

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

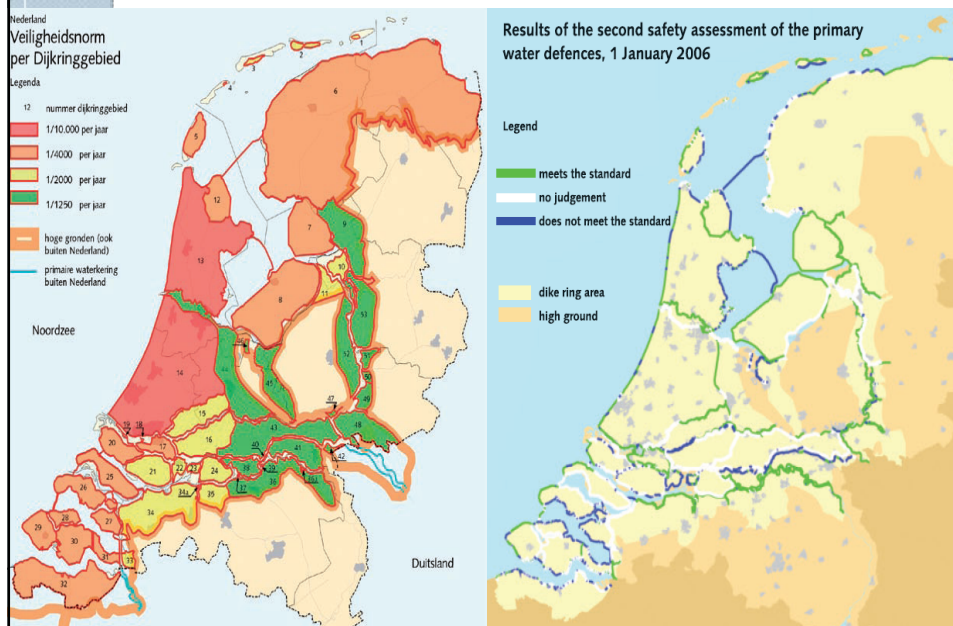


Valeria Krzhizhanovskaya, Gleb Shirshov, Natalia Melnikova, Robert Belleman

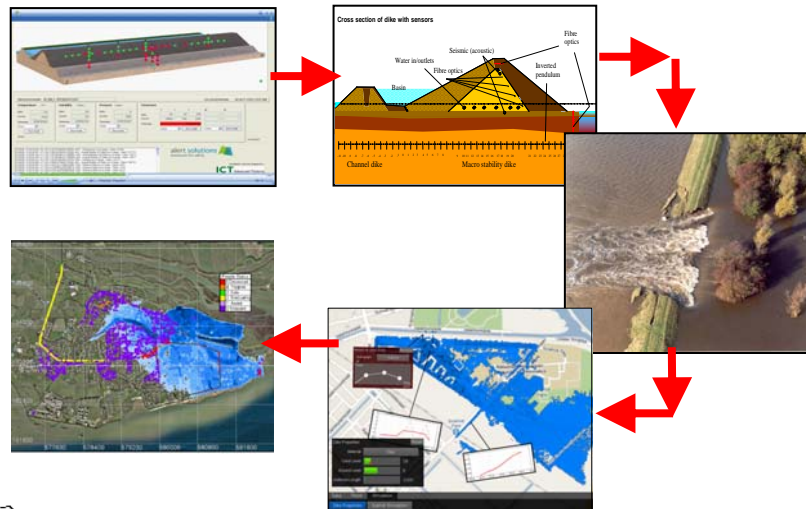
University of Amsterdam, The Netherlands
St. Petersburg State Polytechnic University, Russia



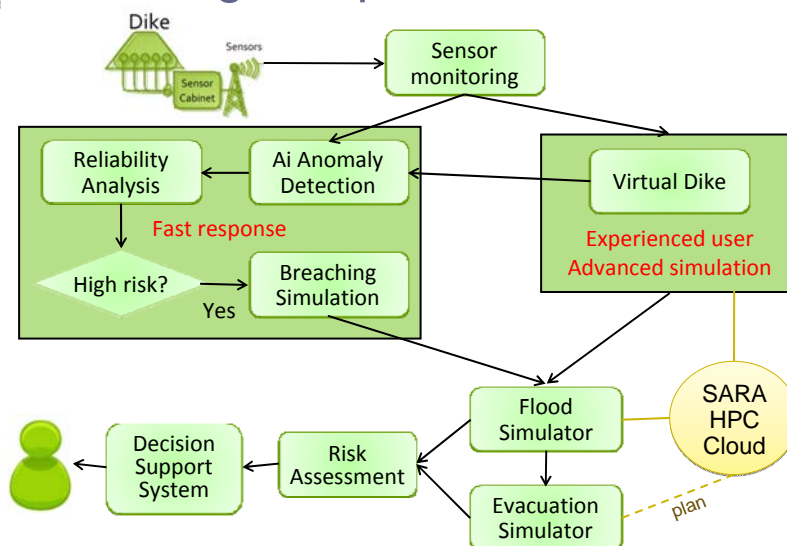
Netherlands: half of dikes are weak



UrbanFlood modelling workflow



Modelling components



SARA cloud user interface

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



HPC Cloud Management Console

vm overview | vm configuration | disk image upload | disk image management | hosts | networks | public firewall exceptions | quotas

Logged in as valeria - logout | version: 1.0.1

last refresh was 10 seconds ago: (refresh now)

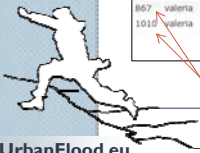
Deploy a new VM

Cloud vm's:

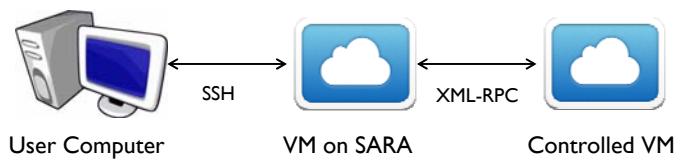
Id	User	Name	VM State	LCH State	Cpu	Memory	Host	VNC Port	Time	Links	Selection
427	valeria	tutorial_VM	stopped	init	0	524288	node14-one	6327	40d 5:34:44	[console] [details] [log]	<input type="checkbox"/>
428	valeria	tutorial_VM_test	stopped	init	0	1048576	node14-one	6328	40d 5:29:12	[console] [details] [log]	<input type="checkbox"/>
368	valeria	Ubuntu_03_configuration	active	running	0	8388608	node11-one	6468	33d 3:10:51	[console] [details] [log]	<input type="checkbox"/>
759	valeria	Ubuntu_04_configuration	stopped	init	0	4194304	node11-one	6659	28d 19:0:12	[console] [details] [log]	<input type="checkbox"/>
867	valeria	Ubuntu_conf_2disks	stopped	init	0	4194304	node11-one	6767	25d 0:55:35	[console] [details] [log]	<input type="checkbox"/>
1010	valeria	DRFSM_01	active	running	0	2097152	node13-one	6910	22d 4:10:41	[console] [details] [log]	<input type="checkbox"/>

Virtual Dike

Flood simulator



Remote invocation & control



Advantages:

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

Disadvantages:

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



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?

vm overview vm configuration disk-image upload
disk image management hosts networks public firewall exception
Logged in as valeria - logout | version: 1.0.1 sara
Reken- en Netwerkdiensten

quotas
last refresh was 139 seconds ago: [refresh now]

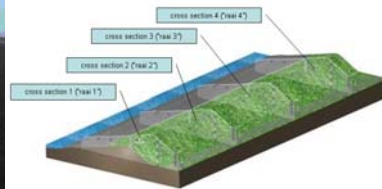
Quotas
Currently only CPU hours are recorded to count towards your quota.

Username	Used Hours	Total Hours	CPU quota used %
valeria	166849	10000	1668 %



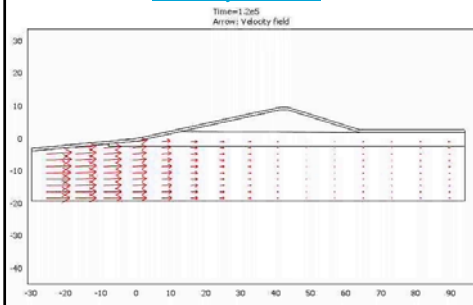
Virtual Dike

- 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

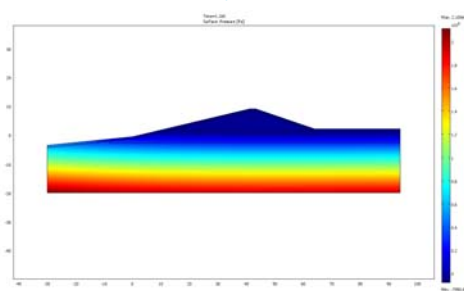


Virtual Dike simulation results

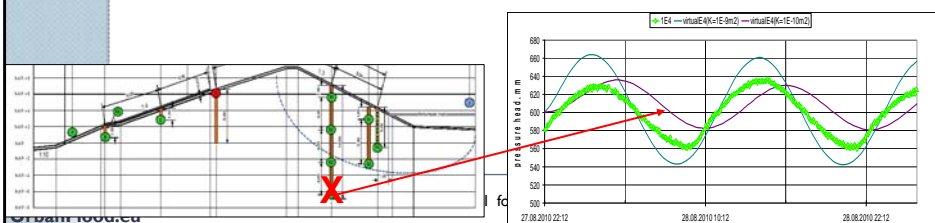
Velocity vectors



Pressure dynamics

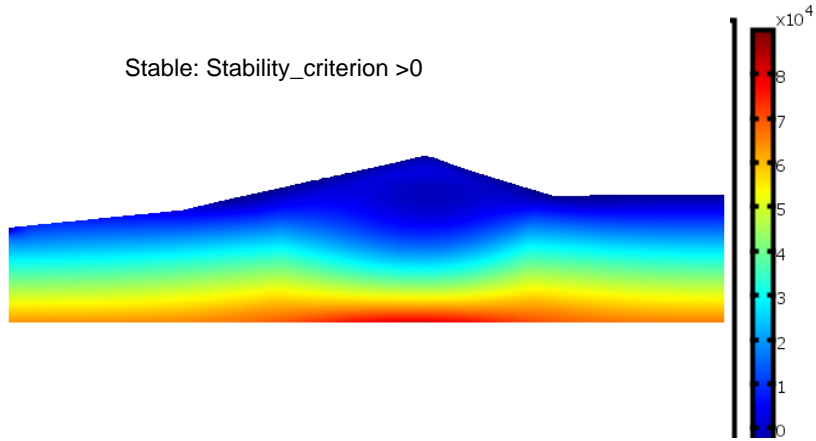


Virtual and real sensor dynamics



Dike structural stability

Stable: Stability_criterion >0



Flood Simulator

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



Simulated flood of UvA Science Park



My office

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

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Simulated flood

- St. Petersburg, Russia
- Boston, UK



Valeria@

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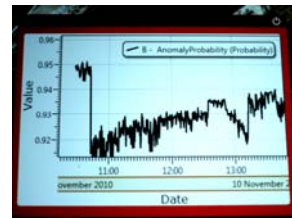
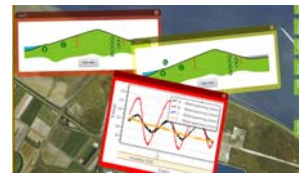
City evacuation

- 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 →



UrbanFlood.eu

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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



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- Waterschap Noorderzijlvest, The Netherlands, especially Christiaan Jacobs
- Andre Koelewijn (Deltares), Erik Langius (TNO), Lourens Veen (UvA IBED-CGE), Guido van Reenen (UvA GIS Studio)
- WaterNet & Rob van Putten
- AlertSolutions & Erik Peters



UrbanFlood EWS demos

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

The screenshot shows a YouTube search interface with the search term 'ICTdijk'. The search results are as follows:

Video Title	Duration	Views	Upload Date
UrbanFlood flood mitigation support demonstration	2:17	67 views	4 weeks ago
UrbanFlood Dike and environment monitor system and anomaly detection	5:43	76 views	4 weeks ago
IJkdijk experiment september 2008	1:08	888 views	2 years ago

