

Improving flood preparedness with early warning systems



Photo credit: Peruvian Red Cross

Prof Hannah Cloke
University of Reading & Uppsala University

With thanks to Water@Reading, Water@Uppsala, Flooding From Intense Rainfall, Copernicus EMS floods, HEPEX, IMPREX, FATHUM, LANDWISE, Environment Agency & many others



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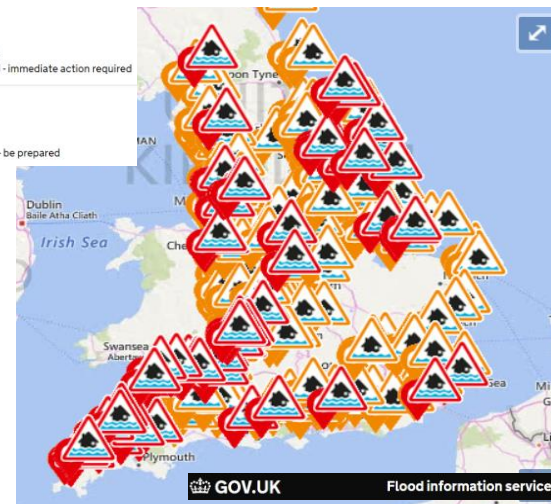
Flood warnings

Flooding is expected - immediate action required

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Flood alerts

Flooding is possible - be prepared



Improving flood forecasting for better flood preparedness



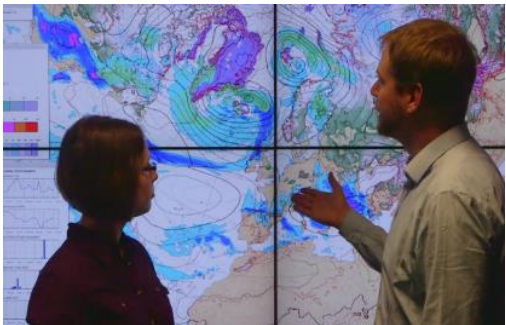
Towards end to end flood forecasting



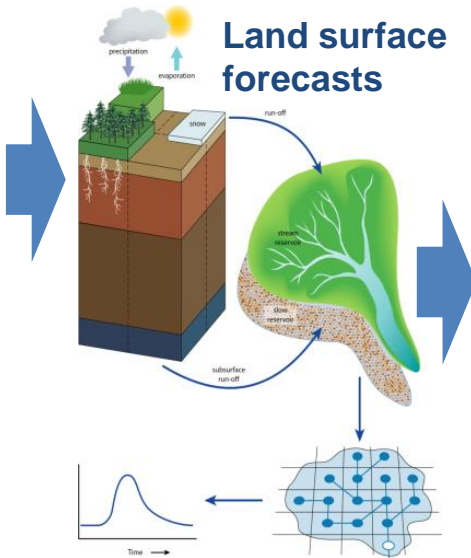
Global weather predictions & earth system models for better flood preparedness



Flood forecasting



Weather forecasts



Land surface forecasts

Warnings



Action



Flash flood forecasting & surface water flood forecasting

“I feel confident saying the universal biggest challenge facing everyone involved in forecasting flooding from intense rainfall is communicating the uncertainties around the location and timing of flood events.”

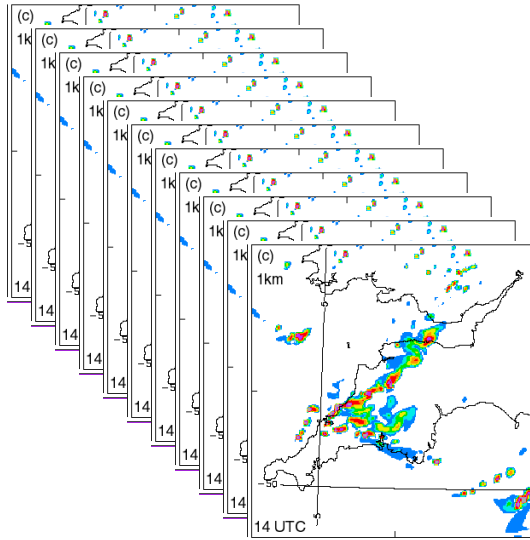
Dr Linda Speight, FFIR researcher





Balance – all important

Computational cost



Beven et al (2015) **Hyperresolution information and hyperresolution ignorance in modelling the hydrology of the land surface.** Science China: Earth Sciences



Flooding from Intense Rainfall 2013-2019



FRANC:

Forecasting Rainfall exploiting new data Assimilation techniques and Novel observations of Convection

SINATRA:

Susceptibility of catchments to INTense RAINfall and flooding

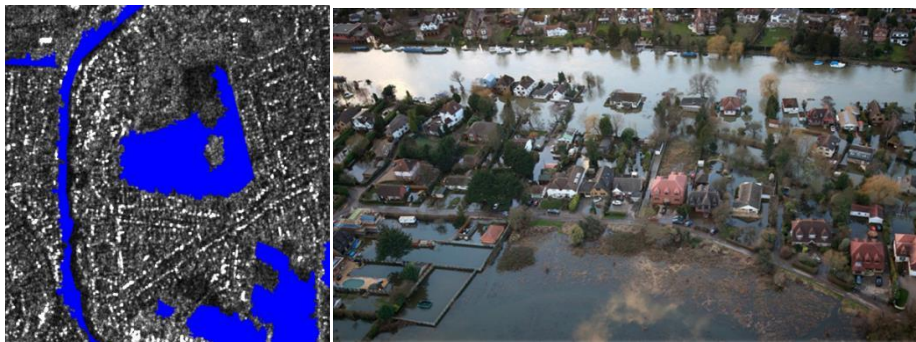


TENDERLY:

Towards END-to End flood forecasting and a tool for Real-time catchment susceptibility



- New methodologies, tools and datasets to identify places susceptible to flash flooding.
- Improved weather forecasts for intense rainfall through improvements to radar-rainfall methods, data assimilation and better understanding of probabilistic forecasts.
- New techniques for monitoring rivers during flood events.



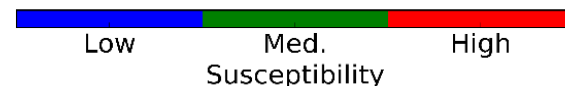
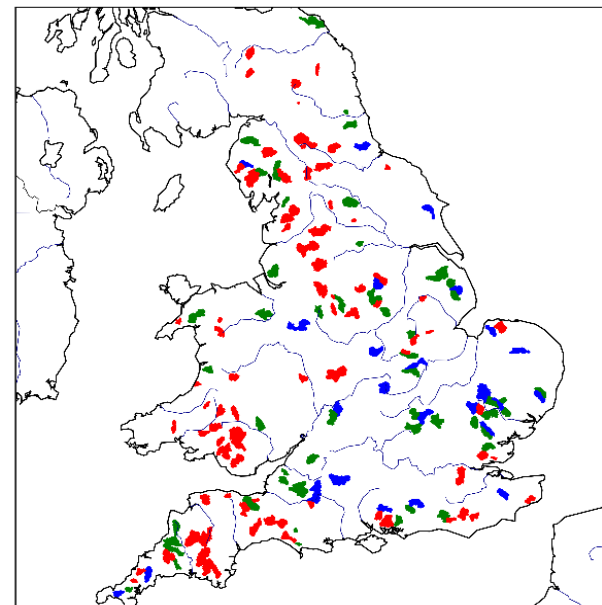
Mason et al (2018) **Robust algorithm for detecting floodwater in urban areas using Synthetic Aperture Radar images.** *Journal of Applied Remote Sensing*, 12 (4). 045011

Matt Perks (Newcastle University) working with the Environment Agency to install CCTV cameras to observe floods.

Photograph from Nick Everard, Environment Agency



<http://ceg-fepsys.ncl.ac.uk/outputs/>



Location of catchments identified as susceptible to flash flooding

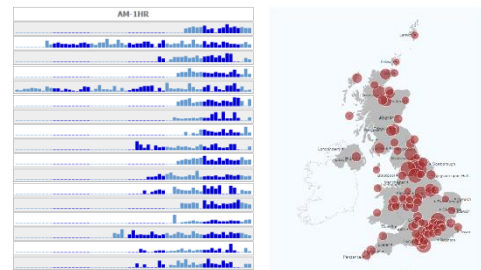
Map produced by Greg O'Donnell,
Newcastle University

- **Flood Chronologies: Timelines**

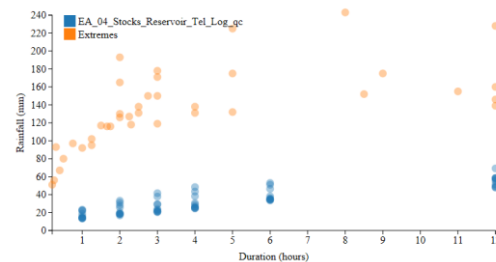
Chronology of Flooding in SW England: 1850-2013



Hourly quality-controlled hourly data set for the United Kingdom



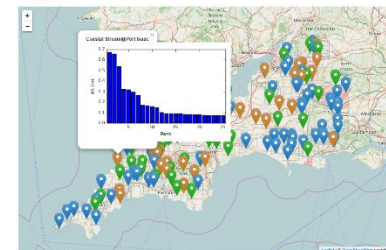
Annual max 1hr
totals



Depth-duration & extremes

Absolute Rise: 15min

The 25 highest absolute rates of rise over a 1-min period are provided below. The values of the numbers refer to the maximum AaL recorded.



River rise – flash floods



<https://seriousgeo.games/games/>



FFIR Highlights

- Find out more:

<https://tinyurl.com/nercffir>



<https://tinyurl.com/nercffir-sum>





Improving flood forecasting for better flood preparedness



Towards end to end flood forecasting

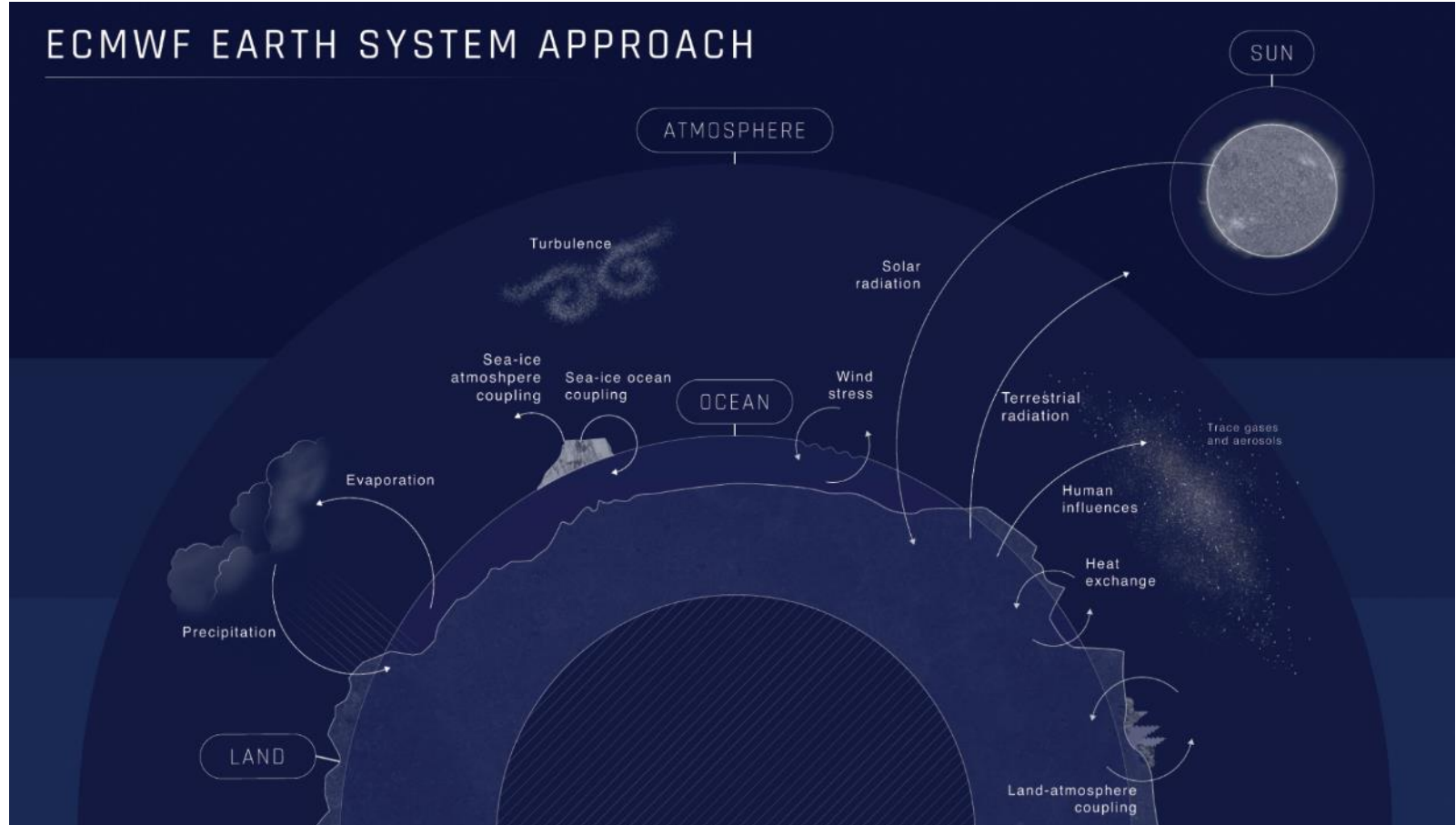


Global weather predictions & earth system models for better flood preparedness



Global weather prediction, earth system models & freshwater natural hazard forecasts

ECMWF EARTH SYSTEM APPROACH





Early warning for
preparation of aid
assistance



European/World-wide
comparable
information

Complement
National/regional
services



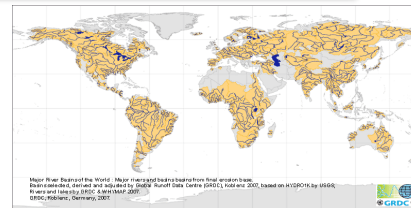
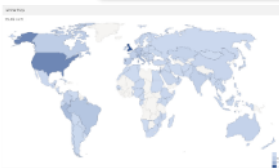
Forecast Day	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	
06/06/2016																																	
05/07/2016																																	
10/09/2016																																	
13/09/2016																																	
12/01/2016																																	

Knowledge transfer &
exchange

Support international
organisations



Improved data sharing

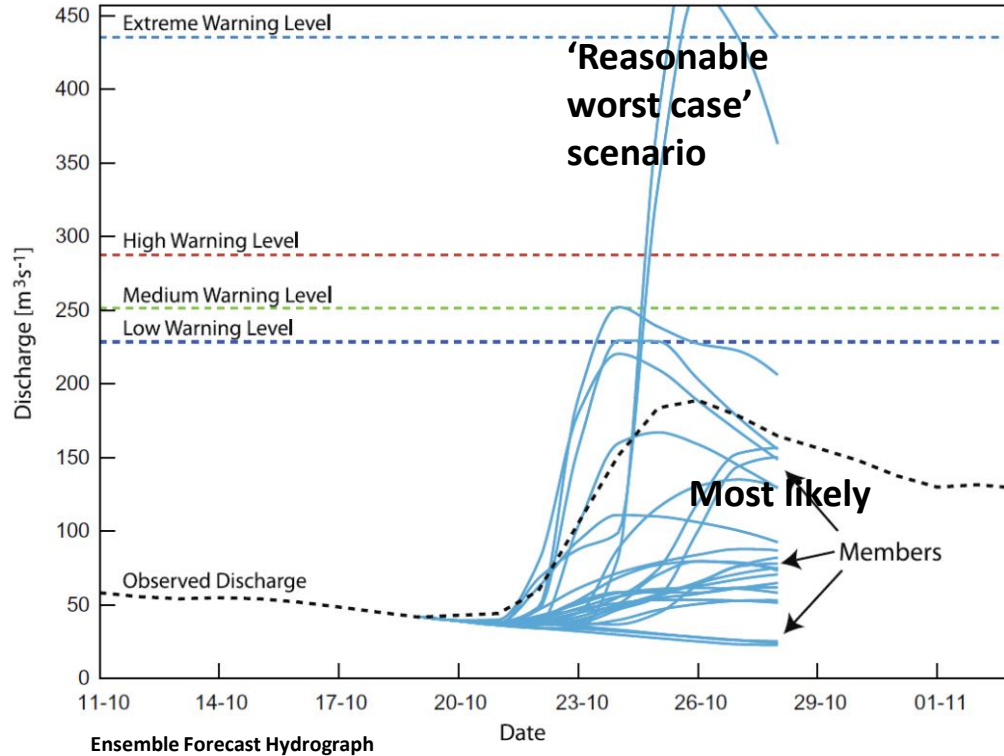


ENSEMBLE forecasts

Better decision making



University of
Reading

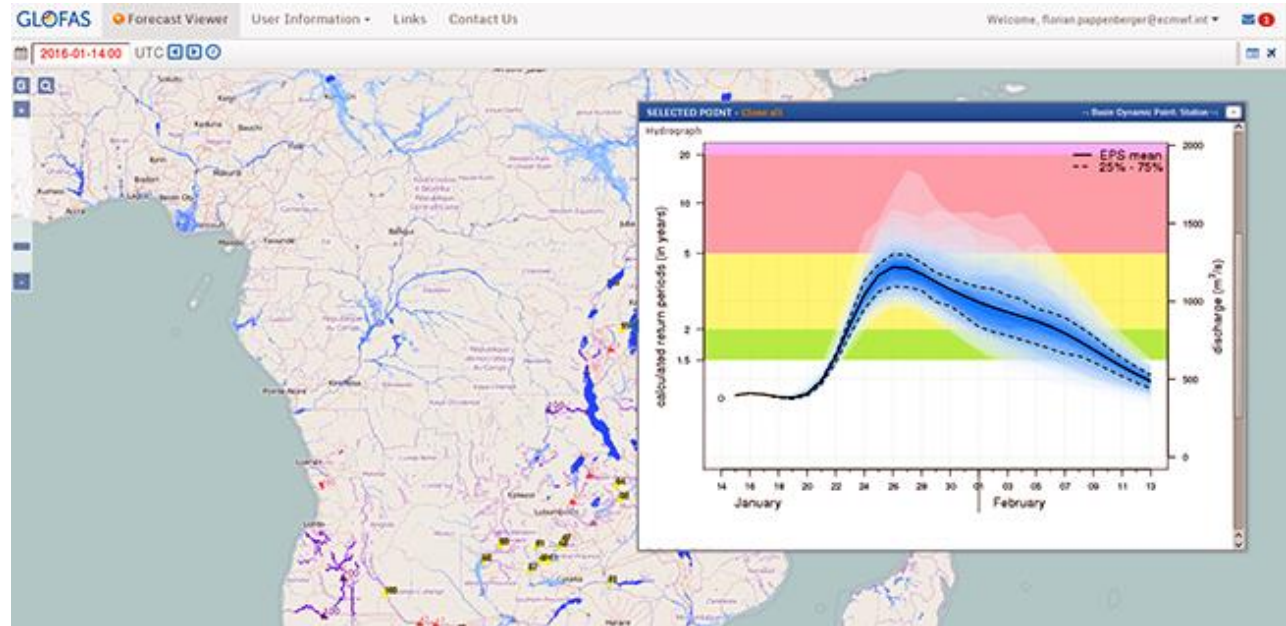




- Early probabilistic flood warnings (restricted in Europe)
- Transboundary system

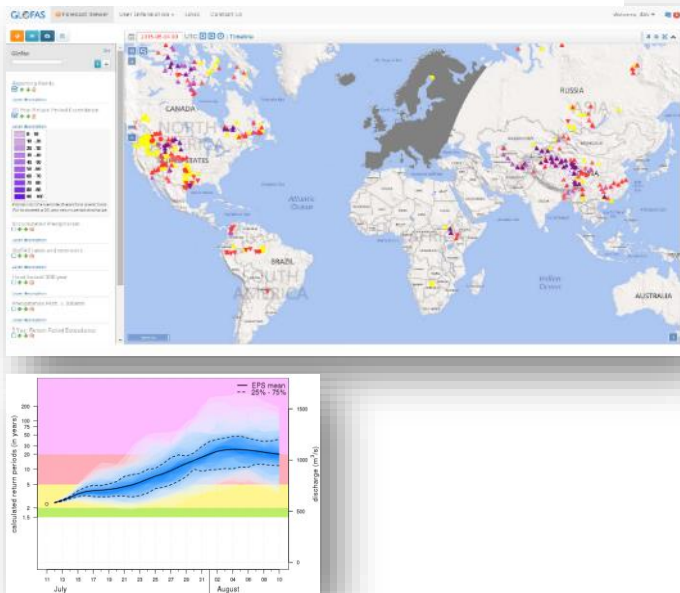
www.globalfloods.eu

**Open access
(just need to register)**

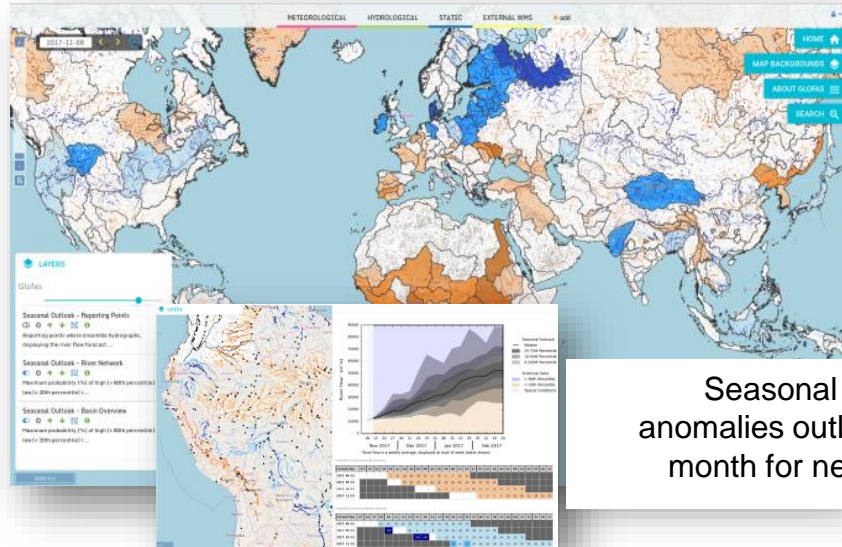




Ensemble flood forecasts daily for next 30 days (catchments > 1000km²)



Emerton et al (2016) Wiley
Interdisciplinary Reviews:
Water



Seasonal hydrological
anomalies outlooks once a
month for next 16 weeks

Emerton et al (2018)
*Geoscientific Model
Development*



diagnoses problems for peak river flow particularly in snowmelt-dominated areas, caused by land-atmosphere coupling & data assimilation

How Well Do Operational Numerical Weather Prediction Configurations Represent Hydrology?

ERVIN ZSOTER

European Centre for Medium-Range Weather Forecasts, and Department of Geography and Environmental Science, University of Reading, Reading, United Kingdom

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Department of Geography and Environmental Science, and Department of Meteorology, University of Reading, Reading, United Kingdom, and Department of Earth Sciences, Uppsala University, and Centre of Natural Hazards and Disaster Science, Uppsala, Sweden

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European Centre for Medium-Range Weather Forecasts, Reading, United Kingdom

(Manuscript received 27 April 2018, in final form 16 April 2019)

ABSTRACT

Land surface models (LSMs) have traditionally been designed to focus on providing lower-boundary conditions to the atmosphere with less focus on hydrological processes. State-of-the-art application of LSMs includes a land data assimilation system (LDAS), which incorporates available land surface observations to



Assessing the performance of global hydrological models for capturing peak river flows in the Amazon basin

Jamie Towner¹, Hannah L. Cloke^{1,2,4,5}, Ervin Zsoter^{3,1}, Zachary Flamig⁶, Jannis M. Hoch^{7,8}, Juan Bazo^{10,11}, Erin Coughlan de Perez^{9,10}, and Elisabeth M. Stephens¹

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Photo credit: Peruvian
Red Cross



<https://doi.org/10.5194/hess-2019-286>

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Hydrometeorological drivers of the 2017 flood in the Brahmaputra basin in Bangladesh

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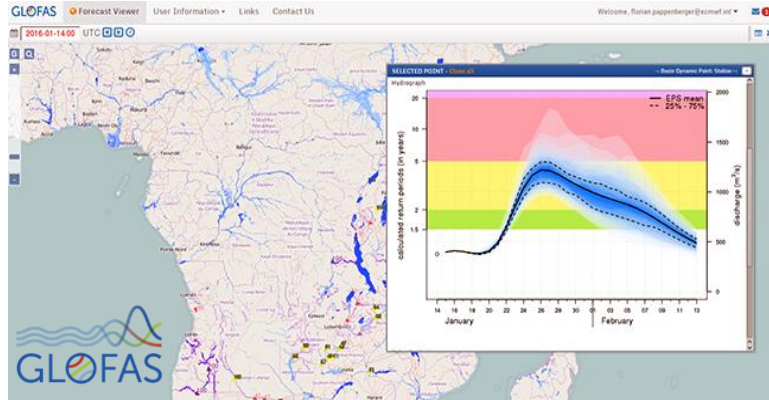
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Abstract. Flooding is a frequent natural hazard in the Brahmaputra basin during the South Asian summer monsoon. Understanding the causes of flood severity is essential for flood management decisions, but to date there has been little attempt to identify sub-seasonal variability of flood characteristics and drivers for the Brahmaputra in Bangladesh. In the 2017 summer monsoon, there was severe flooding in Bangladesh, but the

Early humanitarian action with Ensemble Flood Forecasting FATHUM & Forecast based financing



Photo credit: Peruvian Red Cross (top left, below right), Floodlist (centre), Juan Bazo (right)





GloFAS in action – Cyclones March - May 2019, Mozambique





GloFAS in action cyclone Idai & Kenneth



Source: Mike Hutchins/Reuters



"UN humanitarian response actors stated that the reports produced were tremendously helpful"

- UN OCHA & DfID (UK) requested emergency reports

Flood hazard & impact Emergency Report - Cyclone Kenneth

Event start: Expected 25 April 2019 Report date (first): 24 April 2019
Area: Mozambique, Tanzania Update #4 (FINAL): 3 May 2019

Key points

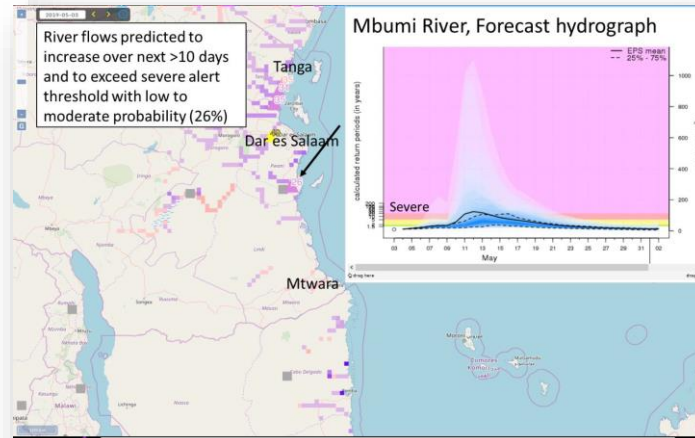
Cyclone Kenneth made landfall in northern Mozambique (Cabo Delgado province) on 25 April. It significantly weakened after landfall, but has brought significant amounts of rainfall and severe flooding from 26 April onwards, particularly in the Cabo Delgado province. More rainfall from another event is expected over the next 7 days in southern and central Tanzania, while rainfall accumulations over northern Mozambique will significantly reduce over the next 3-4 days. GloFAS forecasts indicate that river flows have now peaked in rivers in the Cabo Delgado province of northern Mozambique, but probabilities of flooding are increasing in southern and central Tanzania.

Meteorological forecast

- Rainfall is expected to further decrease over the Cabo Delgado province of Mozambique in the coming days, with up to 25mm/day expected today and over the weekend (3-5 May), reducing to <4mm/day from 7 May.
- From 4 May onwards, the majority of the rainfall is expected in southern and central Tanzania, between Mtwara and Tanga regions, with more than 25mm of rainfall expected per day, and up to 100mm in localised areas.
- Heavy rain is expected to continue in southern and central Tanzania for at least the coming week. This is associated with a large convergence zone independent from cyclone Kenneth.

Flood forecast

- Flooding has now peaked in the Messalo, Montepuez and Megaruma rivers in the Cabo Delgado province of northern Mozambique, and river flows are expected to significantly decrease over the coming week.
- A European Commission JRC Emergency Report (issued 30 April) indicates that "Chipembe Dam has been identified as significantly exposed", having already reached capacity with flow discharge increased in recent days. This could have an impact on flooding that GloFAS forecasts are currently unable to simulate, particularly



EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS



Why forecasting floods should be a global collaborative effort

September 4, 2019 11:26am BST



Flooded houses in Buzi, Mozambique after tropical cyclone Idai struck. INOC (Mozambique) & PHOTUM

Email
Twitter
Facebook
LinkedIn
Print

The number of people exposed to the risk of floods is rising. More and expanding human settlements are being built in flood-prone areas, [especially in Africa, Asia and South America](#). This is undoubtedly linked to the dramatic increase in death tolls and economic damages from floods [experienced in Africa over the past decades](#).

The largest flood events in Africa often cross countries' borders. They overwhelm national and local authorities' capacities. This makes early warning and response challenging, as was seen during tropical cyclones Idai and Kenneth in early 2019.

Author



Andrea Fiochi
Postdoctoral Researcher in Hydrology, University of Reading

Disclosure statement

Andrea Fiochi receives funding from the UK's Natural Environment Research Council and Department for International Development (grant number NE/P00825/1). He is affiliated with the University of Reading (Water@Reading group) and is a visiting scientist at the European Centre for Medium-Range Weather Forecasts (ECMWF).

Partners



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Communicating, coproducing & engaging







SHEAR

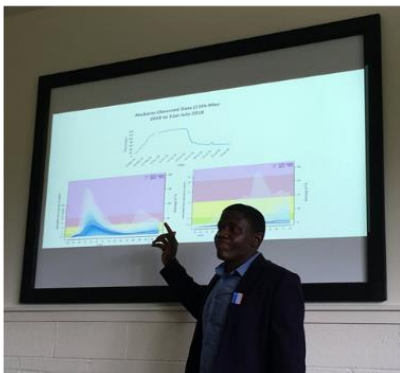
NERC

SCIENCE OF THE
ENVIRONMENT



UKaid
from the British people

Summer Placements



- **Steven Chanda** - Zambian Water Resources Department (WARMA)
- **Joaquim Cuna** - Technical University of Mozambique
- **Douglas Mulangwa** - Ugandan Ministry of Water
- **Sidiky Sangare** - Direction National de L'Hydraulique in Mali
- **Moses Tumusiime** - Uganda National Meteorological Authority



“Me as a person I have already started achieving from GLoFAS even before returning home ...[We’ve benefited from] interaction with high level researchers who opened our eyes academically” *Moses Tumusiime*



“I came to Reading in order to learn more about the framework of GloFAS model and how the data analysis can be done in a smartest way... I would that I am now very much competent with GloFAS data analysis and understood the full operation of the model itself.” *Steven Chanda*

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Global weather predictions & earth system models for better flood preparedness



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Prof Hannah Cloke
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