



Smart Dikes, IJkdijk

Prof. Dr. Robert Meijer

27 sep 2008



UNIVERSITEIT VAN AMSTERDAM

Robert Meijer

TNO: Sr. Strategist

University of Amsterdam: Professor

- Advanced Telecommunications
- Control structures for cyber physical systems



On-and-offshore infrastructures:

things that cost 1000 €/m, 1000 €/m², 1000€ per person



Infrastructures are in trouble

- Infrastructures are
 - used to **limits** of capacity
 - **exploited** by > 1 organization
 - erode
 - **used in reverse**
 - too **complex** to understand
 - too **costly** to have
 - ... cyber attacks



Infrastructures are saved by society scale information structures



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CITRIS researchers on four UC campuses (Berkeley, Davis, Merced, Santa Cruz), along with industry partners, are developing information technology solutions to large-scale problems facing our society.

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EXPLORE A RESEARCH TOPIC:

- energy
- transportation
- health care
- environment
- disaster response
- homeland defense
- education
- culture



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NEW → **CITRIS Student Research Poster of the Month**

RESEARCH SPOTLIGHT //

EECS senior works on CITRIS research project that aims to give elder care without sacrificing independence



Soon there could be much better help for people who have fallen and can't get up. EECS senior Jerry Luk is working on the CITRIS research project called ivy, the first wireless sensor network with human applications. [LEARN MORE](#) ↘

NEWS & EVENTS //

EVENTS»

Berkeley Institute of Design (BiD) [Lab opening kick-off event](#)

Berkeley Quantum Information & Computation Center [Kick-Off](#)

Download CITRIS [Corporate Sponsor Day presentations and videos](#)

NEWS

Technology, business cases and other *motivations* are readily found to create the *smart infrastructures* and, hence, *the smart city*



Siemens



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Challenges of smart infrastructures

Technical **vague**

- Uncertainties in the **construction** of the infrastructure
- Uncertainties in the infrastructures **environment**
- Uncertainties in the **response** of the infrastructure **to change**

Organisational **complex**

- **Many** companies
- **Many** institutions



The great example of dikes

And the
IJkdijk



This is a **dike**

there is > 1M km on earth



IJkdijk Fieldlab



The infrastructure

The Open
Innovation
foundation

- Owners
- Researchers
- Companies

Dikes and **The IJkdijk**

Dutch **IJk** = to **calibrate** (of models)

Dutch **dijk** = **dike**





Dikes:

Netherlands: 15 000 km

World: 1 000 000 km

Costs

New dikes: 500-5000€/m

Dike upgrade: 500-5000€/m

Value protected:

Rotterdam: 750 000 000 €



3000-2M kilometers @ 100 bytes/s/m => 2,4 Gbit/s - 1,6 Tbit/s





The innovator

Initiator www.ijkdijk.nl

Coordinator www.urbanflood.eu

Infrastructure

+Sensor networks

+Internet

+Intercloud

+AI

+Operating System

=

Intelligent Infrastructures



Fieldlab IJkdijk

started in 2004 with a **maquette** and **horror** stories



Leading to a **foundation** and **consortium** in 2007

Involving

- dike owners
- R&D organisations
- SME
- Multinationals



2007 **official** opening Dike overtopping experiment



Macro(in)stability



Stein, 2004

Experiment Sep 2008



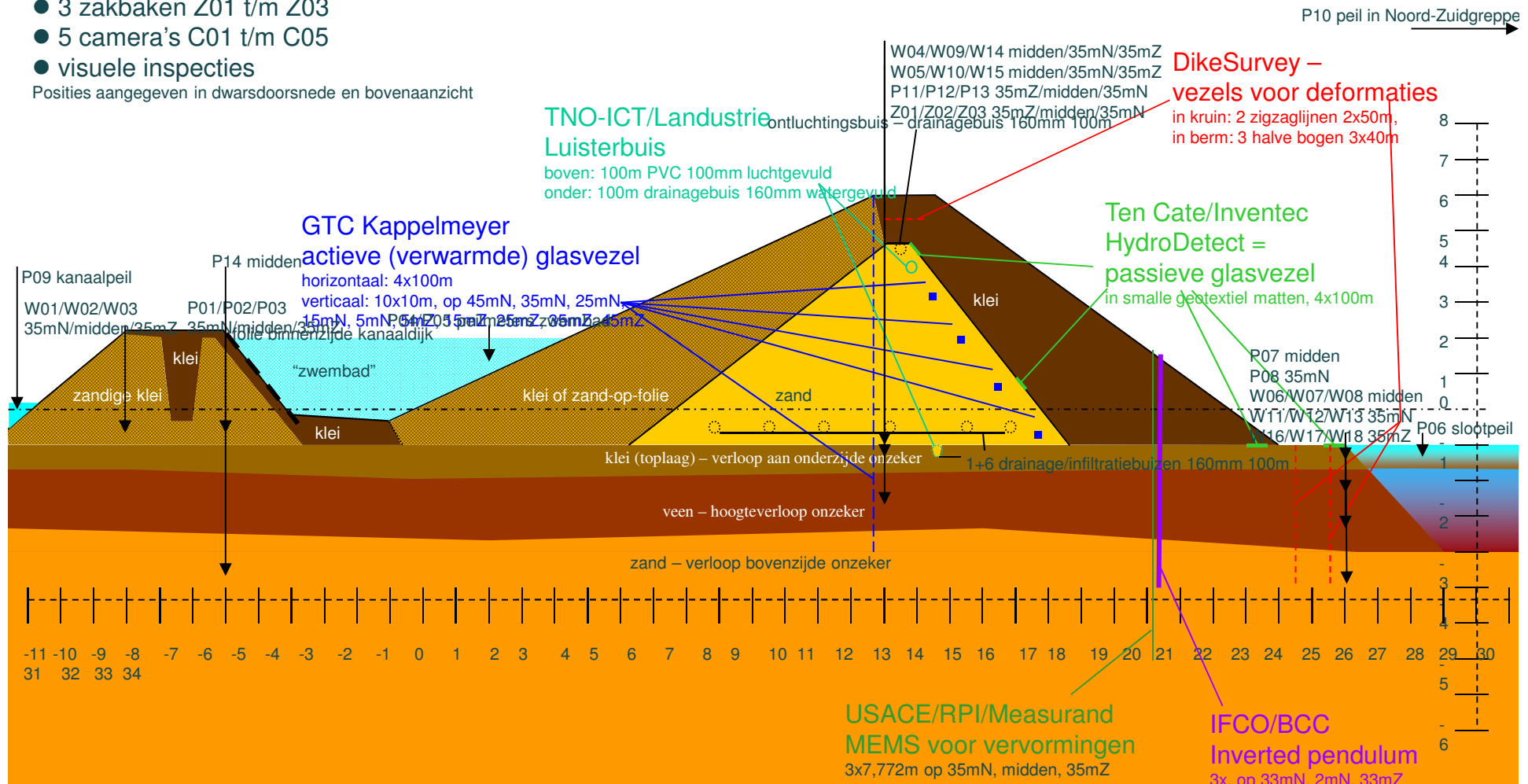
Cross section of dike with instrumentation

Deltares

referentiemonitoring

- 14 peilbuizen P01 t/m P14
- 18 waterspanningsmeters W01 t/m W18
- 12 vochtmeters V01 t/m V12
- 3 zakbaken Z01 t/m Z03
- 5 camera's C01 t/m C05
- visuele inspecties

Posities aangegeven in dwarsdoorsnede en bovenaanzicht

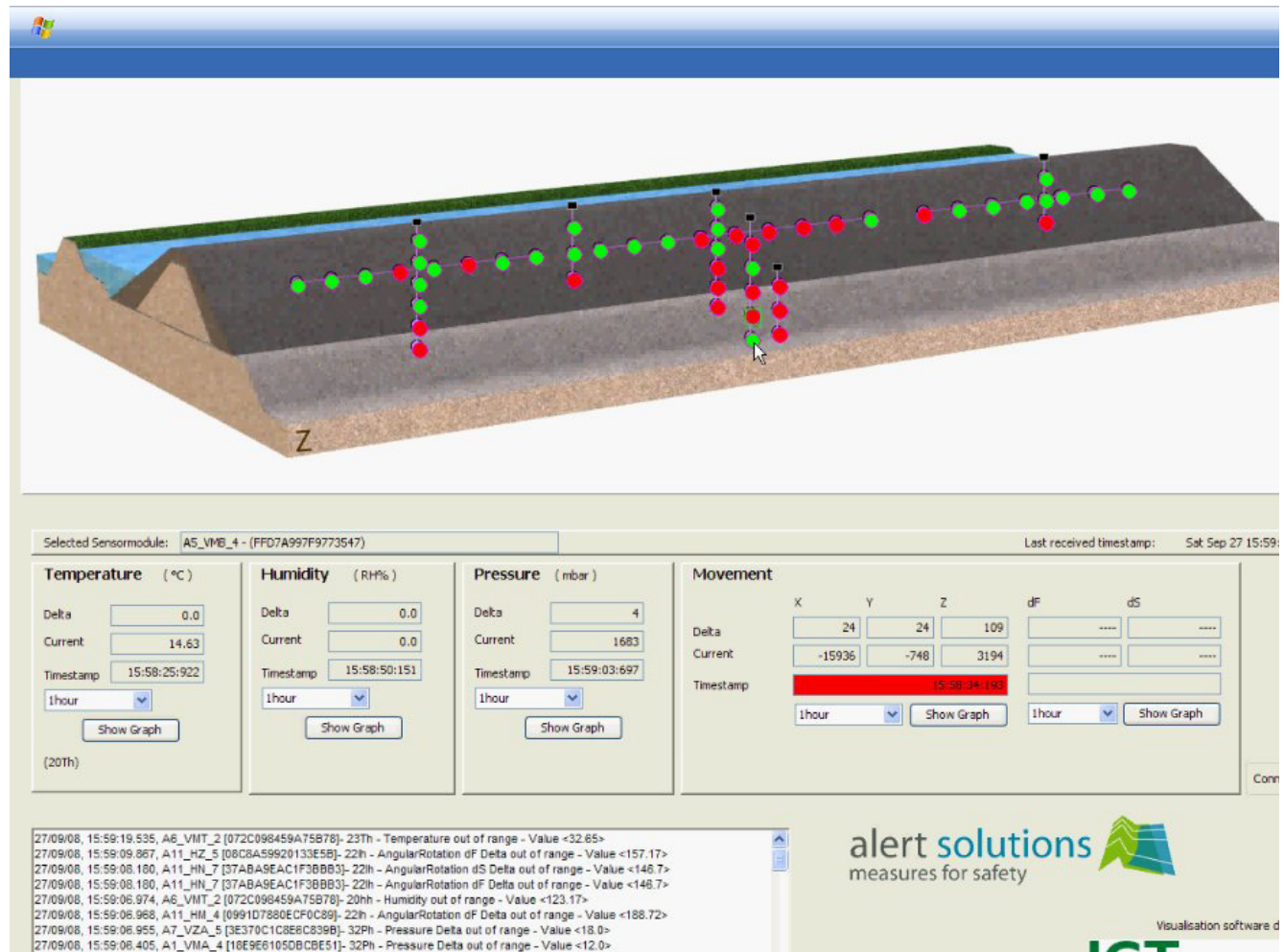






12 types of **sensor** systems

- Solid state
- Fibre optic
- Acoustic
- ...

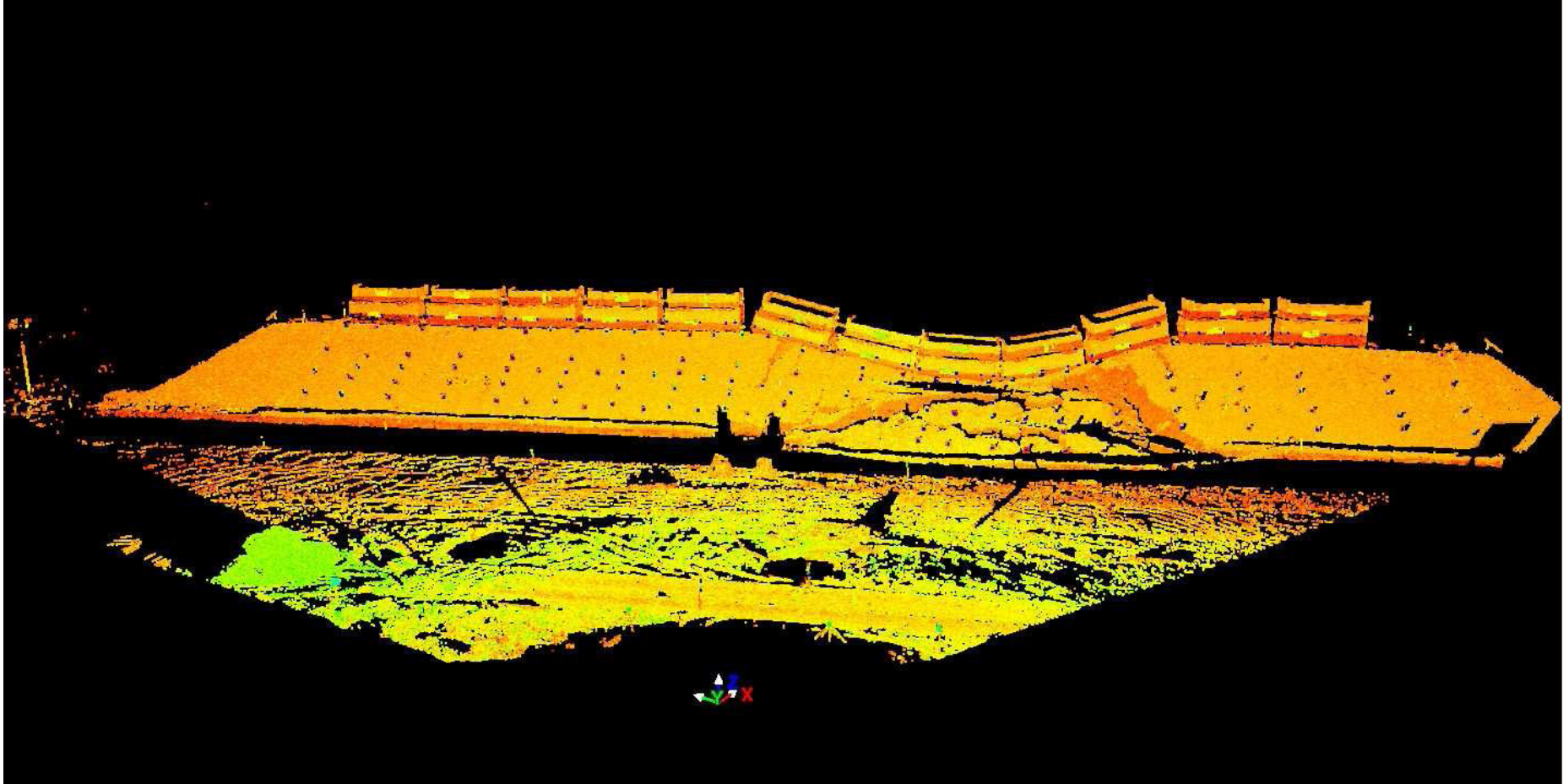




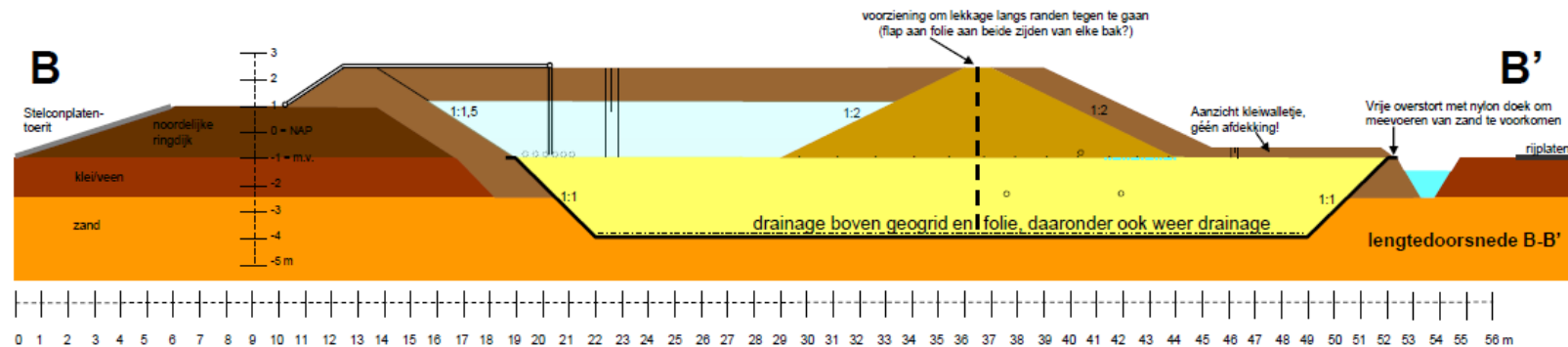




Learned a lot about sensors



Piping experiment (2009)



SEP 2009



17/08/2009 03:21 PM







Bassin bovenstrooms

proefdijk

benedenstrooms



Dec 2009





Sensor validation test 2012









Livedijk Eemshaven Okt 2009



2013 Livedijk locations



Yellow River online (2012)

AGT International, Royal Ten Cate, TNO



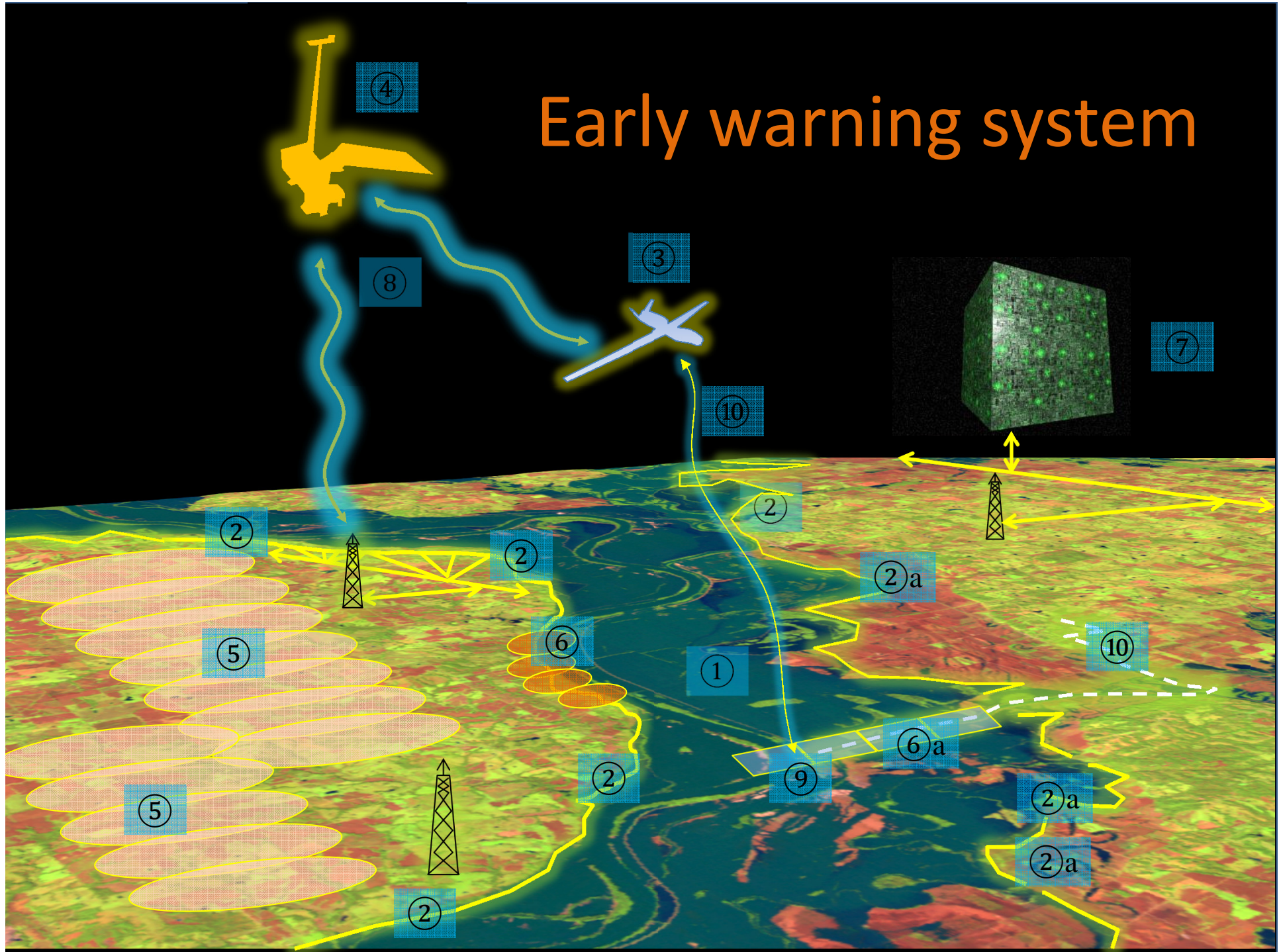
Soon 70km Yellow River



AGT International & TNO



Early warning system



From sensors to early warning system

- IJkdijk gave leading position
- UrbanFlood FP7 project granted 2009



URBANFLOOD

SEVENTH FRAMEWORK PROGRAMME
THEME ICT-2009.6.4

ICT for Environmental Services and Climate Change Adaptation

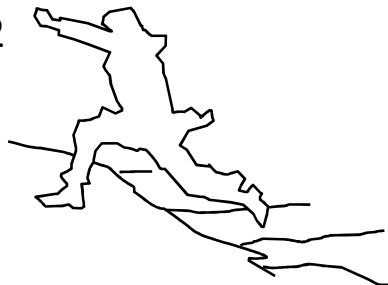
TNO	NL	Coordination, System Integration
Univ. of Amsterdam	NL	Computation
Cyfronet	PL	Workflow
HR Wallingford	UK	Hydraulics
STOWA	NL	Dissemination / Stakeholders
Siemens	RF	AI, System Integration

≈3M€, 1-12-09—30-11-12

Prof. dr. Robert Meijer

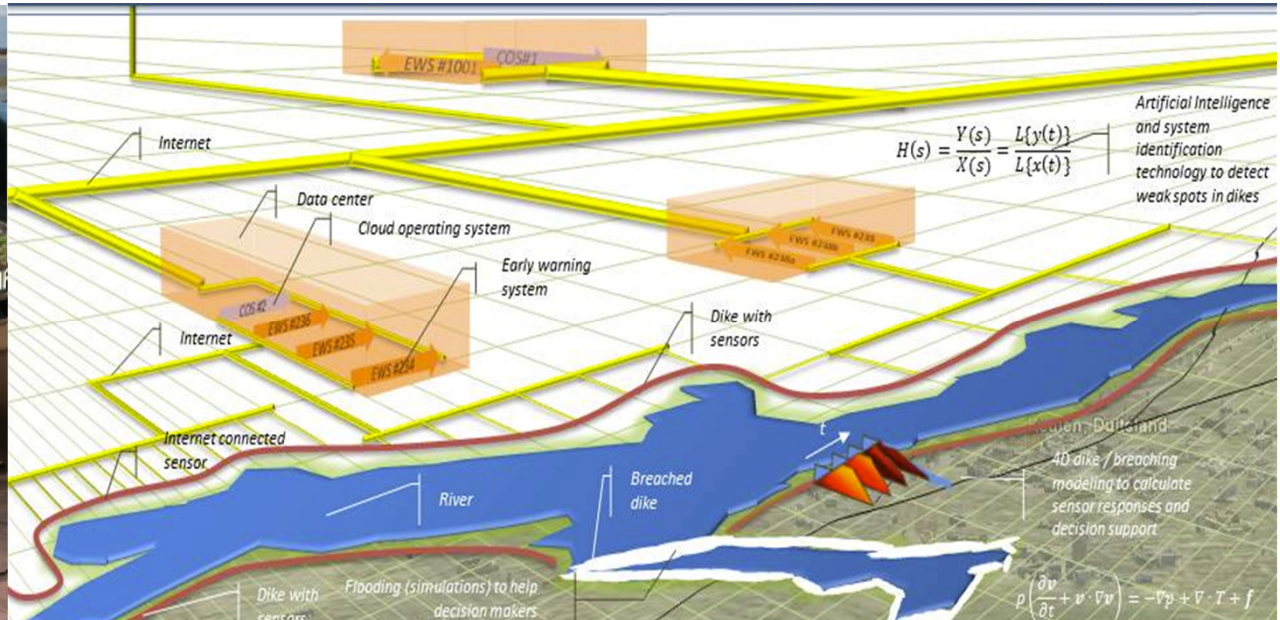
robert.meijer@tno.nl

+31653720517

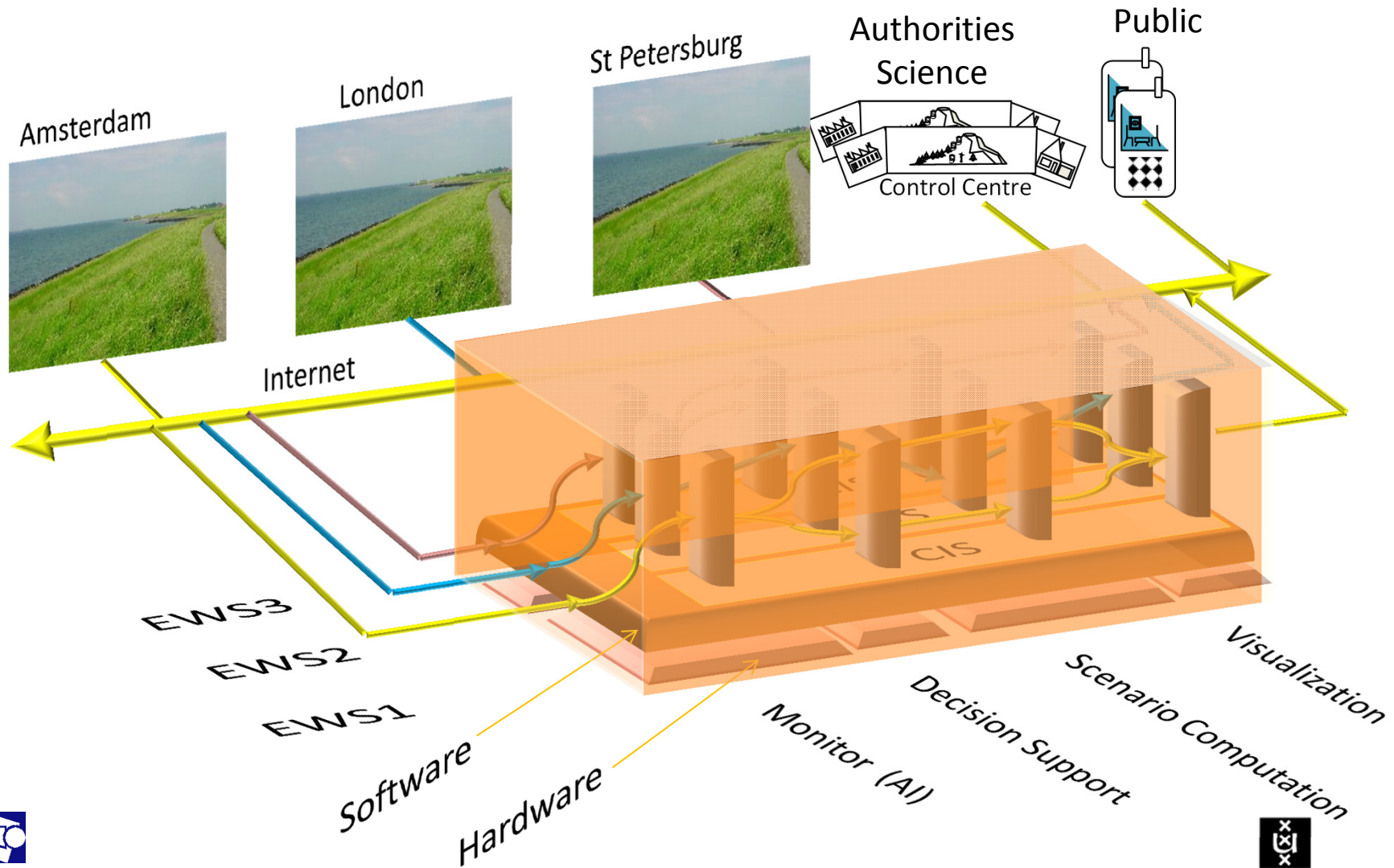


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Created: global monitoring system for dikes, www.urbanflood.eu

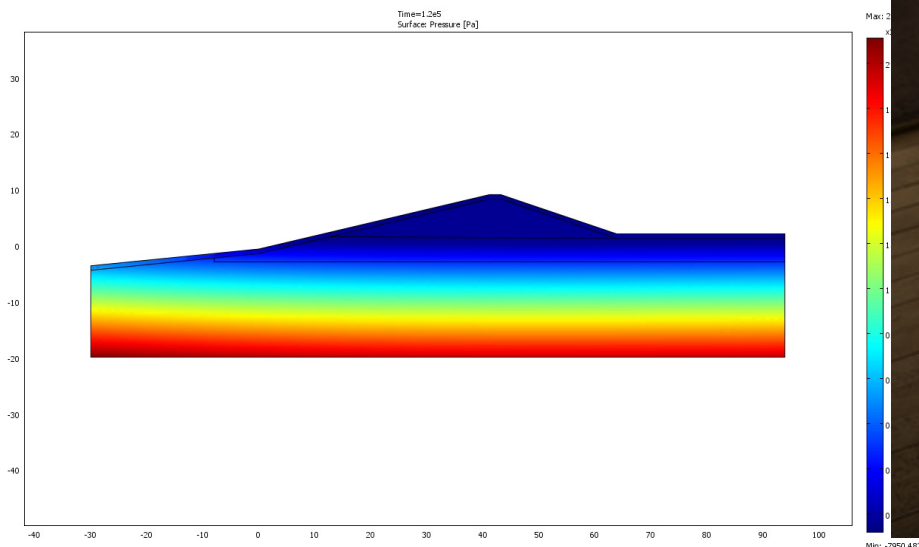
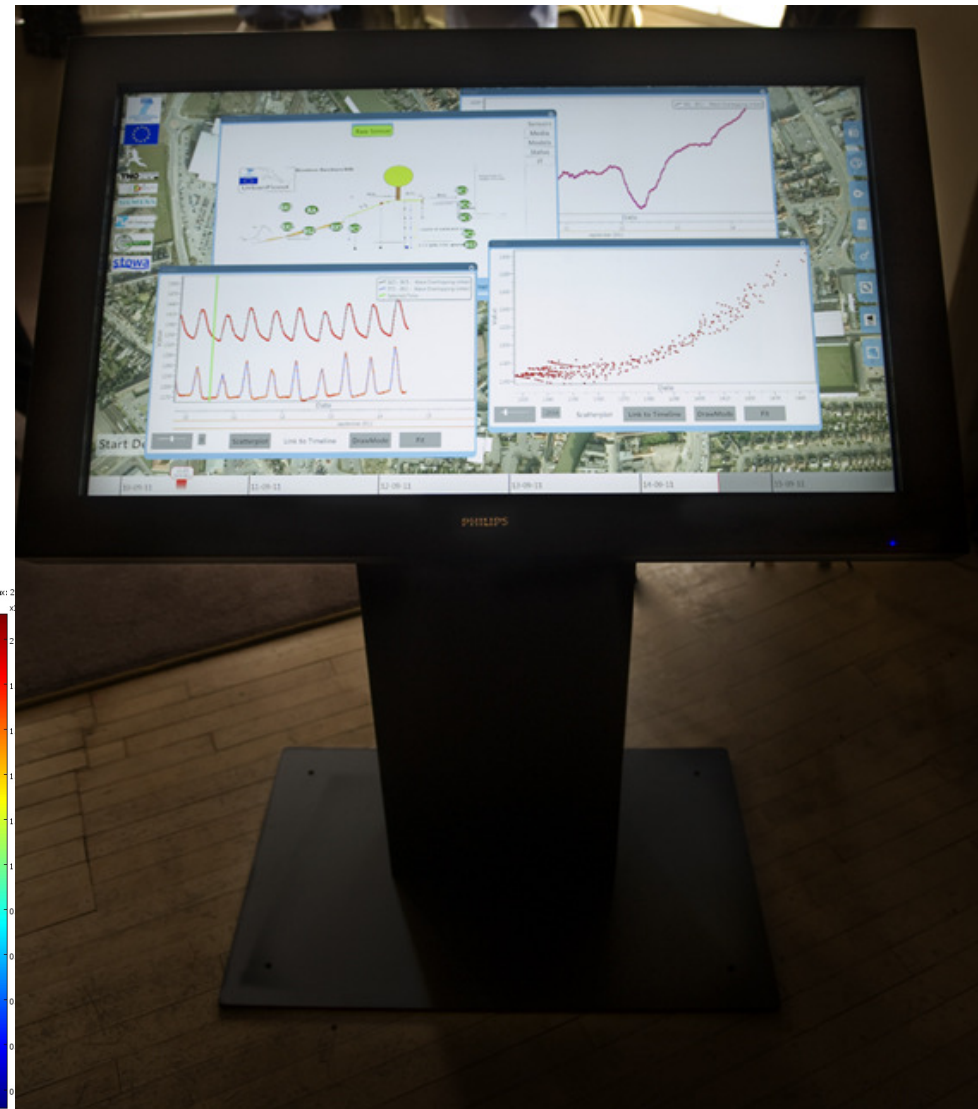


UrbanFlood early warning system ...



UrbanFlood features

- ✓ Flooding Simulator
- ✓ Virtual Dikes
- ✓ Interactive decision support
- ✓ Finite element model
- ✓ Artificial Intelligence



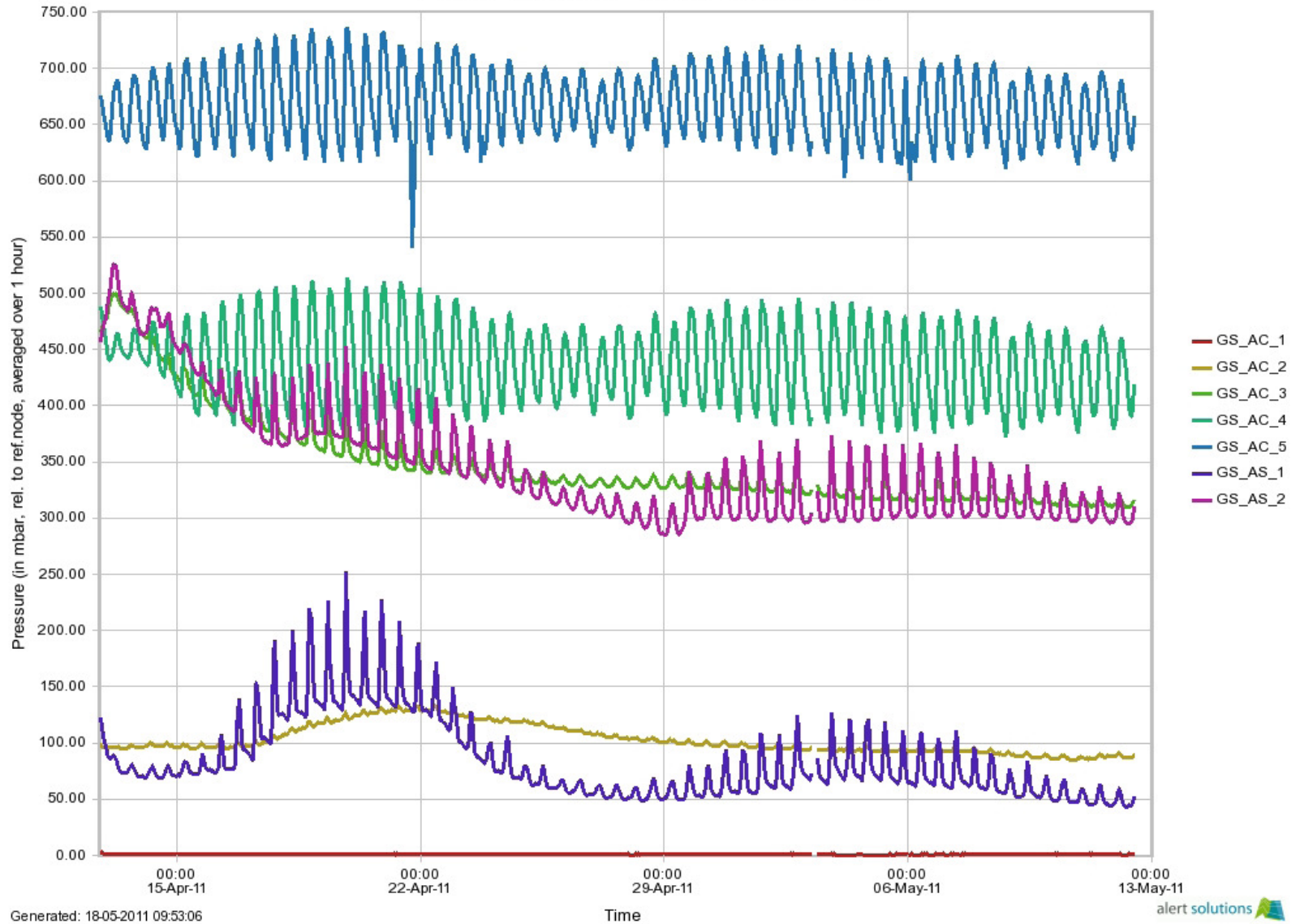
River Wash, Boston, UK



Tide: 4-6 m



Pore Pressure - GS section A - all



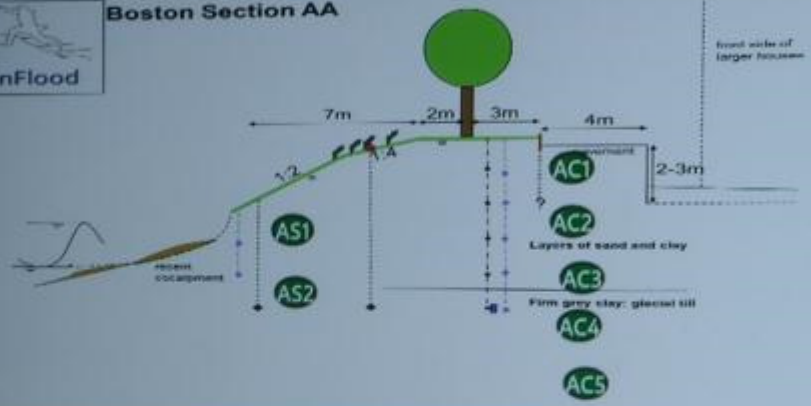
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alert solutions

Raw Sensor Safety

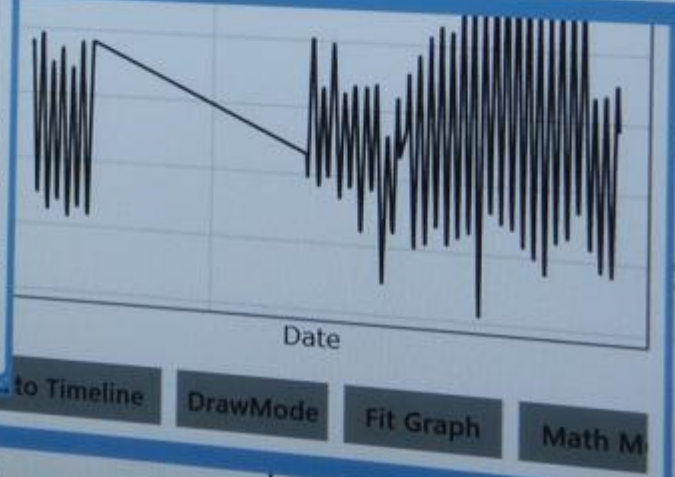
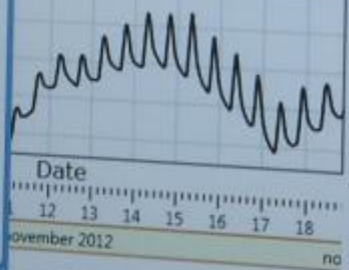
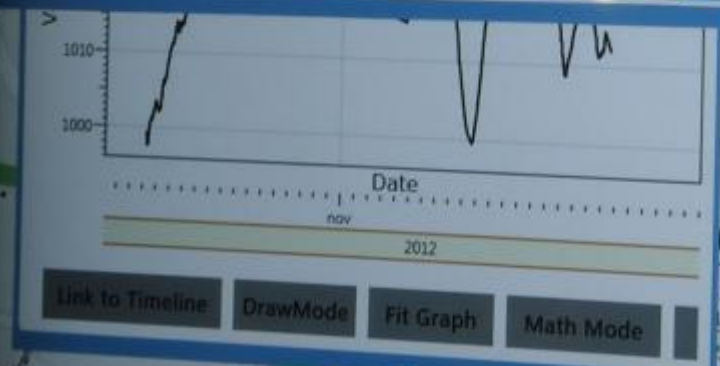
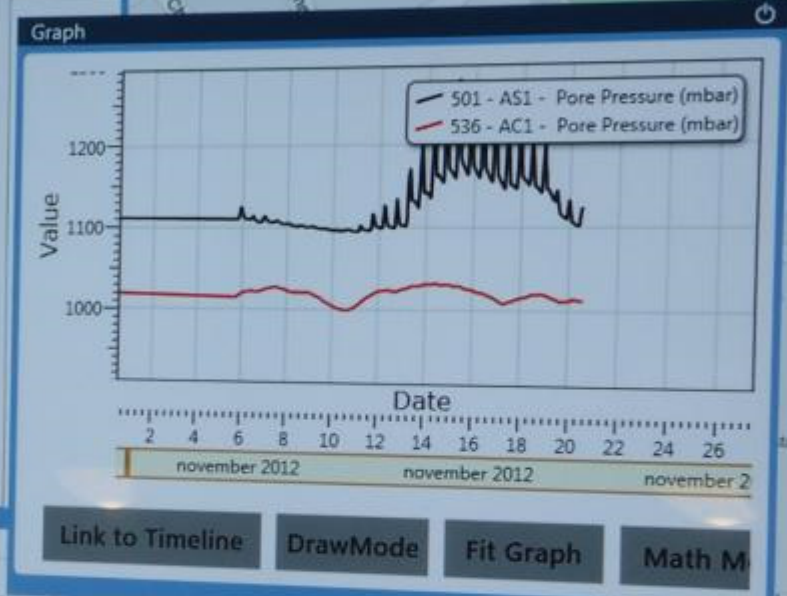


Boston Section AA



Temperature Acceleration Inclination **Pore Pressure** Displacement

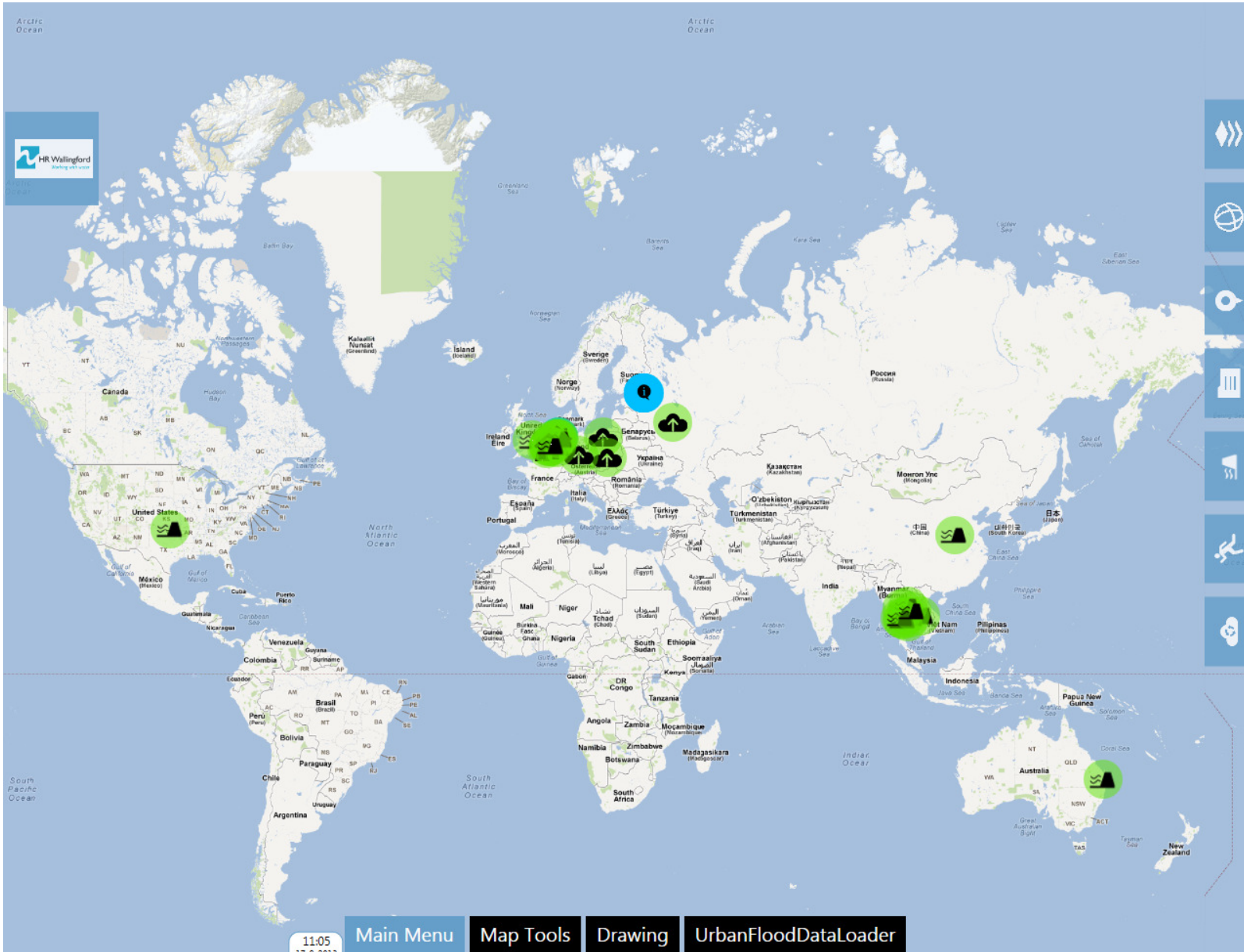
- Sensors
- Media
- Models
- Status
- IT



Timeline navigation bar:

- 18-11 16:00
- 10:15 18-11-2012
- 19-11 0:00
- 19-11 8:00
- 19-11 16:00
- 20-11 0:00

Navigation icons: Home, Drawing, and other controls.



17-09
8:00

17-09
10:00

11:05
17-9-2013

17-09
12:00

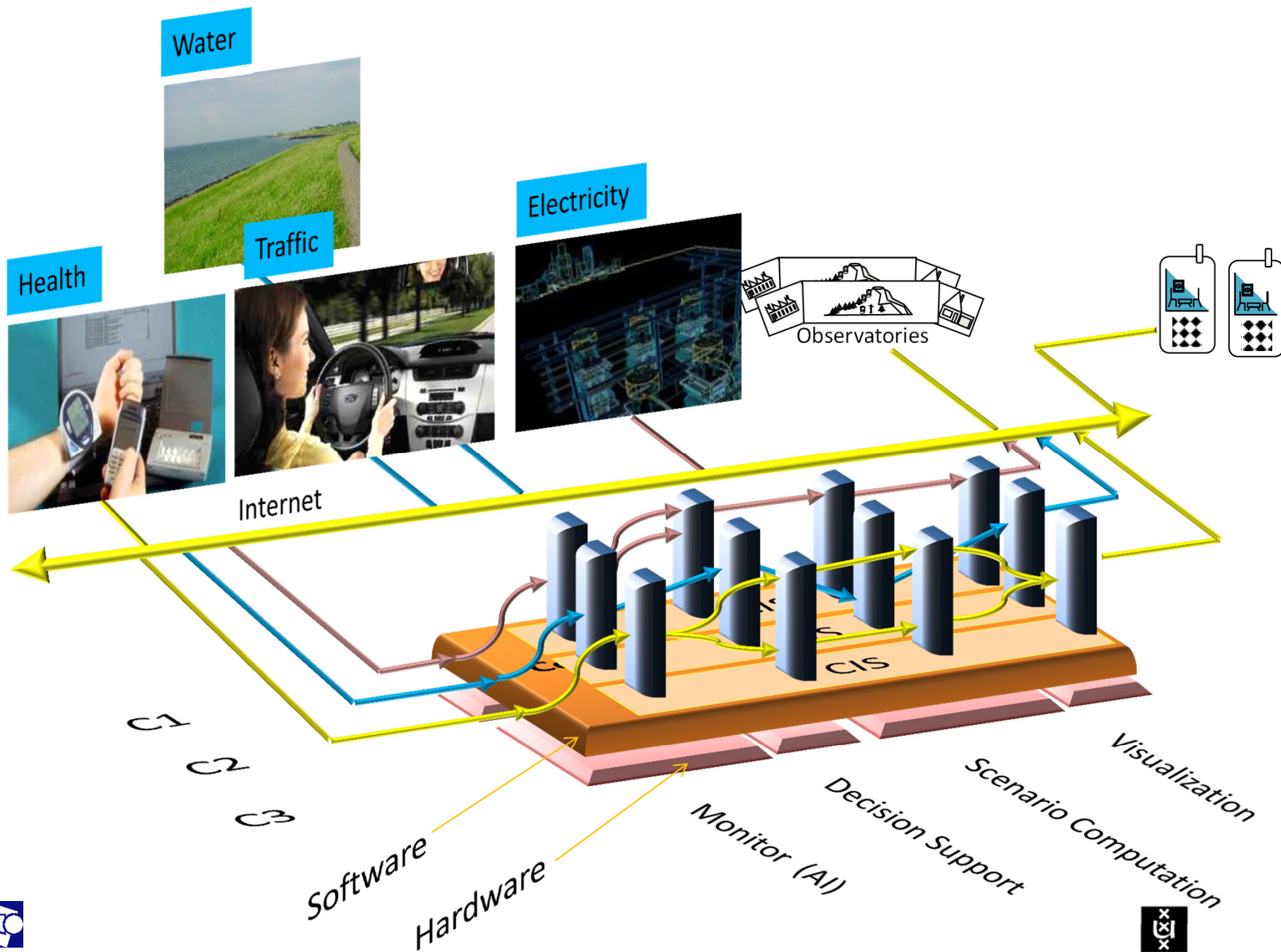
17-09
14:00

17-09
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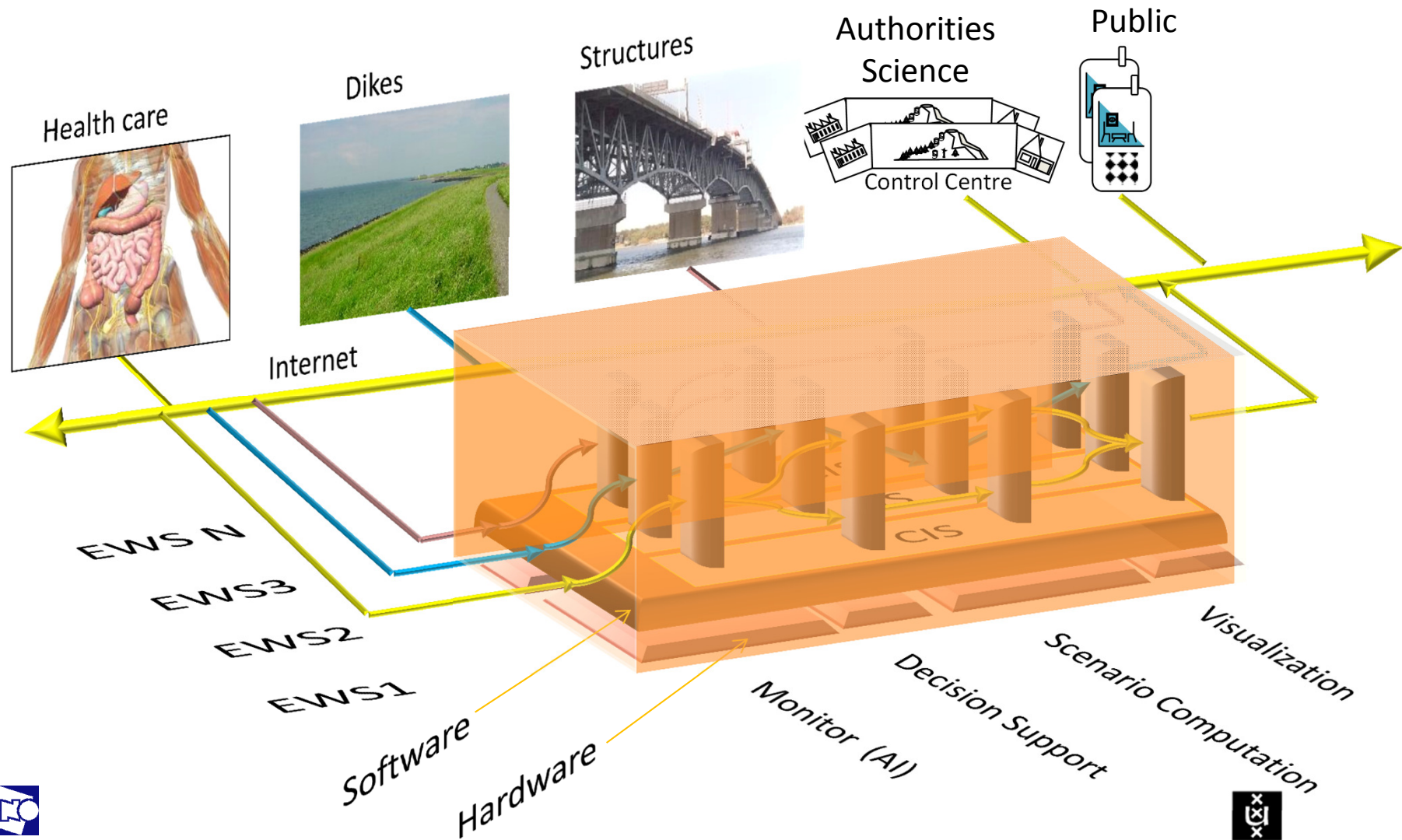
17-09
18:00

17-09
20:00

17-09
22:00



... operating system for infrastructures



Groningen gas fields - the Dutch earthquake zone

By Anna Holligan

BBC News, The Netherlands

As earthquakes become more intense and more frequent in the north of the Netherlands, there is mounting pressure on the government to reduce the amount of gas being extracted there.

It is a curse for thousands of inhabitants having to cope with the effects of living amid the Groningen gas fields - the largest in Europe.

There exists a consensus among all parties - including the gas companies - that the process of extracting the gas is causing earthquakes, but the country is thriving on the proceeds.

In 2012 the Dutch government made about 14bn euros (£12bn; \$18bn) from the Groningen gas fields. Without these revenues, the Netherlands' deficit would be similar to that of crisis-struck Cyprus (6.3%).

"It comes rumbling towards you, louder and louder and louder," says Daniella Blanken, who runs the Groningen Ground Movement.



Klaas Koster and Jannette Schoorl show a crack in the wall of their home in Middelstum



Massive Exploitation of the North Sea



7.11 km

Image Landsat
Image © 2013, Aerodata International Surveys
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google earth

Datum van beeldmateriaal: 10-4-2013 52°30'09.54" N 4°43'56.76" O verh -1 m ooghoogte 27.97 km TERDAM

Q ? & A ?



Robert.meijer@tno.nl +31653720517



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