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Publication date

2012

Document Version

Author accepted manuscript

Published in

Comprehensive flood risk management: research for policy and practice

[Link to publication](#)

Citation for published version (APA):

Krzhizhanovskaya, V. V., Melnikova, N. B., Shirshov, G. S., Rusadi, F. I., Belleman, R. G., Lhomme, J., Gouldby, B. P., Topple, A., & Simm, J. (2012). Computational models in flood early warning systems. In F. Klijn, & T. Schweckendiek (Eds.), *Comprehensive flood risk management: research for policy and practice* (pp. 1533). CRC Press.

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Computational models in flood early warning systems

V.V. Krzhizhanovskaya, N.B. Melnikova & G.S. Shirshov

University of Amsterdam, The Netherlands
National Research University ITMO, Russia

F.I. Rusadi & R.G. Belleman

University of Amsterdam, The Netherlands

J. Lhomme, B.P. Gouldby, A. Topple & J. Simm

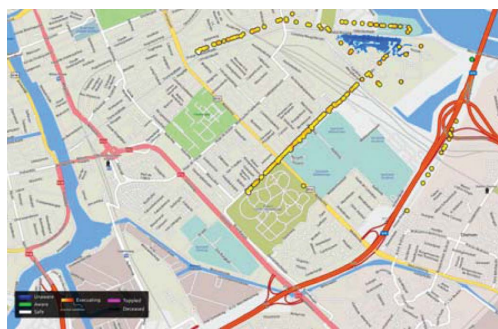
HR Wallingford, Wallingford, UK

Keywords: UrbanFlood; modelling; simulation; early warning system; decision support; dike stability analysis; dike breaching; flood simulation; city evacuation; life safety; Virtual Dike

We present computational models for flood early warning systems developed within the *UrbanFlood* European Union project. The models are used for prediction of dike failures and for flood risk assessment. The *UrbanFlood* early warning system monitors sensor networks installed in flood defences (dikes and levees), detects sensor signal abnormalities through an artificial intelligence module, calculates dike failure probability, and simulates possible scenarios of breaching, flood propagation, and city evacuation. Additionally, a *Virtual Dike* computational module has been developed for advanced research into dike reliability and potential failure mechanisms. The *Virtual Dike* is also used for training the artificial intelligence module on signal parameters induced by dike instabilities. All the relevant information and simulation results are fed into an interactive decision support system that helps dike managers and city authorities to make informed decisions in case of flood emergency and in routine dike quality assessment. Some developments have been reported in <http://dx.doi.org/10.1016/j.procs.2011.04.012> and <http://dx.doi.org/10.1016/j.procs.2011.04.084>.

In this paper, we introduce a modelling workflow that includes modules for dike reliability analysis, dike breaching, breach discharge calculation, flood simulation, and evacuation planning. We focus on two models recently introduced into the system: (1) the HR-Breach model predicting the growth of dike breach and (2) the Life Safety Model simulating city evacuation scenarios. Finally, we present simulation results and a comparison of different dike stability models.

One of the critical issues in modelling is validation. Full-scale *IJkdijk* failure experiments and trusted modelling tools are used to develop,



Simulation results in the UrbanFlood decision support system: dike breach, flood dynamics, and evacuation modeling for Science Park, Amsterdam.

calibrate and validate simplified models for operational decision support systems requiring real-time response and quick analysis of multiple scenarios in critical flood situations. To achieve this goal, a number of models that simulate dike reliability have been compared.

Computational modules are invoked by workflow-based expert scenarios via the Common Information Space middleware. Compute-intensive models are run on a high-performance Cloud system of SARA supercomputing centre. This Cloud system provides dynamic resource allocation on demand, which is especially important in flood emergency situations.

This work is supported by EU FP7 project *UrbanFlood* #248767; by *Leading Scientist Program* of Russian Federation #11.G34.31.0019; and by *BiGGrid* project BG-020-10 #2010/01550/NCF with support from the Netherlands Organisation for Scientific Research.