Detective service	API created by HR to save crowdsourcing data. Pearl products can connect to this API to retrieve the crowd sourcing information.
WebAPP	Application that runs on in browsers (the world wide web).
App	Application, mostly for smartphones.
MIKE Workbench	A desktop client for interactive data analysis and processing.

1 Introduction

Deliverable 4.6, the generic Multilanguage smartphone app, is a composition of various prototypes which have been developed by project partners within work package 4. This work package aims to improve the state of art in flood forecasting and early warning for coastal areas across the whole chain of early warning from data to warning dissemination.

The prototypes are part of the task where new methodologies, concepts and tools for effective dissemination of early warnings are created.

Technologies and apps are not submitted as code or software deliverables, rather as descriptions and highlights of the prototypes in this document.

The Pearl Detective and the FloodReadyQ smartphone apps are prototypes of HydroLogic Research. UNESCO-IHE has developed an Evacuation app – EvacuAPP which provides information about e.g. shelters, directions for evacuation and hurricane forecasts. DHI created a GIS environment showing real-time hydrodynamic data. The features of these prototypes are explained in this document.

2 Pearl Detective app

2.1 Description and aim of the PearlDetective

The Pearl detective app is a ‘social sensor crowdsourcing’ app that initially has been developed for the FP7 project WeSenseIt (www.wesenseit.eu). Within Pearl, several prototypes have been created, using that first prototype as a template. The crowd sourcing app has been tailored to the use cases of Pearl and its data can be retrieved through other Pearl products.

The Multilanguage app, which is build using Ionic (Ionic Framework), enables citizens to create observations (reports with geo location, images, remarks, Pearl knowledge based categories and unstructured data like text fields) which can be sent to the Water Detective service. The data observed and uploaded by citizens can be used in an early warning tool by organisations that are connected to the service. E.g. Control rooms (like HydroNET) are able to present the location, time and information of the reporting citizens. On the basis of this information local authorities can immediately determine a problematic location. The app can also be used after incidents or calamities, notifying agencies that certain location need to be investigated. These agencies can then send out field staff, equipped with the tools to further explore the nature and cause of the problem.

The app contains functionalities to involve the community in the flood-warning process. Data that is sent can be seen in a local map together with the observations of other users. The app contains a social rating system, making it possible to up- or downvote submitted observations. With a ranking list, users can observe ‘how the competition’ is doing. This competing element might be used to validate observations; trusted citizens with high rankings will most likely send ‘useful’ new contributions.

2.1.1 Key Functionalities:

- Create your own profile.
- Create observations with location, category, level of severity, remarks and pictures.
    - Including Google address search.
- Save observations and send at a later moment (e.g. when the mobile network is temporarily down).
- Overview of observations sent by user.
- Observations in the area.
    - Include filters for time, category and area.
- Ranking list.
- Account page.
    - Set your own profile image.
    - Select other language.

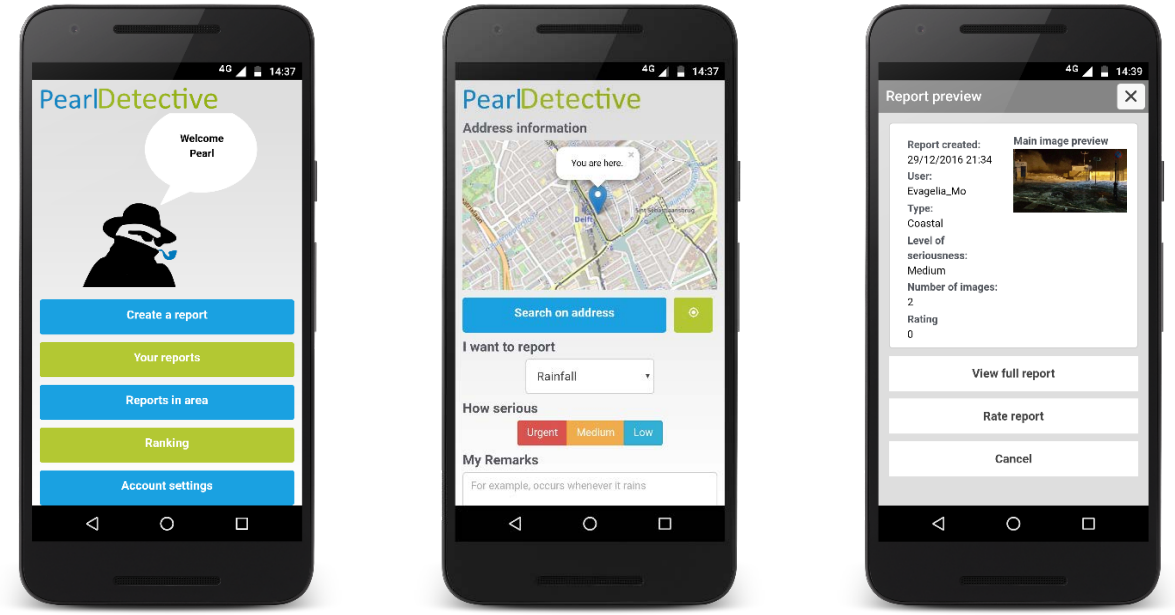

Figure 1 Screenshots of the PearlDetective crowd sourcing application, including a preview on the create observation screen (middle) and an overview of reported observation (right).

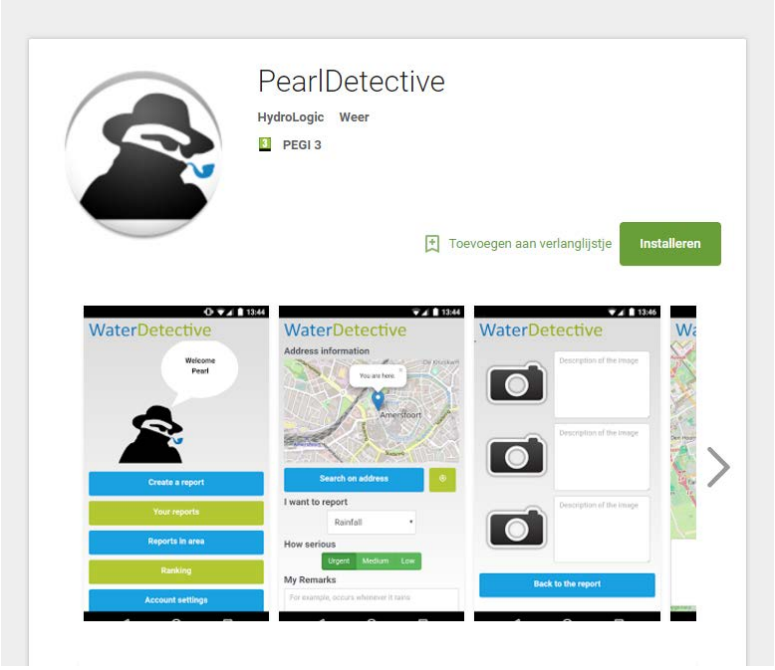

Figure 2 PearlDetective in the Google Play store, available for download to Android smartphones.

Installation:

https://play.google.com/store/apps/details?id=com.hydrologic.pearldetective

The users of the Pearl detective app have created approx. 50 accounts with approx. 100 observations. Several users evaluated and tested the application using a questionnaire about the app functionalities.

The responses we got about the usability of the app have been very positive. Users understand why this can be a good contributing tool for flood observations before, during and after the event. Still, citizens are not yet ‘triggered’ to send observations that much, particularly during periods of absence of heavy rainfall. The general idea has been implemented successfully and the app is working smoothly. Also during periods of rain it appears to be hard to receive much real-time information through citizen observations. This is analysed to be because users don’t think of using the app when the data is needed. It is not common to observe and report to a life service when it comes to extreme weather. Therefore you can say that the technology can be very useful, but it needs more time to become internalised in peoples’ lives and needs to be communicated more as being a monitoring tool. Citizens are more likely to send observations after events, or monitor sensors that do not automatically send data to a service.

2.2 FloodReadyQ

In the frame of the project we have prototyped a similar app which was developed for demonstration of public flood communication in Queensland, Australia.

The idea of the app is that citizens can be alerted when water risks may occur. They are able to see at which water level a potential harm to their homes, offices or schools exists. The prototype ‘connects’ to the closest rain gauges and shows area flood maps based on the current surface-water levels. Users can add locations, switch gauge locations and modify water- levels used in the computation, using a scroll bar on the map.

The app produces warnings in text and on the map as shown in Figure 3. The app is used to showcase current technologies and potential new warning systems using smartphone applications.

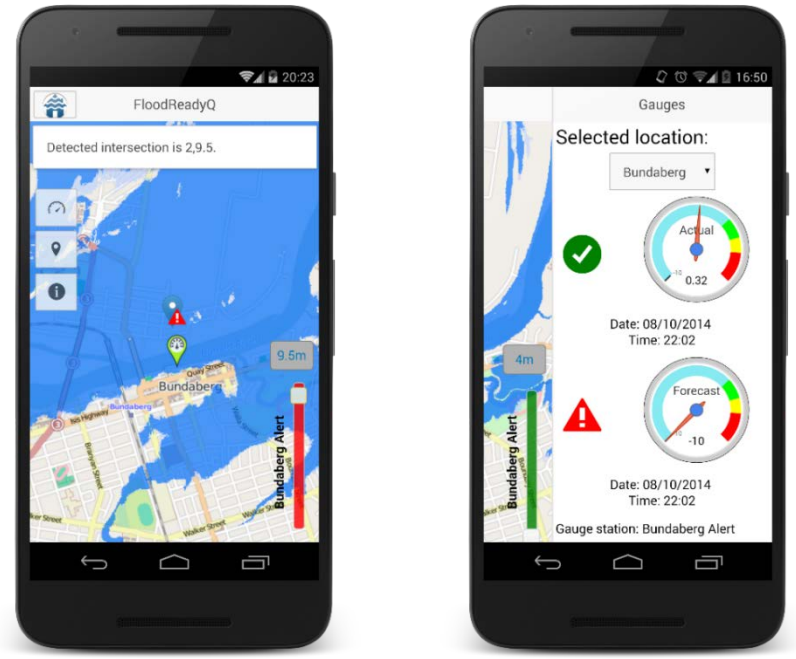

Figure 3 Prototype app with flood warning on current location (left image) and overview of actual and forecasted water levels at the nearest water-level gauge station (right).

3 Evacuation app

3.1 Description and aim of the EvacuAPP

The Pearl evacuation App. Called EvacuAPP has been developed following the concept of a web application. This means that the application is based on web technologies and its interface is a website where front-end users can interact with the application. The EvacuAPP can be easily accessed from any device with internet connections. The application adapts itself on screens of any size and therefor works well on computers, laptops, tablets and smartphones.

The EvacuAPP was initially developed and adapted to be used in the PEARL case study of Sint Maarten in the Dutch side of this Caribbean island. The app enables citizens of this island to access information about the location of the official shelters that are available around the island. This information intends to allow the user to select the best shelter option they have at any given moment of an ongoing evacuation. The information of the shelters can be updated by the administrators of the shelters using the administrator rights of the EvacuApp. Figure 4 shows the available information of a particular shelter user. This includes the name, location and Status of the shelter (Open or Closed) among other data (i.e. capacity).

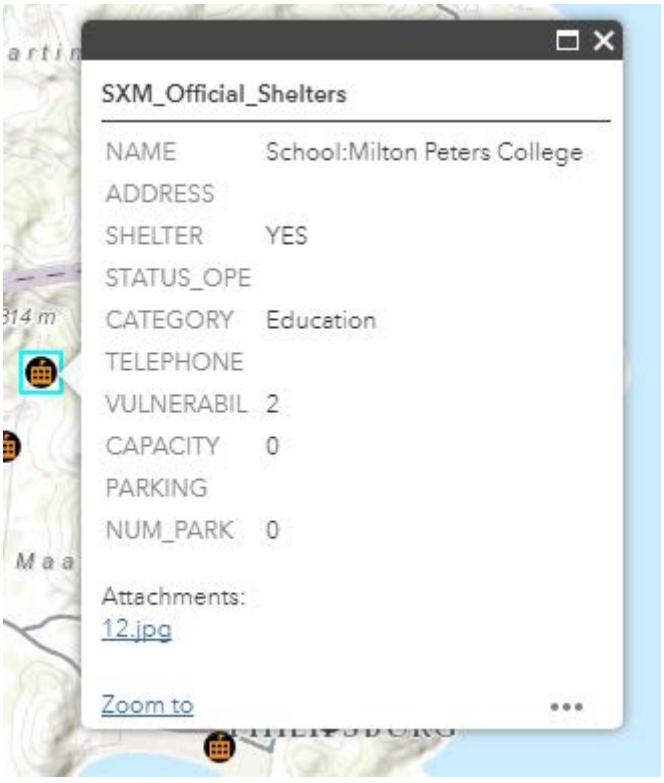

Figure 4 Shelter Information available for the end users of EvacuAPP.

For the administrators of the shelters and/or evacuation authorities a more complete information (and editing capabilities) can be accessed for each of the shelters. The table showing these capabilities is located in Annex 1.

The EvacuAPP contains extra layers of information, in particular the location of critical buildings of the island of Sint Maarten. It was decided to include this layer of information, mainly intended for the administration/operational control to be able to take specific actions over this infrastructure in times of evacuation. And also to take into account that in large scale evacuation scenarios for this island some of these buildings can potentially be used as shelters. Figure 5 shows the different types of critical buildings around Sint Maarten Island. The front user of the app has access to the exact same information that was defined for the shelters. The administrator has full access and editing control of the properties of each object as it was described in Annex 1 Table 1. The Administrators (operational disaster management) can change at any given moment the status of any critical building to function as a shelter for example.

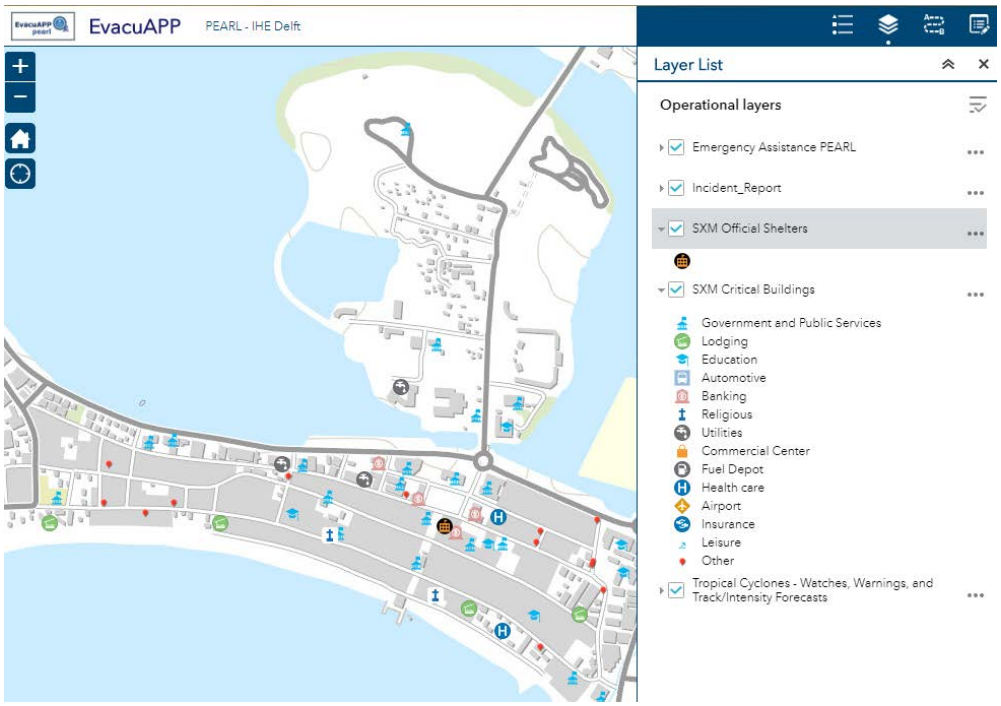

Figure 5 Operational layer of critical buildings within EvacuApp for Sint Maarten Island.

3.2 Funtionalities

3.2.1 Evacuation route / Directions

The user can select to which shelter they want to evacuate from their current location and they can use the built in directions functionality developed within EvacuAPP. The application allows users to set the starting point and the desired shelter as destination. A step by step instruction on how to get to the selected place is displayed on the screen and the route is marked and displayed. The estimated time of the trip is shown based on the transportation means chosen by the user (Driving,

walking, etc). This functionality is illustrated in Figure 6. After a route has been selected the user can choose to print the advice results and keep it safe in case there is loss of internet connection.

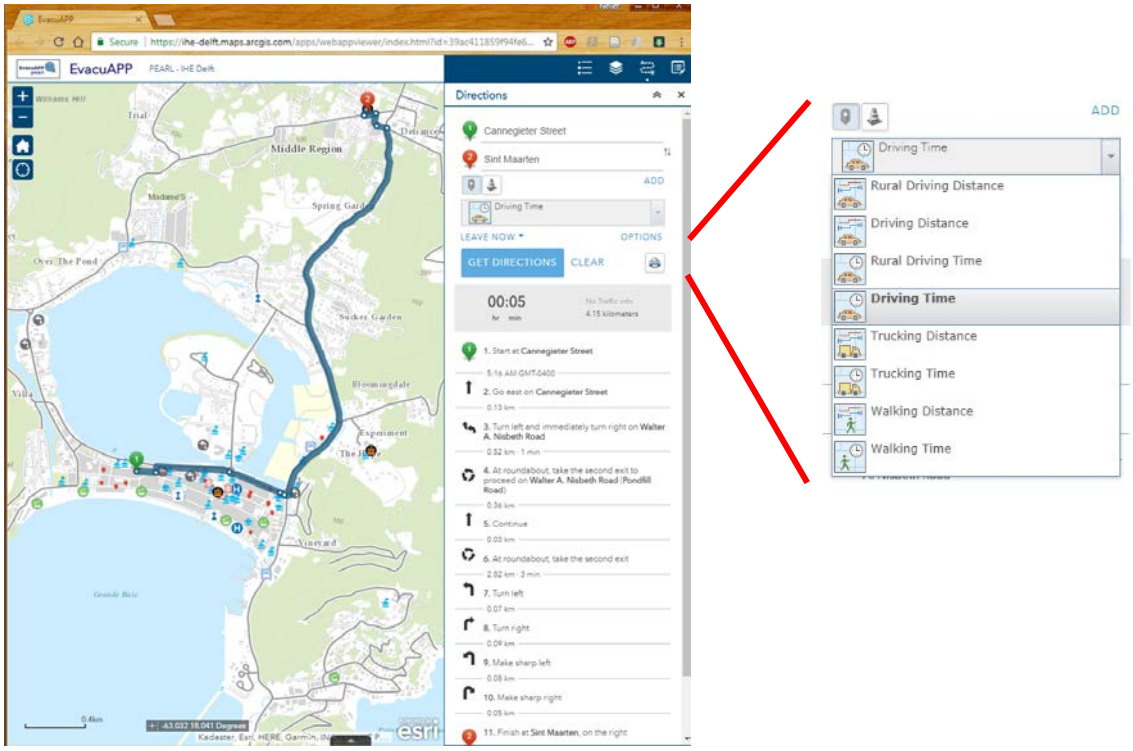

Figure 6 Directions functionality within EvacuAPP

3.2.2 Request emergency assistance, report safe

As an integral part of the evacuation app, a functionality that enables the users to access and request emergency assistance has been included in the interface. With this functionality any user can report themselves at their current geolocation and report their need for assistance at three different levels (Yes –NO and Partially). Users can also provide basic information which can be used by the authorities to have a better and more coordinated response, see Figure 7.

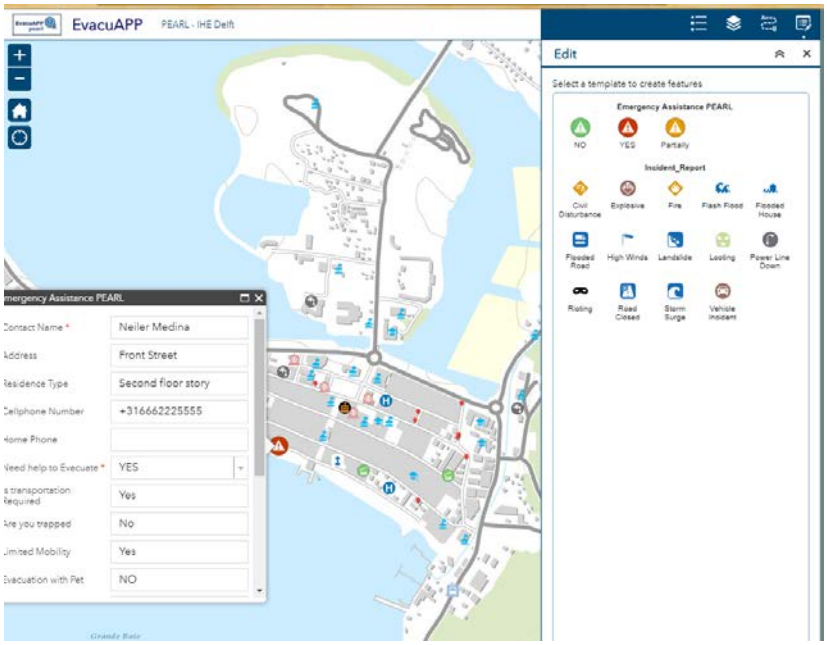

Figure 7 Emergency Assistance within EvacuApp for Sint Maarten Island.

As can be seen in Figure 8, the user can request for a full, partial or no assistance (in case the citizen just want to report him/herself safe). Provide the address and information about the house, contact numbers, request for transportation and/or pet/cattle evacuation assistance and provide some emergency contact details. They also can report themselves as trapped and finally they can add a photo in case they want to provide it as useful information on the assistance process.

Figure 8 Information that can be provided when using Emergency assistance in EvacuApp.

3.2.3 *Report incident*

Another functionality included in the EvacuApp is the ability of the users to act as a crowdsource of information regarding incidents that are related to the evacuation or emergency situation. This information can be of use for authorities when deploying ground assistance or planning rescue missions on the evacuation. Figure 9 shows the type of incidents that can be reported using EvacuAPP.

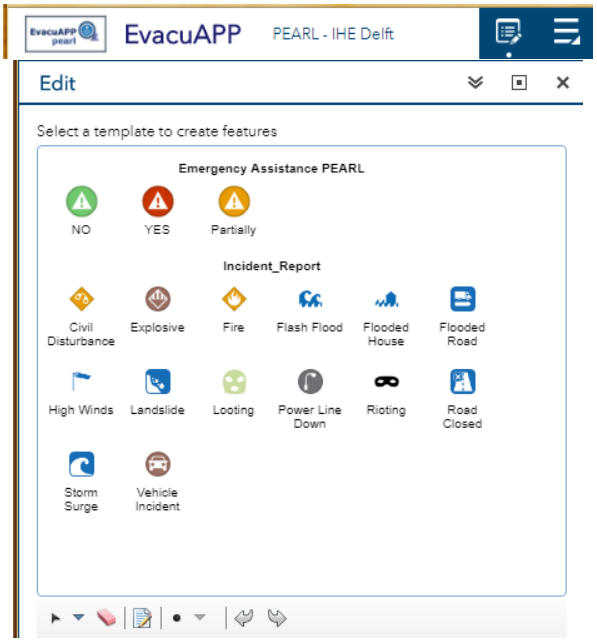

Figure 9 Information that can be provided when using incident Report layer in EvacuApp.

3.2.4 *Explore/view current warnings*

The last functionality of EvacuApp allow the user to activate the layer of current warnings. This functionality allows the user to watch the warnings and to track the intensity and location of hurricanes and tropical cyclones forecasted by the National Hurricane Center (NHC) of the United States of America. This allows the user to be aware of major threats and possible storm paths and arrival time to their location. Figure 10 shows the current threat (15 October 2017) of Hurricane Ophelia in the Caribbean --the only storm active in the Atlantic at this time).

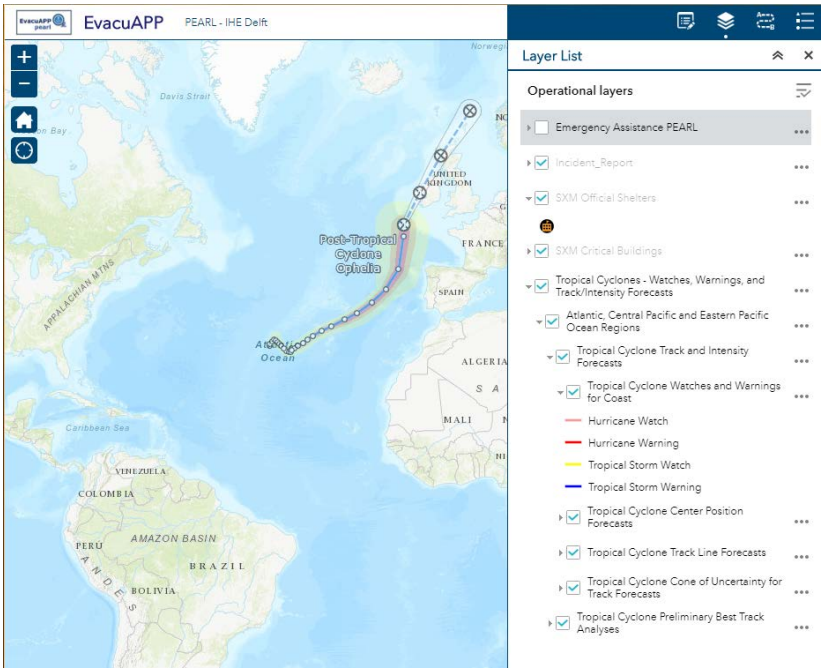

Figure 10 National Hurricane Center forecast layer of hurricanes within EvacuApp.

3.3 User Experience

Finally the following figures show how adaptable is the WebAPP to multiple screen sizes.

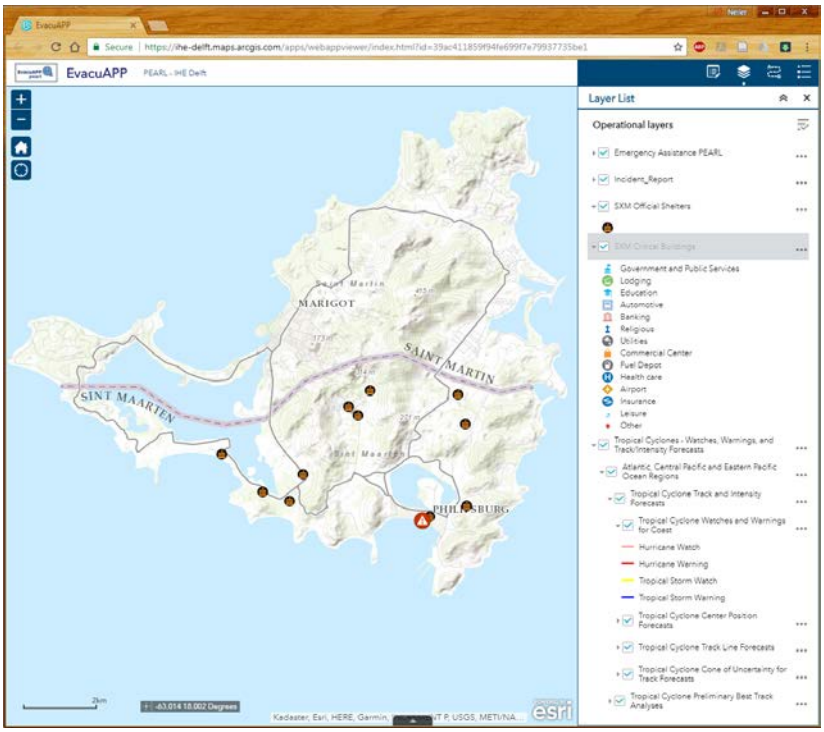

Figure 11 EvacuApp on Laptop web-browser

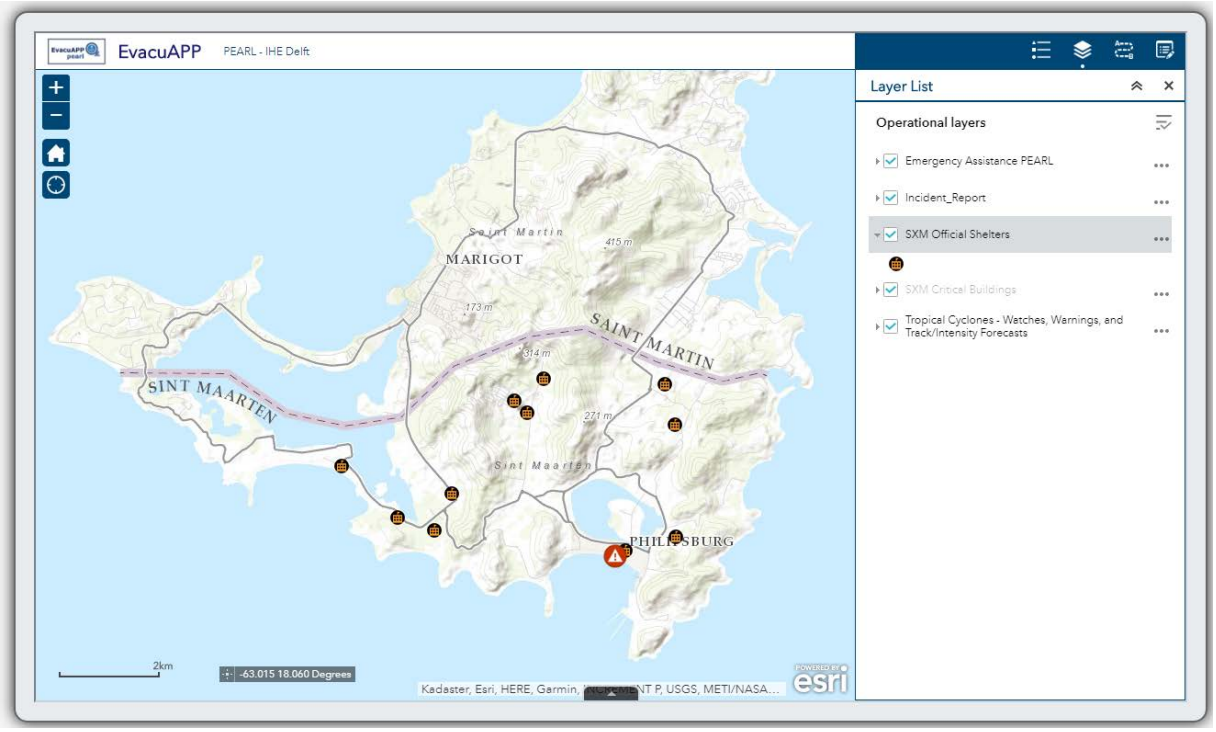

Figure 12 EvacuApp on Tablet web-browser

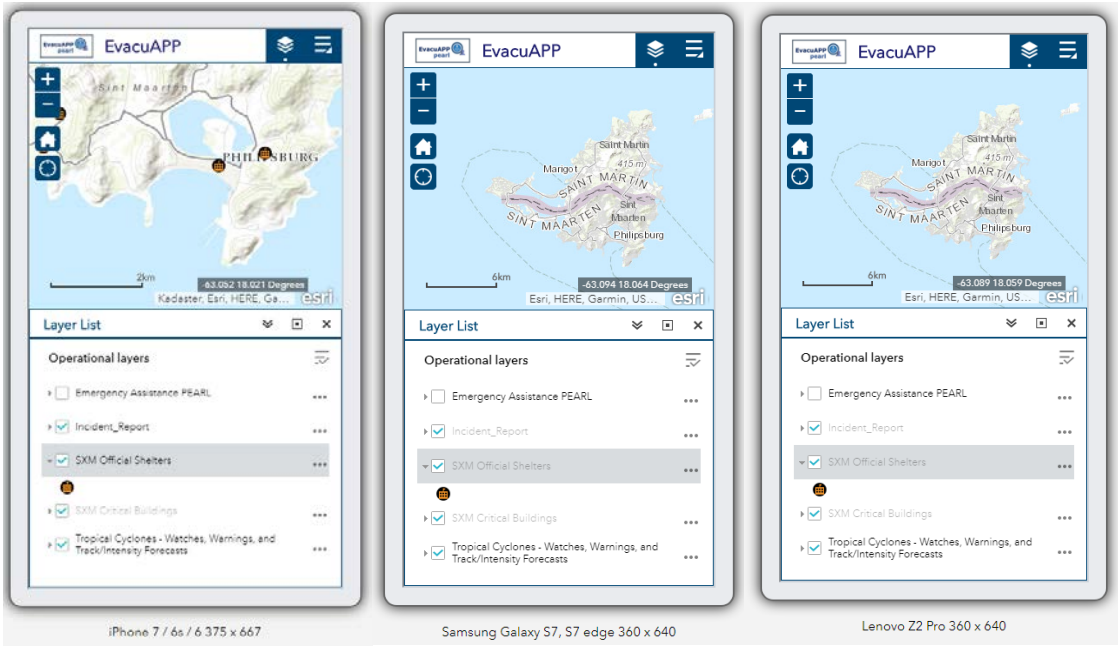

Figure 13 EvacuApp on iPhone (left), Samsung (center) and Lenovo (right)

3.3.1 *Key Functionalities:*

- Access without logging to the App from multiple devices.
- Request key information of official shelters.
- Driving and/or walking directions to preferred shelter.
- Access forecast information form the NHC about current hurricane threats.
- Request for assistance to evacuate.
- Crowdsource about incidents of relevance during evacuation.

In addition this App can be further used to collect information of usage and acceptance of citizens regarding evacuation on the island of Sint Maarten. This can be used to improve mechanism and strategies for future evacuation when needed. Figure 14 shows the number of users/visitors of the EvacuaApp during the period October-November 2017.

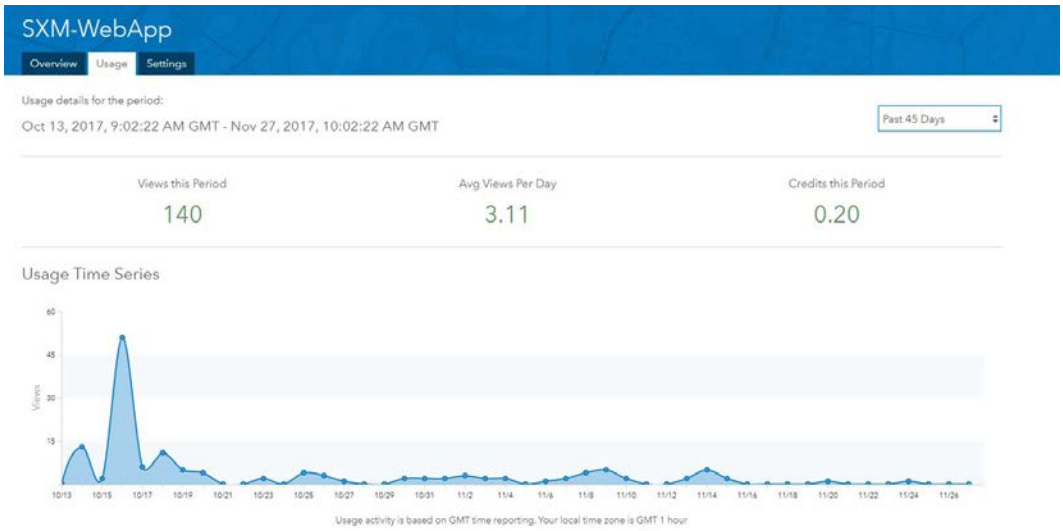

Figure 14 Users statistics for the EvacuApp in Saint Maarten.

Access/Installation:

https://ihe-delft.maps.arcgis.com/apps/webappviewer/index.html?id=39ac411859f94fe699f7e79937735be1

4 Web-Based Flood Forecasting

4.1 Description and aim of Web-Based Flood Forecasting

Flood forecasting systems issue advance information on potential flooding in an area, allowing people and the authorities to prepare, take action and reduce the potential negative impacts of the flood. Several interconnected components typically comprise flood forecasting systems:

- Data acquisition. Involving the collection, measurement, and processing of data needed to assess existing and estimated future flood conditions.
- Flood forecasting. Estimation of potential flooding based on collected data. Models may be used for flood forecasting. They can be physically-based, data-driven, conceptual, or combinations of different model types.
- Decision-support. Integrates and processes information from the other components for analysis and identification of action regarding the forecasted hazard. Information products for different end-users are prepared at this stage.
- Dissemination. Involves the timely distribution of relevant, understandable information to the exposed population. This may be through web-based viewers, SMS messages, emails, or automatic emergency messaging systems.

In this report, a web-based real-time coastal flood forecasting system is presented as an example tool for early warning dissemination. Its implementation in Greve, Denmark, one of the case study areas in the PEARL Project, is described to illustrate the different components and functionalities of such a system. Also, more details on this solution as well as other modelling tools and techniques for early warning are found in report D4.1 “Online Modelling Tools and Techniques for Early Warning Systems” issued under Work Package 4 of the PEARL Project (PEARL, 2016).

4.1.1 Components

A coastal flood forecasting system was implemented in the PEARL case study area in Greve, Denmark. Its key components are illustrated in Figure 15 below.

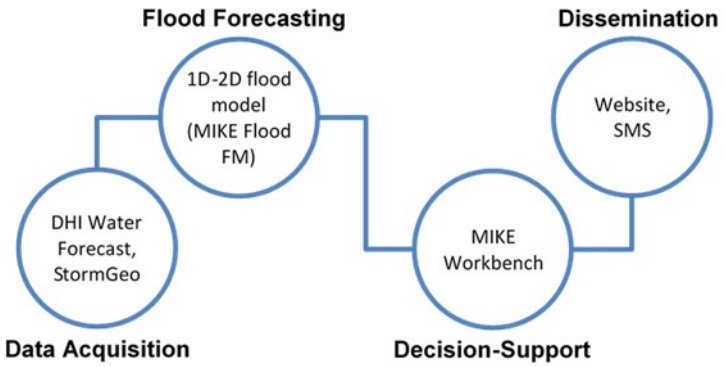

Figure 15 The main components of the Greve Flood Forecasting System

It employs a 1D/2D hydrodynamic model for flood forecasting, comprising of a 1D model of the drainage system coupled to a 2D surface flow mesh model of the inland and sea areas along the coast.

The forecast model is driven by rainfall and sea level forecasts as boundary conditions. MIKE Workbench (DHI, 2016), stores and processes data to ensure the forecast period is covered. It

then exports the data into files useable as boundary conditions by the flood model. The files are updated every time-of-forecast, and the simulation period for the flood model adjusted accordingly. Flood forecasts for the next 24 hours are made every 4 hours.

A website that is accessible through all devices with a web browser is used to show flood forecast results (Figure 16). The website was built using Polymer (Polymer, 2015) with the DHI Web API accessing data through MIKE Workbench (PEARL, 2016). The data displayed on the website are:

- Result files for 2D animation of water depth as well as display of maximum water depth.
- Time series for water depth at important locations.
- Time series for boundary conditions.
- GIS data layer with the model extent.
- Spreadsheet with a list of locations and their maximum depth values for the next 24 hours.

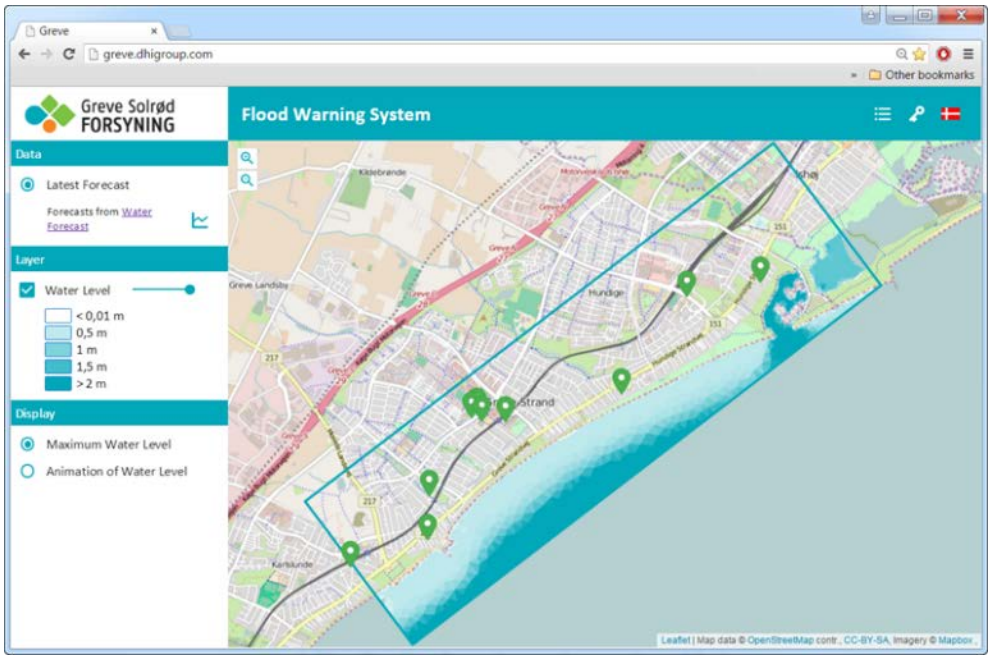

Figure 16 Homepage for the online coastal flood warning system in Greve, Denmark (www.greve.dhigroup.com) (Source: PEARL, 2016).

The website shows a map of the most recent flood forecasts in the case area (see Figure 16). By default, the maximum depth is displayed, but under the ‘Display’ menu, the user may also choose to show an animation of water depth results.

Colour coded results for some specific (critical) locations are also shown on the map. The coloured place markers may be activated to view water depth time series results at each point (Figure 17). Some information on these critical locations, such as coordinates, name, area type, and computed flood time series, are stored in a spreadsheet in MIKE Workbench.

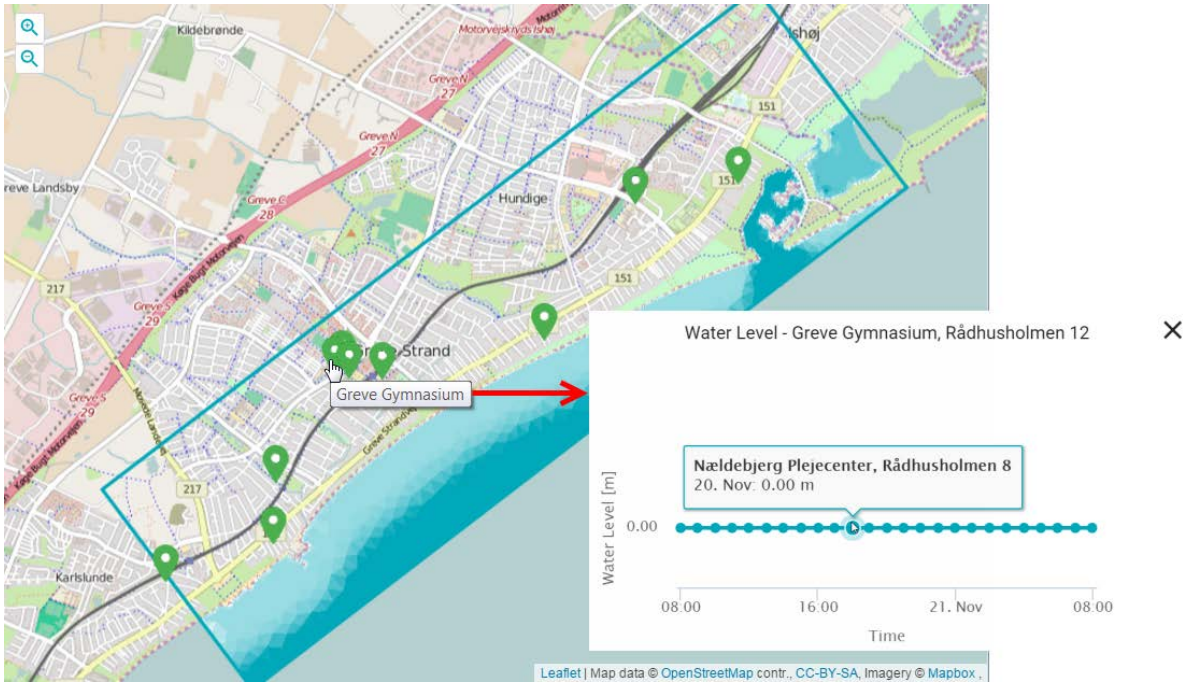

Figure 17 Place markers for pre-identified important places in the case area are also plotted on the map. The markers are colour-coded according to computed flood depths—from green (0-20 cm) to yellow (20-40 cm), and to red (above 40 cm).

Information on the rainfall and water level forecast data are also published on the website as time series plots. Under the ‘Data’ menu, the time series icon may be activated to view the boundary conditions used in the latest forecast (Figure 18). Six-day sea level forecasts around Greve are obtained from DHI’s Water Forecast service every twelve hours (DHI, 2011). Rainfall forecasts for the next 24 hours are also collected from the service, which obtains the (NWP) data from StormGeo (StormGeo, n.d.). The data are then stored through MIKE Workbench.

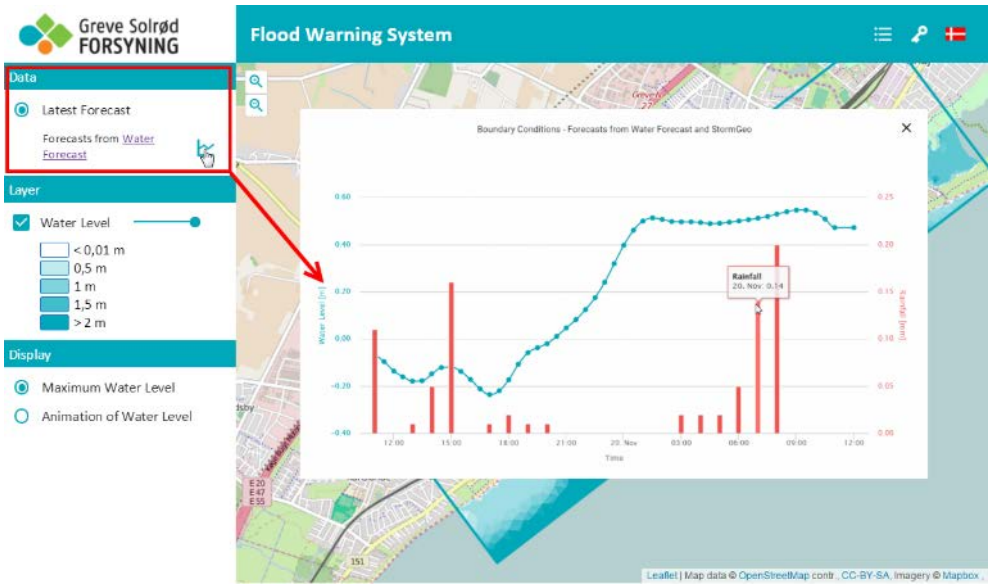

Figure 18 Forecasted sea water level (blue lines) and rainfall (red bars) data used to drive the flood forecast model as viewed on the website.

Besides real-time flood forecasts, results from other (extreme) flood modelling scenarios may also be viewed on the website, but only with login information due to the sensitivity of the information.

The Greve Flood Forecasting system also includes functionality for monitoring system performance in MIKE Workbench. Job statistics data on simulation run times are stored, giving information on model efficiency as well as system function.

Summary

A flood forecasting system may be customised in terms of its components depending on its main purpose, stakeholder needs, and data availability. They can be as streamlined or as sophisticated as fits the purpose, as illustrated and discussed in the various examples in PEARL (2016) (D4.1 Report Online Modelling Tools and Techniques for Early Warning Systems).

The Greve flood forecast system had components for:

- Data acquisition. Forecasted rainfall and sea water levels are routinely obtained from DHI's Water Forecast service through MIKE Workbench and used to drive the flood model.
- Flood forecasting. A coupled 1D/2D hydrodynamic flood model was built with MIKE Flood FM (DHI, 2016b) model for calculating potential flooding in the coastal area of Greve.
- Decision-support. MIKE Workbench, a desktop client for interactive data storage, analysis and processing, was used in the system for
- Dissemination. A website (http://greve.dhigroup.com/), built using Polymer and the DHI Web API, is used to show coastal flood forecasts in the Greve. It is accessible in all devices with a web browser.

Because of good data availability in the Greve case study, a full, solid flood forecast system could be built and implemented for the area, mainly based on a state-of-the-art method of coupled 1D/2D hydrodynamic coastal flood modelling. Although stakeholder requirements for information dissemination were relaxed, robust facilities for real-time dissemination of forecast results were implemented. A website was built for showing up-to-date flood forecast results, and forecast boundary input data.

5 Conclusion

The Pearl consortium intended to develop an app interface for public warnings, GIS information and sensor data as part of work package 4, task 4.5. The products created within this task are encapsulated within multiple life applications. These apps can be seen as new methodologies and tools that have been developed for effective dissemination of (early warning) flood information. Within Pearl, citizens are seen as sensors which can supply unstructured data to other citizens and authorities. These individuals have the possibility to report on blockages, damages on infrastructure, flooded areas or any other information. The crowdsourcing data is collected and available for the users and authorities.

The partners created even more functionalities like a rating system, evacuation routing, shelter information lookup and the visualisations of hurricane and forecasted data. These new data sources, e.g. easy accessible shelter information and forecasted water levels are crucial for authorities in crisis management strategies. These technologies have been created in a way that both citizens and authorities can use the tools in multiple ways: as an public early warning system, as a flood information platform and as an evacuation guide.

These prototypes created in Pearl are evaluated by the partners and users and show a new approach in the distribution of flood warning information to the world and the partners will continue their research on these products after the project lifetime.

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Annex 1

Attributes	Description
FAC_ID	Corresponds to the shelter Facility ID assigned to the building
Name	Name of the Building
Address	Address of the main entrance of the building
Shelter	To assign the official (or NOT) status of the building as a shelter
STATUS_OPEN	To assign by the shelter manager if the building is currently accepting or NOT people in the facility
DateCollection	To fill in the date of the latest updates on status as shelter
Inspector	Name of the person who check for the last time the shelter.
Category	The use of the building according to the Domain of building uses
Shelter Telephone	Cell phone or landline to contact the shelter
Shelter Owner	Name of person or organization that owns the shelter
Owner Consent	Field to enter weather the shelter's owner agreed to use the facilities to a specific evacuation
Ground_Elev	Input the elevation above sea level of the building
Flood_Risk_Height	Select the risk height according to the domain
Physical_Cond	Physical condition of the building in terms of vulnerability according to domain
Vulnerability	Vulnerability assessment for the building according to the risk and physical condition. See Domain
Capacity	Define the total number of people the shelter can accommodate
Parking	To indicate if the shelter is equipped or NOT with parking units
NumPark	Field used to indicate the number of parking spaces available at the shelter
Nbeds	Total number of beds available at the facility
Ntoilets	Total number of Toilet units available at the facility
RunningWater	To indicate if at certain moment the shelter can provide water from the public water system
WaterStorage	To indicate if the shelter is equipped or NOT with tanks to storage drinking water
WS_Capac	Field used to indicate the storage capacity (If exist) of drinking water (m3)
BottledWater	Field used to indicate the current storage of bottled drinking water (m3)
Storage_Capacity	Input the space available in m3 for storage of supplies to attend an evacuation
Roof_Structure	Define the structure of the building's roof
Roof_MAT	Define the type of the building's roof
WindowsProt	To specify whether or not the windows and/or glass doors protected by shutters
PowerGenerator	To specify whether or not the shelter is equipped with an alternate energy power source
FoodPrep	To specify whether or not the shelter is equipped with an inside kitchen facility or NOT
Photo	A photo of the shelter to identify the location

Table 1.Full list of attributes available for user administrator on Shelters.