

CTCN assistance in Thailand

Strengthening Bangkok's Early Warning System to respond to climate induced flooding



Deliverable 2.3 Design, configuration and deployment of data and business process system

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This report has been prepared under the DHI Business Management System certified by Bureau Veritas to comply with ISO 9001 (Quality Management)



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1 Introduction

An urban flood early warning system, applied for a limited, but representative catchment within the Bangkok Metro area has been developed. The system integrates the existing data-monitoring network with flood simulations. The result is an automated, operational warning system providing information on flood risk zones (extent and duration) by means of web/mobile platforms.

The document describes the state of the early warnings system installed in March 2017, and the system will be updated in the test phase running over the next couple of months. Feedback from BMA will be an important input to the expected system updating. The report focuses on the data management system parts. The web-reporting functionality and features are described in more details in Activity 2.4 and the associated report.

The dedicated software, deployed and configured in this activity, has been a part of the training session in December 2016 (Activity 3.2) and the workshop at DHI, DK attended by BMA in August 2017 (Activity 3.1).

BMA and DHI have initiated a dialogue process on how to secure maintenance and updates of the demonstration when the TA ends. The concept being discussed is a Maintenance Agreement between BMA and DHI. DHI has offered to waive all costs associated with the necessary software licenses.

2 Early warning system components and system data flow

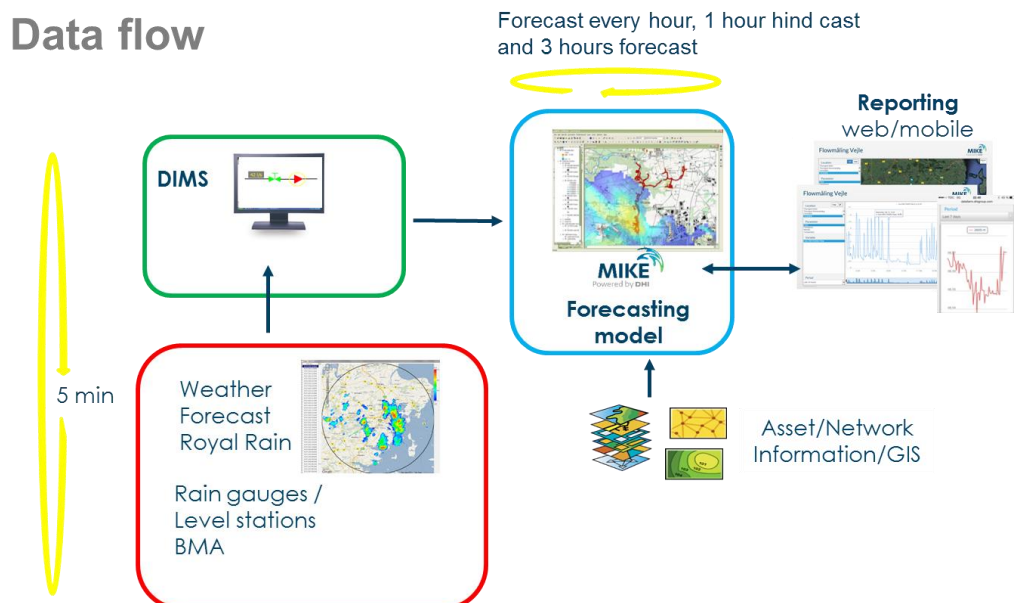


Figure 2-1 Data flow in - and system components of - the early warnings system. The system applies the two DHI software packages DIMS.CORE and MIKE OPERATIONS.

DIMS.CORE is the data repository for the early warning system. This component collects data from the BMA citywide operated SCADA system together with radar-based rainfall forecasts provided by Royal Rain. SCADA data are collected every 5 minutes, while Radar data are collected every half hour. DIMS-CORE is linked to MIKE OPERATIONS, which is a combination of a standardised out-of-the-box software product and a flexible and open software framework. The BMA installation is configured to launch flood simulation every hour. MIKE OPERATIONS builds on the MIKE Workbench data management framework. Not only does MIKE OPERATIONS offer online modelling capabilities, but it is also a versatile data management system.

The MIKE OPERATIONS features are made available through three complementary applications:

- MIKE OPERATIONS Desktop – a user-friendly desktop client, designed for users who need a quick overview of the operational system status and who need to test operational alternatives.
- MIKE OPERATIONS WEB – a web-client with a look-and-feel feature similar to the MIKE OPERATIONS Desktop but with a subset of the functionality and a focus on data sharing.
- MIKE Workbench – an advanced desktop client, designed for expert users who apply data analysis and process tools interactively and are able to configure automated workflows, scripts and custom-made data reports.

Presently, the online system is hosted by DHI servers, and BMA has access to flood warning reporting through the MIKE OPERATION WEB interface. If BMA decides to expand the demonstration system to a city wide-system, the hardware/software installations will be migrated to Bangkok. The decision, if to go system-wide, depends on different aspects, including financing options. The latter will be discussed in Activity 5.

2.1 Hardware configuration

After dialogue with BMA, it was decided to implement a hosted solution at DHI, rather than establishing the required hardware components at BMA. Either solutions provide the functionality needed for the technical assistance. The hosted solution was preferred as it was more straightforward with the tight time schedules. Engaging with BMA's IT department would have delayed the activities with several months, maybe 6 or more.

The hardware setup of the project implementation consists of two computers:

1. An application host (a virtual PC) within the DHI domain. This PC hosts DIMS.CORE and MIKE OPERATIONS and the necessary databases of the DHI MIKE tools.
2. The virtual PC is linked to an 8 core GPU workstation (high performance workstation), which is used for flood simulations.

2.2 Data collection

Two services are configured in DIMS.CORE:

1. A gateway
2. A scheduler

The Gateway addresses the needs of disparate data access to the heterogeneously distributed environment and accelerates the performance of the tool – securing rapid access to data etc. The gateway facilitates the link between DIMS.CORE and MIKE OPERATION databases.

The scheduler launches regular time interval tools that are used to read external data into the DIMS.CORE database. In the present installation, the scheduler reads data published on FTP sites and executes the data-scraping tool that scraps data from BMA SCADA websites. The gateway as well as the scheduler service are deployed on the virtual server, but in a larger and more complex setup. These services could have been deployed on other resources in the network.

The different data types that are collected in DIMS.CORE are:

1. Rain gauge precipitation data
2. Hindcast and forecast rain data from Royal Rain radar installation
3. Water level measurements

All values in the DIMS.CORE database are time-stamped using local Bangkok time, UTC + 7 hours.

Detailed information in DIMS.CORE configuration is provided in the /1/ DIMS.CORE manual.

2.2.1 Precipitation data from rain gauges

Precipitation data are retrieved from the html page:
<http://weather.bangkok.go.th/scada/rainfall.aspx>.

A dedicated program that “scrapes” data from this SCADA webpage has been developed and integrated in DIMS.CORE. Data from 77 citywide rain gauges are collected, but only rain gauges located within the flood model area are transferred to MIKE OPERATION and applied in flood warning simulations (see Figure 2-2).

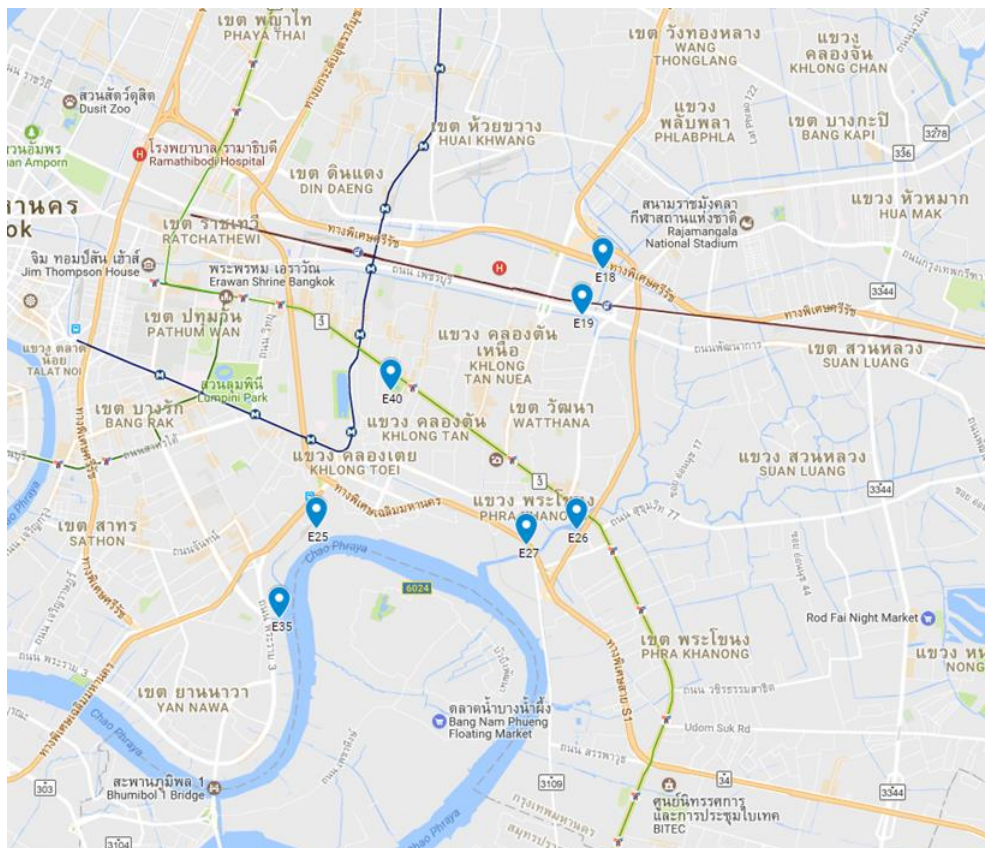


Figure 2-2 Rain gauges applied in flood simulations

Rain gauges data have a 5 minutes frequency, and generally there is small time delay in the data scraping (data are available within approximately 10 minutes). Sometimes, however, the SCADA webpage is reacting slowly, which will result in lack of data in the time series. It may also occur that the webpage holds no data for a number of stations.

2.2.2 Royal Rain radar hindcast and forecast rain data

Radar perceptions images, with a spatial resolution of 1 km x 1 km are collected. From these images, time series data are extracted from the 42 cells that covers Sukhumvit demonstrations. Data are read from a dedicated FTP site. There is a considerable time delay in radar data. As shown in Figure 2-3, data processing at Royal Rain requires 30–60 minutes as a minimum. In this project, BMA doesn't have direct access to radar images from Royal Rain but must collect these data from HAI - the Hydro and Agro Informatics Institute, Ministry of Science and Technology. HAI collects the data from Royal Rain and the three steps data collections procedure results in a considerable time delay. The time delay varies, but it is minimum in the order of 60 minutes and sometimes up to 2-3 hours.

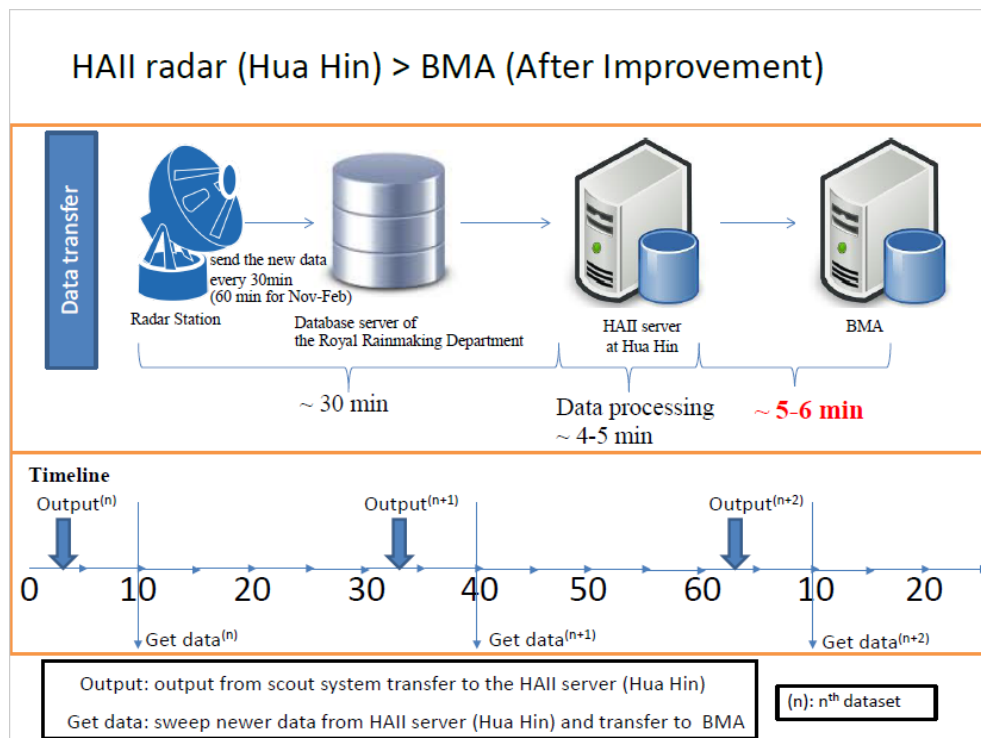


Figure 2-3 Radar data processing

The collected radar data package contains one hind cast image and 1 hour, 2 hours and 3 hours forecasts.

The many steps in the data transfer also introduces a relatively high risk of failure in the communication line. Radar data are often not available due to computer failure in one of the different links, and direct access to radar images would improve data collection stability.

2.2.3 Water level monitoring

Water level data are collected from two different sources:

- Scraping of SCADA web pages
- Flood data published on FTP site

Scraping data from BMA SCADA website is done in the same way as scraping data from rain gauges. However, data are not available at the same frequency – only every 15 minutes at 40 stations.

Flood and canal water levels are published on a DHI FTP site. The delay of these data is approximately half an hour. The frequency of these data varies from 5 minutes, 10 minutes right up until 15 minutes.

In the current configuration, only measurements from water level stations that bound the model area are transferred to MIKE OPERATION.

2.3 Flood simulations

The MIKE OPERATION database is configured with functions that read flood simulation input data from DIMS.CORE, execute flood simulations (including pre-processing of simulation input data) and report flood simulation results. MIKE OPERATION manually provides detailed information on MIKE OPERATION configuration /2/.

The core of the flood warning system is the MIKE URBAN flood model, which is registered in the MIKE OPERATION database and applied in flood simulations. A new flood simulation is automatically launched every hour. This simulation covers a 1 hour hindcast period and a 3 hours forecast period, in total 4 hours simulation period, see Figure 2-4. Every new simulation reads initial conditions from the previous simulation (initial conditions are taken one hour into the previous simulation). For example, a simulation that starts at 12:00 covers a period from 11:00 to 15:00. This simulation reads initial conditions at 11:00 (water levels in pipes, flow in pipes, surface flood level etc.) from the previous simulations that started at 11:00 and covered a period from 10:00 to 14:00. Applying initial conditions from the previous simulation ensures that simulations are as precise as possible and limits the total simulation period of each flood warning to 4 hours. In order to have flood simulation results as fast as possible it is essential that the flood simulation period is as short as possible.

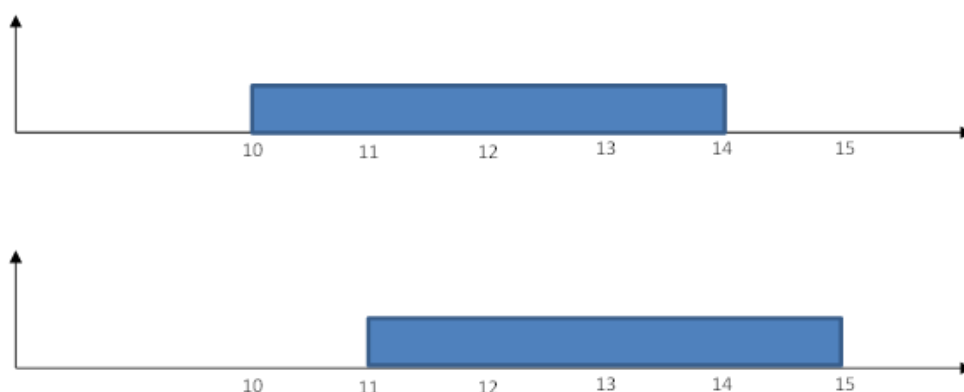


Figure 2-4 Flood simulation, x-scale is hour

2.3.1 Flood simulation rainfall processing

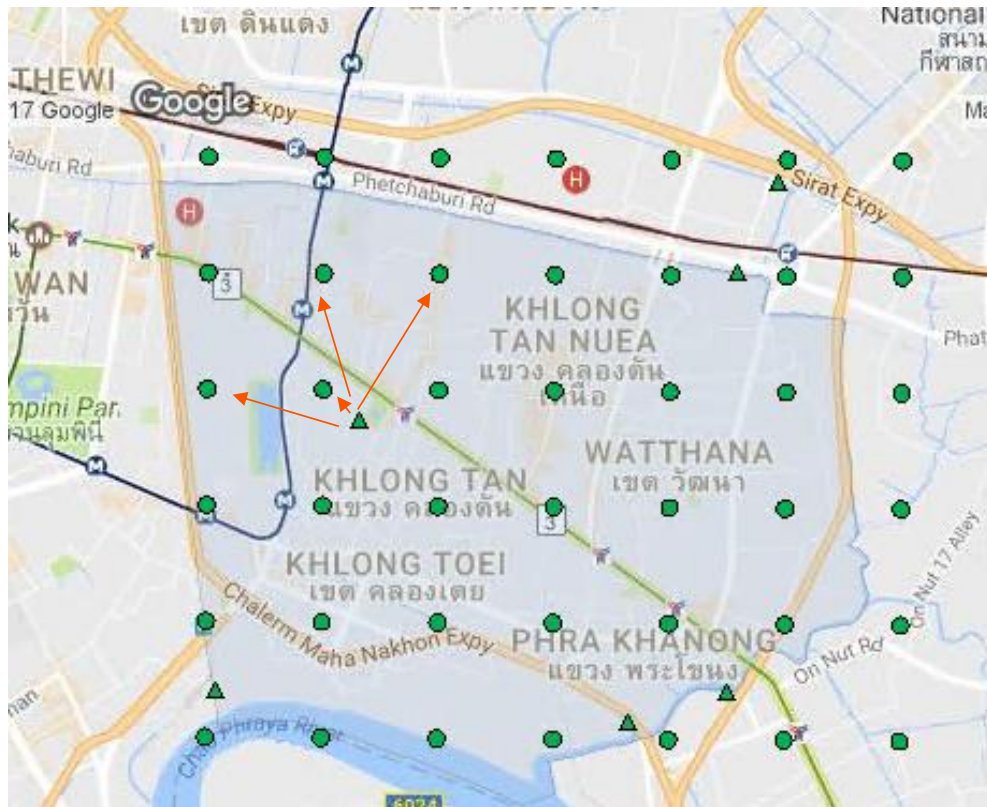


Figure 2-5 Location of rainfall time series extracted from radar images (circle) and rain gauges (triangle)

Flood simulations are driven by a combination of rain gauge measurements and data extracted from radar images. As BMA has reported to DHI that the reliability of rain gauges measurements is higher than that of radar images, rain gauges values have first priority and radar images second priority. MIKE FLOOD simulations use 42 radar images cells as input (see Figure 2-5). 42 time series are created from radar images; one for each cell that is within the modelled area, see Figure 2-6. There are only 6 rain gauges located inside the model area, and as illustrated in Figure 2-6, rain gauge values are distributed to image time series locations. This means that the same rain gauges values are applied in several cells.

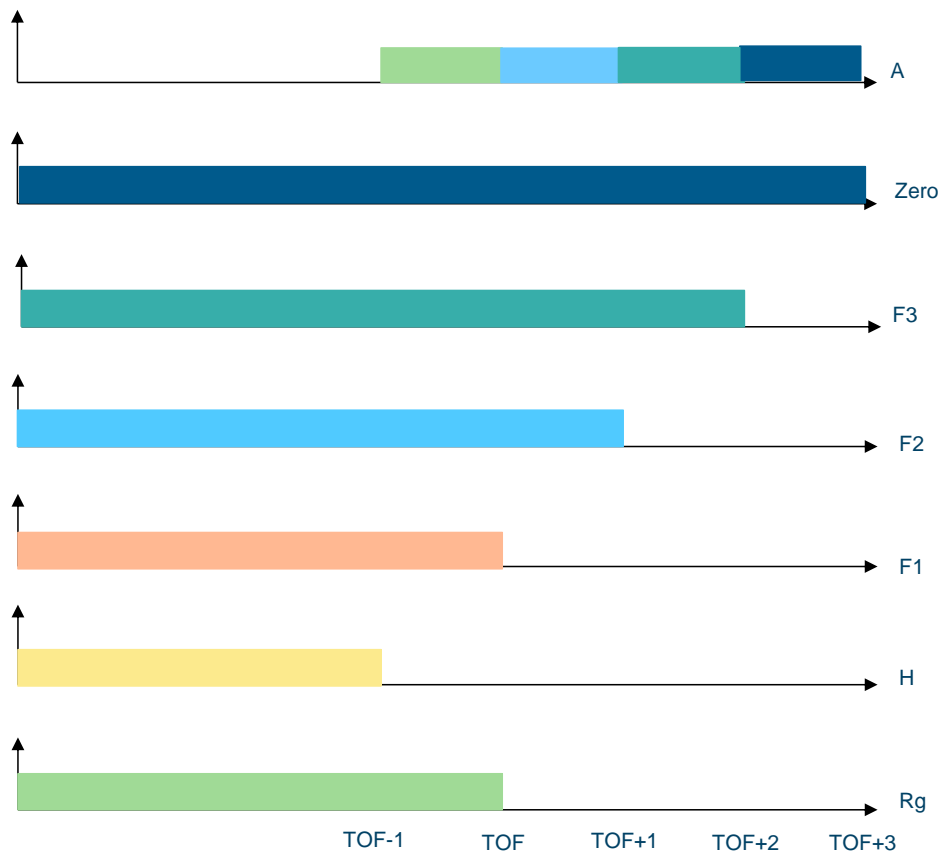


Figure 2-6 Creation of rain time series used as input to flood simulation. A = Resulting time series, TOF = time of forecast (time when flood simulations starts), TOF +1 = one hour after TOF and so on, Rg = time series of rain gauges values available, H = time series of radar images values available, F1 = one hour forecast values available, F2 = two hours forecast values available, F3 = three hours forecast values available and Zero = the sixth priority zero rain fall intensity.

The 42 time series that will be applied in the flood simulation are created according to following priority:

- First priority is measured rain gauges value
- Second priority is radar images hindcast value
- Third priority is 1 hour forecasted value
- Fourth priority is 2 hours forecasted value
- Fifth priority is 3 hours forecasted value
- Sixth priority, if neither rain gauges value or radar images values are available, zero rain fall intensity should be applied

The applied procedure is illustrated in Figure 2-7. In the illustrated example, measured rain gauge values will be applied in the first hour of the simulation period, 2 hours forecasted values in the second hour, 3 hours forecasted value in the third hour and zero values in the last hour.

All activities related to flood reporting are reported under Activity 2.4 and the corresponding report.

3 Conclusion and recommendations

The technical assistance resulted in additional skills and competences to the staff of BMA, and an early warning system that can be expanded to a city-wide warning system has been developed.

There is a considerable time delay in collection of radar data. The quality of flood warning simulation depends highly on reliable rainfall forecasts. It is recommended the radar data procedure be optimized.

The many steps in the transfer of radar data introduces a relatively high risk of failure in the communication line. Radar data are often not available due to computer failure in one of the different links, and direct access to radar images would improve data collection stability and reduce the time delay.

Data-scraping from web sites is a feasible data collection method in a demonstration like this, but can be unstable. Direct access to BMA SCADA database would increase stability and performance of data collection.

The quality of flood forecasts also depends very much on the applied flood model. Results of warning simulation have to be evaluated with due consideration to the applied model and the data that are available to develop this model.

4 References

References are published and made available to BMA as a part of the project. The references are integral parts of the software applied in the TA.

/1/ DIM.CORE DHI manual

/2/ MIKE OPERATION documentation