European Commission

JRC TECHNICAL REPORTS

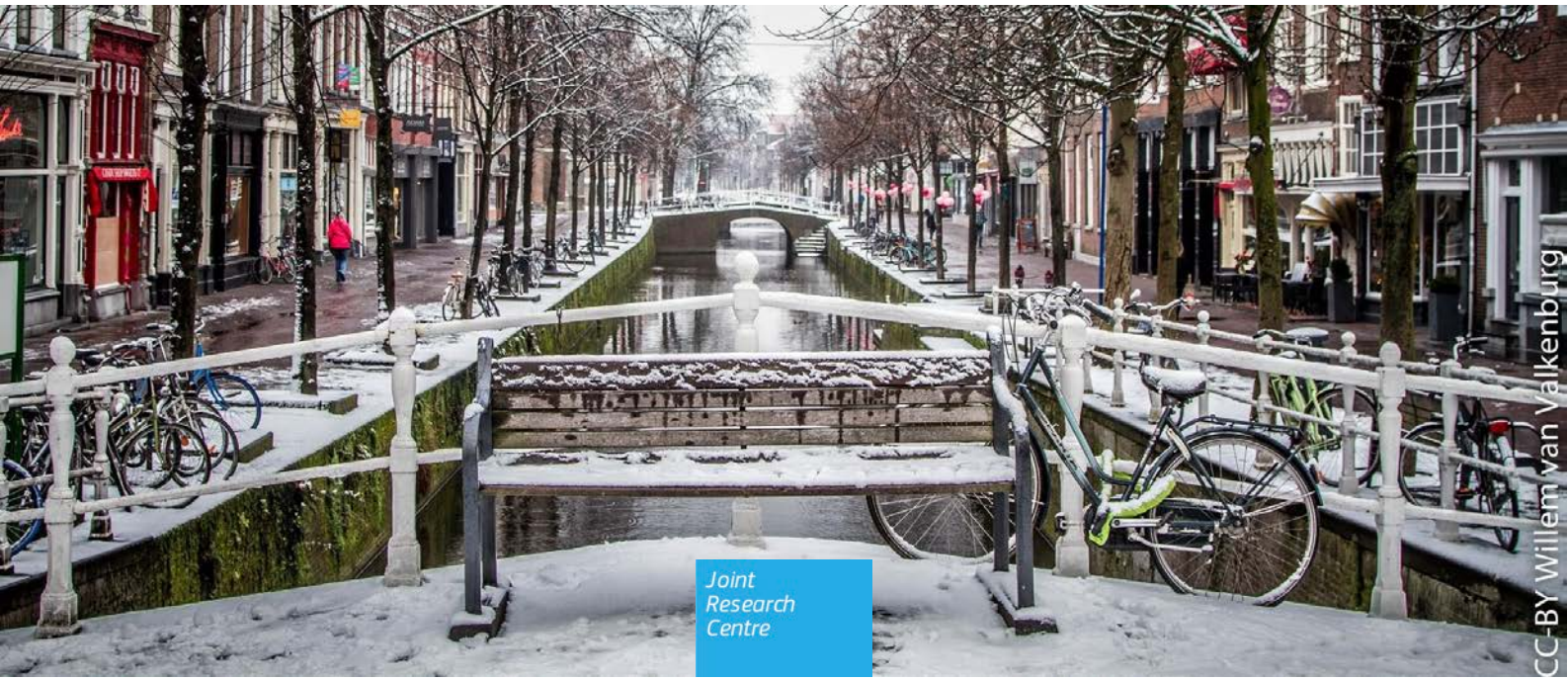
The Global Flood Partnership Annual Meeting 2018

Bridging the gap between science and users

GFP global flood partnership

Salamon P., Kettner A., Coughlan de Perez, E., Rudari R., Trigg M., Weerts A., Cohen S., Prados A., Wu H., Schumann G., Ward P., Neal J., Bernhofen M., Livesey D., Alfieri L., Bhardwaj A., Prudhomme C., Nelson J., Ficchì A., Bevington J., Tavakoly A., Brakenridge R., Galantowicz J., Matgen P., Winsemius H., Green D., Glasscoe M., Schultz L.

2018



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JRC113100

PDF ISBN: 978-92-79-93665-4 doi:10.2760/05644

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How to cite this report: Salamon P., Kettner A., Coughlan de Perez, E., Rudari R., Trigg M., Weerts A., Cohen S., Prados A., Wu H., Schumann G., Ward P., Neal J., Bernhofen M., Livesey D., Alfieri L., Bhardwaj A., Prudhomme C., Nelson J., Ficchì A., Bevington J., Tavakoly A., Brakenridge R., Galantowicz J., Matgen P., Winsemius H., Green D., Glasscoe M., Schultz L.; The Global Flood Partnership Annual Meeting 2018 - Bridging the gap between science and users; European Commission, Ispra, 2018, ISBN 978-92-79-93665-4, doi:10.2760/05644, PUBSY No. JRC113100

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Acknowledgements

The Global Flood Partnership conference 2018 was hosted and sponsored by Deltares. We would like to acknowledge Deltares, the contributions from the conference participants and their organizations, and especially the logistic and organisational support provided by Aashish Bhardwaj from Deltares.

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1. Introduction

The Global Flood Partnership (GFP) Conference 2018 was held June 25 - 27 2018, at Deltares in Delft, the Netherlands. More than 100 participants attended the conference coming from 29 different countries of 5 continents. They represented 70 institutions including international organisations, the private sector, national authorities, universities, governmental research agencies and non-profit organisations.

The organising committee of the 2018 conference consisted of Albert Kettner (University of Colorado, Dartmouth Flood Observatory), Erin Coughlan de Perez (Red Cross/Red Crescent Climate Center), Lorenzo Alfieri and Peter Salamon (Joint Research Centre of the European Commission), Mark Trigg (University of Leeds), Albrecht Weerts and Aashish Bhardwaj (Deltares), Ana Prados (University of Maryland Baltimore County), Huan Wu (Sun Yat-sen University), Roberto Rudari (CIMA Foundation) and Sagy Cohen (University of Alabama). In addition, Deltares kindly supported on the logistics and with some dedicated funding.

The conference theme was “Bridging the gap between science and users” and participants discussed how to best foster the dialogue between scientists and users and how GFP products and expert knowledge can work in synergy to provide key information to emergency managers at different stages before, during and after severe flooding. The participants had the opportunity to share their latest relevant research and activities through ignite talks, posters, presentations, the GFP market booths, sub-workshops and a table-top exercise. As usual, the advances and success stories of the partnership were reviewed and the next steps to further strengthen the GFP were discussed.

2. Welcome and review of the advances of the GFP

Albrecht Weerts (Deltares and GFP steering committee member) as well as Jaap Kwadijk (Director of Science at Deltares) welcomed all participants on the opening day of the GFP meeting. Jaap Kwadijk provided a general introduction of Deltares, its support and work with global tools and the most recent scientific challenges that Deltares is facing regarding flood risk management.

Peter Salamon (Joint Research Centre, European Commission and current chair of the GFP steering committee) provided an overview of the GFP's advances since the previous annual conference. He reminded the participants of the history and the principal objective of the GFP, which is *"to establish a partnership for global flood forecasting, monitoring and impact assessment to strengthen preparedness and response and to reduce global flood disaster losses"*.

The GFP has been very active since the last annual meeting in 2017 which is also reflected in the increasing number of participants of the GFP mailing list. The mailing list contains now more than 350 members including 60 new members since the last GFP 2017 meeting.

Since last annual meeting, the GFP hosted a number of side events at major conferences. Early September 2017, the Disaster Risk Reduction (DRR) across the Americas summit, held in Buenos Aires, Argentina, provided a unique opportunity for a needed joint dialogue and work planning between representatives of the scientific earth observation (EO) and DRR community, including stakeholders in regional preparedness and planning, disaster mitigation, emergency response, and recovery. The meeting focused on connecting the end-to-end flow of data and information from providers to practitioners and end users with specific attention to the social and culture context across the Americas. Albert Kettner (DFO, University of Colorado) chaired a GFP related session focussing specifically on the aspects related to flood risk management.

Also in September 2017, Mark Trigg (University of Leeds) co-chaired a special session at the Seventh International Conference on Flood Management (ICFM7) together with Jeffrey Neal (University of Bristol) and Philip Ward (Vrije Universiteit Amsterdam) with a session entitled "Global Flood Models: From theory to practice". The session explored global flood models and identified and discussed a number of points which are also relevant for the GFP:

- Are these models good enough to be used for real management decisions?
- What scale limitations apply to their application and how do we localize the global outputs to have meaningful local relevance?
- What can we learn from examples where they have been used already?
- How do we improve the physical process representation in the models and what are the data challenges associated with this?
- What level of physical process detail is necessary within the context of the application and data uncertainty?
- With more ready access to the outputs through webtools, does this bring a wider inclusiveness to flood management and therefore an urgency to communication the uncertainty of the outputs to a wider audience?
- As model physics, resolution and computing improve, what are the opportunities for these models to compliment traditional flood modelling?

A number of GFP members attended the American Geophysical Union (AGU) fall meeting, December 11-15, 2017 in New Orleans, USA. Huan Wu (Sun Yat-Sen University and member of the GFP steering committee) convened together with others a session called "Global Floods: Forecasting, Monitoring, Risk Assessment, and Socioeconomic Response",

which looked at how the recent scientific developments in this field can contribute to the aims of the GFP. Furthermore, a number of GFP related presentations were given at this AGU meeting which included:

- Toni Jurlina: NH23E-2803 (poster): Medium range forecasting of Hurricane Harvey flash flooding using ECMWF and social vulnerability data;
- Sagy Cohen: NH23E (poster): Rapid-response flood mapping during Hurricanes Harvey, Irma and Maria by the Global Flood Partnership (GFP);
- Son Nghiem: NH23E-2873 (oral): Hurricanes Harvey and Irma - High-Resolution Flood Mapping and Monitoring from Sentinel SAR with the Depolarization Reduction Algorithm for Global Observations of InundatioN (DRAGON);
- Son Nghiem: NH51D-06 (eLightning): Typhoon Doksuri Flooding in 2017 – High-Resolution Inundation Mapping and Monitoring from Sentinel Satellite SAR Data;
- Mark Trigg: H12C-07 (oral): Validation of individual and aggregate global flood hazard models for two major floods in Africa;
- Nasser Najibi: A43I-2587 (poster): Coupled Land-Atmosphere Dynamics Govern Long Duration Floods: A Pilot Study in Missouri River Basin Using a Bayesian Hierarchical Model;
- Albert Kettner: NH21E-05 (oral): Towards a Flood Severity Index.

Erin Coughlan de Perez (Red Cross/Red Crescent Climate Center and member of the GFP steering committee) organized, together with the International Research Institute for Climate and Society at Columbia University, a GFP side event called “Many small drops make a big flood: Global Flood Partnership” at the Understanding Risk conference in May 2018 in Mexico City, Mexico. The event brought together both developers and users of global flood risk information. The highly interactive event focused on innovation in understanding flood risk and in developing collaborations and partnerships for global flood forecasting, monitoring and impact assessment to strengthen preparedness and response, with the goal to reduce global disaster losses contributing to the Sendai framework.

The event featured a lively debate on the future of global flood modelling, and the importance (or not) of assimilation of local data. Participants reflected on the critical importance of developing mechanisms to assimilate local data into global flood models, while identifying several applications where existing models can already be useful without such assimilation.

Some activities have already been planned for after the GFP 2018 meeting, including another special session at the AGU 2018 fall meeting and considerable contributions from GFP members for an AGU Geophysical Monograph Series on “Global Drought and Flood Prediction”. Peter Salamon encouraged participants to contact the GFP steering committee for ideas and proposal on where the GFP could contribute.

During the GFP 2016 meeting, it was agreed that in order to ensure a sustainable and successful effort towards the identified strategic objectives of the GFP, there is a need to establish a more mature governance structure for the group in the form of a “Steering Group”. Based on this requirement, the terms of reference[1] were developed and a GFP steering committee was established in March 2017. Since last GFP 2017 meeting two openings have been fulfilled in the steering committee. Robert Brakenridge was replaced by Albert Kettner (both from the Dartmouth Flood Observatory), who also took over the responsibilities of the GFP STC vice chair. Furthermore, Yang Hong, University of Oklahoma, has stepped down and was replaced by Huan Wu, Sun Yat-Sen University. The steering committee is currently composed of the following members:

[1] https://gfp.jrc.ec.europa.eu/sites/default/files/2017-06/SteeringCommittee_Terms_of_Reference_web_version.pdf

Name	Organization
Peter Salamon (Chair)	Joint Research Centre, European Commission
Albert Kettner (Vice Chair)	Dartmouth Flood Observatory, University of Colorado
Roberto Rudari	CIMA Foundation
Mark Trigg	University of Leeds
Huan Wu	Sun Yat-Sen University
Erin Coughlan de Perez	Red Cross Red Crescent Climate Centre
Ana Prados	University of Maryland, Baltimore
Albrecht Weerts	Deltares (Host of the GFP 2018 meeting)
Sagy Cohen	University of Alabama

In March 2018 a paper entitled "A global network for operational flood risk reduction[2]" describing the emerging role of the Global Flood Partnership in supporting emergency operations and in reducing the socio-economic impacts of disasters was published in the journal Environmental Science & Policy. The paper outlines a range of global flood products developed by GFP partners, and how these provide complementary information to support and improve current global flood risk management for large scale catastrophes. Furthermore, the paper discusses existing challenges and ways forward to turn current experimental products into an integrated flood risk management platform to improve rapid access to flood information and increase resilience to flood events at global scale.

Additional in August 2018 a paper "Assisting Flood Disaster Response with Earth Observation Data and Products: A Critical Assessment[3]" was published in the Remote Sensing journal. The paper reviews flood related products and services that currently exist to deliver actionable information about ongoing flood disasters to emergency response operations. It also discusses requirements, challenges and perspectives for improving operational assistance during flood disaster using satellite remote sensing products.

To better integrate global flood products into emergency response and to improve the link to end users, the GFP 2018 conference included for the first time a table-top exercise. The exercise aimed at stimulating discussions and feedbacks for global flood risk products in a simulated emergency response. The outcomes were not only useful for the developers of global flood products but will also serve to establish a GFP support service in the future.

Finally with 26 oral presentations, about 30 posters, 4 sub-workshops, a marketplace and various discussion sessions the GFP 2018 conferences presented a unique opportunity to foster the scientific development of global flood risk management tools, introduce recent

[2] Lorenzo Alfieri, Sagy Cohen, John Galantowicz, Guy J-P. Schumann, Mark A. Trigg, Ervin Zsoter, Christel Prudhomme, Andrew Kruczkiewicz, Erin Coughlan de Perez, Zachary Flamig, Roberto Rudari, Huan Wu, Robert F. Adler, Robert G. Brakenridge, Albert Kettner, Albrecht Weerts, Patrick Matgen, Saiful A.K.M Islam, Tom de Groeve, Peter Salamon, A global network for operational flood risk reduction, Environmental Science & Policy, Volume 84, 2018, Pages 149-158, ISSN 1462-9011, https://doi.org/10.1016/j.envsci.2018.03.014.

[3] Schumann, G.J.P., Brakenridge, G.R., Kettner, A.J., Rashid, K., and Niebuhr, E., 2018. Assisting Flood Disaster Response with Earth Observation Data and Products: A Critical Assessment. Remote Sensing, 10, 1230. DOI: 10.23390/rs10081230.

developments, establish networks and collaborations, and bridge the gap between scientists and end-user for global flood risk management tools.

3. Workshop outcomes

3.1 Global Flood Hazard and Risk Mapping

Workshop conveners: Mark Trigg (University of Leeds), Guy Schumann (RSS/CU Boulder/University of Bristol), Philip Ward (Vrije Universiteit Amsterdam), Jeff Neal (University of Bristol); Rapporteurs: Mark Bernhofen, Duncan Livesey

Introduction

There was a short introduction provided by Mark Trigg highlighting the theme of GFP 2018, "bridging the gap between users and science" and how as part of this theme the workshop would focus on "sharing and comparing user stories".

The aim of the workshop was to jointly define user stories for global flood hazard and risk mapping. This will help providers understand what they need to know about the people that use their outputs, and help users understand what they need to know about the products that they could use.

Mark Trigg then explained the concept of a user story, which focuses on four specific aspects:

- Who are the users?
- What do they do?
- What information and data do they need?
- How will they use the data?

Activity 1: Writing your own user story

Participants were given 10 minutes to write user stories. Some examples of user stories include:

- *An agricultural insurance employee* who wants to develop an index-based crop insurance program. They need historical flood maps to assess viability and use it to "sell" to stakeholders. They also need near real time flood data to serve as the payout trigger. Additional, they need to know how the risk for agricultural flooding will change in future.
- *An insurance underwriter* who wants to analyse a purchased flood model to identify model failure and calibrate using DFO maps.
- *An insurance company employee* who wants to evaluate the exposure to flood risk in areas where there are no local flood maps.
- *A manager in an insurance company* in China who needs a flood depth map that has already considered protection levels. The manager needs this to determine the insurance rate.
- *A reinsurance company* that does not have its own flood model so needs flood model output to help assess whether the company allocates sufficient capital.
- *An insurance underwriter for smaller company* needs to evaluate new policies. His IT underwriting system needs to return information such that he can directly understand e.g. size, location, and other relevant info of a flood event.
- *A civilian* who is looking to decide about where to build a home at a given location and checks flood maps to make sure that the property is not at risk of flooding.
- *A model developer* wants to validate a flood model.
- *A FEMA employee* who is experienced in GIS and wants to provide daily maps for relief action and needs to evaluate products in light of scarce data but wants efficient & effective deployment of personnel & resources.
- *An NGO head* who needs to decide which regions to prioritize for resource allocation. Needs flood maps integrated with other critical information such as infrastructure, flood duration, population, erosive action, and impact.

- *A GIS analyst* who wants to easily work with flood data of ongoing events (preferably in shapefile format).
- *A watershed manager* who wants to use historic flood maps to improve HEC-RAS based flash flood alerts so early warning evacuations are more successful.
- *A regional planner* of a flood prone country which has insufficient flood protection wants to find out the required minimal height of dykes for the future given climate change.
- *A tourist expert* who wants to understand which coastal / tourist locations have higher flood risk in future to help with planning tourism / business.
- *A social housing officer* in a developing country who wants to know whether it is appropriate to build at a certain location, how often might the location flood and if they can protect this area at a low cost.
- *An urban planner* who wants to build in deltaic areas. Needs flood maps of certain return period to place critical infrastructure outside of the flood-prone areas.
- *A local member of the zoning board* who wants to update their flood plain maps, rezone areas, and make decisions regarding construction.
- *A building inspector* who issues building permissions needs flood risk maps for the region to determine the risk of inundation of future property to help him decide whether to grant permissions or not.
- *Someone who works at allocating flood mitigation funds* needs to know which areas are at risk of fluvial flooding for a range of return periods and wants to know which Global Flood Model (GFM) to use for a certain area/region. Using this data resource can then be allocated.
- *A politician* with no experience with flood risk is responsible for allocating funds to reduce flood risk. He/she needs probability hazard maps and Gross Domestic Product (GDP) estimates to decide the level of funding available to reduce flood risk for certain areas.
- *A technical expert in the Ministry of Finance in Kenya* who needs an estimation of exposed GDP to floods for policy considerations. GFMs are a good tool but Nairobi (which accounts for 25% of Kenyan GDP) is not included in GFM hazard maps.
- *A representative for National Platform for Disaster risk reduction (DRR)* of a country who needs to know how risk is changing over time so that they can monitor progress towards reaching targets of the Sendai Framework.

Activity 2: Discussion of user stories

Participants were organized into discussion groups based on the broad category of their chosen user. Each group discussed the needs of their users and what they might expect from the data. In addition, similarities and differences between participant's stories were discussed. User discussion groups and key discussion outcomes are listed below:

Category 1: Insurance

- Need clarity on model structure
- Need information on how data is produced
- There needs to be some consistent way of evaluating and validating datasets
- Any gaps in the data need to be specifically mentioned
- Need information on flood protection
- Data availability and accessibility is problematic in certain countries

Category 2: Humanitarian/GIS analysts

- Some GIS users may have a lot of skill but limited computing power. They are time and resource limited. Need to provide computing capabilities
- NGOs: resource limited but want long term data
- Military: need data fast but are less worried about data quality.

Category 3: Agricultural insurance

- Need flood maps to determine who can be paid by insurance
- Need flood maps that are consistent with historical maps
- Need flood maps that account for seasonal cycle
- Need to account for climate change

Category 4: Planning

- Timescale: short term planning (social housing)
- Needs a quick map that is understandable. User will likely have little experience with flooding
- Credibility and accountability. To what degree are you accountable as a provider?
- How much is the user interested in the data structure used and the modelling chain?

Category 5: Policy makers

- Different users with different prior knowledge
- Different scales depending on the user
- What they have in common is they need to know what and where to invest in
- Do the users know what datasets are available and the limitations of the data?
- Not a flood modeller so are less familiar with all details of a flood model (for example, spatial and temporal limitations, processes incorporated, used input data).

Category 2: Insurance CAT Risk Manager

- Don't have a full probabilistic model
- Flood risk scientist needs to inform the manager about model setup and modelling limitations

Activity 3: Writing a story for a user who should NOT be using the global data (inappropriate users)

Participants were asked to come up with users who might like to use global data but that should NOT be using this data. Some examples of inappropriate users are listed below:

- *Farmers*: The scale we are working on is global and not at the farmer's level.
- *Flood response*: some flood response users expect too much from global datasets. E.g. Dartmouth Flood Observatory data for any event globally, including for example flash flooding.
- *Users with unrealistic expectations:* some users should take time better understanding model simulations (attend training) to manage their expectations of the data.
- *Military rebel groups*: South Sudan military groups use flood data to plan their operations. Some data may fall into the wrong hands.
- *Specific engineers:* hydraulic structures are often not captured by global data. Those users who rely on such structures should not use flood models that don't represent them.
- *Developers or politicians* who make decisions based on the absence of flood hazard according to global flood models.
- *Insurance underwriters* who use global flood maps as the sole source of information.
- *Local pressure groups* aiming to challenge national flood maps locally.
- Users who are only interested in data at a local level.
- *Disaster risk coordinators* (e.g. Army/FEMA) in a small catchment area.

- *Large-Scale developing country* that is looking for a quick solution to a lack of local data.

Activity 4: Examples of real User Stories

Two speakers were asked to share their own user stories or experience of users.

David Maréchal (re)insurance broker

- Help clients identify and manage risk
- Develops flood risk models in countries where they don't have them
- Chooses one model provider
- How can he assess the quality of those maps given the difficulty in changing the maps that he is using?

Working with Users: Phillip Ward

User stories and experiences highlight the limitations of models but they are also a good way for both the user and developer to manage expectations and understand caveats and strengths of products, services and models.

- Using the GLOFRIS GFM in Nigeria to develop a national flood risk management plan.
- User needs risk at provincial or subnational level.
- 3 days of work for GLOFRIS developers. Producing outputs of affected people (maps). These maps are used for stakeholder engagement.
- User comes back and indicates they need to see how many people will be affected by floods of different depths.
- This is an additional couple of weeks work for GLOFRIS developers. Need maps of people affected by different flood depths. Maps to be used in discussions of where to prioritise risk reduction.
- User asks can you use this data to identify where to build dams and dykes and how to build them?
- This can NOT be done using global models
- Another question often directed by the user is what is the uncertainty of the results?

Conclusion

Mark Trigg summarised the outcomes and made concluding remarks about the importance and usefulness of user stories.

3.2 Global Flood Forecasting

Workshop conveners: Albrecht Weerts (Deltares), Lorenzo Alfieri (EC Joint Research Center), Christel Prudhomme (ECMWF), Jim Nelson (Brigham Young University); **Rapporteurs:** Andrea Ficchi, John Bevington, Ahmad Tavakoly

The workshop participants were grouped into 3 groups, to foster the discussion. Each group was requested to discuss about 3 questions and plenary report back at the end. A summary of the discussion is reported below.

Inventory of the systems: What global (and not global) flood forecasting systems are currently available?

A number of large-scale flood forecasting systems were discussed in the workshop, including global systema (University of Tokyo system – under development- , GloFAS, GFMS and GLOFFIS), quasi global systems (ERDC-Steamflow Prediction Tool and the BYU system), and other local or regional systems (flood forecasting model for the region of Santa Caterina in Brazil, and another country wide system in Brazil, for hydropower production).

What are the current gaps and main challenges in global flood forecasting?

- Data availability: including historic data available at gauging stations, reliable DEMs, access to local data, and efficiency in data collection.
- Model assumptions and limitations: Reservoirs and major dams are difficult to model, levees system and hydropower production, local scale data is often difficult to obtain.
- Model calibration, performance evaluation, including accuracy and uncertainty: often, no or few data are available for model calibration in large data-scarce regions (e.g. sub-Saharan Africa) and only a few flood events can be available for validation;
- Effective communication along the flood forecasting workflow: Need for products training, feedback, emergency drills, good communication strategies, building trust in the information received and investigating best communication technologies.
- Link with decision makers and to local information: think about how the information will get to the local public and provide locally relevant information.
- Lack of continuity to maintain and improve an efficient system.
- Provide relevant information for users: Need for more information on the impacts, so flood maps, flood duration, river flow thresholds, and river levels, rather than just river discharges.

Possible solutions

A number of possible solutions were proposed, though with precaution and not finalized, highlighting that some gaps will remain until better approaches and procedures are developed and new data and technologies become available. Among the points mentioned by the participants are:

- Travel to different continents, get feedback and develop new courses for users, and invite relevant end-users to the GFP;
- Implement systems with contingency plans to use the information operationally,
- Provide model skill scores, including social scores;
- Transparency (e.g., independent comparisons);
- More focus on data standards and interoperability;
- Provide loss and damage estimation, rather than just flood hazard.

3.3 Global Satellite-based Flood Monitoring

Workshop conveners: Sagy Cohen (University of Alabama), Robert Brakenridge (Dartmouth Flood Observatory), John Galantowicz (Atmospheric and Environmental Research), Patrick Matgen (Luxembourg Institute of Science and Technology)

Using the seismological community as an example, we had a discussion about whether a remote sensing-based global flood observatory was possible and needed.

Co-chair Brakenridge posed this question: "What are our present capabilities, and what is needed to bring a truly operational, automated, satellite- and model-based flood *Prediction, Detection, Measurement, Mapping, and Recording* system into existence, to serve a global community?

The question in effect asks: "What would this kind of Global Flood Observatory actually be, what would it look like?" Rather than our first alarm of major flood events coming only from media reports, or from people in any way, can we envision automated systems that accomplish these functions?

Responses included…

1) The idea of course appealed to many; the potential value was understood, but…

2) No "business model" was put forward. Robert Brakenridge stated this is what we need to discuss (the logistics). David Green commented that he felt this would be premature: first really spell out why it is needed. In other words, GFP partners might be quite ready to just see this as our next steps, but he felt, instead, we really need to not just show it is technically possible, but why it is needed. So this is a "to be done" for GFP, if participants want to pursue.

3) Sagy Cohen pointed out that prediction maybe does not belong to such a system. It makes the suite of capabilities too all inclusive, too complicated. GFP members of course are interested in forecasting and prediction, but the actual capabilities now ready to be made operational, and unique to this group, are those listed above but excluding prediction.
This idea may be more congruent with the overall objective, and more feasible too: a flood observatory could observe: detect and measure and record…just as seismological stations observe and measure.

4) So the idea might be to create a consortium of the data producers? The consortium would maintain a kind of "integration facility" to produce the automated data product: for alerts, measurement, and monitoring, at the least. A place where these different alert detection automated processes can be sent to, and where they can be vetted and a high quality real time final product provided to the GFP and public?

5) Peter Salamon expressed concern: "GFP is working, do we need this? Seems like embarking on a grand project, when what we are already doing needs to be continued, expanded perhaps, but is already showing good outcomes." Maybe he is right. Is there really any critical need to integrate such different data processing systems in this hard-wired way? Or if there is, is GFP the right framework to accomplish such?

6) Co-chair Robert Brakenridge ended with a suggestion: perhaps what could happen is a small group of people here at GFP, creating and operating already these automated systems, could join together, voluntarily and demonstrate via a pilot product what is possible. By GFP meeting, next year? We have the components, can we move forward to assemble them?

3.4 Defining Guidelines & Capacity Building Needs for Global Flood Risk Management

Workshop conveners: Ana Prados (University of Maryland, Baltimore), Hessel Winsemius (Deltares)

The workshop began with a statement of three challenges to be addressed. Each challenge was addressed by a separate group. The task for each group was to come up with concrete action items that could be pursued within the next year. Groups were urged to keep the following questions in mind: 1) What action is feasible to achieve within one year?, 2) who should implement the action?, and 3) when would be the best opportunity to implement the action?

The aim of the workshop was not to identify actual data and service needs, but actions for identifying those needs.

Group 1: There is a desire for a feedback mechanism from end-users on capacity building needs

- It is important to acknowledge the different levels of capacity building (human, institutional, contextual)
- Systematically collect feedback from end-users after they receive data from data developers. This could help identify barriers to data use. This action could be taken on a regular basis, but it is particularly relevant during flooding events.

Group 2: There is a desire for a feedback mechanism from end-users on data and service needs

- To enable end-user feedback, create a platform for existing data, tools, and models, paying attention to transparency regarding the characteristics and assumptions behind the data and models.
- Organize meetings for sector of end-users, together with the insurance industry, and develop a table of available data tailored to specific end-users. Good venues for the GFP to engage with end-users: 1) the bi-annual Understanding Risk conference (https://understandrisk.org/); 2) Institute of Risk Managers (FIRMA) annual meeting (insurance companies, brokers, clients).

Group 3: The need to involve end-users in the development of flooding tools

- A common theme across all three groups was to identify a vehicle for sharing of experiences working with end-users within the GFP community.
- There was discussion regarding the difficulty in attracting end-users to the GFP meeting, and how to make the meetings more user-centric.
- Have a cohort of volunteers within the GFP community (GFP ambassadors) that attend end-user meetings representing the GFP and report back. The GFP could help provide a list of meetings. Examples included CEMADEN (https://www.cemaden.gov.br/) and UNISDR (https://www.unisdr.org/we/inform/events) meetings.

4 Table-top exercise

Exercise lead: Guy Schumann (RSS/CU Boulder/University of Bristol), David Green (NASA)

Exercise material: Margaret Glasscoe, Lori Schulz (NASA)

Overview

The exercise was a ***simulated emergency*** in which players carry out actions that would be expected of them in a real emergency. The aim of the exercise was to enable collaboration between organizations and test response and recovery capabilities and tools.

Objectives

- **Foster collaboration and learning** between data providers, emergency managers, decision makers and responders.
- **Simulate a disaster scenario** in order to test participants' ability to adapt to rapidly changing conditions.
- Demonstrate how (Earth Observation and) Global Flood Partnership products can support Emergency Management/Emergency Response/Disaster Risk Reduction by **providing timely, actionable and relevant products and tools to improve decision making**.

Exercise

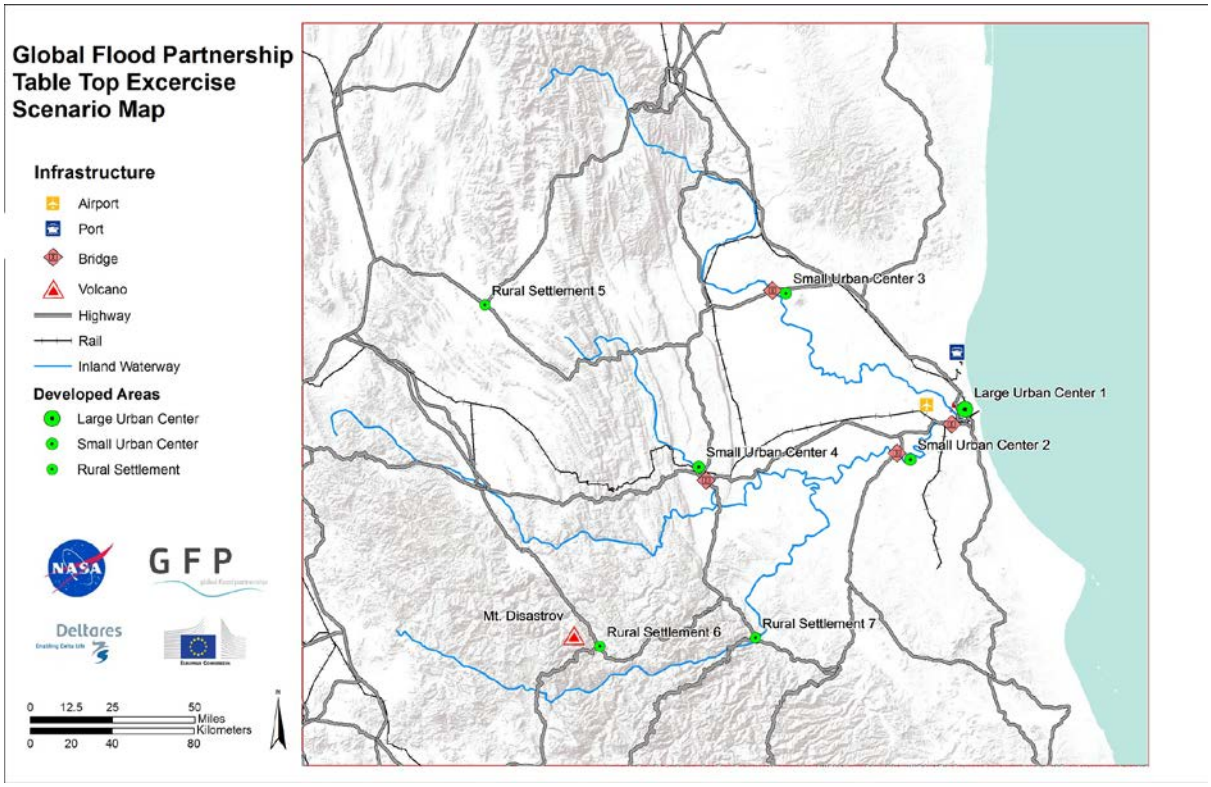


Figure 1: Infrastructure features for the Disastrov region provided to the table-top exercise participants.

Six teams were created, including members from multiple communities:

- Data providers
- End-users

- Commercial partners
- NGOs
- Government/operational agencies

The exercise director and facilitators were assisting with: answering questions, motivating discussion, and offering alternative thought processes.

The exercise took place in the region *Disastrov* (see Figure 1) which is fictive region, composed out of different topographical features (low lying coastal regions, mountains, volcano, rivers) as well as a number of potentially exposed assets such as cities and infrastructure features (airport, roads, dams, railway lines, etc.).

The exercise was divided into three stages: 1.) storm early warning phase; 2.) Storm landfall; 3.) extensive flooding. A detailed timeline of the exercise stages is illustrated in Figure 2. At each stage the teams were given certain information (e.g. early warning information in stage 1, more precise forecasts in phase 2, etc.). The teams had to use the information, provide potentially new information from their global tools and make specific decisions such as when and how to inform the public, evacuate a specific location or respond to specific requests from the emergency response agency of Disastrov.

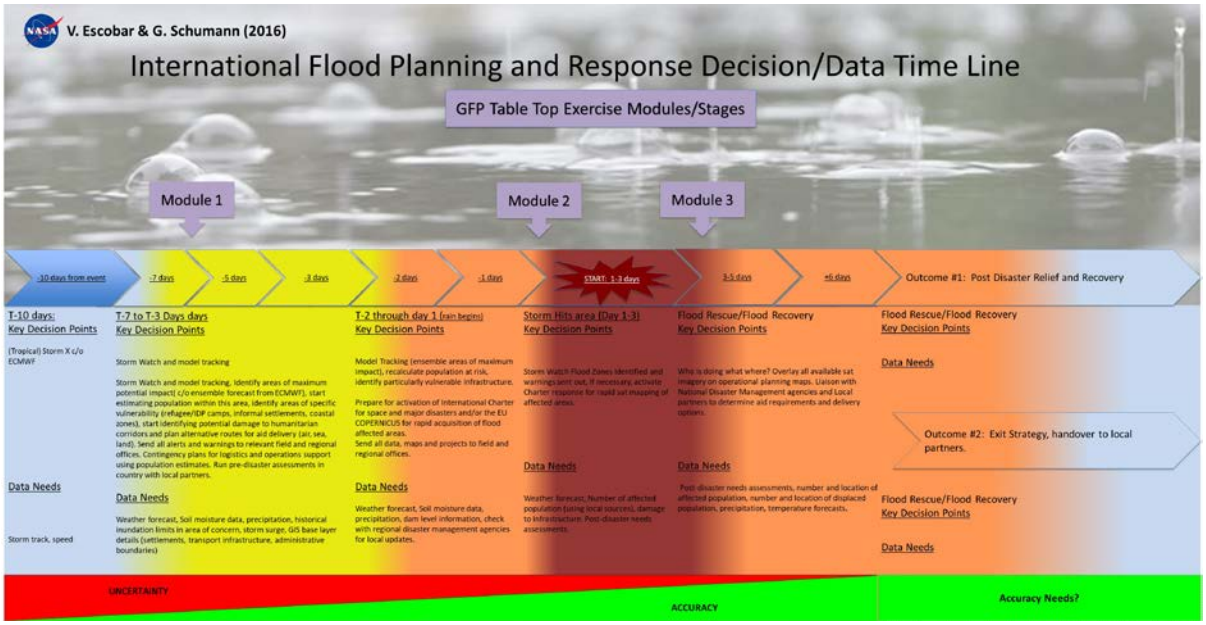


Figure 2: Timeline of the simulated event for the table-top exercise

Discussion after the exercise

After the exercise, everyone was asked to think collectively about a set of pre-defined questions:

1. For the data providers in the group, what specific data products do you make, create, or know about and who are the potential end-users for these products?
2. For the data providers in the group, how specifically would you deliver the data product that you listed to the end-users?
3. For the end-users in the group, what are your specific data needs and what data formats do you require or prefer?
4. How can GFP improve data delivery to end-users?

5. How well does data interpretation and data integration work with existing decision support system and workflows?
6. What data accessibility issues have the group identified in the past as a data provider or user? E.g. Proprietary/open source data or software.
7. When do they need what data and when do they provide data? What is the temporal latency and what is the need from the user side (before, during and after the disaster).
8. How do you think you can better foster collaborative relationships between data providers and end-users?
9. What are some specific actions between now and the next GFP meeting?

The most important common points raised when discussing the above questions and the outcome of the exercise are captured below:

- At the first stage it is mandatory to get information about the past and present situation. Providers can support with:
    - Global and regional forecast. Identifying possible scenarios
    - Hazards/risk maps
    - Historical records from previous events
    - Social media historical data
    - Information about the uncertainty of the models and the data

  Uncertainty in the information made it difficult for the users to actually request more information or to use it.
- At the second and third stage of the exercise the information requested changed:
    - Risk maps change to flood maps
    - Real time observation maps (here: flood extent) are very important
    - Monitoring of the affected area

  This information is needed in order to take decisions, activate evacuation plans and/or to define the evacuation routes.

A second important point during the discussion concerned the interaction between the data providers and the end-users. The main common points raised were:

- A focus on **impact** is required. Currently most of the products are focused on hazards, but users require mostly impact information hence linking vulnerability and exposure with the hazard.
- The users usually have information about the hazards, but are lacking information about **exposure in real time**. Especially focussed in particular areas: infrastructure and population.
- **Uncertainty and probability**. Most users want a concrete and precise answer; they don't like to deal with uncertainties. Although, there is not a proper way to manage this issue, one solution is to educate the users in these issues.
- **Maps production**. More intuitive and easier to understand products should be developed. This could include more intuitive symbols or various scales for a faster interpretation. Keep it simple!
- **Relation quality-time**. It is needed to pay more attention to the quality of the information over the quality of the map, especially in emergency situations, when the products developed are crucial for making decision.

- The value of information in an emergency depends on timing. Information arriving late can be useless. Keep a close communication with the end-user to ensure that information and products are delivered when required most.

A third point extensively discussed was the way to deliver products to the end-user. The main points raised were:

- **Standardization.** In the market there are several providers that manage a wide quantity of products. For a specific situation the users have to interpret different products. Reach out and work together with Open Geospatial Consortium (OGC) or other communities that work on standardization of geospatial data.
- **Interpretation.** The products should be clear and easy to understand. It is needed to simplify the language used, think about the end-users.
- **Communication**. Instruct the end-users how to use a product. In emergency situations digital platforms can be difficult to handle or have access to. Many users therefore request printed maps. Inform the user about the production process and expected delivery times of products.
- **Detail.** Some users demand details about the data sets and the procedures used. It is recommended to keep in touch with the users, for delivering the proper product. Keep in mind the needs and expectations of the users.
- **Data:** If required, provide the user also with the actual data as sometimes the user might want to create an individual product for a very specific purpose. Provide support for the interpretation of data.

5 Discussion: GFP support service

Discussion lead: Peter Salamon (EC Joint Research Center) **Rapporteur:** Lorenzo Alfieri (EC Joint Research Center)

One way to better link to end users and to receive their feedback on global flood risk models is the establishment of a GFP helpdesk or support service. In practice this has already been performed in an informal way as GFP participants sometimes request information about a forecasted or ongoing flood event and receive a wealth of information about this event, based on the different tools developed by the GFP participants. Examples are the "GFP activations" for the South Asia floods, or Hurricane Harvey of August 2017 that caused severe flooding in Texas and have been described in a recent paper[2] and presented at poster[4] (see Figure 3). The aim of this discussion was to agree with the participants on a way forward to better implement and structure GFP activations and how to transform them into a GFP support service in the future.

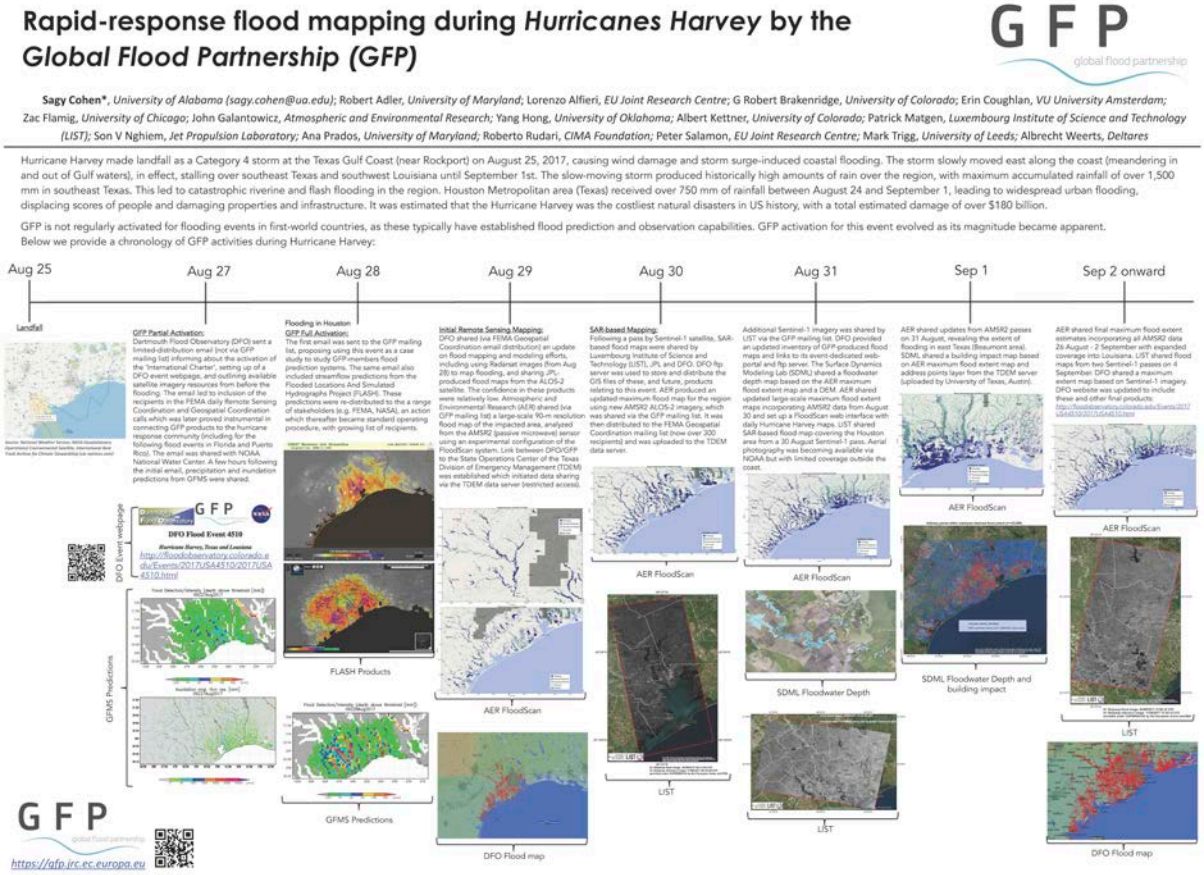


Figure 3: Rapid-response flood mapping during Hurricanes Harvey, Irma and Maria by the Global Flood Partnership (Cohen et al., 2017)

Peter Salamon presented two possible options on how to better structure the GFP support service:

[4] Cohen, S.; Alfieri, L.; Brakenridge, G. R.; Coughlan, E.; Galantowicz, J. F.; Hong, Y.; Kettner, A.; Nghiem, S. V.; Prados, A. I.; Rudari, R.; Salamon, P.; Trigg, M.; Weerts, A. (2017) Rapid-response flood mapping during Hurricanes Harvey, Irma and Maria by the Global Flood Partnership (GFP), AGU Fall Meeting Abstracts, http://adsabs.harvard.edu/abs/2017AGUFMNH23E2822C .

1.) The first option consisted in the already existing global-flood-working-group mailing list[5] which represents an easy and flexible way to request information about a flood event. The mailing list has the advantages that GFP participants do not have to register somewhere else for the support service and that everyone is aware of the information shared through email. The disadvantages are that information has no specific structure and can sometimes be difficult to retrieve, especially when the email subject has been changed or has no relation with an event, or that big data files cannot be shared via email. Furthermore, the information received on a flood event is not very structured (e.g. into forecast products, monitoring products, impacts, etc.) which makes it likely for users to overlook some of the information or e.g. difficult to make a post-event analysis.

2.) The second option consisted in the Global Flood Observatory (GFO). The GFO was developed by the JRC in 2015 as an outcome of the discussions of the GFP kick-off meeting in 2014 with the aim to pool expert flood monitoring and forecasting resources into a collective, collaborative platform to provide near real-time flood information. The system aims at expanding the current methodology of the Dartmouth Flood Observatory, maintaining the same procedures and quality assurance, but sharing the workload of registering flood events with interested organizations. The observatory provides a unique identifier for each flood, a detailed location including flood extent/impacted area polygon, context information and impact information (see for example Figure 2). Once flood events are recorded in the platform they are published on the Global Disaster Alerting Coordination System GDACS[6] website. Currently, the GFO is used only by the JRC.

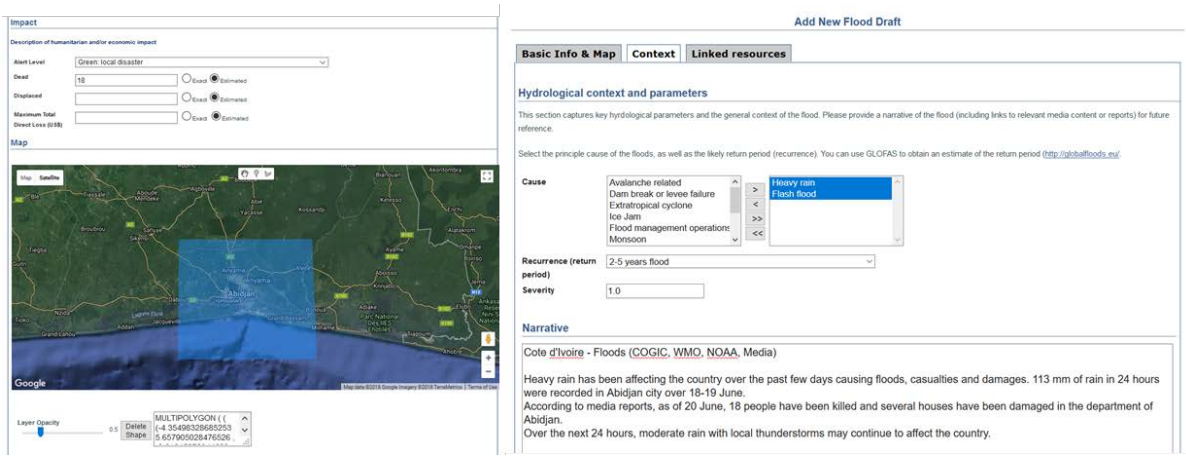


Figure 4: Sample screenshots of the Global Flood Observatory platform

The flood events recorded in the GFO are well structured, have a minimum set of metadata (e.g. unique identifier, detailed location, etc.) and the information is published on GDACS. This allows for a very quick overview of available information on a flood event. The disadvantages are that participants have to request access to the editor interface in order to be able to contribute information, and the system requires a basic training to better understand its functionalities. The platform does not allow the upload of all data types and has limited storage capacity. Furthermore, as not all of the GFP participants check the GDACS website on a regular basis, there is a high risk that participants are unware that the GFP support service has been triggered for an event.

[5] https://gfp.jrc.ec.europa.eu/contatc-us

[6] http://gdacs.org/

After the presentation participants were organized in four groups and each group was asked to (i) discuss the two existing options, (ii) propose a possible 3rd option, and (iii) to propose three important improvements to any of the options. The groups were then asked to report back on their discussions.

The proposed improvements and possible 3rd option can be grouped into three areas:

Better data sharing during a GFP activation

- Use of the Humanitarian Data Exchange platform[7] to better share data
- Make more products downloadable (not just screenshots) and stored on users' own platform (also on the cloud) with a download link (to avoid big attachments)
- Use the Hydroshare[8] project to better share data
- Use and promote common file formats (NetCDF and shapefiles)

Improve communication during a GFP activation

- Use an RSS feed to show the flow of information
- Set up a demonstrator and connect to a third party software to advertise the activities
- Use twitter and social media to promote the GFP support service and the activation of the support service
- Increase the users of the mailing list
- Create a discussion forum or chat especially for feedback on products
- Use the same email subject throughout an activation – email subject should have a fixed structure
- Use Microsoft teams, Trello or similar project platforms for managing an activation of the GFP support service

Better structuring of the information for a GFP activation

- Link data to metadata and geotags
- Tag replies to better classify events and make them easier to find
- Archive products and the links to the relevant emails

After the four groups had reported back suggested improvements and potential additional ways on how to better structure the GFP support service, participants were asked to vote which of the different options would be their preferred solution if all of the proposed improvements had been implemented. The majority of the participants voted for the GFP mailing list and its improvements as best option to better implement and structure the GFP support service.

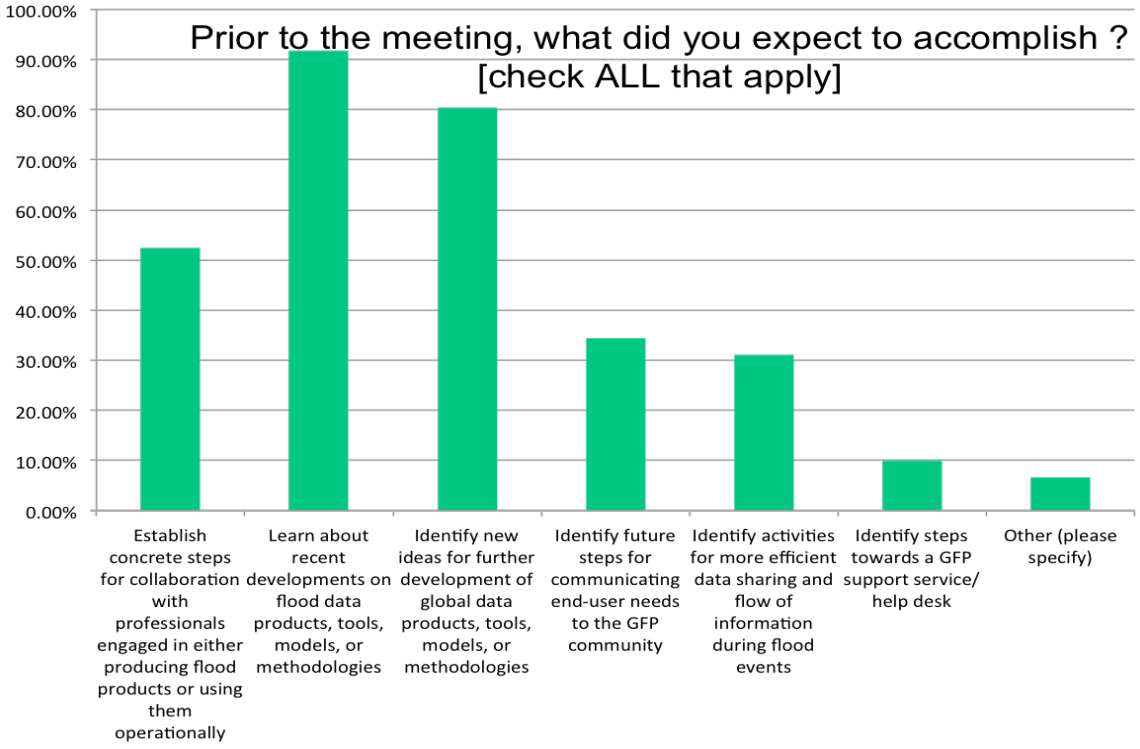
[7] http://data.humdata.org/

[8] https://www.hydroshare.org/

6 Participant survey of the GFP 2018 meeting

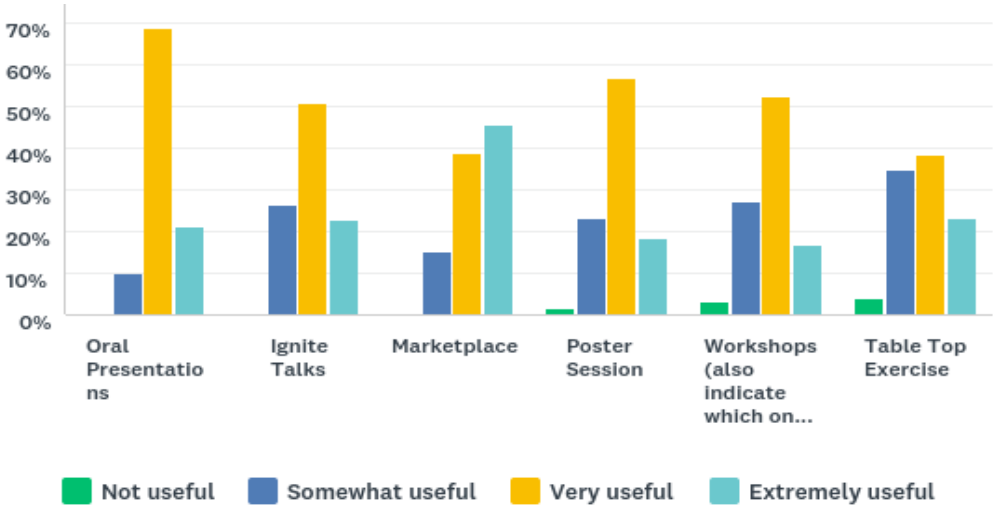
A survey was sent to all conference participants on the second day of the conference. A total of 61 participants completed the survey. Nearly 74% of the participants were affiliated with a research institution (modeling, forecasting, or other work related to flooding), 13% with operations (managing or supporting flood preparedness, risk assessment, response, or recovery), 6% with program/project management, and 7% with other types of institutions, including the insurance sector.

When participants were asked what they expected to accomplish at the GFP conference, the top two answers were 1) to learn about recent developments, and 2) identify new ideas for future development of flood data products, tools, models, or methodologies. 50% of participants indicated they were seeking to establish concrete steps for collaboration.



In terms of their overall assessment of the conference, all except one respondent indicated the conference either met their expectations (62%) or exceeded their expectations (36%).

Attendees were also asked to rate the conference components in terms of their usefulness. Oral presentations and the marketplace where particularly popular, and the marketplace received the highest weighted average, with 85% of survey respondents indicating that they found it very or extremely useful. Among survey respondents, the workshop attendance distribution was global flood hazard and risk mapping (57%), global flood forecasting (37%), global satellite-based flood monitoring (59%), and defining guidelines for capacity building needs for global flood risk management (30%).



To learn more about which topics participants would like to see covered at future conferences, the survey included a list (see table below) of possible options. 'Risk assessment' and 'Hands-on session on how to handle uncertainty/limitations in flood information' received the most positive responses.

What topics would you like to see covered at future GFP conference(s) [check ALL that apply]

Answer Choices	Responses	
Global flood monitoring	55.74%	34
Urban flood monitoring	44.26%	27
Flood modeling	49.18%	30
Flood data and tools for disaster response	57.38%	35
Risk Assessment	65.57%	40
Hands-on session on data and model output for flood applications	39.34%	24
Hands-on session on how to handle uncertainty/limitations in flood information	63.93%	39
Other (please specify)	19.67%	12
	Answered	**61**
	Skipped	**0**

Finally, the survey requested ideas for activities to help increase GFP conference attendance. There was much discussion about this topic during the conference, especially on how the GFP could attract more end-users. Responses included:

- Reaching out to additional communities, such as organizations working on coastal flooding, disaster risk, commercial software developers, etc.
- Increase the visibility of the GFP by representing the GFP at scientific and end-user conferences, and engaging current and past GFP conference participants in this process; develop flyers or brochures about the GFP that can be handed out at conferences.
- A special issue on the GFP in a hydrology journal.
- Providing sessions, side events, or workshops tailored to end-users.
- Communicating to end-users the relevance of the conference, and conducting demonstrations of concrete use of scientific data products in real-world scenarios.

7 Conclusions and recommendations for next steps

The GFP Annual Meeting 2018 set a record in participation with more than 100 participants. With numerous presentations, posters, workshops, a marketplace, and several group discussions including, for the first time a table-top exercise the GFP 2018 fostered the scientific development of global flood risk management tools and attempted to bridge the gap between scientists and end-users. Progress has been made throughout the year to achieve the objectives set out in previous meetings. Some challenges remain and new action items to further evolve and strengthen the GFP were discussed during the meeting. The list below summarizes the key actions that the GFP and its participants will try to address in the coming year:

Better linking to end users:

- Continue to engage with end users. This should be done by organising GFP workshops and sessions at related conferences or by addressing specific user groups at their meetings (e.g. insurance, humanitarian organizations).
- Develop user stories. User stories and experiences highlight the limitations of models & data, but they are also a good way for both the user and developer to manage expectations and understand caveats and strengths of products, services and models.
- Continue to invite and, where possible, support the end user participation at the GFP annual meetings
- Systematically collect feedback. Set up a system to collect feedback from user of global flood model products to help improve those products.

Improving global flood risk models:

- Provide transparency on global models including descriptions of model and data used, skill scores and model comparisons.
- Promote data standards and interoperability. Several providers manage a large quantity of products with sometimes different formats which can make interpretation by the user challenging. The GFP should reach out and work together with OGC or other communities working on standardization.
- Focus on impact rather than just hazard. Currently most of the products are focused on hazards, but users require mostly impact information hence linking vulnerability and exposure with the hazard.
- Uncertainty and probability. Most users want a concrete and precise answer; they don't like to deal with uncertainties. Although, there is no a proper way to manage this issue, one solution is to educate and train the users in these issues.
- Improve product usability. More intuitive and easier to understand products should be developed. This could include more intuitive symbols, simplified languages or various scales for a faster interpretation.
- The quality-time relationship. The value of information in an emergency depends on the timing. Information arriving late can be useless. Keep in close communication with the end-user to ensure that information and products are delivered when required most.
- Communication. Instruct the end-users how to use the product. In emergency situations digital platforms can be difficult to handle or access is limited. A lot of users therefore request printed maps. Inform the user about the production process and expected delivery times of products.

Better promoting the GFP and its added value:

- Establish a GFP Support Service. The support service should foster the testing and further development of new global food risk tools and represent the link to end users. The support service should include a data exchange platform and a system to collect feedback on products.

- Provide a generic GFP presentation for promotion purposes and develop flyers or brochures about the GFP that can be handed out at conferences.
- A special issue on the GFP in a hydrology journal .

Appendix

Conference agenda:

Day 1: 25 June 2018
Chair: Peter Salamon, JRC

Time	Topic	
8:30 - 9:00	**Registration** *Location: Delta Plaza - Main Building*	
9:00 – 9:30	**Welcome & Introduction** Chairs GFP: Peter Salamon (JRC) & Albrecht Weerts (Deltares) *Location: Colloquium - Main Building*	
9:30 – 10:30	**Ignite Talks: Global Flood Partnership in Action** (see program below) *Location: Colloquium - Main Building*	5 min each
10:30 – 12:30	**Coffee break & GFP Marketplace** Find out about new programs, tools & ideas and discuss at the marketplace! List of market booths can be found in the program below. *Location: Delta Plaza - Main Building*	

12:30– 14:00: Lunch break and Poster session
Location: Delta Plaza - Main Building

14:00– 15:00	**Presentations – Session 1** *Location: Colloquium - Main Building*	**Speakers**
14:00 – 14:20	The application of high resolution satellite derived soil moisture for flood prediction and estimation	Jaap Schellekens, VanderSat
14:20 – 14:40	A first collective validation of global fluvial flood models for major floods in Nigeria and Mozambique	Mark Bernhofen, University of Leeds
14:40 - 15:00	Comparison of flood footprints and insurance claims data - case study Germany 2013	Katherine Wenigmann, Allianz SE
15:00 – 15:30	**Poster Ignite Session**	
15:30 – 16:00	**Poster session & Coffee break** *Location: Delta Plaza - Main Building*	
16:00 – 17:30	**Workshop:** ***Global flood hazard and risk mapping*** Chair: Mark Trigg, Guy Schumann, Philip Ward, Jeff Neal *Location: Colloquium - Main Building*	**Workshop:** ***Global flood forecasting*** Chair: Albrecht Weerts, Lorenzo Alfieri, Christel Prudhomme, Jim Nelson *Location: Pavilijoen*

Day 2: 26 June 2018
Chair: Sagy Cohen, University of Alabama

Time	Topic	
9:00 – 10:20	**Presentations – Session 2** *Location: Colloquium - Main Building*	**Speakers**
9:00 – 9:20	SmartFlood - A Web service for large-scale, high-resolution, index-based flood hazard research: pan-European implementation	Stefano Bagli, GECOsistema
9:20 – 9:40	A global framework for future costs and benefits of river flood protection in urban areas	Phillip Ward, Vrije Universiteit Amsterdam
9:40 – 10:00	The uncertainty in flood wave timing caused by the difference in spatial patterns of precipitation estimations	Huan Wu, Sun Yat-sen University
10:00 - 10:20	Making the GFP agile	David Green, NASA
10:20 – 11:00	**Poster session & Coffee break** *Location: Delta Plaza - Main Building*	
11:00 – 12:30	**Workshop:** ***Global satellite-based flood monitoring*** Chair: Sagy Cohen, Robert Brakenridge, John Galantowicz, Patrick Matgen *Location: Colloquium - Main Building*	**Workshop:** ***Defining guidelines and capacity building needs for global flood risk management*** Chair: Ana Prados, Hessel Winsemius *Location: Pavilijoen*

12:30 – Group photo

Location: Delta Plaza - Main Building

12:30 – 14:00: Lunch break & Posters & Tour of Deltares

Location: Delta Plaza - Main Building

14:00 – 15:30	**Table-top exercise on past flood events** *Location: Colloquium - Main Building and Pavilijoen*
15:30 – 16:00	**Coffee break**

	Location: Delta Plaza - Main Building / Pavilijoen
16:00 – 18:00	**Table-top exercise on past flood events** *Location: Colloquium- Main Building and Pavilijoen*

18:30 Social Dinner - 't Postkantoor, Hippolytusbuurt 14, 2611 HN Delft

Day 3: 27 June 2018
Chair: Albrecht Weerts, Deltares

Time	Topic	
9:00 –10:20	**Presentations – Session 3** *Location: Colloquium - Main Building*	**Speakers**
9:00 - 9:20	New global topography dataset for flood modeling & simulation	Dai Yamazaki, University of Tokyo
9:20 - 9:40	Linking Flood impact Forecasting and Satellite Rapid Mapping in Europe	Francesco Dottori, Joint Research Centre
9:40 - 10:00	Decentralized Coordination and Information Sharing in Flood Early Warning and Response	Vittorio Nespeca, Delft University of Technology
10:00 - 10:20	Utilizing Flood Inundation Observations to Obtain Floodplain Topography in Data-Scarce Regions for use in a Hydrodynamic Model	Apoorva Shastry, Ohio State University
10:20 – 11:00	**Poster session & Coffee break** *Location: Delta Plaza - Main Building*	
11:00 - 11:20	Large Scale Flood Risk Analysis Using New Population Data	Jeff Neal, University of Bristol
11:20 - 11:40	Mapping the impacts of large-scale climate patterns on flood timing and frequency over Sub-Saharan Africa using GloFAS	Andrea Ficchi, University of Reading
11:40 - 12:00	Impacts of climate change on coastal extreme sea-levels	Martin Verlaan, Deltares & TU Delft
12:00 - 12:30	**Discussion: GFP support service/helpdesk** *Location: Colloquium - Main Building*	Peter Salamon, JRC

12:30 – 14:00: Lunch break & Posters & Tour of Deltares

14:00 – 14:40	**Reporting of outcomes from workshops, table top exercise and discussions** *Location: Colloquium - Main Building*	
14:40 – 15:00	**Summary, conclusions, way forward, AOB for the partnership** *Location: Colloquium - Main Building*	Peter Salamon & Albrecht Weerts

15:00	**Closure of the meeting** *Location: Colloquium - Main Building*	

Ignite Talks (25 June 2018 9:30 – 10:30)
Speakers program

#	Time	Title	Speaker
1	9:30 – 9:35	A global network for operational flood risk reduction: The Global Flood Partnership	Lorenzo Alfieri, Joint Research Center
2	9:35 - 9:40	Impact-based flood forecasting	Joost Annegien Deltares
3	9:40 - 9:45	Exploring human response to floods using global satellite data	Johanna Mård, Uppsala University
4	9:45 - 9:50	FwDET-C: Coastal Version of the Floodwater Depth Inundation Tool	Sagy Cohen, University of Alabama
5	9:50 - 9:55	Addressing Compound Floods in Global Flood Modelling	Dirk Eilander, IVM-VU University
6	9:55 - 10:00	A multipurpose flood inundation framework for Europe	Jeison Sosa, University of Bristol
7	10:00 - 10:05	Flood Foresight: A pilot project in the Brahmaputra basin provides flood inundation forecasts in response to the summer 2017 floods	Beatriz Revilla-Romero, JBA Consulting
8	10:05 - 10:10	Community mapping to identify flood risk	Hessel Winsemius, Deltares
9	10:10 - 10:15	A Global Streamflow Forecasting Service Derived from the GloFAS System	Jim Nelson, Brigham Young University
10	10:15 - 10:20	U.S. Hurricane Support by the U.S. Army Engineer Research and Development Center (ERDC)	Ahmad Tavakoly, U.S. Army Engineer Research and Development Center
11	10:20 - 10:25	World Water Atlas	Tiaravanni Hermawan, Deltares
12	10:25 - 10:30	Scoping for the Operation of Agile Urban Adaptation for Secondary Cities of the Global South: Possibilities in Pune, India	Tejas Pathak, IHE Delft

GFP marketplace (25 June 2018 10:30 – 12:30)

Title	Moderators
From forecasting hydrological modelling to impacts	Marcio Moraes, CEMADEN
Cat Modeling for Rapid Loss Assessment at Country Level	Gabriele Coccia,RED - Risk Engineering+Design
Use of online media in flood risk management	Jurjen Wagemaker, FloodTags, Jens de Brujin, IVM-VU

The Global Flood Awareness System	Peter Salamon, JRC Ervin Zsoter, Christel Prudhomme, ECMWF
NASA Disasters program	David Green, NASA
Global Flood Analyzer 2.0	Hessel Winsemius, Deltares
GEOGLOWS - Global Streamflow Forecasting Pilot	Jim Nelson, Brigham Young University
Applied Research and Development at U.S. Army Corps of Engineers	Mark Wahl, U.S. Army Engineer Research and Development Center
Flood forecast mapping at scale using simulation library approaches	John Bevington, JBA Consulting
Dartmouth Flood Observatory - Web Map Services	Robert Brakenridge, University of Colorado
HASARD on GPOD	Patrick Matgen, Luxembourg Institute of Science and Technology
Satellite derived soil moisture for flood applications	Mendy van der Vliet, VanderSat
FloodScan: Daily near-real-time and historical flood mapping	John Galantowicz, Atmospheric and Environmental Research
Map your flood!	Beth Tellman, Cloud to Street

Poster program

Title	Presenter
Flood Hazard Mapping Combining Hydrodynamic Modeling and Multi Annual Remote Sensing data	Leon Orotta, VSO-NEPAL
Flood monitoring and mitigation in Pakistan using optical and microwave remote sensing data	Yaseen Muhammad, University of the Punjab
Simulating DEMs for flood models	Laurence Hawker, University of Bristol
Floods in a warmer world - learning from the past	Paolo Scussolini, Vrije Universiteit Amsterdam
Coupling large-scale flood models for improved flood hazard simulations	Jannis Hoch, Utrecht University
The dynamic exposure of urban land and population to fluvial floods in China	Shiqiang Du, VU Amsterdam

Global Flood Detection and Monitoring Using Social Media	Jens de Bruijn, IVM-VU
NASA Disasters Program & GFP	John Murray, NASA Disasters Program
Remote Sensing Training for Flood Applications	Ana Prados, University of Maryland Baltimore County
Rainfall Erosivity and Its Implication on Land Use and Conservation Planning in Ghana	Samuel Ayodele Mesele, Federal University of Agriculture Abeokuta Nigeria
Updating the Global Flood Map	Yasir Kaheil, FM Global
Flood risk and willingness to pay for flood risk control among agricultural households in low- and middle-income countries	Stephen Frimpong, University of Wyoming
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KJ-06-18-080-EN-N

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doi:10.2760/05644

ISBN 978-92-79-93665-4