MUFFIN - MULTI-SCALE URBAN FLOOD FORECASTING

NEWSLETTER 2 (June 2018)

The MUFFIN project is now in the middle of the project. Four countries are working together and the hydrodynamics models in Finland and Denmark are running, input data to the models have been collected and the requirements of the end-users have been surveyed.

PROJECT MEETING IN DELFT, NETHERLANDS

Figure 1 Project members and Advisory Board

In February 2018, 18 people gathered for a two-day meeting. During the first day the project group presented their work for each other and planned the upcoming work. The Advisory Board (AB), consisting of six representatives from all countries and different sectors, joined the meeting on day two to get information and about the progress and challenges. The AB was very active and came with a lot of interesting suggested improvements about the development and the outcome of the project.

The meeting was concluded with a study visit at the operational water management control room at Rotterdam Municipality to see which actions the city is implementing to increase resilience to heavy rainfall and flooding.

Figure 2 Study visit at Rotterdam Municipality.

End-user requirements

SGI presented the results from the questionnaire and the interviews sent to different end-users. More information about the result will be presented in another newsletter.

Outcome of the meeting

Apart from getting to know each other and get information about what all project members are working with, some of the interesting outcomes were:

- The discussion during of meeting is one of the most important effects because one get to know the different needs and can help each other with different challenges.
- There is a lot to explore concerning the integrated large-scale (hydrological) and small-scale (hydro-dynamic) modelling in joint experiments (page 3).
- The visualization of the project results should be in a format that is familiar to the end-user. Only the most important information *to the end-user* should be available during the three different stages of the flooding; before, during and after. The end-user should not be given false indications. Animated 3D maps can be an option.
- A study visit is often very informative both concerning how the end-user works and it also gives good ideas to implement in the project.

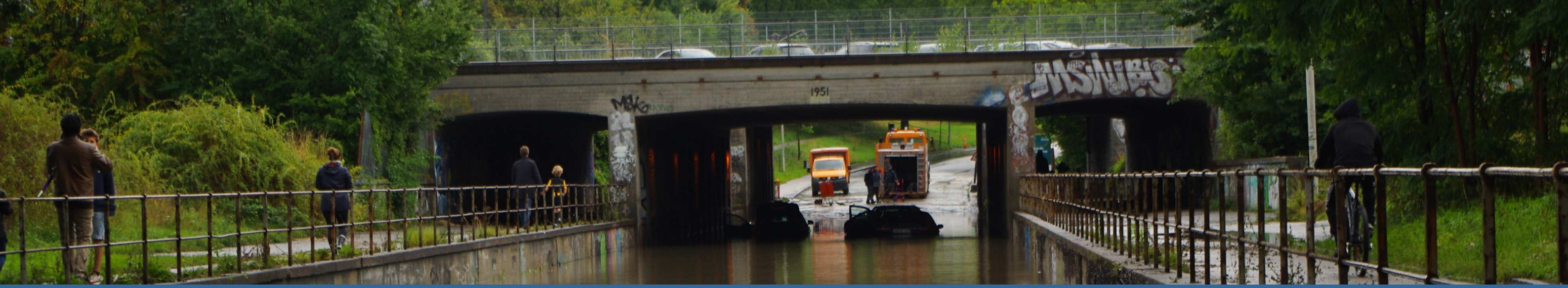
Figure 3 Project meeting with Advisory Board

INXCES – "sister-project" of MUFFIN

Floris Boogard and the project leader Tone Muthanna working in another Water JPI-project, held a very interesting presentation and inspired the project with their visualization techniques. To collect data and inform people about the project, they have conducted public events (*City Climate Scan*) where about 100 people met to collect and analyze urban environmental data.

INXCES web site: https://inxces.eu/

MUFFIN is funded by the EU and FORMAS, financed under the ERA-NET Cofund WaterWorks2014 Call. This ERA-NET is an integral part of the 2015 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI).



MUFFIN - MULTI-SCALE URBAN FLOOD FORECASTING

The hydrodynamic models in Helsinki and Aalborg

Which models are in use?

There are two types of models available for flood simulation and forecasting in cities: local hydraulic models and multi-basin hydrologic models. The former are primarily designed for pluvial flooding in highly urbanized areas, describe coupled flows on surface and in sewers and the resolution is very high with time resolution in seconds and spatial resolution in meters. The latter models are mainly designed for fluvial (i.e. river) flooding in rural areas, simulate surface runoff and river discharge, among other variables, and the resolution is generally 1 day and several km^2s. MIKE and SWMM are used as local hydraulic models and HYPE as hydrological model in the project.

The hydraulic models

A MIKE model of urban drainage systems and streams is running in Aalborg. It consist of MIKE URBAN (drainage model) and MIKE SHE (hydrological model). To complete the hydrological cycle the model will be merged with a ground water model. The model is a fully distributed model but will be simplified due to computation time to be able to run in real time operation. The objective is to develop an operational real-time flood model for Aalborg.

In Helsinki a Storm Water Management Model, SWMM, is running. The aim is to improve nowcasting of extreme precipitation and the associated urban flooding. The impact of urban densification on flooding is investigated. The model predicts storm water runoff using nowcasted precipitation fields as input. It gives the means for assessing the efficiency of alternative storm water management scenarios.

The hydrological model

Each city has a HYPE model, which has been developed for improved applicability at higher resolutions and in urban environment. More information about HYPE will come in an other newsletter.

Latest result of the hydraulic models

The SWMM model is running (calibrated and validated) and showing good results. The model was constructed utilizing a novel adaptive sub-catchment generator algorithm. A manuscript describing the new algorithm and how it aids in constructing model sub-catchments where land-use and topography are considered is currently under review for the Journal of Hydrology.

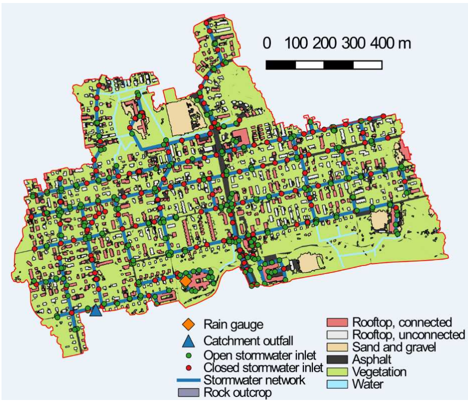


Figure 4 Landuse of the SWMM hydraulic model in Länsi-Pakila catchment.

During summer the joint multi-scale experiments are starting (page 3). The MIKE models are being prepared to go into a pre-operational state for the real-time flood forecasts. Different model set-ups combining multi-scale forecasts are evaluated to investigate if large-scale forecasts are beneficial as input to the MIKE-models in terms of urban flooding.

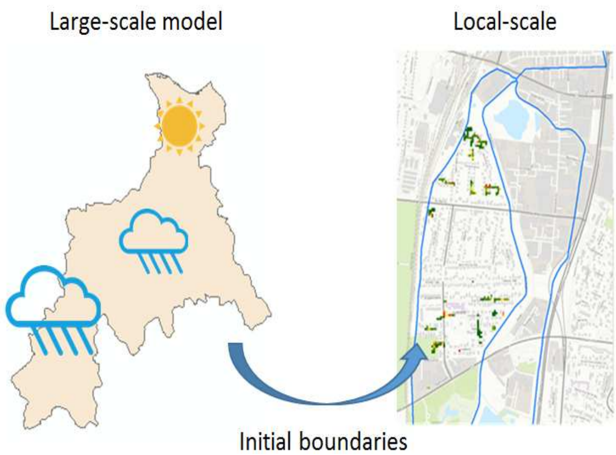


Figure 5 Incorporating the states of the large-scale models into the local-scale models.

A presentation of a sensitivity analysis of the MIKE-models are presented at UDM 2018 and a paper analyzing the results is due to submission.

MUFFIN is funded by the EU and FORMAS, financed under the ERA-NET Cofund WaterWorks2014 Call. This ERA-NET is an integral part of the 2015 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI).

MUFFIN - MULTI-SCALE URBAN FLOOD FORECASTING

JOINT EXPERIMENT ON URBAN FLOOD RISK ASSESSMENT

Problem statement

An accurate description of urban hydrological water fluxes requires both (*i*) a detailed specification of the (surface and sub-surface) man-made structures (sewer systems, detention basins, etc) that alter the natural flow paths in an urban basin and (*ii*) incorporation of hydraulic equations to calculate pipe flows, water levels, etc. These components are not included in hydrological models but they generally assume natural flow paths based on topography and a generalized sub-surface, which substantially limits the possibility to describe routing and integrated discharge in urban environments. Still, there are several hydrological model variables with a potential relation to urban flood risk, e.g. surface or total runoff on impervious areas, when simulated with a sufficiently short time step.

The advantages of multi-scale modelling

When combining the large scale models, like HYPE, to the small-scale models, like MIKE or SWMM, HYPE can give the amount of water that will come and that will be the boundary/initially data to the local scale-models. The local models will predict where it will be a flood. The combination of the multi-scale models can overcome the problems that the individual model types have when using them for urban flood risk assessment.

Objective

In this joint experiment the correspondence between urban flood risk as estimated by a high-resolution hydrological model and a hydraulic model, respectively, is analyzed. The key question to be answered is: To which degree can purely (high-resolution) hydrological forecasting provide useful signals of flooding in an urban environment?

Common forcing dataset

A long-term precipitation forcing dataset from the rain gauges in the WPC-network in Copenhagen is used in all models as input to the hydrological model and for simulate random realization of individual events at higher spatial and temporal resolution to study the responses of the hydraulic models.

One gauge with observation period from 1979-2017 has been selected out of the 73 rain gauges for Aalborg, se Figure 1 (another rain gauge has been selected in Helsinki in order to better fit the form of the catchment). The gauge will be used as center-point for the catchment location. The gauges are selected due to a continuous record with few errors and due to a location with a high density of gauges. The data of the selected rain gauges have been analysed and 95 rain events in Aalborg and 87 events in Helsinki have been selected/calculated. The events are both short high-intensive events as well as longer events with lower intensities and have different durations (10 min-48 h) and return periods (1-39 years).

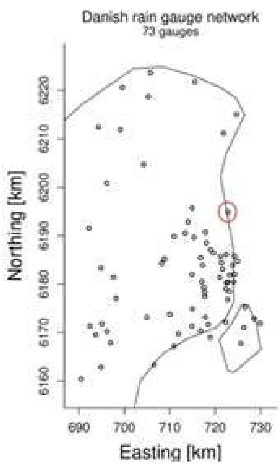


Figure 7 Rain gauge selected for the joint experiments in Aalborg

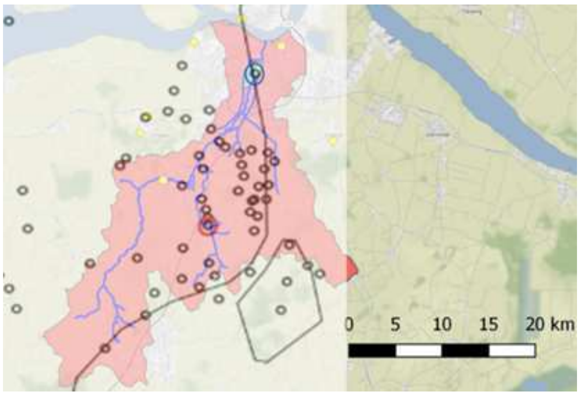


Figure 8 The rain gauge data set of Copenhagen placed over the Österå catchment in Aalborg, Denmark.

MUFFIN is funded by the EU and FORMAS, financed under the ERA-NET Cofund WaterWorks2014 Call. This ERA-NET is an integral part of the 2015 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI).