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G-WaLe:

Enhanced Flood Prediction based on a mobile GNSS application

United Nations
Committee on the Peaceful Uses of Outer Space
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The Problem (I)
Some Facts

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- Flood catastrophes caused by rivers are a permanent threat all over Europe and world wide.
- Damages caused by floods are enormous and represent a significant economical and social problem in the affected regions.
  - According to UNESCO, more than 2,200 major and minor water-related disasters occurred worldwide between 1990 and 2001. River floods accounted for half of these disasters.
  - Flooding annually affects about 520 million people and their livelihoods, claiming about 25,000 lives worldwide.
- Why can't even highly developed countries disseminate flood warnings in sufficient time to reduce the disastrous effects of floods significantly?

Floods in Ivrea, Italy, 2001

Floods in Dresden, Germany, 2002

The Problem (II)

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- Measured water levels are keystones for model calibration and flood forecasting
- Today, water level measurements systems rely on fixed gauging stations
  - Only few measurement stations exist even in large river systems.
    - Water level measurement in the Elbe River consists on gauging stations about every 30 km.
    - In the upper Elbe (Czech/German border to Torgau (~ 150 km)) only six gauging stations are setup (see figure below).
  - Gauging stations are complex and expensive, causing problems for emerging countries
- The G-WaLe system addresses the demand for a system capable of providing near real-time data on water levels during extreme situations with both high spatial and temporal resolution.

Proposed Solution

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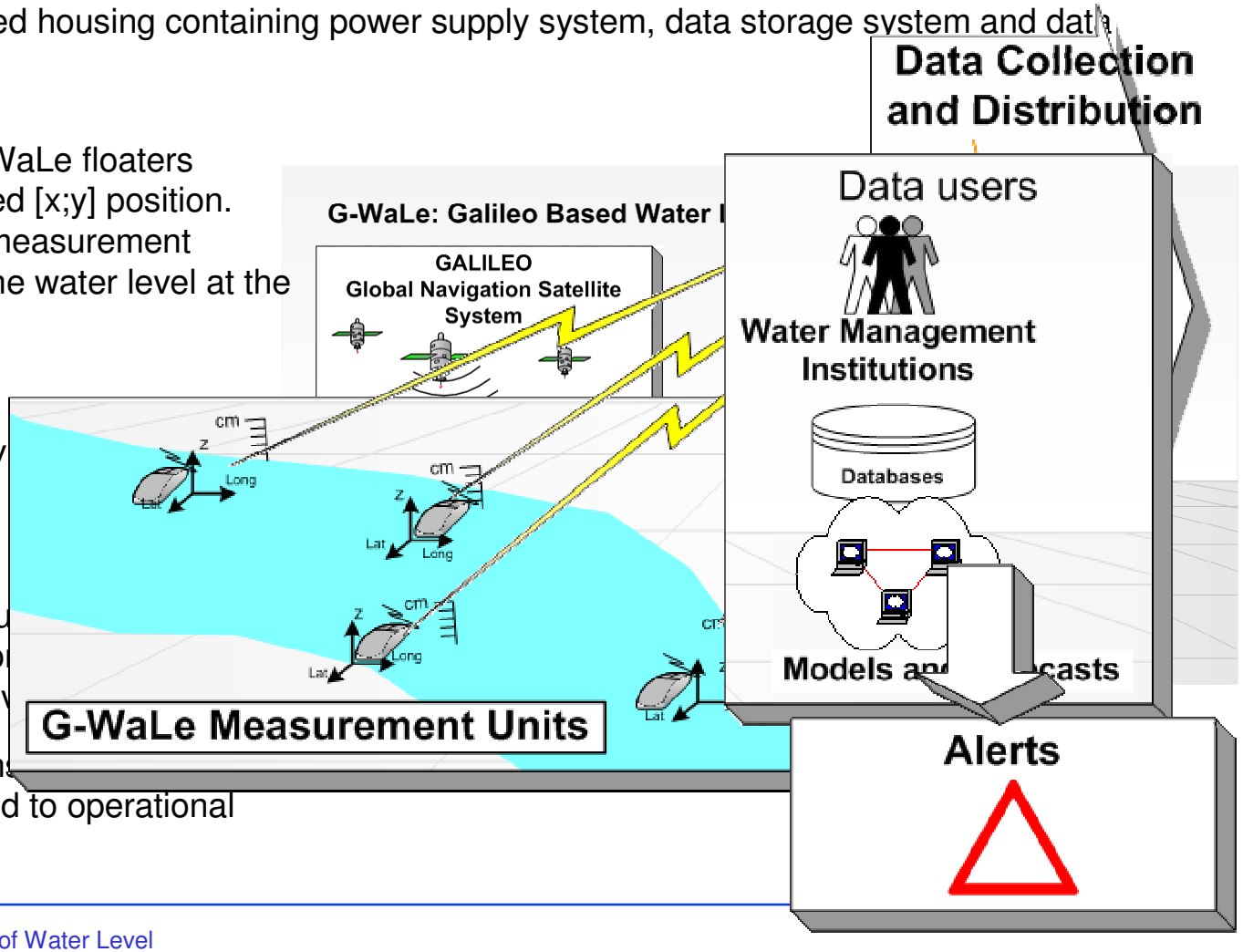
- The G-WaLe system consists of several (~100) self-contained mobile floaters with integrated Galileo receivers connected to a fixed housing containing power supply system, data storage system and data transmitter.

(1) After being deployed, G-WaLe floaters remain ("anchor") at a fixed [x;y] position. The z-component of the measurement provides information on the water level at the floater position.

(1)

(2) The position of the floater
floaters either stored
(1) satellite links) transmitted
(stationary) radio or
satellite links) to a
(3) central (national) Water Management institu
data center, where
ad hoc or short term water lev

(4) In case of critical situations established and distributed to operational forces and to the public.



G-WaLe
Proposed Solution

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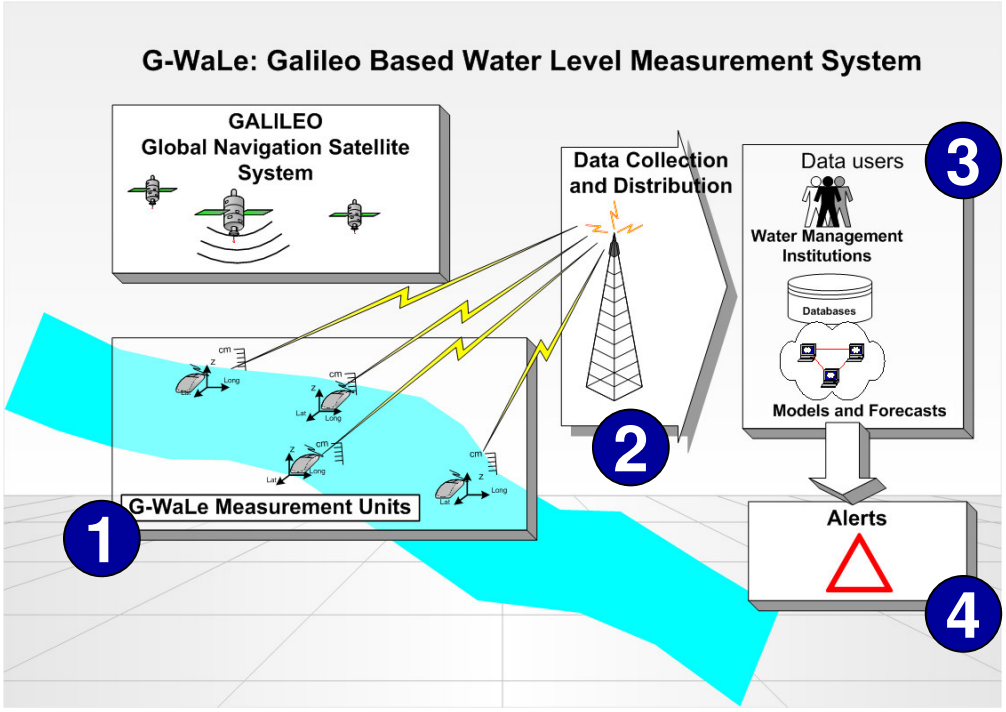
- The G-WaLe system consists of several (~30-50) self-contained mobile floaters (1) with integrated Galileo receivers connected to a fixed housing containing power supply system, data storage system and data transmitter.

(1) After being deployed, G-WaLe floaters remain ("anchor") at a fixed [x;y] position. The z-component of the measurement provides information on the water level at the floater position.

(2) The position of the floater is either stored internally or transmitted (via GSM; radio or satellite links) to a central (mobile or stationary) unit.

(3) Water Management institutions process the data to establish ad-hoc or short term water level forecasts.

(4) In case of critical situations, alerts are established and distributed



The G-WaLe system

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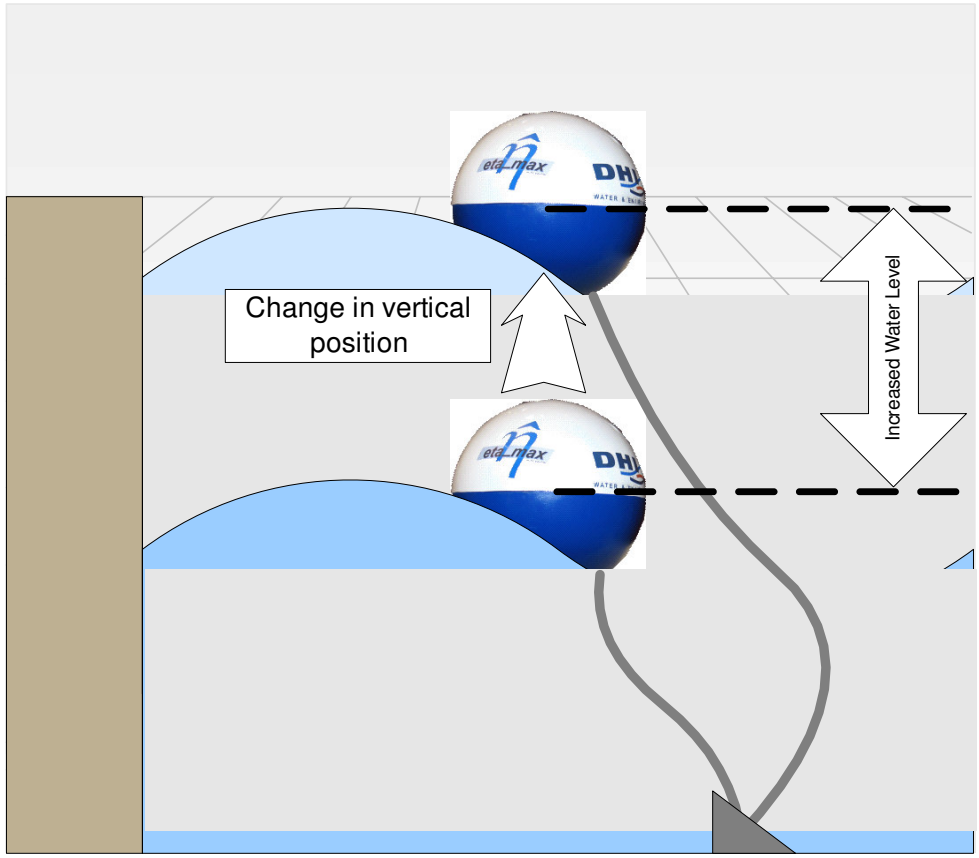
- A floater consists of:
  - GNSS receiver
  - Storage unit
  - Communication unit (GSM; radio)
  - Energy unit
  - Controlling unit
  - Anchor



Advantages

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- The G-WaLe system provides data with very high spatial and temporal resolution
- The G-WaLe system is highly mobile.
  - Floaters may be deployed by land vehicles, helicopters, or ships.
  - The system may be operated also in remote regions or emerging countries
  - The system is operational on very short notice
- The G-WaLe system is cost efficient
  - Only a limited number of actually needed measurement units have to be maintained
- The G-WaLe system may provide a contribution …
  - .. to better calibrate river models needed for preventive flood protection
  - .. to support operational forces in the event of a crisis
  - .. to decrease the economical and social impacts of river flooding events

GNSS Systems

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- The proposed approach is probably provides its best performance when it uses the future GALILEO system.
  - Enhanced accuracy in the vertical position information
  - Integrity information

- The G-WaLe principle is, however, potentially usable also with other GNSS systems, e.g. GPS + EGNOS enhancement (tbc)

- Accuracy ~25 cm of vertical position component is one of the key issues. It is intended to reduce the effect of accuracy issues by different methods:
  - Use of fixed station for correction information (Differential GNSS).
  - Filtering techniques applied to the data from many receivers.
  - Reference stations may use SaPos (network of reference points with sufficient accuracy in the position information)

The Team

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DHI Wasser & Umwelt Wiesenstr. 10a; 28857 Syke

- eta_max space GmbH (www.etamax.de)
  - Expert in space projects, mainly for ESA and EUMETSAT
  - Software engineering incl. verification/validation
  - Expertise on GNSS navigation services
  - Premium member of GAUSS (Galileo Applications and Users in Safety & Security) providing support in the certification of safety relevant Galileo applications

- DHI Wasser & Umwelt GmbH
  - Independent member of the DHI Water & Environment company group (www.dhigroup.com)
  - Working as consultant and software developer in the field of water
  - Modeling of rivers for various flood mitigation studies and flood forecast systems
  - The flood projects are all carried out using software developed by DHI, which is one of the most widely used commercial packages worldwide.

Summary

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- G-WaLe is a GNSS-based system for measuring the water level in rivers and flood affected areas.
- Services possibly provided by G-WaLe system represent a significant improvement of the flood modeling and forecasting process.
- G-WaLe may provide a contribution to decrease the social and economical impacts of water floods world wide.
- Its mobility as well as low costs make the system well applicable also in remote areas or emerging nations.