Chapter 29
From Meteorological Forecasting to Floodplain Forecasting for the Protection of Populations in Urban and Peri-Urban Areas

Sandrine Vidal and Jean Paul Ducatez

Abstract The best measure to protect residents in flood areas remains anticipating relief efforts. This requires early availability of reliable spatial and temporal information on future flood risk. We will present 2 case studies on which flood forecasting and warning systems have been set up. These systems all have the objective of translating rainfall forecasts into flood risk for the safety of people, however we will see that the flood risk information can be different depending on the context and the need of each administrator. These systems have been set up in the MIKE OPERATIONS platform to import and process rainfall data, carry out hydraulic simulations and provide flood risk information adapted to each user.

The first case studies is about the flood forecast system of Pointe à Pitre developed for the CAP Excellence where the real time system can show a map with red point where the network can overflow in the next 24 h gives the flood risk information. The second case studies concern the flood forecast system developed for the SIAVHY which integrates a 1D/2D model running in real time with rainflow model based on spatial rainfall forecast. The flood risk information is a flood map with discretization of the water depth on the flood area.

The main objective of all these systems is to provide an understanding of the expected risk for better anticipation, based on the transformation of the rainfall forecast information.

Keywords Flood forecasting · Urban area · Real time flood map

S. Vidal (✉) · J. P. Ducatez
DHI, 2/4 Rue Edouard Nignon, 44300 Nantes, France
e-mail: svi@dhigroup.com

J. P. Ducatez
e-mail: jpd@dhigroup.com

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29.1 Introduction

In urban or peri-urban areas, the main sources of flooding are river overflows or resurgence of rainwater systems. Urban flood management requires accurate spatial and temporal information on the risk of future floods, for good emergency management and effective anticipation of local protection measures. To assist crisis management services, weather forecasting technology and flow now makes it possible to set up flood forecasting systems, using modelling software in platforms such as MIKE OPERATIONS. These systems can be very simple for basic applications with the location of potentially problematic areas (flow forecasting, overflow forecasting) and more complex with the mapping of areas potentially submerged by floods. All these systems have the same objective of providing a knowledge of the risk expected for better anticipation, based on the available rainfall forecasts. We will present you 2 systems realized on territories sensitive to floods in urban and peri-urban areas.

29.2 Two Case Studies with Common Methodology but Different Flood Risk Informations

29.2.1 Context

In Guadeloupe, rainfall events can be sudden and extremely violent, generating floods, particularly through the resurgence of rainwater networks. Determining the location of overflow points and mobilizing resources at the right time and place are important organizational issues for CAP Excellence, Communauté d'Agglomération de Pointe à Pitre. The need was therefore to know precisely, as the looks could extend beyond the next 24 h in order to intervene on the network and in the field before the events.

In the Yvette catchment area, rainfall generates significant runoff both in rural catchment areas and in urban catchment areas located mainly at the bottom of the valley. The river, the Yvette, thus presents risks of overflows in particularly vulnerable areas. Knowing the flows generated in the catchment areas, the flows and water level expected early in the river, anticipating the consequences of foreseeable overflows are the needs of the SIAHVY.

These 2 forecasting and warning systems have been created in the MIKE OPERATIONS platform. They make it possible to transform rainfall forecast information into flood risk information adapted to the needs of each manager.

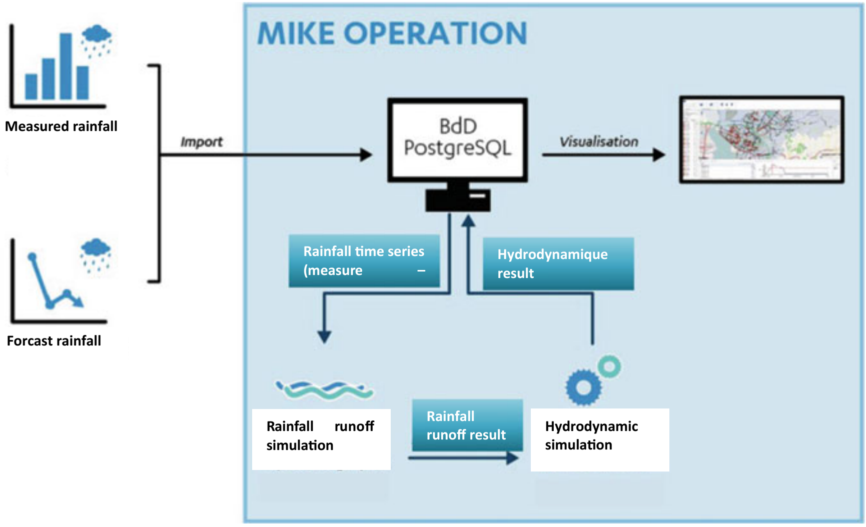


Fig. 29.1 Information processing chain from rain to flood risk

29.2.2 Methodology

The platform imports in real time the information on the observed rainfall up to the forecast time and the rainfall forecast. Rainfall forecasts are provided by Météogroup. In the case of the Yvette system, the data provided are spatialized data for the entire watershed (radar).

This data is then post-processed and sent to the on-board hydrological and hydraulic modelling software, which finally provides a flood risk.

The following figure shows the information processing chain, from rain to flood risk (Fig. 29.1).

The information provided on flood risk depends on the context and needs of each manager. The system' renderings have thus been adapted to meet these needs as closely as possible in order to facilitate decision-making by each user of the forecasting tool. These adaptations are presented in the following paragraphs.

29.2.3 Flood Risk Informations

29.2.3.1 Pointe à Pitre: Information About the Rainfall Network

The need of CAP Excellence was to have information on the risk of rainfall overflow that could generate flooding.

For this purpose, the hydraulic model of the rainwater network developed under MIKE URBAN was used and imported into the MIKE OPERATIONS platform. The

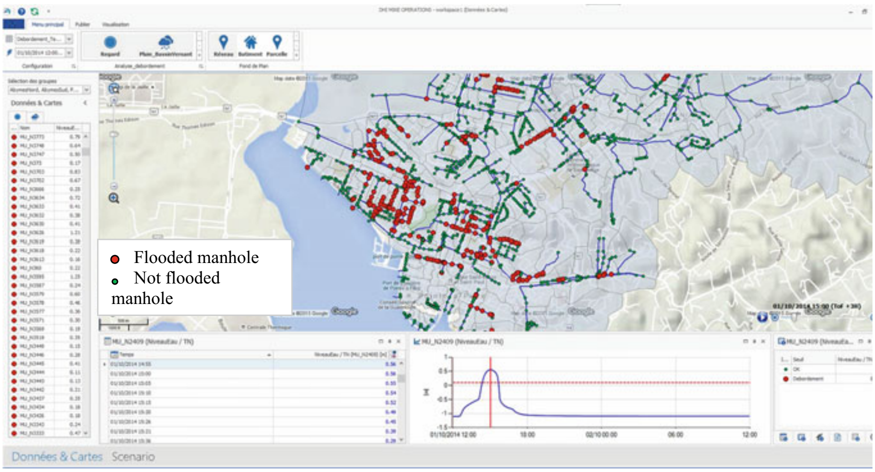


Fig. 29.2 User interface of the real-time system given the map of overflowing manhole on the rainfall network for the next 24 h

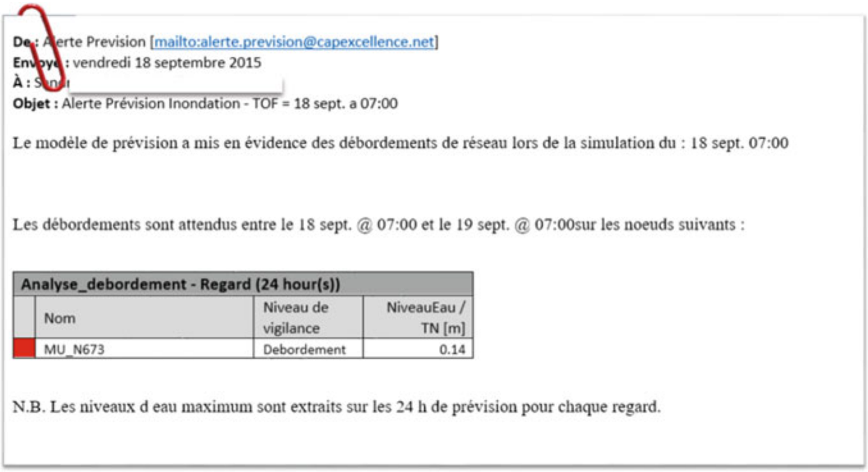
particularity of this model is a large modelled territory with the presence of more than 2500 nodes, generating a large number of time series to be processed and visualized. This feature can make the tool that has to work in real time cumbersome. However, the choice was made to keep the entire network in order to preserve the exhaustiveness of the results. Thus, the optimization of the tool' operation focused on defining the flood risk indices to be provided by reducing it to a minimum without losing the necessary information. This was done in consultation with the future manager of the tool.

It was decided to provide a WEB page with a map showing the overflowing (red) or not (green) looks, as shown in the following Fig. 29.2.

In order to facilitate the visualization of information for the future manager in terms of numbers and manhole density, the display has been divided into 3 geographical sectors. The overflow threshold on each manhole was placed 10 cm above the natural ground to limit alerts and focus treatment on more problematic areas. However, the user has the choice of visualizing the time series of the expected water levels in each manhole in order to know the importance of overflows. These water levels are normalized in relation to the ground level terrain at each node.

In parallel, the system sends alert emails to CAP Excellence managers only when floods are confirmed. The following figure shows an example of an alert email received (Fig. 29.3).

With the aim of making it as easy as possible for CAP Excellence managers to use, the tool has been configured so that it operates daily in perfect autonomy, without any manual intervention (import and processing of rainfall data, launching simulations, and sending alert emails). This allows the manager to limit processing and analysis efforts only when overflows are expected.



De : Alerte Prevision [mailto:alerte.prevision@capexcellence.net]
Envoyé : vendredi 18 septembre 2015
À : S
Objet : Alerte Prévision Inondation - TOF = 18 sept. a 07:00

Le modèle de prévision a mis en évidence des débordements de réseau lors de la simulation du : 18 sept. 07:00

Les débordements sont attendus entre le 18 sept. @ 07:00 et le 19 sept. @ 07:00sur les noeuds suivants :

Analyse_debordement - Regard (24 hour(s))			
	Nom	Niveau de vigilance	NiveauEau / TN [m]
	MU_N673	Debordement	0.14

N.B. Les niveaux d eau maximum sont extraits sur les 24 h de prévision pour chaque regard.

Fig. 29.3 Example of email alert send to the network manager when a flood is confirmed

29.2.3.2 SIAVHY: Operational Flood Forecasting System

Following the floods of June 2016, the SIAHVY initiated a reflection for the implementation of an operational flood forecasting system. The system developed is based on a calculation chain allowing the generation of predictable flood maps. Rainfall information is provided by Météogroup through its Hydromaster application. It is composed of an observation part resulting from the analysis of the rain gauges present on the territory as well as the analyses of the radar imagery. The rainfall forecast integrated into the operational system consists of radar information (nowcast at short notice 3 h) and a 48-h forecast.

The operational system integrates a rain-flow transformation model developed under the NAM module as well as a 1D/2D hydraulic model developed with MIKE FLOOD. This model, initially developed by SAFEGE, has been adapted to generate overflow maps from the 2D model in 1 h; the modeled period includes 1 day of observation and 2 days of forecasting.

In addition, the prediction of water levels in the river is made more reliable by assimilating the data recorded on the river. To date, 2 flow points and 1 water level point have been uploaded into the system to update the model data in real time.

The operational system is developed in the MIKE OPERATIONS operational platform which manages rainfall imports from Hydromaster and imports of observed flows and heights from SIAHVY supervision. The calculation chain developed in the platform includes the integration of radar data at the watershed scale, the calculation of runoff hydrographs, the launch of the hydraulic model at a 12-h frequency, correction by data assimilation, and the generation of maximum flood maps with a 48-h time frame. A customized interface allows the display of expected water levels

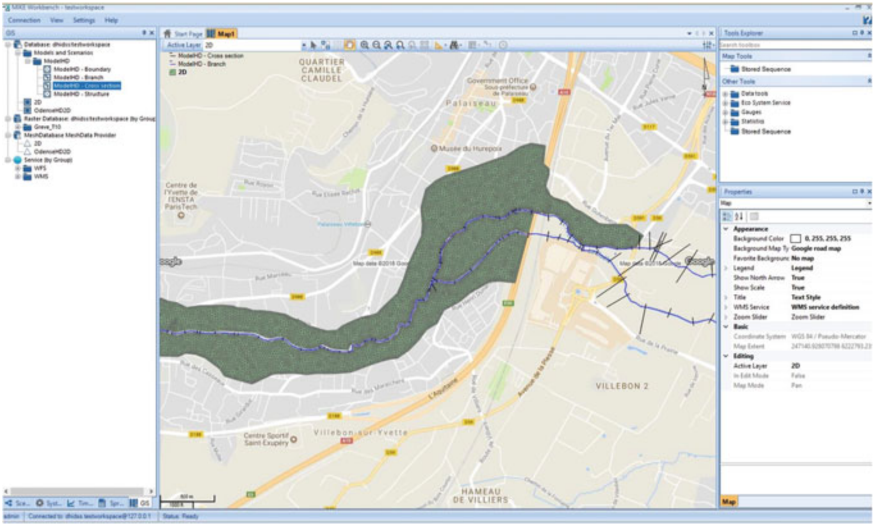


Fig. 29.4 MIKE OPERATIONS system with MIKE FLOOD model integrated

at different points of vigilance and the filling rate of the storage basins on the river (Fig. 29.4).

The operational system developed for SIAHVY will be made more reliable by integrating two additional data assimilation points. In the long term, the forecasting system will allow for better management of flood control structures.

29.3 Uncertainties and Prospects

The quality of hydraulic forecasting remains highly dependent on the uncertainties of weather forecasts. To improve the quality of flood risks, it is possible to integrate a probabilistic dimension into forecasts by developing overall simulations.

29.4 Conclusion

Technological advances have made it possible to improve weather forecasting in terms of forecast quality and frequency and to improve the calculation times of hydraulic simulations. Intrinsically, these advances have enabled real-time simulation to be carried out up to the establishment of real-time floodplain mapping.