HPC clouds for flood early warning systems

Modeling dike stability and inundation dynamics with real-time sensor input and remote invocation from *UrbanFlood* decision support system
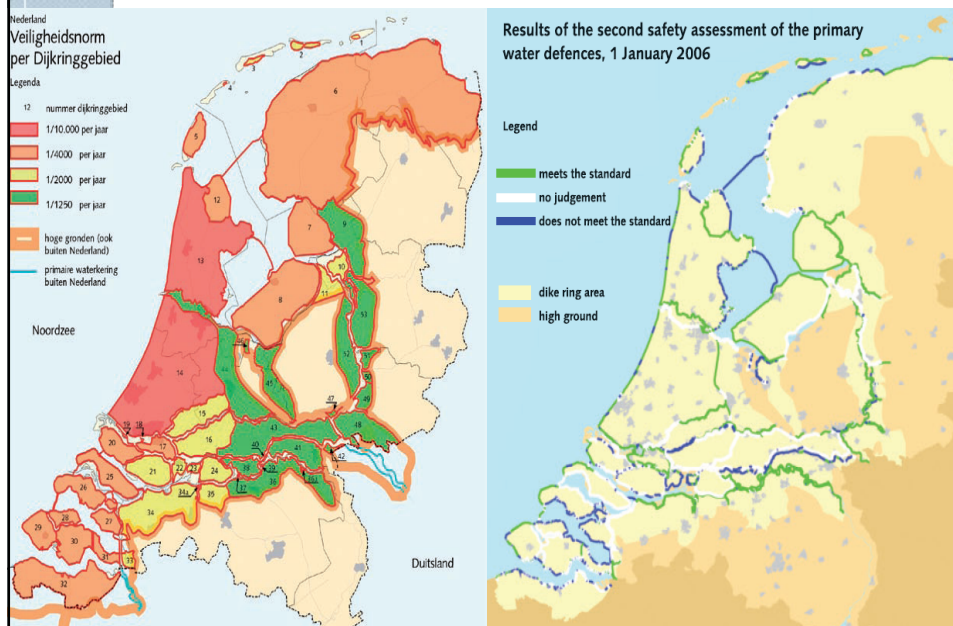
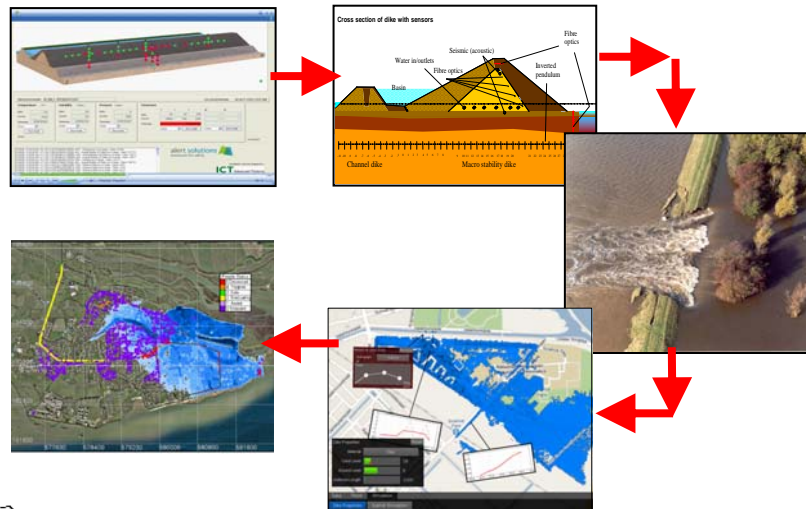**Valeria Krzhizhanovskaya, Gleb Shirshov, Natalia Melnikova, Robert Belleman**

University of Amsterdam, The Netherlands
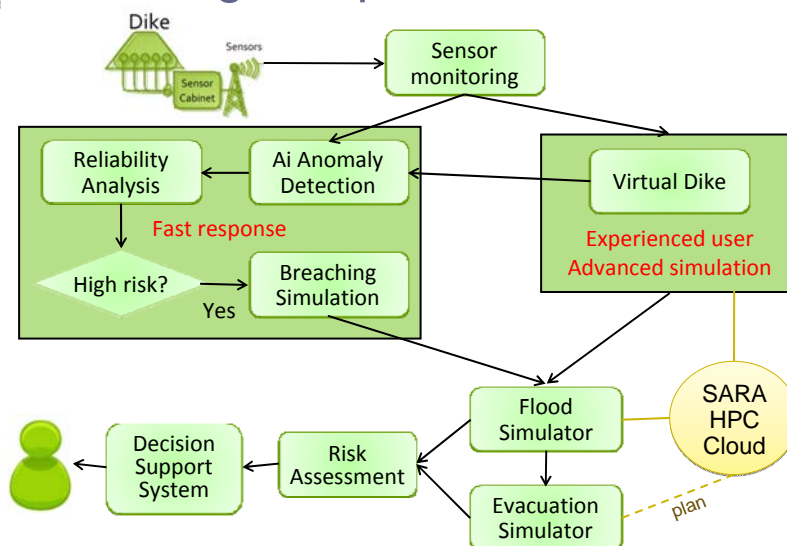St. Petersburg State Polytechnic University, Russia

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Netherlands: half of dikes are weak

UrbanFlood modelling workflow

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Modelling components

SARA cloud user interface

- VM control
- VM image management
- Java VM image upload applet
- CPU hours quotas and other settings

Virtual Dike

Flood simulator

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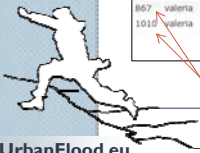
Remote invocation & control

SSH   XML-RPC

User Computer   VM on SARA   Controlled VM
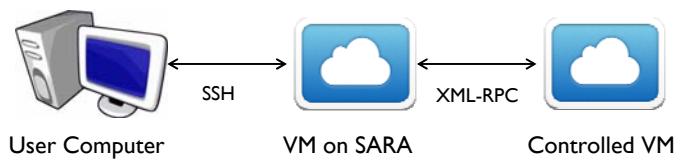
<u>Advantages:</u>

- Full VM access: allocation, deployment, migration, removal, getting information
- Simple, easy to use, libraries for all programming languages

<u>Disadvantages:</u>

- Can only be accessed from SARA VM (via SSH)

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HPC Cloud benefits

- Different VM types supported
- Different OS supported (tested: Ubuntu Linux and Windows XP)
- Great performance (up to 128 cores:16 nodes X 8 cores, 24 GB RAM per node)
- VM images are stored permanently (100 TB disk space available with 20 Gbps connection)
- Very fast and competent Support team

Things to improve

- Delays in VM invocation 5-30 min (~disk size)
- Unknown resource availability
- Windows VMs require manual settings (especially network drivers)
- Change VM parameters without stopping the VM
- Automatic VM format conversion
  (Citrix XEN → Open XEN)
- Stopped VMs still "use" resources
- Quotas?

Virtual Dike

- FSI model: water flow through porous media + structural dynamics
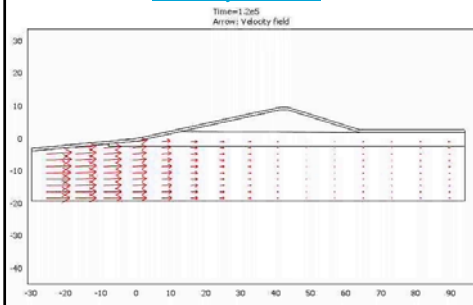 - Partially saturated soils with water retention
  - Finite element method
- Dike in Groningen, NL
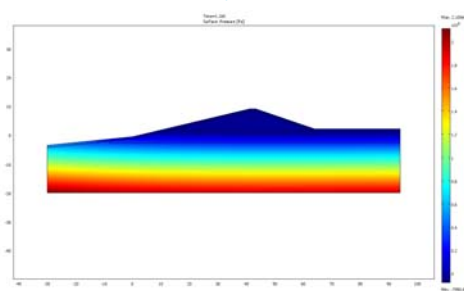 - tidal water load and flood conditions
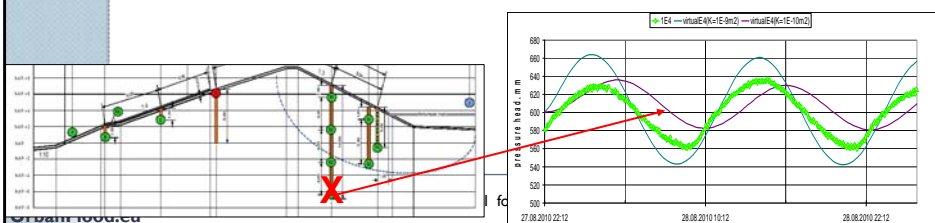 - sensor input
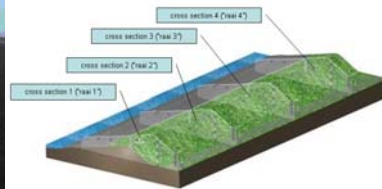
Virtual Dike simulation results

Velocity vectors

Pressure dynamics
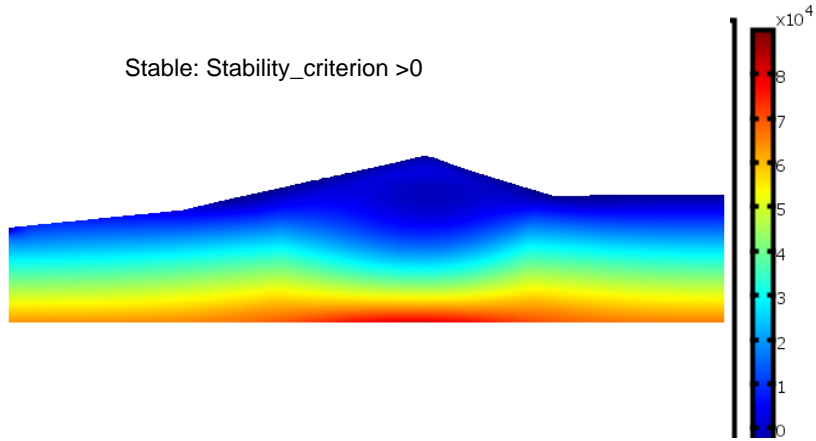

Virtual and real sensor dynamics

Dike structural stability

Stable: Stability_criterion >0

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Flood Simulator

- Model: simplified shallow water eq.
- University of Amsterdam Science Park

-7m

20m

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Simulated flood of UvA Science Park

My office

UrbanFlood.eu
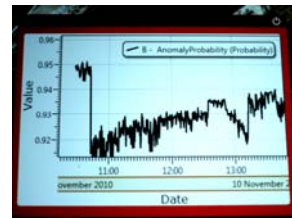

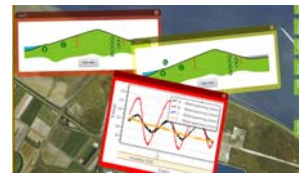# Simulated flood

- St. Petersburg, Russia

- Boston, UK

City evacuation

- Agent-based
- Coupling is in progress

Decision Support System

- Sensor data
- Alert on dike abnormal condition
- Relevant information: maps, weather, ships, roadwork
- Simulation results

DSS on multi-touch table

Robert Belleman →

Valeria@Science.uva.nl fo

UrbanFlood Plans

- Create a resource management system for UrbanFlood consortium resources (UvA, TNO, Cyfronet, Siemens, SARA)
- Port more components to SARA (City evacuation model)
- Virtual Dike: 3D simulations of several dikes (Eemshaven, Zeeland, Ringdijk, Stammerdijk, …)
- Flood Simulator: flood areas protected by the dikes; develop tools for automatic map extraction for flood simulations

Valeria@Science.uva.nl for HPC Cloud Day, Amsterdam. 4 October 2011   18

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- WaterNet & Rob van Putten
- AlertSolutions & Erik Peters

UrbanFlood EWS demos

- www.UrbanFlood.eu
- BBC World Series – Horizons, June 2011