EUROPEAN COMMISSION
JOINT RESEARCH CENTRE
Institute for the Protection and the Security of the Citizen
Global Security and Crisis Management (GlobeSec)

Ispra, 14 April 2011

International Workshop on Global Flood Monitoring and Forecasting

Outcomes

1. INTRODUCTION

From 22 to 24 March 2011, the International Workshop on Global Flood Monitoring and Forecasting gathered 20 scientific experts and 4 humanitarian organisations and 2 insurance groups to discuss the state of the art in this new and multi-disciplinary field.

The principle objective of the workshop was to bring all scientists working on global flood monitoring as well as the user community together and gain a **common understanding of the state of the art**. A second objective was to identify if and how the various **existing prototype, pre-operational or operational systems can be conceptually and practically integrated** to provide systems-of-systems with added value.

2. Overview of systems

Bob Brakenridge (Colorado University; Dartmouth Flood Observatory, DFO) kicked off the workshop with flood remote sensing methods. He presented work on **global passive microwave remote sensing** of floods (in partnership with JRC), as well as **daily global MODIS flood maps** (in partnership with NASA). Fritz Policelli (NASA/ Goddard Space Flight Centre) elaborated on the automated **MODIS flood mapping system** and presented NASA sensors and project (e.g. NASA SensorWeb and SERVIR Africa) related to flood remote sensing. A second system for automatic **water body classification** and analysis based on MODIS data was presented by Franca Disabato (Ithaca). Tom De Groeve (JRC) showed the status and progress of the **Global Flood Detection System**, based on passive microwave remote sensing. Marco Kleuskens (Deltares) showed a new system for using **systematic and automated SAR data** (ASAR) for global flood mapping, aiming at using Sentinel-1 data after its launch in 2013.

Several rainfall based methods were presented. Adriana Albanese, Franca Disabato and Andrea Ajmar (Ithaca) presented an **extreme rainfall detection system** (based on satellite observed rainfall), and Bob Adler (University of Maryland) talked about the status and plans for **Global Flood Calculations** Based on Satellite Rainfall and Hydrological Models.

Flood forecasting systems were introduced by Ad de Roo and Peter Burek (JRC) with work on expanding the European Flood Alert System to Africa and globally. Florian Pappenberger (ECMWF) followed with a presentation on the flood-related research (in collaboration with JRC) ongoing at **ECMWF**, a provider of meteorological forecasts. Nathalie Voisin (Pacific Northwest National Laboratory, University of Washington) talked about **Global flood forecasting** using a physically based distributed hydrology model.

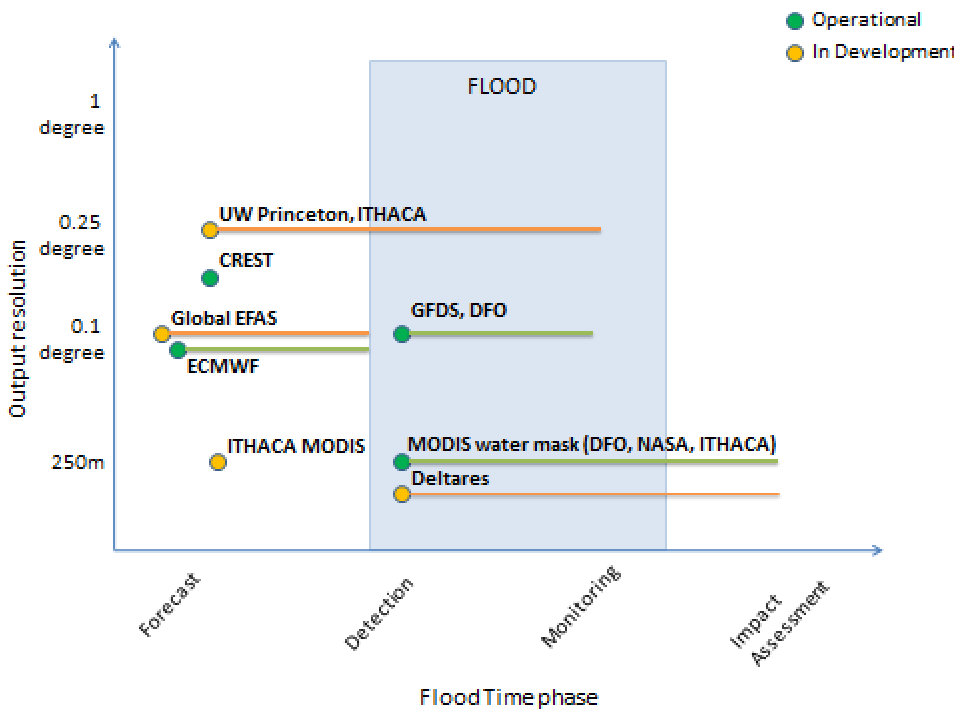


Figure 1. Overview of presented systems.

Last but not least, Uli Looser (GRDC) described the **Global Runoff Data Centre**, a WMO endorsed entity aiming at collecting global in-situ hydrological data.

In the presentation of the available and developing systems, particular emphasis was given to discussing:

- Target user groups: horizontal (e.g. civil protection, humanitarians, reinsurance) and vertical (local, regional, national, international) organisations

- Disaster phase: prevention, preparedness, mitigation, response, relief, reconstruction

- Flood dynamics: flood type, lead time, recurrence

- Interoperability: overview of standards used for publishing information

- Visualization and communication: translation of scientific information (including uncertainty) to unambiguous and useful products for decision making

- Bottlenecks to global roll-out: critical data sets, infrastructure requirements, validation requirements

Strengths and weaknesses were discussed as well as bottlenecks for further development of global roll-out. Some datasets were discussed, either because they are lacking and hamper further development, or because their existence should be brought to the attention of everyone.

3. USER PERSPECTIVES

Chris Chiesa (Pacific Disaster Centre) talked about the importance of disseminating information in standard formats, so they can be **integrated in multi-hazard systems** or legacy information systems. Jens Mehlhorn (SwissRe) presented work done at SwissRe to turn **passive microwave remote sensing** data into products. Tim Fewtrell (Willis) talked about the requirements for flood monitoring for the reinsurance industry.

Humanitarian user perspectives and requirements were communicated by Frederic Zanetta (International Federation of the Red Cross and Red Crescent), Olimpia Imperiali (Monitoring and Information Centre of the European Commission), Marian Cezard and Lara Prades (World Food Programme) and Thomas Peter (Office for Coordination of Humanitarian Affairs).

The importance of flood monitoring in the various operations of the present user organisations was discussed throughout the workshop. At international and European level, floods represent between 30% and 50% of interventions. Key issues were:

- Translation of information for operational use; presentation and visualisation of information adapted to context of targeted users
- Possibility to integrate information in own systems (GIS standards)
- Timing aspects of floods
    - Forecasts: for pre-positioning of relief and response items (5 days before); for planning of VHR imagery; location (within 200km or less) is more important than timing
    - Near real-time assessment (mapping): planning assessments and operations
    - Objective flood size and extent measurements (in all weather conditions): for insurance triggers and humanitarian targeting
- Aggregation of information while preserving the uncertainty and characteristics of each system is more important than improving accuracy of individual systems
- Flood impact is the end product: population and natural resources/livelihoods (or insured property) should be considered.

4. OUTCOMES

The main outcome of the workshop is the creation of an informal platform for collaboration: the Global Flood Monitoring and Forecasting Initiative.

In this platform, participants engage themselves to collaborate and share information useful for mutual improvement, validation, calibration of systems, as well as information on on-going floods. Establishing links with existing initiatives is important (e.g. HEPEX, Asian groups, *International Flood Response Network: guidelines for response to floods*).

Collaboration can be formalized by joint project proposals and/or bilateral collaboration agreements.

In addition, there is an interest in sustaining and expanding the dialogue between scientists and users. Therefore, participants agreed to:

- Enlarge existing feedback loops between some groups (e.g. NASA – IFRC, JRC – MIC, Ithaca – WFP). Some users can now have access to more experimental products and provide feedback.
- Involve users from other continents: WFP has users on all continents and is happy to ask for direct feedback from field offices.

To facilitate the Global Flood Monitoring and Forecasting Initiative, JRC created a website and mailing list for this purpose:

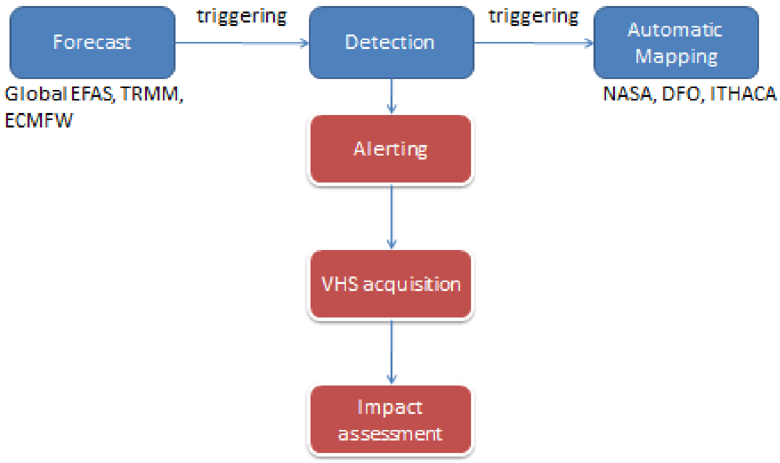
- Mailing list: global-floods@gdacs.org
- Web site / Intranet: "Global Flood Monitoring and Forecasting Initiative": http://portal.gdacs.org/GlobalFloodInitiative/tabid/65/Default.aspx or shorter http://portal.gdacs.org/?tabid=65.

In addition, the participants agreed to hold a yearly workshop to exchange information and follow-up on agreed actions.

4.1. Joint added-value products through system integration

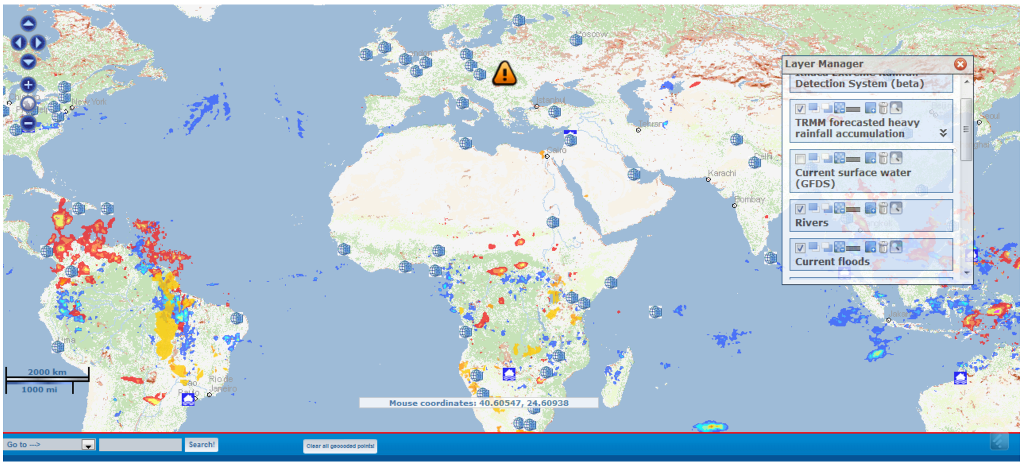
Understanding the state of the art allowed the workshop to create a conceptual map of where systems are positioned in relation to each other, and which links or synergies are possible.

The participants of the workshop commit to focus new developments of systems with in mind possible integration with other systems. Such developments are ideally user driven, with consideration of interoperability aspects for creating "systems of systems".



As a first example, participants agreed to allow co-visualization of products, without data integration. Terms of services will be agreed.

- ECMWF will be asked by WFP
- DMIS access
- Global flood early warning (JRC, Univ Washington)
- 24hr TRMM based forecasting (NASA, Adler) or nowcasting (Ithaca)
- Global flood observations (JRC GFDS)
- Global flood extent mapping (DFO/NASA MODIS, Ithaca MODIS, Deltares SAR)



4.2. Validation

A third objective was to discuss the possibility to set up a joint validation study in one or more study areas over a longer period. Measuring the quality of flood monitoring systems is difficult since little validation data is available. Various systems measure different quantities (stage, discharge, flooded area, rain rate, rain accumulation, etc.) which cannot directly be compared. Flood attributes such as starting date and duration are ill defined and ambiguous at best. In the workshop, we will discuss a methodology to collect data from various systems during a given period to create a data body for later analysis.

4.2.1. Event definition

The participants will work on one or more methodologies to define flood events from remotely sensed or hydro-meteorological models. A limited set of methodologies is important for comparability of systems.

4.2.2. Case studies

Rigorous validation is most easy in well-defined case studies. Proposed case studies are:

- Pakistan Floods ~Jul/Aug 2010
- SE Brazil Floods ~13 Jan 2011
- NE Australia Floods Jan 2011
- Namibia, 2011

In practice, interested participants will make available all products and basic data for the events on central server:

- observed meteo data (P, T, EVPT)
- observed discharge data (Q) (GRDC)
- sat products: TRMM; observed flood extent: VHR satellite imagery
- assessments of flood extent (shapefiles, WMS)
- meteo forecasts (ECMWF)
- JRC/UW: flood forecasts (>24 hours before, up to 6-8 days)
- NASA/Adler: TRMM/24 hour forecast
- JRC: GFDS products
- DFO/NASA/Ithaca: MODIS type
- Deltares: SAR
- NASA TRMM products
- ITHACA TRMM products

4.2.3. Real-time comparison studies

Using systems in real situations can show weaknesses that are not revealed in case studies, but also strengths and opportunities of combining systems. Therefore, real-time comparison studies are very valuable to optimize systems.

In practice, interested participants will make available all products in real-time in a single platform (ftp site, common map, GDACS (restricted access) or other) for a limited period (e.g. 1 year). For each major flood disaster, the various system outputs can be compared, and a comparison report compiled.

- Global flood early warning (JRC, Univ Washington)
- 24hr TRMM based forecasting (NASA, Adler)
- TRMM based rainfall product (ITHACA)
- JRC GFDS
- DFO/NASA/Ithaca MODIS flood extent
- Deltares SAR flood extent

5. AGENDA

Tuesday 22 March: Global flood monitoring using satellite-based techniques

9:00	Introduction: Tom De Groeve (JRC), Welcome and introduction
	Discussion: Actors and responsibilities in global flood management
10:00	Talk: G. Robert Brakenridge (Colorado University)
10:45	Talk: Fritz Policelli (NASA/Goddard Space Flight Centre)
11:30	Discussion: Flood disaster cycle and timing aspects
12:00	Lunch break
14:00	Talk: Adriana Albanese, Franca Disabato, Andrea Ajmar (Ithaca), ITHACA global flood monitoring systems
14:45	Talk: Robert Adler (Maryland University), Status and plans for global flood calculations based on satellite rainfall and hydrological models
15:30	Coffee break
15:45	Talk: Tom De Groeve et al. (JRC, GlobeSec), Global Flood Detection System
16:15	Discussion: From proof of concept to global output

Wednesday 23 March: Global flood forecasting using weather-based techniques

9:00	Talk: Ad de Roo et al. (JRC, Natural Hazards), European, African and Global Flood Alert System
9:45	Talk: Florian Pappenberger (European Centre for Medium Range Weather Forecasts), Seamless global extreme weather forecasting at ECMWF
10:30	Coffee break
10:45	Talk: Ulrich Looser (Global Runoff Data Center)
11:30	Discussion: Local, national, international perspectives
12:00	Lunch break
13:30	Visit to the crisis room
14:00	Talk: Nathalie Voisin (Pacific Northwest National Laboratory)
14:45	Talk: Marco Kleuskens (Deltares, Netherlands)
15:30	Coffee break
15:45	Talk: Chris Chiesa (Pacific Disaster Centre)
16:30	Discussion: Interoperability

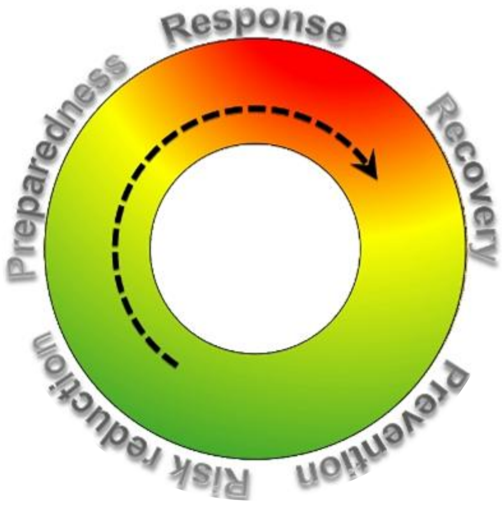
Thursday 24 March: Towards an integrated flood monitoring information system

9:00	Talk: Frederic Zanetta (International Federation of Red Cross and Red Crescent Societies)
9:30	Talk: Jens Mehlhorn (Swiss Re)
10:00	Talk: Thomas Peter (United Nations Office for Coordination of Humanitarian Affairs)
10:30	Coffee break
10:45	Talk: Olimpia Imperiali (European Commission Humanitarian Aid & Civil Protection (Monitoring and Information Centre))
11:15	Talk: Lara Prades, Marion Cézard (World Food Programme)
11:45	Talk: Timothy Fewtrell (Willis)
12:15	Lunch break
14:00	Discussion: Validation study, mapping of various systems, gap analysis, priority countries
15:30	Conclusion and way forward
16:30	Closure of workshop

6. DISCUSSION TOPICS

6.1. Actors and responsibilities in global flood management

Disaster management is a cycle. Response during actual disaster is preceded by preparedness and mitigation measures and followed by recovery and reconstruction. During "peace time", the focus is on efforts on risk reduction and prevention.



Many organisations play a role in flood disasters. Later, we'll discuss the vertical aspects (from local to national to international). Here, we look at the horizontal aspects. Different organisation types involved include:

- Development agencies: prevention, risk reduction and mitigation (e.g. EU or South African Development Community)

- Hydro-meteorological agencies: early warning for floods: national, basin-wide (e.g. Zambezi River Authority) and international (WMO)

- Civil protection agencies: typical in charge of response measures (from national to international, like ECHO/MIC)

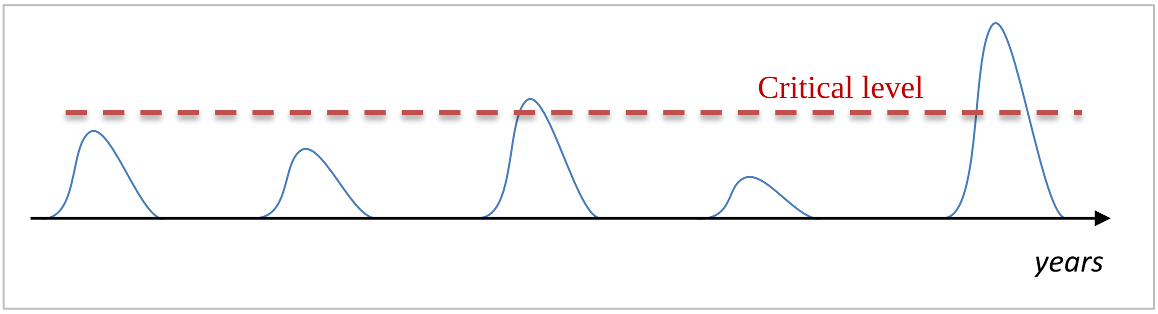
- International humanitarian assistance: relief and funding

- Post Disaster Needs Assessment: assessment of damage, losses and recovery needs (UN, World Bank, European Commission): field missions, satellite mapping

- Rapid mapping: time-critical acquisition of satellite imagery and fast processing (e.g. Flood Observatory, Charter, UNOSAT, SAFER, Sentinel Asia)

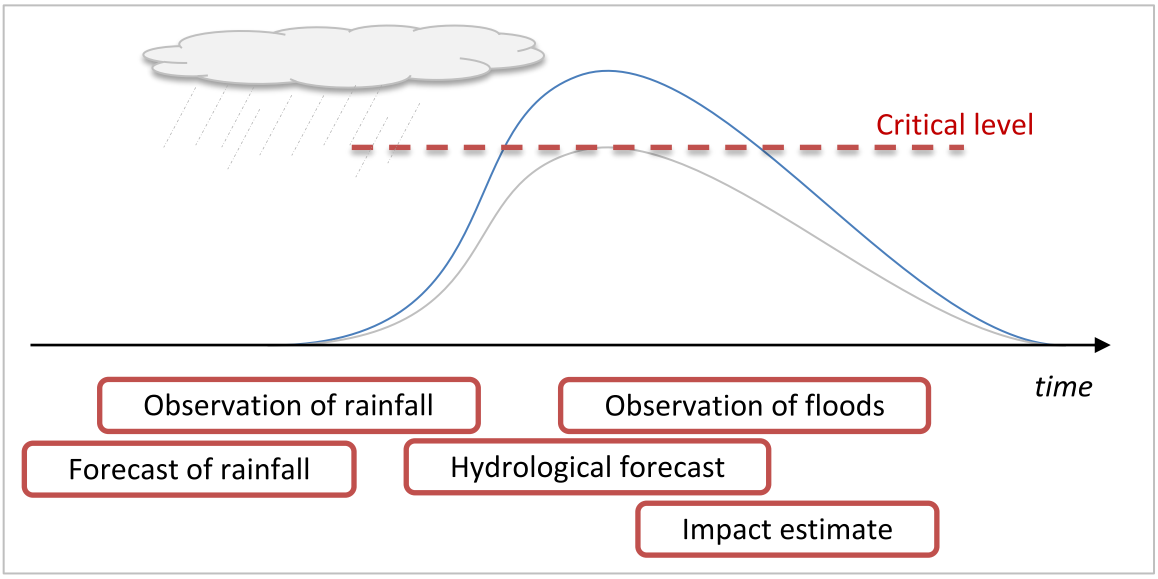
6.2. Flood disaster cycle and timing aspects

More than in other disaster types, the temporal scale of floods is very relevant. For one, floods are recurrent events that can be described statistically with properties like return periods. This is important for preparedness, for designing flood defences and for comparing flood events over the years. Historical floods can be used as impact scenarios for on-going or future floods.



Second, floods have spatio-temporal dynamics that can vary significantly (from hour-long, localised flash-floods to month-long seasonal floods affecting several countries). Some of the dynamics can be modelled accurately with hydro-meteorological models, measured with in-situ gauging or observed via satellite systems. The different dynamics are important for designing early warning and response to floods: lead times can vary from hours to weeks; inundations can last hours to weeks, affecting response and relief needs. They are also limiting factors for flood monitoring systems: orbital or aerial remote sensing is not feasible for short floods; alert chains cannot be moderated for flash floods.

Question: in which phase of the flood does your system provide unique information?



6.3. From proof of concept to global output

Flood systems create added value information based on processing of observations or model results. Development of global systems from proof-of-concepts (maybe developed in a particular geographic area or making non-universal assumptions) to useful systems must overcome different bottlenecks. Systems "could" work globally, provided some conditions are met. These bottlenecks can be methodological (e.g. needs lengthy calibration for each flood basin), IT related (e.g. need of massive disk space or CPU), cost (e.g. need of commercial satellite imagery) or model related (e.g. unstable solution). Most bottlenecks are related to data: global output depends on the availability of, for instance, high resolution elevation data, real-time rain data, accurate river data, in-situ gauging time series, seasonally adjusted average rain values, knowledge on location and type of flood defences, etc.

Some of these data sources can be of use to more than one system. Some of the data sources are maybe created by an existing system. Some data sources may exist, but the uncertainty, spatial resolution, temporal resolution or precision might not be sufficient.

Question: what are key datasets for your system that currently limit its global applicability or could improve drastically the performance?

6.4. Local, national, international perspectives

The larger a flood disaster is the more levels of government are involved. Different levels have different responsibilities and resulting information needs. This drives the fit-for-use analysis of flood monitoring and forecasting systems.

Some characteristics of different management levels are:

- Local: <u>implementation role</u>. Most early warning and response decisions are made locally, as are design choices for preparedness and mitigation. The "last mile" of alert chains and evacuation orders come from local authorities, using systems adapted to local context and culture.

- National: <u>coordination and funding role</u>. Legislation and funding for floods preparedness, mitigation, response and relief is mostly decided nationally. For large floods, response and relief coordination can be national too. Flood information systems are often nationally implemented (e.g. in hydrological or meteorological ministries), but they provide information to local authorities for action.

- International: <u>supporting role</u>. When flood disasters exceed the national coping capacity, bilateral or multilateral international assistance can play a role, mostly through coordination of response (e.g. OCHA), funding (e.g. ECHO), damage assessment campaigns (e.g. World Bank). In addition, some flood monitoring systems are more effective at continental or global scale (e.g. satellite monitoring and meteorological forecasts) and can provide information to national or local levels.

Question: for which level is your system most useful?

6.5. Interoperability

It is unlikely that a single method or system can provide all the required information for use by the heterogeneous flood disaster user community. More likely, coupling or integration of different systems in one way or another will provide better results. A system of systems can also grow more easily and can take advantage of advances in particular fields by replacing old system components by new ones.

Essential for integrating systems (whether tightly or loosely) is system interoperability. Since flood monitoring is by nature very interdisciplinary (with each discipline using different standards), interoperability is a challenge. Some standards used are:

- Open Geospatial Consortium
  - WMS: web mapping
  - WFS, KML: geospatial features
  - Sensor Web Enabling: sensor time series (query, task, discover)
  - WPS: web processing service
- GRIB: multi-dimensional dataset, mostly used for meteorological data
- HDF: multi-dimensional dataset, mostly used for remote sensing
- Web services or API (XML or json)

Question: what interoperability standards are supported by your system?

7. PARTICIPANTS

Scientific community (11)

- G. Robert Brakenridge, Colorado University, Director of Flood Observatory, G.Robert.Brakenridge@Dartmouth.EDU
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