UrbanFlood
'The Story'

The impact of UrbanFlood on combating climate change induced disasters – D7.9

November 2012

CYFRONET HR Wallingford SIEMENS stowa TNO innovation for life UNIVERSITY OF AMSTERDAM SEVENTH FRAMEWORK PROGRAMME

URBANFLOOD

A project funded under the EU Seventh Framework Programme Theme ICT-2009.6.4a – ICT for Environmental Services & Climate Change Adaption

Grant agreement 248767
Dec. 2009 – Nov. 2012

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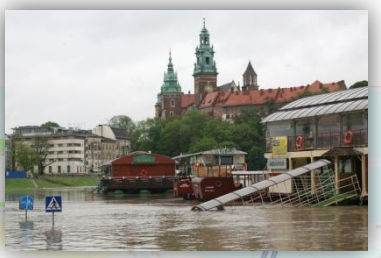
DISCLAIMER

URBANFLOOD

has developed an online early warning system (EWS) technology for climate induced disasters in urban areas with support for real time emergency management and routine asset management.

The technology is widely applicable; however UrbanFlood has validated it for the case of flood risk management in urban areas.



The Expectations

Early Warning Systems (EWS) can play a crucial role in mitigating flood risk by detecting potentially unsafe conditions and predicting the onset of a catastrophe before the event occurs, and by providing real time information on the behaviour and strength of a flood defence structure during an event.

UrbanFlood investigated and demonstrated the feasibility of remotely monitoring dikes and floods, whether from nearby offices or from other countries and continents, through the secure use of Internet based technology.

HISTORY

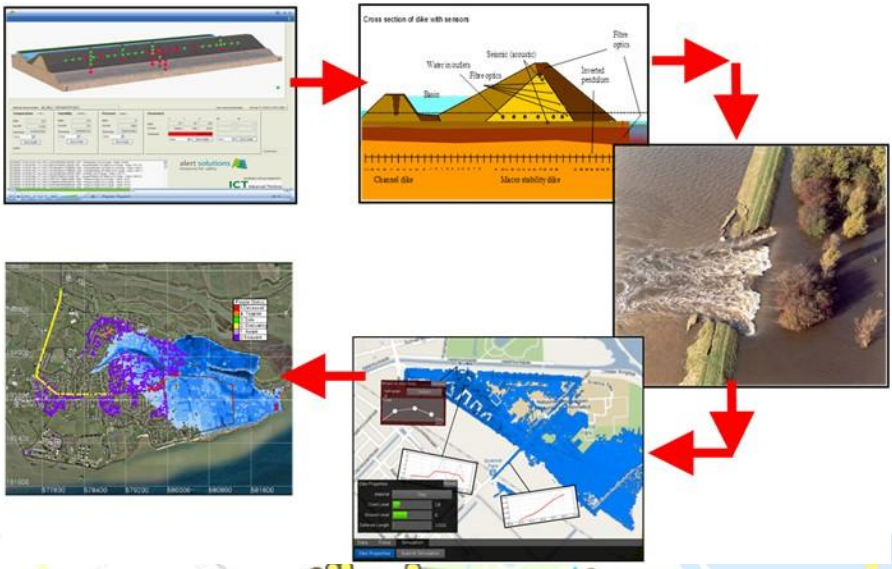
UrbanFlood has built on the successful IJkdijk programme: test dikes were equipped with sensors and then loaded until they failed. www.ijkdijk.nl

The Concept

The UrbanFlood concept is realized by implementing sensor systems in test dikes and analysing the resulting data in two ways:

1. feeding the data into the relevant geophysical models and calculating the actual dike strength for the different fail mechanisms involved, and
2. feeding the data into artificial intelligence software that detects anomalies in the data streams, which can be an indication that something is wrong.

If there is an indication of impending failure a cascade of models can be started, evaluating the possible breach, the estimated breach growth and flood spreading, and evacuation options.



The systems that process and use the sensor data along with the necessary visualization software are all linked using Internet technologies.

The UrbanFlood System

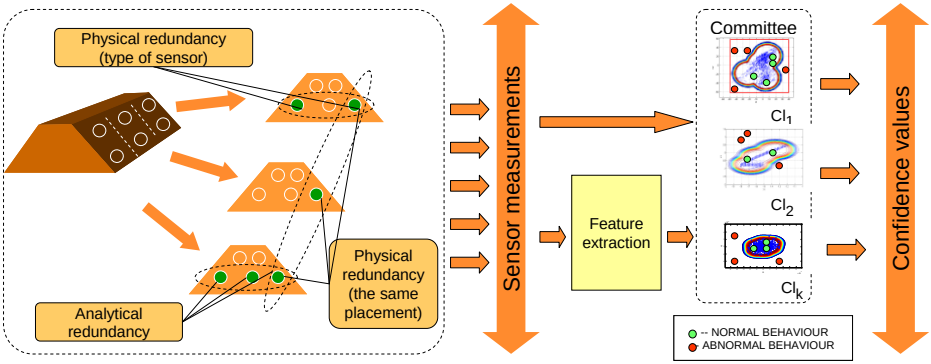
Sensors

Sensor data are the starting point of the UrbanFlood system. Sensors are everywhere, and are increasingly installed inside flood defences. Typically these may measure water pressure, tilt, temperature and movement / acceleration.

Different sensor types are deployed: modules as nodes on strings, for localised measurements, and fibre-optic systems, for two- and three-dimensional monitoring of dikes. Of course data from external sensors such as (infrared) video cameras are also used.

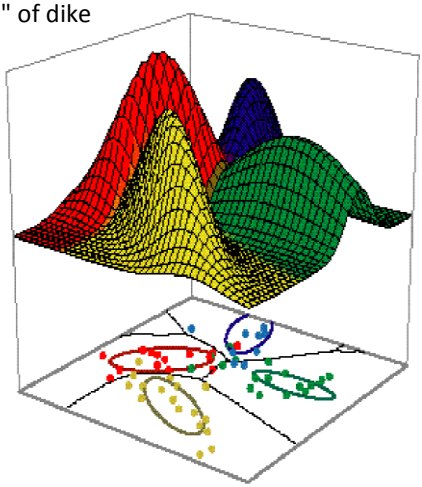
IJkdijk and LiveDijk

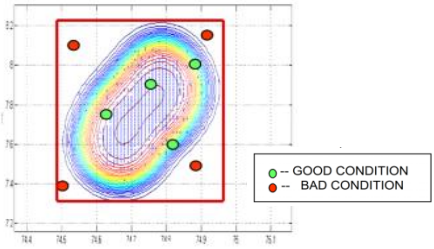
The experiences from IJkdijk were scaled up to the LiveDijk programme, where existing dikes were equipped with sensors. Datastreams from the LiveDijk programme were linked to the UrbanFlood Early Warning System, and dike managers were able to test monitoring with sensors in real dikes.

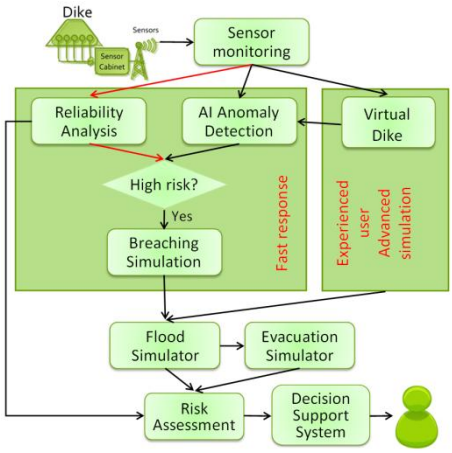


Artificial Intelligence

The Artificial Intelligence (AI) component detects abnormalities in the behaviour of monitored objects by analyzing sensor data with machine learning methods. It is "trained" on historical data of "normal" (reference) conditions and on extracted known "features" of dike behaviour. The training stage determines the confidence values indicating the current reference state of the system.



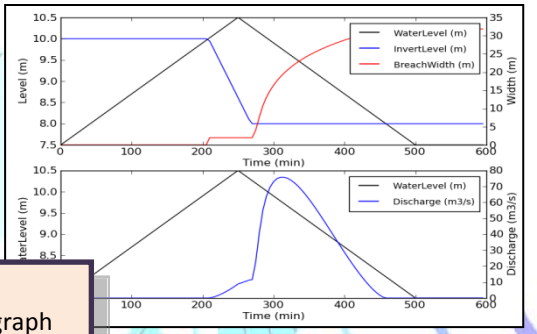




The UrbanFlood EWS examines sensor data with Artificial Intelligence and a parallel engineering reliability analysis. If deviations from the reference state are detected, it flags exceptions and alerts flood experts. Based on all available information they decide if the situation is potentially dangerous or if further analysis is needed, for instance by using the Virtual Dike module.

Early Warning modules

When an imminent breach is detected the following modules can be used within the UrbanFlood EWS.

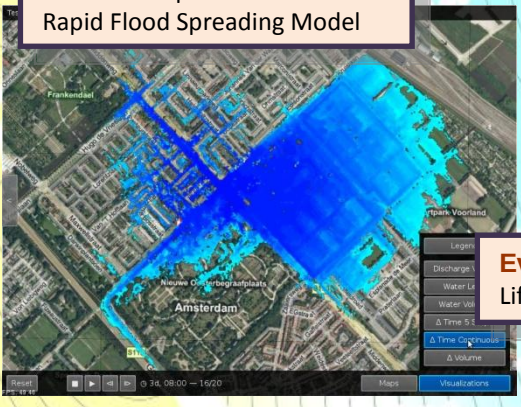


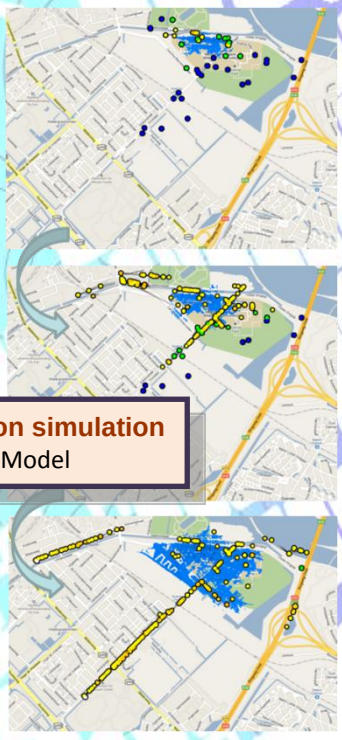
Breach behavior

Estimate inflow hydrograph with HR Breach

Flood spreading

Extent and speed of inundation: Rapid Flood Spreading Model



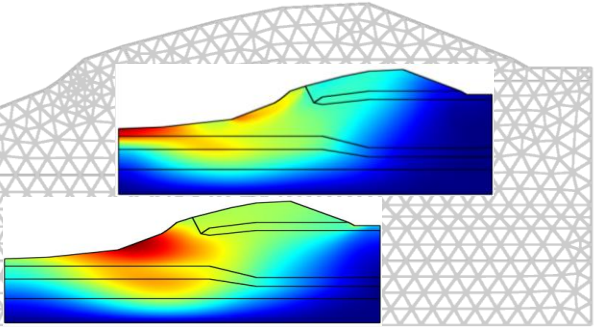


Evacuation simulation

Life Safety Model

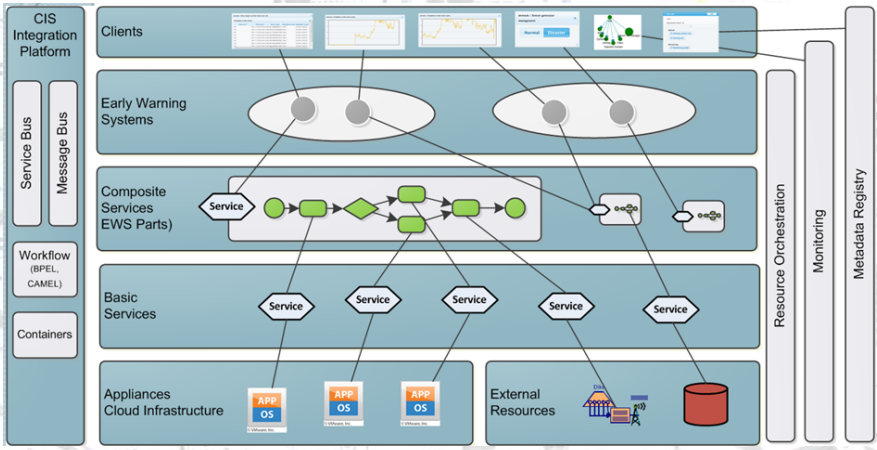
Virtual Dike

Advanced dike stability research and AI training module. Based on the finite element method, solving fluid-structure interaction problems: flow through porous dike and deformation of soil skeleton due to hydraulic load and external forces.

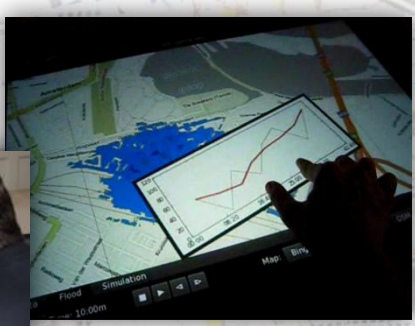


Integration and Visualization – Common Information Space

To organize individual components into a working Early Warning System, UrbanFlood provides the Common Information Space, a generic framework for creating and hosting any EWS. The CIS works according to a four-step cycle: Monitoring, Analysis, Value Judgment, Advice/Act. The CIS takes care of the organization of the resource management processes 'under the hood', like virtual machine control, provenance, data management etc.



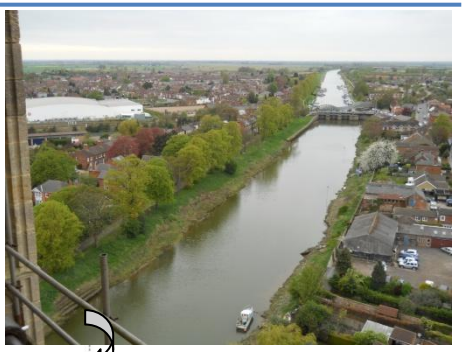
Client applications allow users to create new simulations by defining simulation parameters and submitting these to the CIS for execution. Several client applications have been created: a prototype of a Decision Support System (DSS) for a multi-touch device, a web-based interface that visualizes pre-executed simulation results and an application for visualization of sensor data. Simulations are quickly computed and visualized, allowing interactive testing of different flooding scenarios.



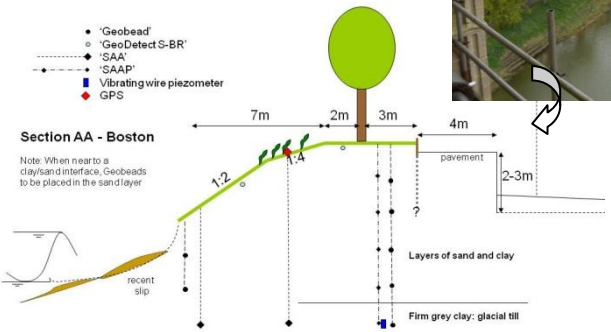
Multi-Touch Table
Teamwork on one surface

Test Sites

UrbanFlood has established a number of “smart dikes” to test the use of sensors and to ensure a continuous stream of test data.

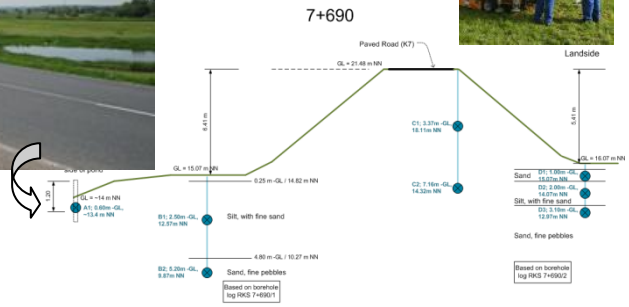


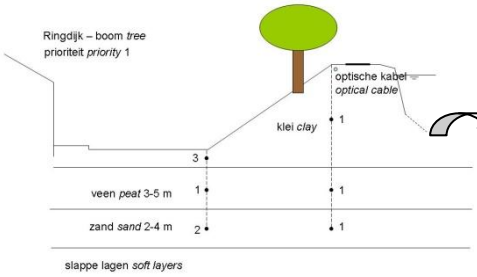
Boston, UK



Landside

Rhine Dike, Rees, D





Ringdijk, Amsterdam, NL

Boston, UK

The UrbanFlood Early Warning System Demonstrated

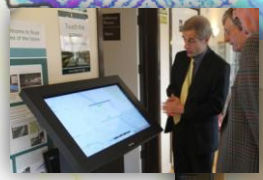
International Water Week, Amsterdam, NL

Museon, Amsterdam, NL

Nemo, Amsterdam, NL

KennisEstafette, Rotterdam, NL

Semi-permanent demonstrations of UrbanFlood



Boston, UK

Saint Petersburg Barrier, RU

The Crystal, London, UK

STOWA and the WaterschapsHuis, Amersfoort, NL

Road Show

An important activity towards follow-up on the UrbanFlood results was the "Road Show" in the UK where the UrbanFlood demo was shown to water management professionals and policy makers on 10 occasions.

Publications - Conferences

UrbanFlood has been very active in the exchange of results and experiences, presenting at international congresses, and producing a good number of publications. See the list with links at www.urbanflood.eu.

UrbanFlood Workshops

Three international workshops were organised at which valuable exchange of experiences took place and useful contacts were made.

Achievements

UrbanFlood brought partners from very different disciplines together, to develop what could be called "the Early Warning System of the Future". By proving that state of the art internet and cloud computer resources can be harnessed to increase flood safety the project has shown the often conservative flood management community a new approach to increase dike safety.

Uptake

The UrbanFlood Advisory Board members, influential water professionals and policy makers, will have an important role in promoting on-line monitoring of flood defences.

The Future

The UrbanFlood partners have worked hard to establish numerous international contacts and have been very active looking at possible follow-up projects and activities. They are now drafting a MoU for joint exploitation of the results as there are several business leads. There is also serious interest for the system in Thailand and China, which face regular floods.

The Real Test

Autumn 2012: UrbanFlood participated in the final IJkdijk experiment in Groningen, the Netherlands, the "All-In-One Sensor Validation Test". Before the experiment no one knew the failure mechanism by which the two test dikes, both filled with sensors, would collapse. A first analysis of the results showed that the tested sensor systems indicated the two dike breaches well in advance.

BBC HORIZONS FEATURING URBANFLOOD

The UrbanFlood partners all worked on more subjects, the lead partner for the subject is mentioned below:

Artificial Intelligence, pilot site Rees D: **OOO Siemens**. Virtual Dike, on-line EWS, interactive visualisation: **University of Amsterdam**. Reliable, HR Breach, Rapid Flood Spreading and Life Safety Models, pilot site Boston UK, Road Show UK: **HR Wallingford**. Integration, EWS interface, visualisation of sensor data and lead partner: **TNO ICT**. Common Information Space: **ACC Cyfronet AGH**. Stakeholder contacts and communication, pilot site Ringdijk Amsterdam, NL , website: **STOWA**.

For more information please visit

www.urbanflood.eu

Design: B.E. Pengel – STOWA (V1.1) 30/11/12