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The Global Flood Partnership Annual Meeting 2019

GFP global flood partnership

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Contents

Acknowledgements 1
1 Introduction 2
2 Welcome and review of the advances of the GFP 4
3 Conference outcomes 5
3.1 Ignite talks 5
3.2 Presentations 5
3.2.1 Flood modelling 5
3.2.2 Urban flooding 6
3.2.3 Risk assessment, flood management, and the human dimension 7
3.2.4 Flood forecasting and monitoring systems and their application 8
3.2.5 Uncertainty 9
3.2.6 Flood inputs: precipitation, DEM 9
3.3 GFP Marketplace 10
3.4 Guided Tour of the Guangdong Emergency Management Agency 13
3.5 Interactive session: GFP User Panel 14
3.6 Discussion on the GFP Support Service 15
4 Participant survey of the GFP 2019 meeting 16
5 Conclusions 18
Annexes 19
Annex 1. Conference Agenda 19

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1 Introduction

The Global Flood Partnership Conference (GFP) 2019 was held from June 11 to 14 in Guangzhou, China. It was the first time that the GFP annual meeting was not located either in Europe or the US with the aim to strengthen the links to the relevant community in Asia. The conference was hosted by the Hydrometeorological Extremes Simulation Group (HENG) led by Dr. Huan Wu, Sun Yat-Sen University (SYSU). 110 researchers, 11 business representatives, 7 NGO members, and 8 government officers from 14 countries participated to the conference with a total of 136 conference participants. The conference venue was the Ramada Pearl Hotel on the bank of the beautiful Pearl River in Guangzhou.

The 2019 conference was organized by the GFP Steering Committee, local organizers and volunteers:

GFP Steering committee

- Peter Salamon (chair), European Commission, Italy;
- Huan Wu (host), Sun Yat-Sen University, China
- Sagy Cohen, University of Alabama, USA
- Erin Coughlan de Perez, Red Cross Red Crescent Climate Centre, Netherlands
- Albert Kettner, University of Colorado, USA
- Ana Prados, University of Maryland, USA
- Roberto Rudari, CIMA Research Foundation, Italy
- Mark Trigg, University of Leeds, UK
- Albrecht Weerts, Deltares, Netherlands

GFP 2019 Local Organizers:

- Lorenzo Alfieri, European Commission, Italy
- Huan Wu, Sun Yat-sen University, China
- Nergui Nanding, Sun Yat-sen University, China
- Jingjing Zhao, Sun Yat-sen University, China
- Yangyang Ning, Sun Yat-sen University, China

GFP 2019 Local Volunteers (Sun Yat-Sen University):

Weitian Chen, Zequn Huang, Zhijun Huang, Lulu Jiang, Chaoqun Li, Qier Li, Xiaohua Li, Xiaomeng Li, Yongxin Liu, Xinshun Pan, Yuan Wang, Yan Yan, Ming Zhong

Similar to previous years the aim of this year's meeting was to 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, and the GFP market booths. 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

The conference started with an opening remark by Dr. Huan Wu. The Dean of the School of Atmospheric Sciences of SYSU, Dr. Wenjie Dong gave a welcome speech introducing the City of Guangzhou, the SYSU and the School of Atmospheric Sciences School. Dr. Dong particularly emphasized that the SYSU and the School have strived to develop the atmospheric sciences at SYSU and the school faculty has rapidly grown from 18 to 123 faculty within last few years. He also highlighted how the GFP conference could provide the opportunity for researchers and decision makers to collaborate and promote the application flood research.

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".

Since the last annual meeting, the GFP hosted a number of side events at major conferences. This included two GFP related sessions at the American Geophysical Union (AGU) fall meeting, December 10-14, 2017 in Washington D.C., 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. In addition, Philip Ward (Vrije Universiteit Amsterdam) convened a session on Compound and Cascading Events: an emerging challenge for natural hazard risk assessment and management. Furthermore, a number of GFP related presentations were given at this AGU meeting. Finally, the GFP collaborated on a NASA supported international flood risk workshop (1-3 October 2018) in Boulder, Colorado; see also: https://eos.org/meeting-reports/the-push-toward-local-flood-risk-assessment-at-a-global-scale)

In relation to the scientific work that the GFP is supporting, the article from Bernhofen et al.[1] , published in October 2018, was highlighted. It evaluates flood extent for a range of global flood models in Nigeria and Mozambique. In addition, the GFP Support Service has been re-organized into a clearer structure to promote its use. All these ongoing activities since the last meeting are reflected in the increasing number of participants of the GFP mailing list which currently includes about 420 members (70 more since the last GFP 2018 meeting).

[1] Bernhofen, M.V., Whyman, C., Trigg, M.A., Sleigh, P.A., Smith, A.M., Sampson, C.C., Yamazaki, D., Ward, P.J., Rudari, R., Pappenberger, F., Dottori, F., Salamon, P., Winsemius, H.C. (2018) A first collective validation of global fluvial flood models for major floods in Nigeria and Mozambique. Environmental Research Letters, 13 (10), art. no. 104007, DOI: 10.1088/1748-9326/aae014.

3 Conference outcomes

3.1 Ignite talks

Eight presenters spent 5 minutes each to kick off the GFP 2019 conference. The talks are briefly described below.

(1) ARC river flood model: African Risk Capacity (ARC) and its application in sovereign disaster insurance, ARC River Flood Model Risk model (AFM-R), the ARC flood extent depiction (AFED) dataset and the AFM-R & the disaster cycle. Presenter: Johan Vermeulen, African Risk Capacity.

(2) TanDEM-X 90-m DEM for flood predictions: the suitability of this DEM free to download at https://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10378/566_read-426 . Presenter: Laurence Hawker, University of Bristol.

(3) GloFAS: the application as a decision support tool in the Madeira River Crisis Room in South America during the March 2014 flood. Presenter: Marcio Moraes, Cemaden.

(4) Coastal water resources vulnerability: storm surge inundation influences the coastal water resources such as salinization and vegetation through land-ocean interaction. Presenter: Xuan Yu, Sun Yat-sen University.

(5) Flood mapping from Vietnam using sentinel-1 satellite data using the Bayesian probability analysis: for the Mekong delta during June-December (rainy season) to achieve higher flood mapping accuracy. Presenter: Khuong Tran, Capital Normal University & Vietnam.

(6) Real-time monitoring and flood outlook: real-time monitoring and flood outlook, ganges Brahmaputra basin, transboundary floods, application of early warning system. Presenter: Mandira Singh Shrestha, ICIMOD.

(7) Multi-sourced flood inventory in CONUS: a flood event inventory for the TRMM era from in-situ, remote-sensing, and model simulations. Presenter: Zhijun Huang, Sun Yat-Sen University.

(8) Global Flood studies from weather to climate scales: 7 challenges including Global Validation, Precipitation Uncertainty, Global Drainage Networks, Global Calibration, global flood database, urbanization, dam/reservoir, Climate change and LUCC impacts on flood and the uncertainty in the assessment. Presenter: Huan Wu, Sun Yat-Sen University.

3.2 Presentations

The presentations and posters covered a wide range of topics. These topics are grouped into the following 6 groups: flood modelling, urban flood, risk assessment and management, uncertainty, flood model inputs, and flood monitoring systems and their applications

3.2.1 Flood modelling

Flood modeling efforts can be categorized into physical-based models and data-driven models. This conference has drawn presentations of both.

Dennis Lettenmaier provided an overview of the evolution of global flood forecasting. He indicated that much progress has been made during the last decade. The presentation included 3 topics: flood forecast protocols in the developed world (focus on U.S.), the special challenges in the developing world (where GFP is most needed), and where are the gaps, and how can they be closed? The presentation concluded with short-term and long-term opportunities of flood modeling research and application. Questions from the audience included what could be the solution to improve precipitation data and how to address precipitation data quality issues, while merging some of the flood products may provide higher accuracy. There were also comments on adding flood depths, duration, timing, and the economic influence to

current flood models. Dr. Lettenmaier also mentioned the capability to faster process SAR data, which also appears in several other presentations.

Guy Shalev introduced Google's Flood Forecasting Initiative, which aims to achieve scalable high-accuracy high-resolution flood forecasting and warnings globally. Google's hydrological model is a regional hydrologic model utilizing machine learning methods and a high resolution DEM; for example a CONUS-wide calibrated LSTM model has been compared with "traditional" calibrated hydrological models. This presentation emphasized the importance of using the right metrics, minimizing data quality disparity, computational cost, and also result interpretability and uncertainty. The audience raised questions regarding meteorological data as the input of Google's model (currently only IMERG & ECMWF precipitation are used as model input), and about the use of the data (liability and users). Google's model has received strong progression with the India government among others. Currently, the lead time of the model is limited to a few hours with expectation of 2-3 days although the longer the lead time, the less accurate the flood model results are (i.e., the trade-off between accuracy and lead time).

As a SAR-based inundation model, Xinyi Shen introduced a near-real-time flood mapping chain with high spatial-temporal resolution SAR data (2-3 days during events, 10 m spatial resolution). The Radar Produced Inundation Diary (RAPID) is an automated open-flood mapping chain that has been applied to several flooding events, and it has been quantitatively validated and tested over many flood events.

Iuliia Shustikova described the potential of a new levee breaching feature of LISFLOOD-FP (LFP) model for large-scale studies. The Raster-based model LFP is enhanced with full 2D simulations on the large scale (river reach ca. 350km long). The research identified that levee breach modelling with LISFLOOD-FP showed the potential to be a tool for various scales flood simulations and production of the envelope of breaching scenarios for various purposes.

Jiren Li briefly introduced the progress of flood monitoring and assessment by remote sensing in China. The presentation includes China's effort on satellite instruments for flood monitoring. He provided an appropriateness evaluation of remotely sensed data for flood monitoring among many international and domestic satellite images in terms of data suitability (very suitable, generally suitable and not suitable). A flood monitoring & assessment system was also included with several case studies. The other 3 topics are: an economic flood disaster loss evaluation model, the loss rate for different sectors at different water depth, and a monitoring water project for flood control, flood forecasting and risk mapping.

3.2.2 Urban flooding

As a subdomain of flood modeling, urban flood modeling and forecasting has received special attention during the conference. Several presentations and posters reported their research activities.

Due to the limitations of SAR intensity, Patrick Matgen proposed an approach using InSAR coherence for the detection of floodwater in urban areas. InSAR coherence is the normalized cross correlation between images and it is related to the change in the spatial arrangement in time of the scatters within a SAR image pixel. A coherence image is built using 2 images: before and during the flood event. InSAR coherence has shown high potential for mapping floodwater in urban areas (along with evidence provided by other groups working on this topic). This research presented several test cases including Houston (2017), Beledwyne (Somalia, 2018), and Beira (Mozambique, 2019). To address audience questions that double bounce scattering sometimes cannot detect some buildings, Patrick stressed the need to combine both double bounce scattering and vegetation data. He also recommended optical data, very high resolution images and other independent data sets for accuracy assessment.

Min Li presented a holistic urban pluvial flood model consisting of 3 sub-models: runoff generation, surface runoff flow, and sewer flow. This presentation introduced a model that describes the water behaviour once the rainfall falls over the land under certain rainfall conditions using a coarse model (a rainfall-runoff sub-model purely based on hydrological method coupled with a river network sub-model) and a refined model (an overland flow model for build-up area, a pipe network model). The refined

model will be computationally intensive. The coarser model aims to evaluate the flood risk due to rivers and reservoirs, and the refined model can provide flow information in urban areas.

Qian-ming Lu from DHI China argued the future paradigm of urban flooding risk analysis and flood management is smart water management based on Internet and Intelligence, applying Artificial Intelligence (machine learning). The presentation introduced an approach combining SVM and MIKE FLOOD, which does not need DEM for urban flood simulation and thus reduced computation cost from hours to seconds. The real-time inundation detecting using video recognition technology, and pipe network anomaly identification was also presented. The presentation concluded with a framework of cloud platform and big data integrated management. The presenter also explained how other urban models can be linked to MIKE, which is widely used in Chinese cities.

3.2.3 Risk assessment, flood management, and the human dimension

As the largest group of topics, 5 out of 27 presentations were related to flood management and risk assessment.

Shirish Ravan introduced the efforts of flood risk management and preparing for flood emergency response by the United Nations Office for Outer Space Affairs (UNOOSA). He described the Sendai Framework for Disaster Risk Reduction (2015-2030) with 4 priorities for action. Risk information is critical for disaster risk reduction, and invisible risks can be predicted and quantified by satellites. Additionally, the UN-SPIDER Mission statement is to ensure the access to information and technical support, and the example of Myanmar was presented. During major disasters, 50% of satellites images provided pertain to flooding, and therefore the GFP can cooperate with UNOOSA on different areas, e.g., region specific guidelines, recommendations, training, massive online open courses, workshops, etc. He also invited the conference participants to the UN Conference on Space-based Technologies for Disaster Risk Reduction to be held September 11-12, 2019, Beijing. One conference participant asked how to define risk and how to make sure the end users understand risk, and Shirish responded that in addition to the terminology in references, disaster agencies in the UN also meet to make sure end users understand risk and disasters. The GFP community is also encouraged to share and publish reports with UN-SPIDER.

Qiang Zhang presented his findings on the statistical characteristics of global flood disasters and flood-affected population loss. It is concluded that global flood leads to increasing economic losses due to various influencing factors; the increased flood-induced affected people and deaths due to increased flood frequency rather than enhanced flood intensity at global scale; a linkages between topography and occurrences of floods, and the relationship between GDP, population density and flood induced mortality; and the tropical cyclone-induced floods had strong impacts on global flood-related mortality particularly for regions along the west coastal countries.

Integrating human dimension, global change and hydrology, Qiuhong Tang introduced an emerging discipline, Global Change Hydrology. Global Change Hydrology facilitates the understanding and quantifying the human fingerprint in the global water system, where human is at the center of flood. In order to illustrate the human dimension of flooding, the presentation included examples of flood modeling with and without flood control measures. The presenters concluded that understanding human-induced impacts to the global water system is the key mission of Global Change Hydrology. The audience raised several questions such as inundation may not be closely related to human activities (e.g., no irrigation during winter or dry season), and whether the risk of hydro power is more related to precipitation.

Laurence Hawker provides several case studies (cyclone Idai & Kenneth) on how flood forecast information can support effective rapid humanitarian response. The presentation introduced various methods such as reporting exposure figures, communicating probability to users, making recommendations based on dodgy data, and knowing what users want. He also indicated what users didn't want including a load of maps, a detailed discussion of probability, detailed discussion of methods, GIS data, etc.

Zhan Tian proposed an XLRM metric of robust flood decision making theory with the urban flood in Shanghai as the case study. When reducing inundation flood risk, different options are compared with respect to their cost and effectiveness. The conclusion was that there are trade-offs between grey infrastructure and green solutions. Grey infrastructure usually have better protection standards, but have a high level of negative impact on ecology. On the other hand, green solutions are typically effective in managing relatively high return period events, but beneficial to the local environment and ecology and such benefits are very difficult to be measured by monetary value.

3.2.4 Flood forecasting and monitoring systems and their application

Several global flood forecasting and monitoring systems have been presented, either with a focus on their flood products or the system functions.

Bob Adler introduced the Global Flood Monitoring System (GFMS) with Mozambique Cyclone Idai (March 2019) as a case study. He also compared the GFMS results with other products including Floodscan, SAR-based results particularly the SAR product provided by LIST. GFMS utilized DRIVE model to simulate and forecast global flood. A participant asked which model provides the best result because every model has uncertainty. Bob indicated that SAR is the best estimate as of now, but it takes a while to produce SAR data. Although other data (passive satellite remote sensing) may be available 1 day after a flood event, GFMS can provide real-time data. But the latency and accuracy have to be considered, and the integration of multiple flood models would be necessary.

The Global Flood Awareness System (GloFAS) was introduced by Shaun Harrigan. GloFAS was upgraded to version 2 on Nov 14, 2018 with major data assimilation upgrade, many new products such as global calibration of LISFLOOD routing and GloFASv2-ERA5 discharge reanalysis; dataset of reforecasts and reanalysis. The overall ensemble forecast skill of GloFASv2 and spatial distribution of skill have been improved. GloFAS forecasts supported the response during the Malawi & Mozambique floods. Lorenzo Alfieri continued to introduce the road towards GloFAS 3.0. GloFAS has become an operational service of Copernicus EMS since 2018. The ongoing research activities (improvement over v2) are: hydrological reanalysis and initial conditions, streamflow predictions, early flood detection (warning thresholds), and product visualization. Regarding the v3 system, one question was about the rationale for varying the flood thresholds for different forecast ranges. The answer was that it enables improved warning skills in the longer range through better model consistency. Another question related to how to define a flood from the flood data provided, and the presenter indicated that the key of GloFAS is to show how big the event is comparing with historical events. GloFAS is not to warn people because it does not send public alerts. It's up to the users to decide how to use the products, which is complementary to national authorities' decision.

The Dartmouth Flood Observatory (DFO) was introduced by Albert Kettner. DFO archives different types of flood products: satellite, modeling, social media, etc. He indicated that there is an information gap between the location, the flood frequency and duration, versus how many people are affected. Albert proposed a one-stop-shop for all flood products (simulations, observations, near real time and historical data). A web system is constructed for the database jointly by DFO and EU's Joint Research Centre. The audience indicated the issues of different flood data formats and sources related to the one stop flood products, the potential users, and the cloud coverage problem.

Roberto Rudari described an application in the South East Asian (SEA) region of risk financing options (DRIF). A SEA DRIF platform was developed to include 3 modules: risk profile, web interface, near-real-time (NRT) flood analyzer. The project has been running for 1 year, and the challenges are: operation in NRT, geographical scope (full country coverage), reliability and urban areas. e-DRIFT has been developed based on the DIAS to provide added value to EO services. The e-DRIFT is integrated into the SEA DRIF system.

3.2.5 Uncertainty

The uncertainty in flood models and flood products were one of the central topics during the conference. The evaluation, validation, comparison, integration and optimization of flood products are critical for the users and decision makers. Uncertainty has been discussed in various presentations, and this section includes those explicitly related to uncertainty.

Yue Miao provided a quantitative evaluation and inter-comparison of major routed-runoff models and reanalysis using observed streamflow in several river basins in China. The conclusions were: VIC-CN05.1, JRA55, and ERAI/land performed better while MERRA-2 and CLM-NCEP are relatively worse; the simulated streamflow of eight products are better in the upper stream stations and large river basins with abundant water resources; and although large uncertainties exist in the simulated inundation area of eight products, the timing and spatial pattern of the 1998 Yangtze river flood were well simulated.

Qingyun Duan explained his research on hydrological ensemble prediction as a new paradigm in hydrological forecasting. The presentation began with a discussion on uncertainty which results from chaos & butterfly effect, initial conditions, model structure & parameters, and observations. The longer the lead time is, the larger the degree of uncertainty that the models produce. Ensemble forecasts are a set of forecasts generated by perturbing the initial conditions. He presented the Handbook of Hydrometeorological Ensemble Forecasting (eds. Duan et al., 2018, Springer). An ensemble system was illustrated which included modules of ensemble data assimilator, atmospheric ensemble pre-processor, parametric ensemble processor, hydrology and water resources models, and post processing. The presentation showed raw forecasts can be improved tremendously by using different ensemble forecasting methods. An audience asked how to study the source of uncertainty for each model separately during the ensemble process, and one possible solution would be the parametric data assimilation.

Representing Cloud2Street as a startup business, Beth Tellmann raised the question of what flood event map accuracy is required to enable governments, aid agencies and insurance companies to protect vulnerable live and livelihoods? After comparing multiple global flood models (GLOFRIS, JRC, CaMa-Flood, ECMWF, CIMA-UNEP, SSBN), she discussed why confusion matrix widely used in remote sensing may not be the best for flood accuracy evaluation and also discussed other measures such as CSI, Hit Rate, Bias. The presentation emphasized flood data users want daily data at different spatial resolution, need error reports at critical floodable objects (not random samples) because floods are different for different people. Also flood maps need to have 5 characteristics: event accuracy, temporal consistency, spatial resolution, and spatial completeness.

Nergui Nanding discussed their research on error propagation of global precipitation estimation through distributed hydrological modeling. The 2 research objectives were presented: how different factors (e.g., QPE product, temporal scale, climate type and topography) influence the quantitative relationship between the errors in precipitation and the errors in simulated discharge (i.e., P-Q error relationship), and under which circumstance, the errors in precipitation show either amplification or dampening effects in simulated discharge. He concluded that the amplification or dampening of precipitation errors through hydrological modelling depends on QPE products, discharge magnitude, temporal scale and seasons.

3.2.6 Flood inputs: precipitation, DEM

Over 61% of global population is distributed in the global monsoon region, and precipitation change is closely related to floods in this region. Tianjun Zhou discussed his research on projecting precipitation changes over global monsoon regions. The changes in annual mean water cycle include the robust intensification in P, E, P-E and total runoff, and the decreased surface and total soil moisture. The changes in annual cycle of water cycle are enhanced by annual cycle in P, P-E and total runoff dominated by thermodynamic contribution of moisture convergence. Both changes imply increasing flood risks in the monsoon season. The presentation concluded with a take home message "Continued efforts to limit

warming to 1.5°C would bring considerable benefits in terms of minimizing exposures to enhanced water cycle, and precipitation extremes in global land monsoon domain".

High resolution DEM is critical for flood modeling and mapping. Dai Yamazaki introduced his ongoing effort on topography data creation and hydrodynamic model for precise global flood simulation. The MERIT Hydro (global, 3-sec) hydrography data based on the MERIT DEM data has been produced and is available at http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_Hydro. The CaMa-Flood v4 model is under development (will be available soon) with improved topography data (MERIT Hydro) leading to more accurate flood simulation, and v5 is being developed as a global calibrated/validated flood model.

Different flood models use different river size thresholds and thus produce different flood products. To address how the global flood models' river size thresholds affect exposure estimates, Mark Bernhofen presented his research on river size representation in global flood models. The Height Above Nearest Drainage (HAND) terrain model was adopted with MERIT Hydro data as model input. Population exposed to flooding was compared. The presentation's conclusions were: certain country's exposure estimates are more sensitive to river size representation than others, and improving river representation beyond current global flood models limits could incorporate an additional 30% of potential exposed population into the modelling frameworks.

It is difficult to derive flood protection facilities (e.g., levee) from global dataset due to the limitation of temporal and spatial resolution. Tanaka and Yamazaki reported their new algorithm to automatically extract flood protection parameters from global river models and applied it to CONUS. Using the National Levee Database, the high resolution DEM (1/3 sec) and MERIT Hydro as the input data, the presenters developed a 4-step algorithm to extract the parameters. These parameters can be used in global river model, as well as validation data for global estimation of parameters.

3.3 GFP Marketplace

The GFP marketplaces aims at engaging developers and users in direct discussions and feedback on the global flood risk management tools. It allows developers of such tools to provide live demonstrations and the users to ask questions or provide feedback. 5 flood systems and/or applications were demonstrated and some impressions of the marketplace are shown below.

Global Flood Monitoring System (GFMS), Robert Adler, University of Maryland

Map your flood! Beth Tellmann, CloudtoStreet

The ARC River Flood Model (AFM-R), Elke Verbeeten, Africa Risk Capacity

Impact & risk computations based on global models, Roberto Rudari, CIMA Foundation

Copernicus EMS - Global Flood Awareness System (GloFAS). Peter Salamon and Lorenzo Alfieri, Joint Research Centre

3.4 Guided Tour of the Guangdong Emergency Management Agency

56 conference participants registered for the guided tour of the Guangdong Emergency Management Agency (GEMA). They visited the Weather Forecast Center, the Data Center, the Regional Numerical Forecast Key Lab, the Ecology & Weather Center, the Early Warning Distribution Platform, etc. at GEMA. The GEMA staff also introduced the emergency response efforts during storm, flood and urban flood in Southern China.

3.5 Interactive session: GFP User Panel

MT introduced the user panel explaining that this year's interactive user session builds on last year's workshop where we tried to understand who the users of GFP outputs are. The output from last year's session was a series of user stories. This year we are taking it a step further to see what the GFP can do specifically for its users. The user panel was split into two panel sessions. The first session focused on the storm Idai response (November 2019). It included Lawrence Harker (University of Bristol, UK), Peter Salamon (Joint Research Centre, Italy), Patrick Matgen (Luxembourg Institute of Science and Technology, Luxembourg), and Shirish Ravan (United Nations Office for Outer Space Affairs). Idai was chosen as the topic for the first panel as it was a very significant event and a lot of the GFP participants were involved in the response to Ida. The goal of the session was to identify what the vulnerable parts of the system are and what parts of the system worked well. Each panellist reflected on: if you were a data provider, what data did you provide? How was it used? Was it used? Why? If you are a data facilitator, what data were you given? What data was useful?

The second session was more general and was looking at not only a specific emergency but also mapping and any other services that the GFP provides. It included Mandira Singh (ICIMOD, Nepal), Marcio Moraes (Cemaden, Brazil), Elke Verbeeten (African Risk Capacity Agency, South Africa), and Ahmat Younous Abdel Lathif (United Nations World Food Programme, Italy).

Both sessions triggered an interesting discussion with the participants. The key highlights are summarized below:

- Users of data post disaster include a wide range, such as scientists who want to use the data to improve flood map algorithms and models and higher level government agencies (e.g EU) who assess the situation to direct aid or respond at a high level in addition to the aid agencies and government agencies involved in the relief effort on the ground. One user mentioned that we often forget the media, who can use data to raise awareness of issues and increase attention.
- Feedback is rare (most data providers never receive it), and users engaged in relief do not have time for assessments until the situation has calmed down.
- Direct use of global flood risk tools by government agencies on the ground may require prior training and engagement to approve, understand, and be able to use data sources
- "Model fatigue" from so many models, and greater need for comparison and capacity builder so users and navigate
- Need for a common platform (maybe GIS) and clear explanations of what each model does/does not do

3.6 Discussion on the GFP Support Service

Peter Salamon presented the GFP support service and how it was updated since the last meeting. He highlighted again that the service aims at (1) enabling users access to the latest scientific development in global flood risk management tools; and (2) for researchers to obtain a better understanding of the practitioners' needs for future development. The update of the service since the last meeting included a better structuring of the activation of the service and an improved communication of what and how this service work. A dedicated tab on the GFP website is now available that explains all the aspects of the GFP support service (https://gfp.jrc.ec.europa.eu/support-service). Peter Salamon explained that the service can be activated via a simple email to the GFP mailing list (users need to be subscribed to the email list) and showed, as an example, what products and information was shared during the GFP support service for the activation of cyclone Idai in Mozambique.

The presentation was followed by a discussion on how to further improve the GFP support service. The main issues mentioned during the discussion were

- *Creation of an event page:* This would facilitate to see what information has already been sent, how often the service was activated and who has been contributing. It would also facilitate the re-use of data/information submitted for retrospective work. However, there are some technical issues to be considered such as creating an event page where basically all subscribers to the GFP mailing list have editing rights (to add info on their tools and products) is not trivial and would require, as a minimum some authentication system to be added to the web page.
- *Provision of metadata:* It is absolutely essential to provide as much metadata with the submitted data/information during an activation of the GFP support service as possible. Metadata includes information on data formats but also on the limitations of the data/information provided or instructions on how to use it. In addition it was highlighted that data/information providers always shut add a disclaimer (either directly in the email or via a link).
- *Need to promote the GFP Support Service:* It was recognized that this service is highly valuable but needs to be further promoted. Everyone was encouraged to promote the GFP Support Service (and the GFP as a whole) if going on conferences. The promotion activities require the constant engagement of all GFP participants.

4 Participant survey of the GFP 2019 meeting

A survey was sent to all conference participants on the second day of the conference. A total of 40 participants completed the survey. Nearly 80% of the participants were working on flood related research (modeling, forecasting, or other work related to flooding), 7.5% were related to flood risk management operations (managing or supporting flood preparedness, risk assessment, response, or recovery), 10% with program/project management, and 2.5% with other types of activities not directly related to floods. Most of the participants in this year's meeting had participated already in previous GFP meetings (82.5%), are subscribed to the GFP google group (37.5%) or are developing flood data products or tools related to the GFP activities or the GFP Support Service (37.5%).

When participants were asked what they expected to accomplish at the GFP conference, the top three answers were 1) to learn about recent developments on flood data products, tools, models, or methodologies, 2) to identify new ideas for further development of global data products, tools, models, or methodologies, and 3) to establish concrete steps for collaboration with professionals engaged in either producing flood products or using them operationally (see Figure 1). 55% of participants indicated that they would like to identify future steps for better communicating end-user needs. Improving data sharing and information during flood events, identifying steps towards a GFP support service and promoting the participants flood data products, tools, models or methodologies were of lesser importance for the participants.

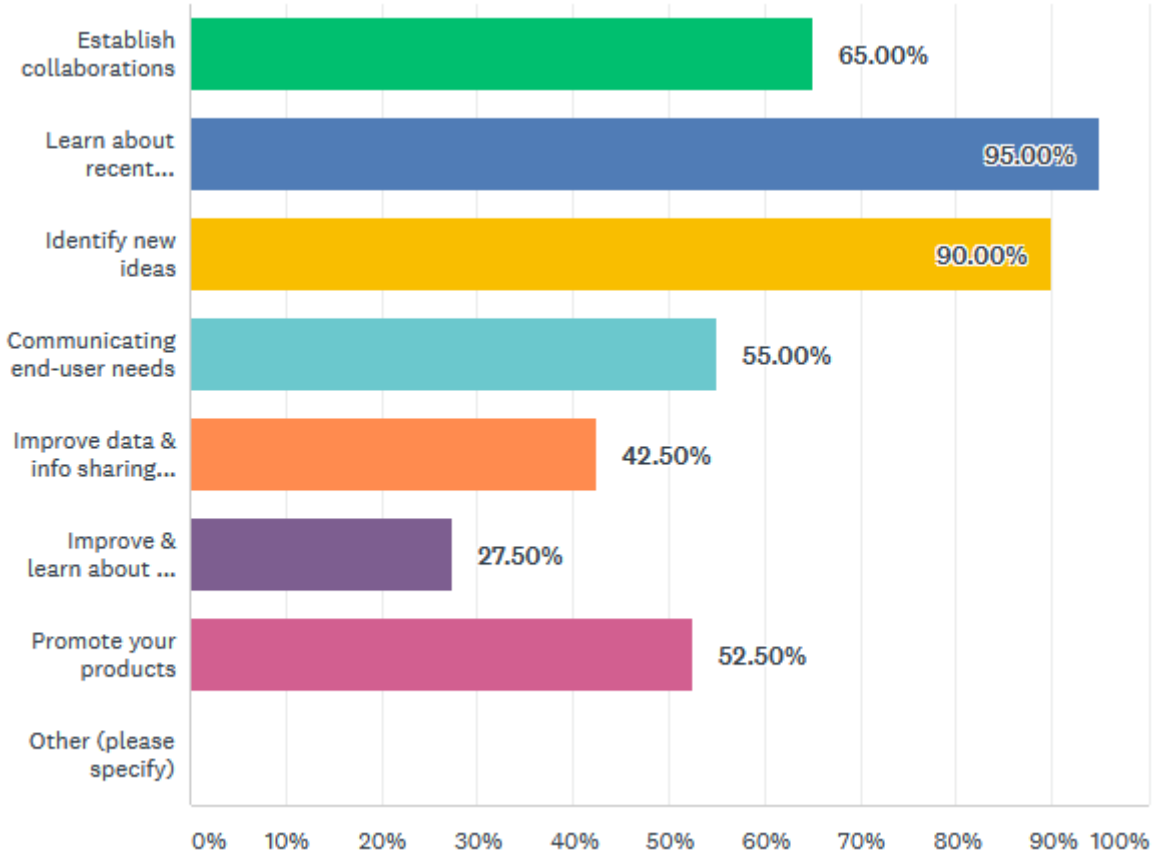

Figure 1 Meeting expectations from the participants

In terms of the overall assessment of the conference, the GFP Annual meeting 2019 met the expectations of 57.5% of respondents and exceeded the expectations of 42.5% of survey respondents.

Attendees were also asked to rate the conference components in terms of their usefulness. Oral presentations, ignite talks, the marketplace and the poster session were particularly popular receiving the highest weighted average. The GFP user panel, the guided tour of the Guangdong Emergency

Management Agency and the GFP Support Service discussions received a more varied reply regarding usefulness but still with 70% or even more of the respondents considering those parts of the meeting as very or extremely useful (see Figure 2).

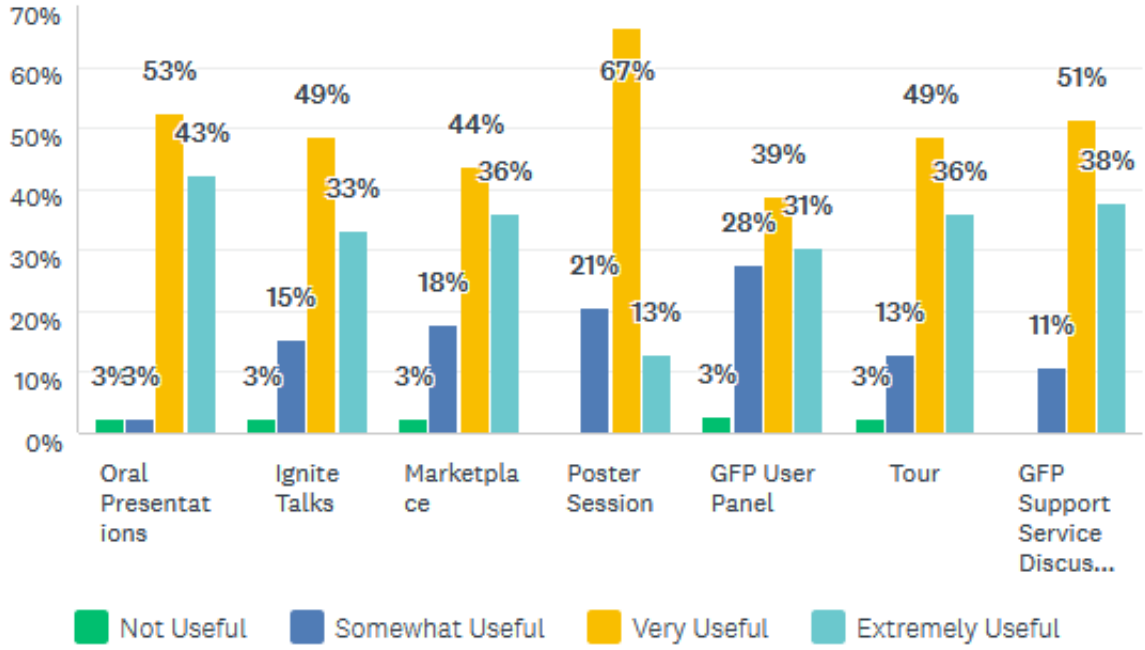

Figure 2 Usefulness of the conference components

When asked about what topics would participants like to see covered at future GFP conference(s) the classical GFP topics such as flood forecasting and modelling (82.5%), global flood monitoring (70%), flood data and tools for risk assessment (65%), and flood risk assessment (62.5%) were ranked highest.

5 Conclusions

For the first time the GFP Annual Meeting was not held either in Europe nor the US. Even though the GFP had not very strong links up to now in Asia, a high number of participants attended the conference. The scientific contributions were at a very high level but, similar to previous years, the GFP needs to continuously work on reaching out better to the users of the global food risk tools. The excellent organization and local support by the Hydrometeorological Extremes Simulation Group (HENG) of the Sun Yat-Sen University and the visit to the Guangdong Emergency Management Agency were considered as highlight by many of the participants, besides the excellent scientific contributions. The challenges and action items that resulted out of the many discussions, presentations and the GFP user panel to further evolve and strengthen the GFP are summarized in a few key points below:

Better linking to end users:

- Continue to engage with end users.
- Users require metadata if developers want their product to be used. This includes technical metadata (e.g. data format) but also other relevant metadata such as underlying limitations and assumptions and how to use (or not use) the data/information.
- User feedback is rare and users engaged in relief actions do usually not have time for assessments until the situation has calmed down. Hence, it is important for the GFP to encourage user feedback (e.g. through creating a user feedback form for the GFP Support Service) or to continue including user based activities such as the GFP User panel of this year or the table top exercise of last years meeting..
- Continue to invite and, where possible, support the end user participation at the GFP annual meetings.

Improving global flood risk models:

- There is a need for model comparison and capacity building to avoid "model fatigue" of users.
- Continue to provide transparency on global models including descriptions of model and data used, skill scores and model comparisons.
- Continue to promote data interoperability and data sharing.

Better promoting the GFP and its added value:

- GFP Support Service: The support service needs to be more promoted as it was recognized as a highly valuable service. GFP participants should be encouraged to promote the GFP support service when going to conferences, workshops and events.
- Better explain on the website what the GFP does and how interested people can participate
- Continue to promote the GFP also throughout the year at conferences, workshops and other events

Annexes

Annex 1. Conference Agenda

Day 1: Tuesday, 11 June 2019

Chair: Peter Salamon, European Commission JRC

Time	Topic	
8:30 - 9:00	**Registration**	
9:00 – 9:30	**Welcome & Introduction** Peter Salamon (JRC) & Huan Wu (SYSU), Welcome by Prof. Wenjie Dong, the Dean of the Atmospheric Sciences School, SYSU	
9:30 - 10:30	Ignite talks 5 minute-presentations Find the detailed program below	
10:30 - 11:00	**Coffee break**	
11:00– 12:20	**Presentations – Session 1**	
11:00 – 11:20	Google's Flood Forecasting Initiative	Guy Shalev, Google Research
11:20 – 11:40	E-SHAPE: Generating a satellite earth observation-derived European wide water bodies and floodwater record (2002 - 2019)	Patrick Matgen, Luxembourg Institute of Science and Technology
11:40 – 12:00	Risk financing against floods: an application leveraging on global models and EO data	Roberto Rudari, CIMA Research Foundation
12:00 – 12:20	Global Flood Analysis and Forecasts Using Satellite Rainfall Coupled with Land Surface and Routing Models—Recent Results	Robert Adler, University of Maryland
12:20– 12:40	**Poster Ignite Session**	

12:40– 14:00: Lunch break and Poster session

14:00– 15:40	**Presentations – Session 2**	
14:00 – 14:20	Bridging Science with Governance through UN-SPIDER for flood risk management and preparing for flood emergency response	Shirish Ravan, UN Office for Outer Space Affairs
14:20 - 14:40	Projection of precipitation changes over global monsoon regions	Tianjun Zhou, Chinese Academy of Sciences
14:40 - 15:00	The use and evaluation of GloFAS for operational flood forecasting	Shaun Harrigan, ECMWF
15:00 - 15:20	Hydrological Ensemble Prediction – A New Paradigm in Hydrological Forecasting	Qingyun Duan, Beijing Normal University
15:20 - 15:40	Flood-induced mortality across the globe: spatiotemporal pattern and influencing factors	Qiang Zhang, Beijing Normal University
15:40 – 16:00	**Coffee break**	
16:00 – 18:00	Coffee break & GFP Marketplace Find out about new software, tools & ideas and discuss them at the marketplace! Check the list of market booths further down in the program	

Day 2: Wednesday, 12 June 2019

Chair: Huan Wu (Sun Yat-sen University)

Time	**Topic**	
9:00 - 10:20	**Presentations – Session 3**	
9:00 – 9:20	Recent advances in topography data and hydrodynamic model for precise global flood simulation	Dai Yamazaki, University of Tokyo
9:20 - 9:40	Some thoughts on the evolution of global flood forecasting	Dennis Lettenmaier, UCLA

9:40 - 10:00	Global Change of Hydrology and Flood Risk in a Changing Environment	Qiuhong Tang, Chinese Academy of Sciences
10:00 - 10:20	A Near-Real-Time Flood Mapping Chain using Synthetic Aperture Radar Imagery	Xinyi Shen, University of Connecticut
10:20 – 10:50	**Poster session & Coffee break**	
10:50 – 12:30	**Presentations – Session 4**	
10:50 - 11:10	Earth observations for flood emergency response and risk reduction	Suju Li, Siquan Yang, Ministry of Emergency Management, China
11:10 - 11:30	Evaluation of routed-runoff from land surface models and reanalysis using observed streamflow in Chinese river basins	Aihui Wang, Chinese Academy of Sciences
11:30 - 11:50	Urban pluvial flood modelling: application study on Beijing	Min Li, China Institute of Water Resources and Hydropower Research
11:50 - 12:10	River size representation in global flood models: a geospatial investigation	Mark Bernhofen, University of Leeds
12:10 - 12:30	The road towards GloFAS 3.0 – recent developments in the Global Flood Awareness System	Lorenzo Alfieri, European Commission, Joint Research Centre

12:30 – 14:00: Lunch break & Poster session

14:00 – 15:30	**Interactive session: GFP User Panel** Composed out of regional/national/local decision makers (e.g. humanitarian aid organizations, NGOs, civil protection authorities, local decision makers) the user panel will describe their current needs and information gaps and, together with all participants, possible solutions or ways forward will be discussed. Organizers: M. Trigg (Univ. of Leeds) & B. Tellmann (CloudtoStreet)

15:30 – 19:00	**Guided tour of the Guangdong Emergency Management Agency (GEMA)**

19:00 Social Dinner - location to be confirmed

Day 3: Thursday, 13 June 2019

Chair: Albert Kettner (University of Colorado)

Time	**Topic**	
9:00 – 10:20	**Presentations – Session 5**	
9:00 - 9:20	What flood event map accuracy is required to enable governments, aid agencies, and insurance companies to protect vulnerable lives and livelihoods?	Beth Tellmann, Cloud2Street
9:20 - 9:40	Error Propagation of Global Precipitation Estimation through Distributed Hydrological Modelling	Nergui Nanding, Sun Yat-sen University
9:40 - 10:00	Progress of flood disaster monitoring and assessment by remote sensing in China	Jiren Li, China Institute of Water Resources and Hydropower Research
10:00 - 10:20	Integrating Global Remote Sensing and Modeling Systems to Support Disaster Relief Agencies	Albert Kettner, DFO
10:20 – 10:50	**Poster session & Coffee break**	
10:50 – 12:30	**Presentations – Session 6**	
10:50 - 11:10	Challenges and opportunities enhancing connection of flood data to anticipatory flood action and flood response	Tanaka, Red Cross Red Crescent Climate Centre - IRI-Columbia University
11:10 - 11:30	A few points on facing the flooding risk analysis and flood management	Qian-ming Lu, DHI China
11:30 - 11:50	Mitigating the Increasing Risks of Urban Flooding in Central Shanghai: Options and Analysis	Zhan Tian, Southern University of Science and Technology

11:50 - 12:10	Potential of a new levee breaching feature of LISFLOOD-FP model for large-scale studies	Iuliia Shustikova, University of Bologna

12:30 – 14:00: Lunch break & Posters

14:00 - 15:00	Discussion: GFP support service and recent GFP activations	Peter Salamon, JRC
15:00 – 15:30	Summary, conclusions, way forward, AOB for the partnership	Peter Salamon & Huan Wu
15:30	Closure of the meeting	

Ignite Talks (11 June 2019 9:30 – 10:30)

#	Time	Title	Speaker
1	**9:30**	ARC River Flood Model	Johan Vermeulen, African Risk Capacity
2	**9:35**	The suitability of the TanDEM-X 90 DEM for flood models	Laurence Hawker, University of Bristol
3	**9:50**	GloFAS in Madeira River Crisis Room	Marcio Moraes, Cemaden
4	**9:55**	Coastal water resources vulnerability to storm surge inundation	Xuan Yu, Sun Yat-sen University
5	**10:00**	Flood Mapping Using Time Series Sentinel-1 Data with A Bayesian Probability Analysis	Khuong Tran, Capital Normal University, Vietnam
6	**10:05**	Real-time monitoring and flood outlook for reduced flood risks in the Ganges Brahmaputra basin	Mandira Singh Shrestha, ICIMOD
7	**10:10**	A Multi-Sourced Flood Inventory in Contiguous United States During TRMM Era	Zhijun Huang, Sun Yat-sen University
8	**10:15**	Global Flood Studies from Weather to Climate Scales: Advancements and Challenges	Huan Wu, Sun Yat-sen University

GFP marketplace (11 June 2019 16:00 – 18:00)

Title	Moderators
The Copernicus EMS - Global Flood Awareness System (GloFAS)	Peter Salamon and Lorenzo Alfieri, Joint Research Centre
Global Flood Monitoring System (GFMS)	Robert Adler, University of Maryland
Map your flood!	Beth Tellmann, CloudtoStreet
Impact and risk computations based on global models	Roberto Rudari, CIMA Research Foundation
The ARC River Flood Model (AFM-R)	Elke Verbeeten, Africa Risk Capacity

Poster program

Title	Presenter
A multidisciplinary approach to develop adaptation strategies to rising coastal flood risk: A case study in Shanghai	Shiqiang Du, Shanghai University
Effect Of Nearshore Structures On Reduction Of Wave Energy Along Different Locations Of Coastline Of Bangladesh	Md. Tawhidur Rahaman, Bangladesh University of Engineering and Technology (BUET)

Hydrological Modeling Of Goranchatbari Storm Water Drainage System Using Storm Water Management Model	Mohammad Shahadat Hossain
Likelihood of concurrent climate extremes and variations over China	Zhiyong Liu, Sun Yat-sen University
Effective and Efficient Calibration of Hydrological Models in Ungauged Basins: Utility of Satellite-based Evapotranspiration Products	Lulu, Jiang, Peking University
Implementing reservoir operation rules in real-time flood forecasting system	Risa Hanazaki, University of Tokyo
Validation and reproducibility of the surface water hydrodynamics by CaMa-Flood ver.4	Megumi Watanabe, University of Tokyo
Global levee height data estimated by model-based approach	Yoshiaki Tanaka, University of Tokyo
Use of global DEMs for pluvial flood modelling.	Victor Olajubu, University of Leeds
A flood inundation hindcast for Europe based on 26-year simulated streamflow	Jeison Sosa, University of Bristol
A Near-Real-Time Flood Mapping Chain using Synthetic Aperture Radar Imagery	Qing Yang and Xinyi Shen, University of Connecticut
Green Infrastructure-Based Drainage Network for Mitigating Flood Risk in Lakes at Woodland Grove Neighborhood	Zhiqioang Deng, Louisiana State University
Developing flood risk maps for India	Naveen Ragu Ramalingam, Aon Impact Forecasting
Urban Flood Modelling	Asheesh Sharma, CSIR National Environmental Engineering Research Institute
Moving towards a Global Flood Model Validation Framework	Mark Trigg, University of Leeds
Error Propagation of Global Precipitation Estimation through Distributed Hydrological Modelling	Nergui Nanding, Sun Yat-sen University
Exposure Analysis of the Flood Risk in Hexi Corridor with SSPs scenarios	Guangxi Zhu, Beijing Normal University
A long-term land surface hydrological fluxes and states dataset for China	Yue Miao, Institute of Atmospheric Physics, Chinese Academy of Sciences
Climatology and Interannual Variability of Floods During the TRMM Era	Yan Yan, Sun Yat-sen University
Uncertainty estimation and improvement of land surface hydrological simulations in China Using land surface model	Jianguo Liu, Huaihua University
Impact of Human Activities on Flood Process in Chabagou Basin of the Loess Plateau	Shuhong Mo, Xi'an University of Technology
China Coastal flood risk in China - Application of DIVA	Jiayi Fang, East China Normal University
Extreme precipitation	Xinshun Pan, Guangdong Meteorological Service
Investigation and Numerical Simulation of Storm Surge of Typhoon 1821	Fumiya Inoue, MS&AD InterRisk Resarch & Consulting, Inc.
A potential bare-earth DEM in urban areas from Global Digital Elevation Models for flood inundation	Yinxue Liu, University of Bristol

Historical and Potential Future Changes of Terrestrial Water Storage from GRACE and Ensemble Model Simulations	Binghao Jia, Institute of Atmospheric Physics, Chinese Academy of Sciences
Hydrologic Modeling as a Service (HMaaS): A new approach to hydrologic modeling	Michael Souffront, Aquaveo, LLC
Evaluation of real-time global flood modeling with satellite surface inundation observations from SMAP	Naijun Zhou, University of Maryland
San Crisanto, a sustainable development project	Jose Ines Loria Palma, Male, Mexico
Global Rapid Flood Mapping with Spaceborne SAR Observations	Sang-Ho Yun, NASA - JPL
Open Data for Resilience Index	Joost Beckers, Deltares
GLOFAS in Madeira River Crisis Room	Marcio Moraes, Cemaden
Potential of a new levee breaching feature of LISFLOOD-FP model for large-scale studies	Iuliia Shustikova, University of Bologna
A global partnership for flood risk reduction	Lorenzo Alfieri, European Commission, Joint Research Centre
A Multi-Sourced Flood Inventory in Contiguous United States	Zhijun Huang, Sun Yat-sen University
Flood Modeling for The Lancang-Mekong River Basin	Jie Wang, CAS
A New Global Hydrography Database at Multiple Spatial Resolutions Based on MERIT DEM and DRT Algorithm	Zequn Huang, Sun Yat-sen University
Fuzzy risk assessment of flash flooding using a cloud-based information diffusion approach	Jiao Wang, Sun Yat-sen University
Study on theory feasibility of decision-making operational intelligent support system for flood forecast in seamless grid service	Wendong Hu, Chengdu University of Information Technology
Flood Forecasting in Ungauged Basin Using Water-Heat Balance Theory and Remote Sensing-Based Distributed Hydrological-Hydrodynamic-Thermodynamic model	Guangyuan Kan, China Institute of Water Resources and Hydropower Research
Study on community resilience to mountain flood	Qian Zhang, Sun Yat-sen University
Discussion on a new method for estimating after floods the spatial distribution of rainfall	Li Xu, Beijing Normal University
A Study on Flood Risk Mapping of a Typical Region in Guangdong-Hong Kong-Macau Greater Bay Area	Zhi Dong, Guangdong Research Institute of Water Resources & Hydropower
Research and Application of Coupled Atmospheric-Hydrological Modeling System on Flood Forecasting	Yan Peng, Guangdong Research Institute of Water Resources and Hydropower
The Probabilistic Flood Prediction Based on Reconstructing Space–Time Variability in Ensemble over the Huaihe Basin	Linna Zhao, Chinese Academy of Meteorological Sciences
Analysis on the Characteristics of Extreme Precipitation in Southwest China	Shaobo Zhang, Chengdu University of Information Technology
Integrating Remote Sensing Data with WRF model for Improve precipitation simulations in China	Wen Xiaohang, Chengdu University of Information Technology

Land Satellite Remote Sensing Application Center, MNR	Shihu Zhao, China Land Remote Sensing Satellite Development and Land Surface/Cover Application
Study on the formation mechanism of urban waterlogging disaster under changing environment	Shanfeng He, Henan Polytechnic University
Study on real-time and dynamic rainstorm flooding analysis system in urban area	Jing Wang, China institute of water resources and hydropower research
Towards high resolution flood monitoring: An integrated methodology using passive microwave brightness temperatures and Sentinel synthetic aperture radar imagery	Ziyue Zeng, Tsinghua University
Study and Practice on Flood Forecast of Three Gorges Reservoir	Peng Li, Three Gorges Cascade Dispatch & Communication Center

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