Global modeling of seasonal mortality rates from river floods

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Motivation

In spite of their recurrent seasonal patterns, every year river floods affect millions of people and kill thousands

Little research has focused on the seasonality of global flood risk

Flood victims are unevenly distributed

Knowing the timing and magnitude of floods key to international humanitarian assistance and the management of resources.

source: Senegal Red Cross 2019

source: EC, DG ECHO (FlickrCC) 2014

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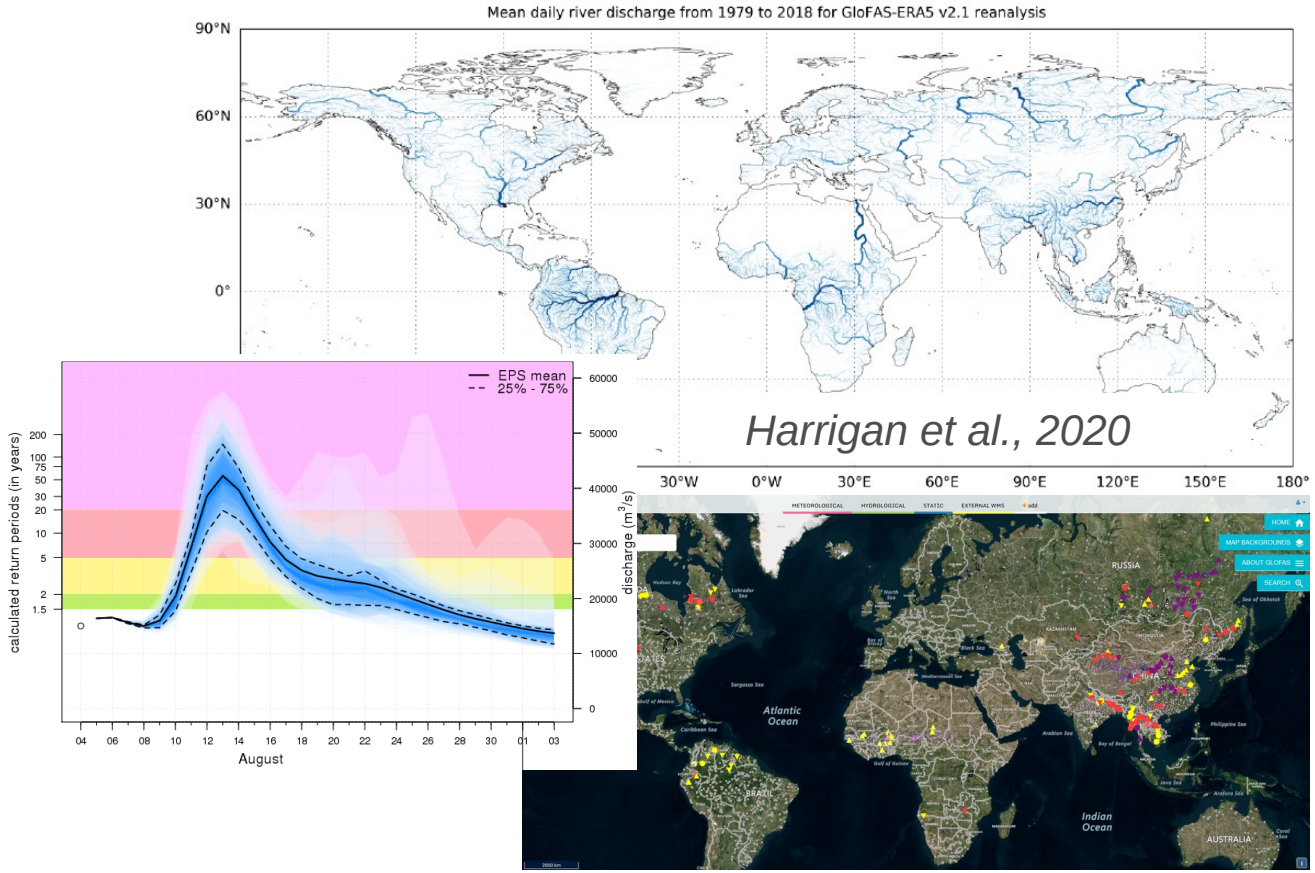
The Global Flood Awareness System

GloFAS is an operational system for early detection of river floods in the future 30 days

Here we use GloFAS daily river discharge reanalysis v3.0 to select peak flows in 1980-2018 in large rivers (upstream area >5,000km^2).



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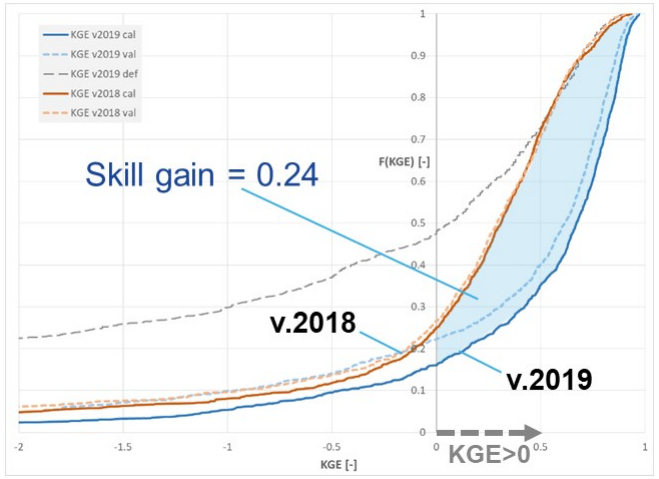
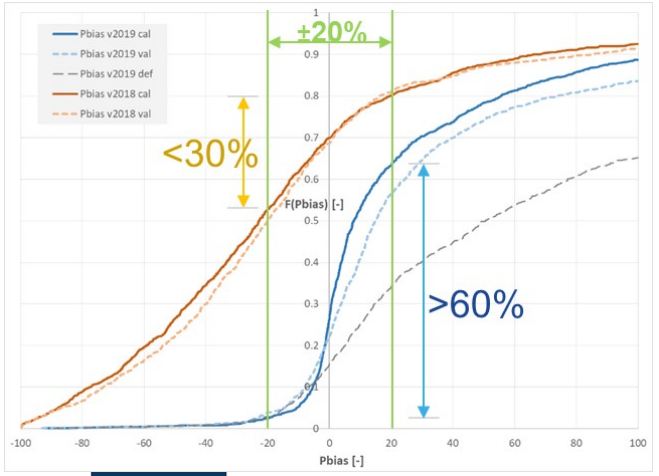
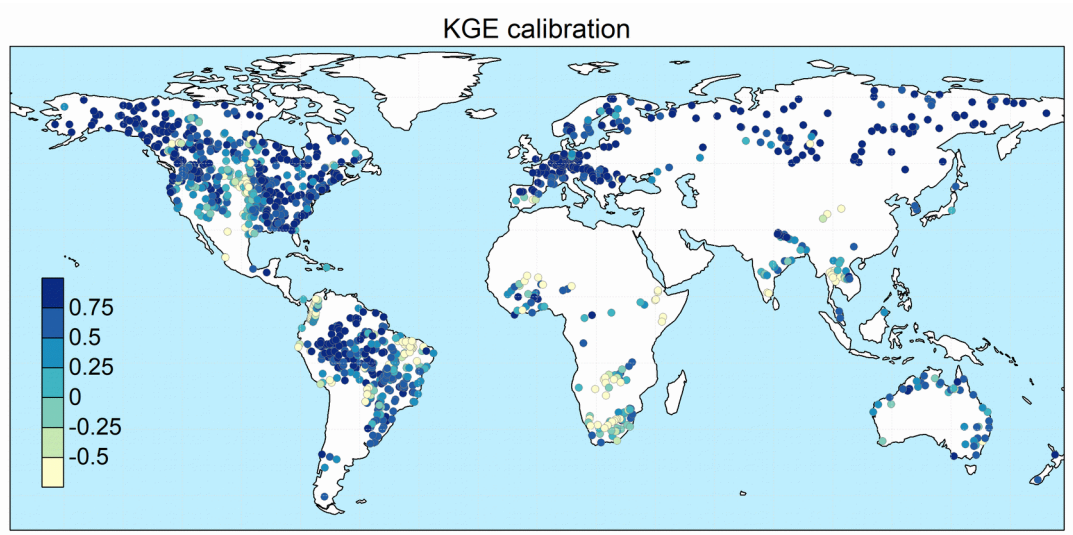
GloFAS reanalysis v3.0

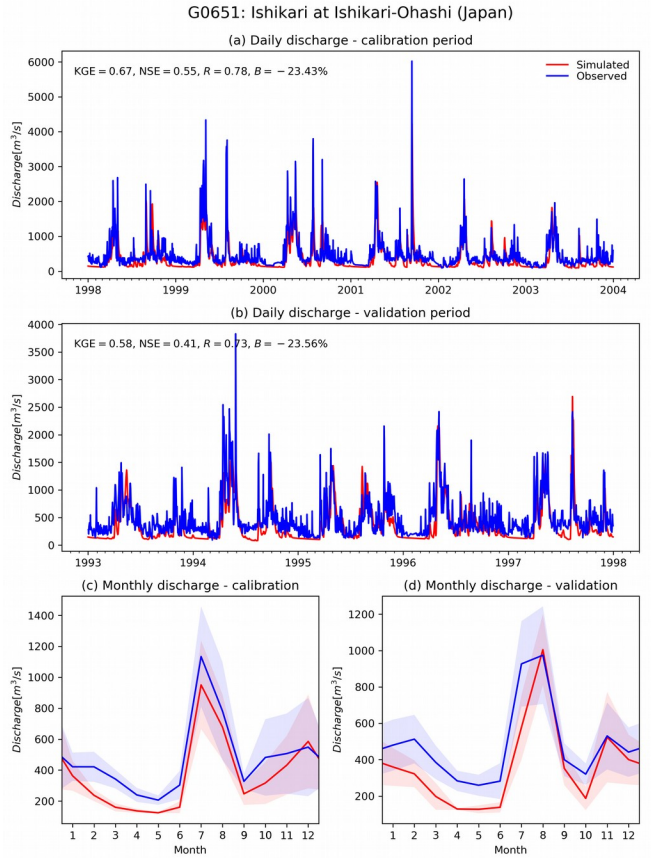






- *Substantial improvement of KGE and percent bias compared to the previous calibration (v.2018)*

Median scores in calibration:
KGE=0.67
r=0.8
NSE=0.42
PBias=8%



Alfieri et. al, Journal of Hydrology X, 2020

1226 stations, 8 model parameters, >320,000 model runs

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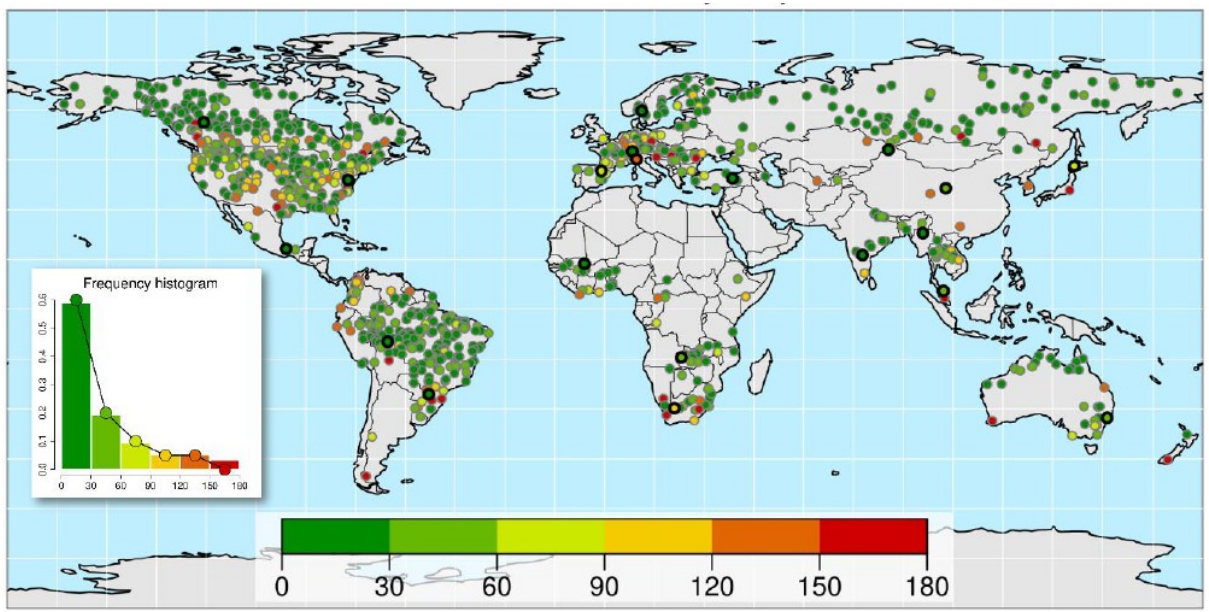
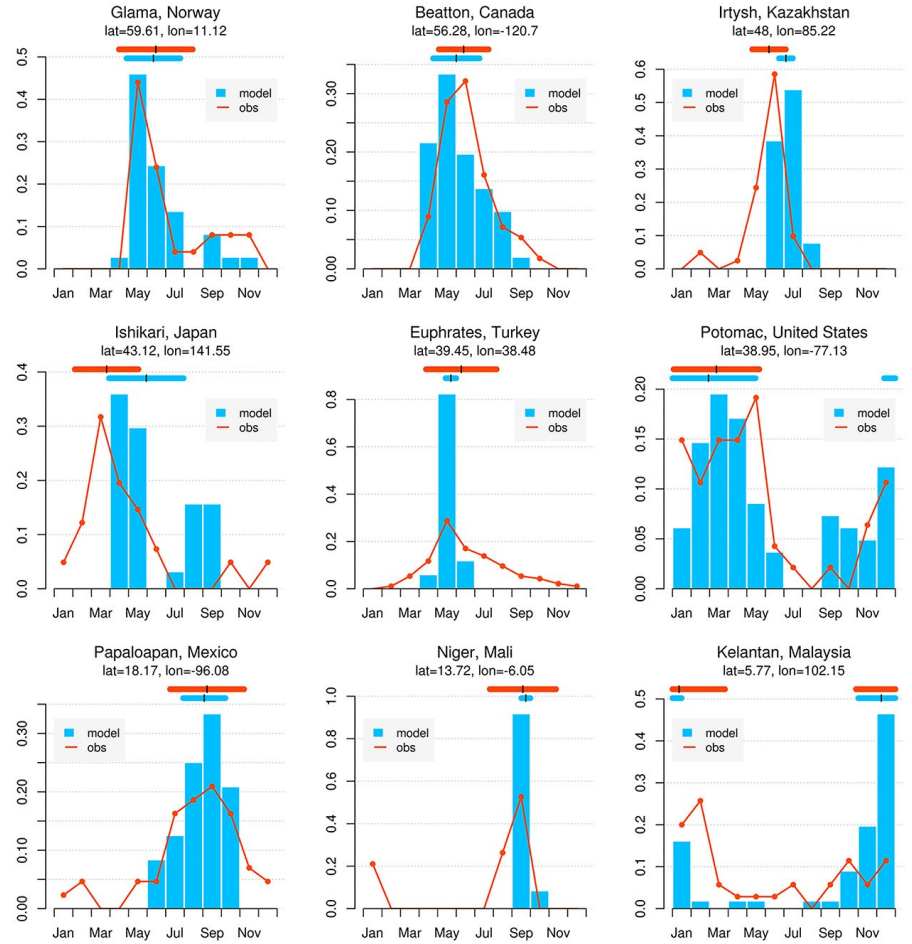
Flood timing – simulated vs. observed

- sim-obs peak timing differ by 22 days or less in 50% of gauges



Alfieri et al., Earth's Future, 2020



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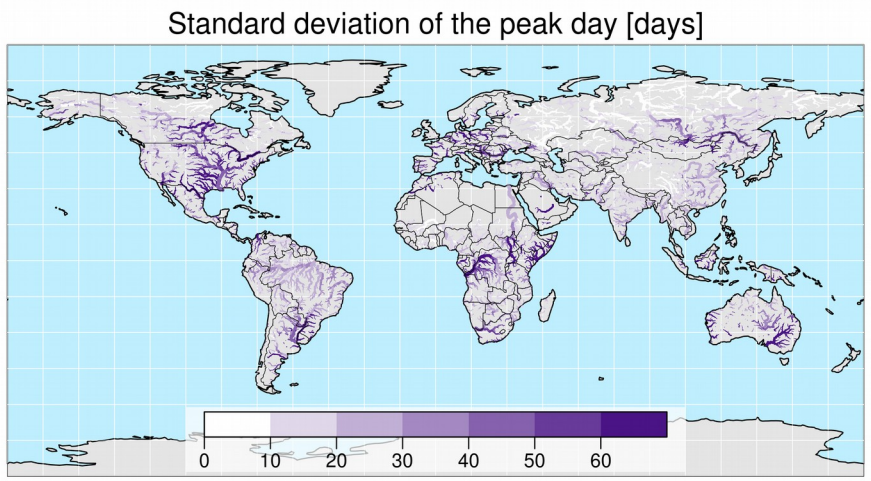
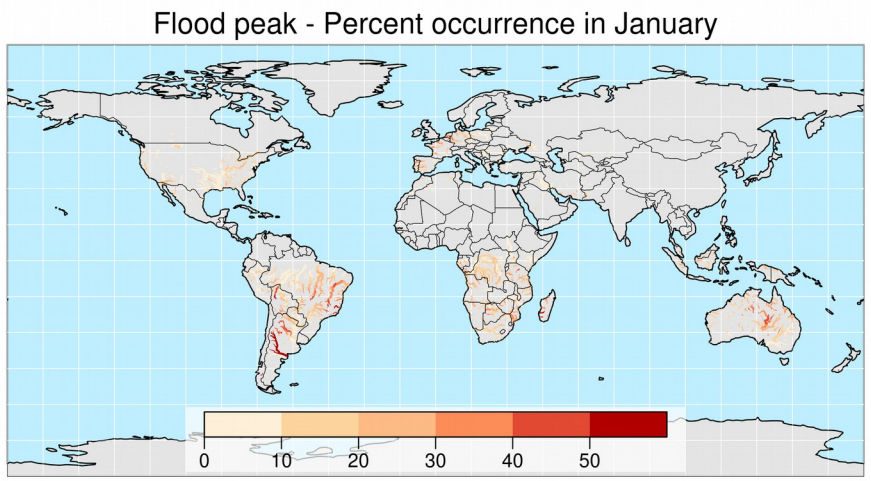
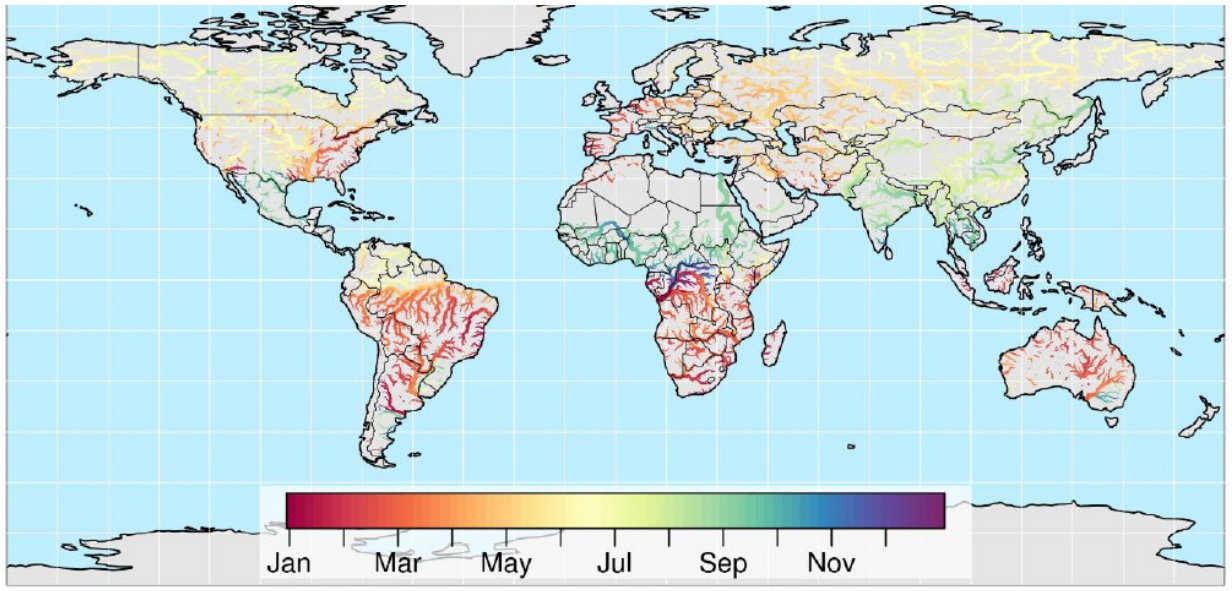
Timing of flood peaks







- **Strong seasonality of peak flows in W Africa, W China, Russia and above 60°N**

- **Variable timing of peak flows in USA, C-E Africa and Europe**

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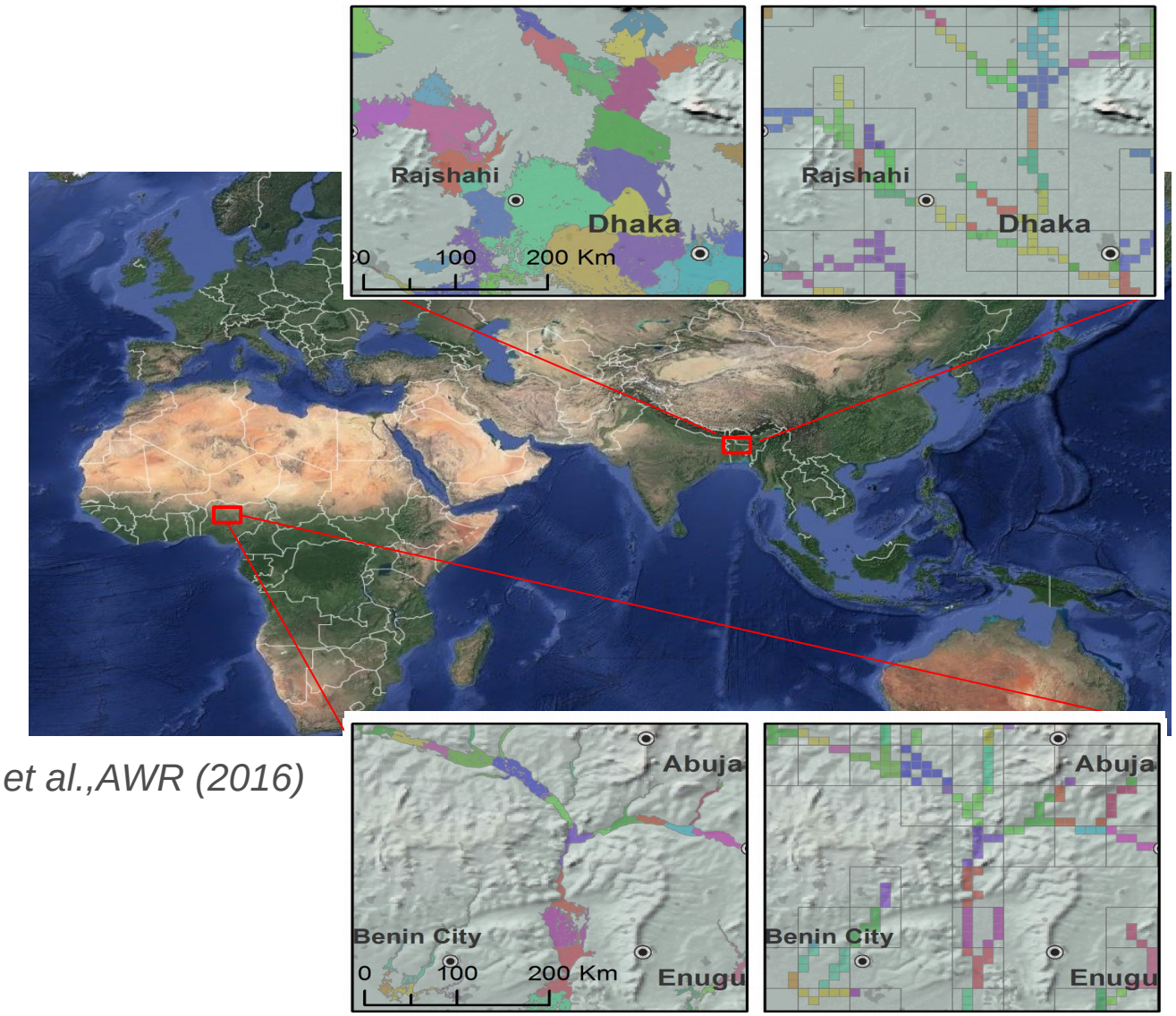
From flood hazard to flood risk

Flood magnitudes are linked to the corresponding inundation extent for dirrerent return periods

Inundated areas are overlaid with population density maps (GHSL-POP 2015) to estimate human exposure in all the world's countries, considering flood protection standards

$$EAEP = \int_{f=0}^{1/FPL} PEP\, df$$



Dottori et al.,AWR (2016)

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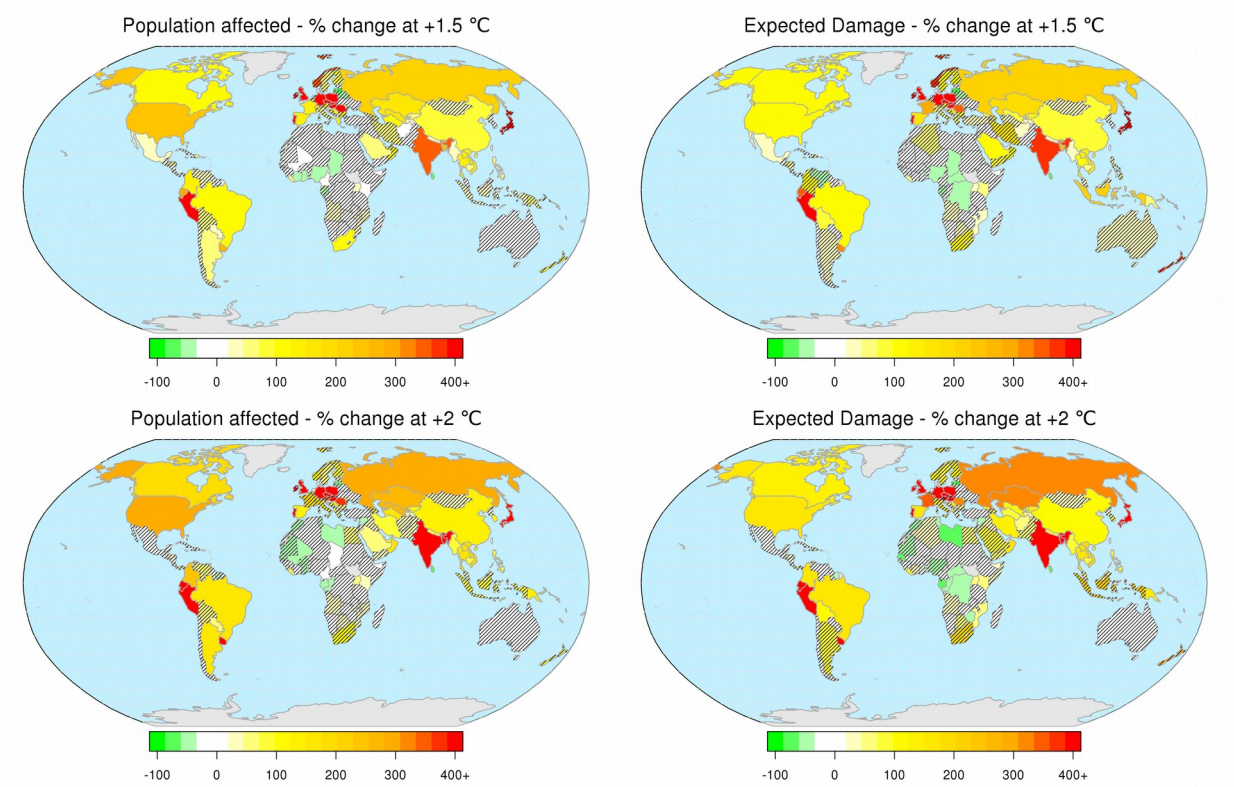
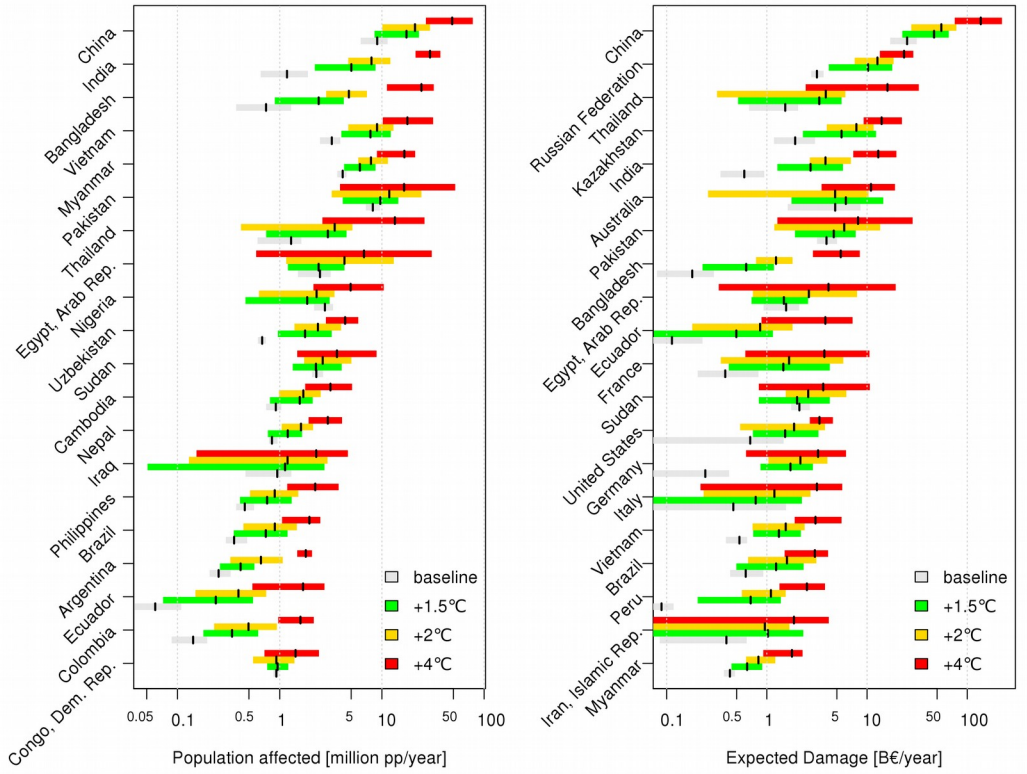
Global Flood Risk at Specific Warming Levels

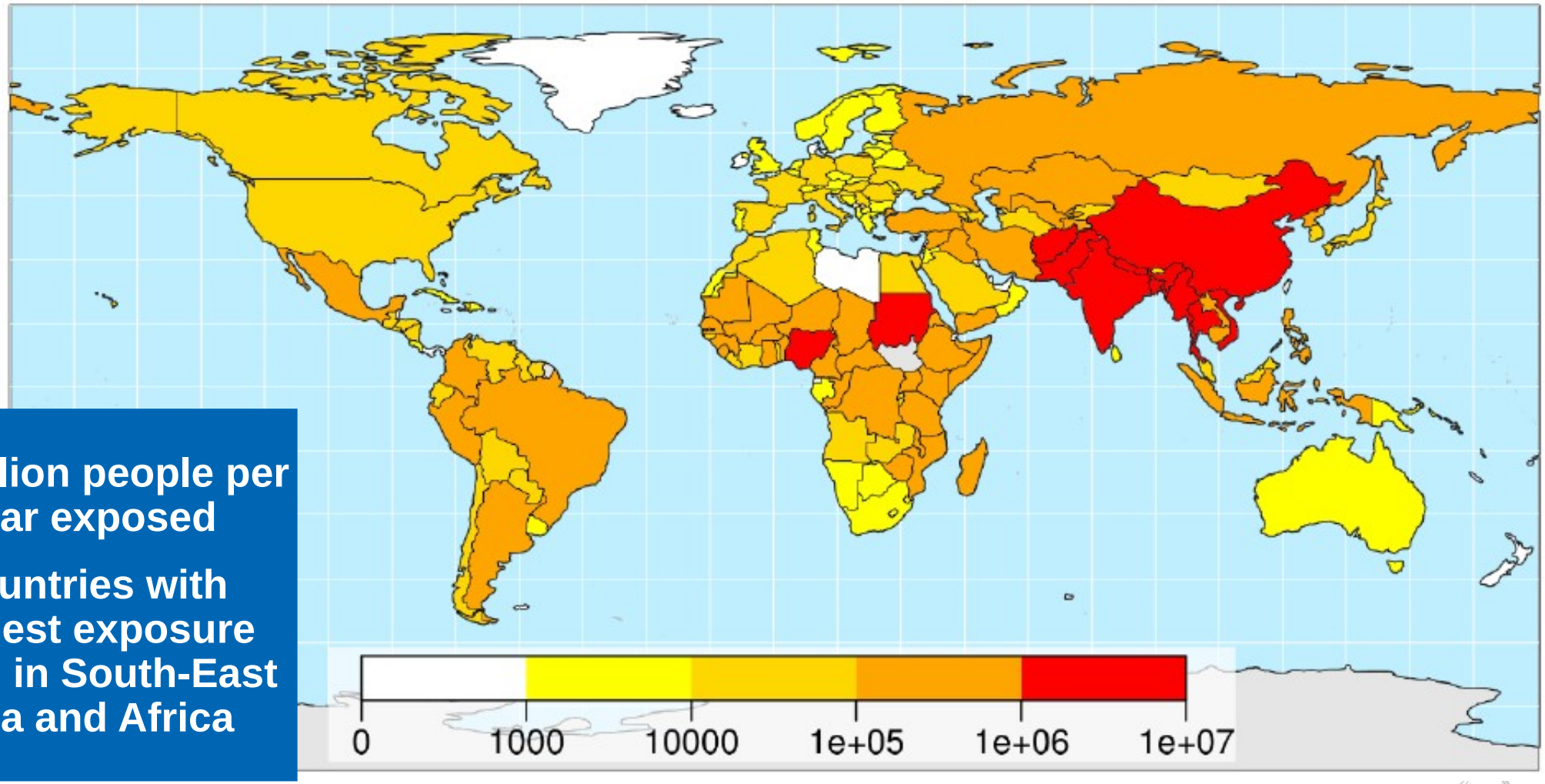
- Process-based global assessment of damage and population affected by river floods at specific warming levels
- Based on an ensemble of climate projections (7 climate models, RCP 8.5)





Alfieri et al., Earth's Future (2017)

Annual population exposed to river floods



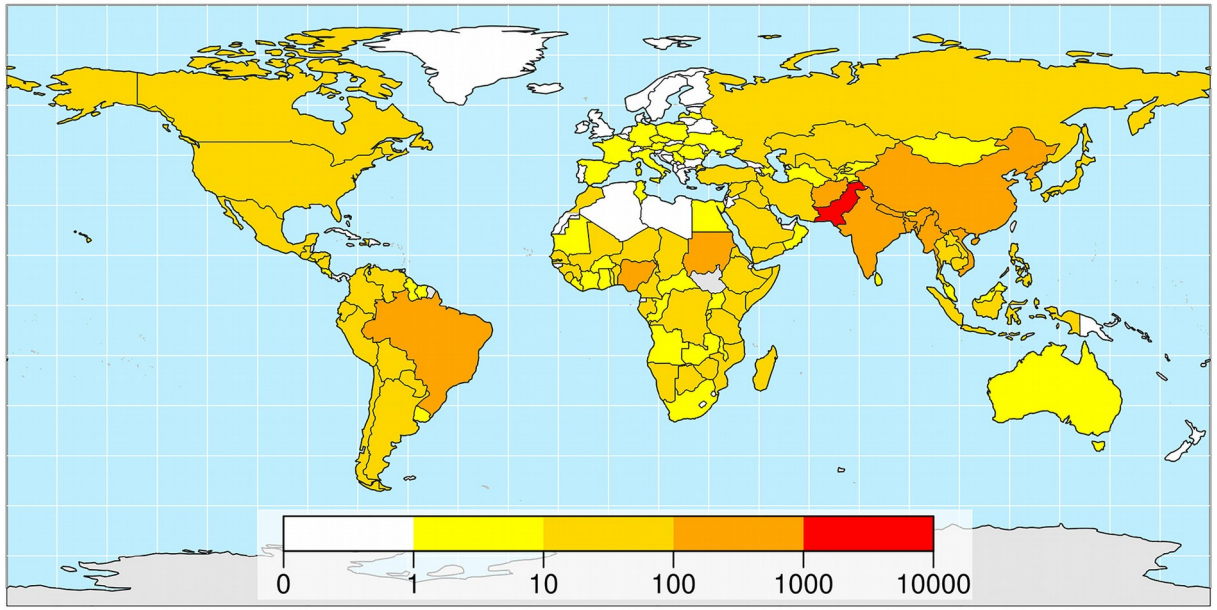
- **54 million people per year exposed**
- **Countries with highest exposure (>1M) in South-East Asia and Africa**

Alfieri et al., EF, 2020

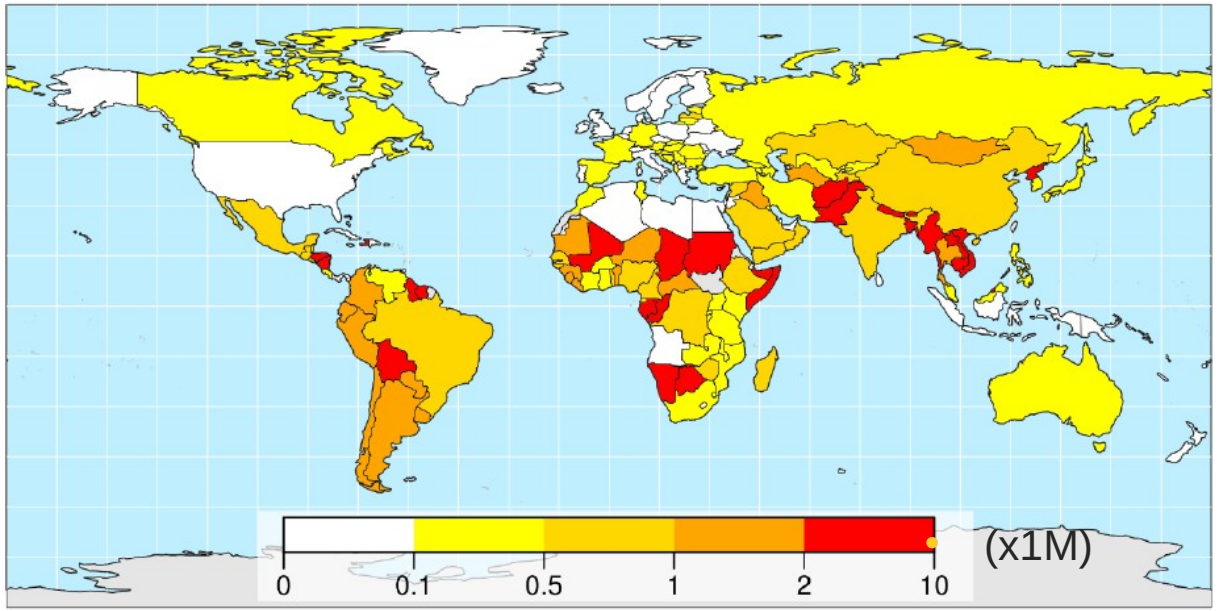
Estimates of flood mortality

Mortality rates per region and income class are inferred from two global disaster datasets (EM-DAT and Munich RE) and linked with flood exposure following Tanoue et al. (2016).

- *Annual mortality*



- *Annual relative mortality (per million)*



6,120 casualties from river floods globally each year

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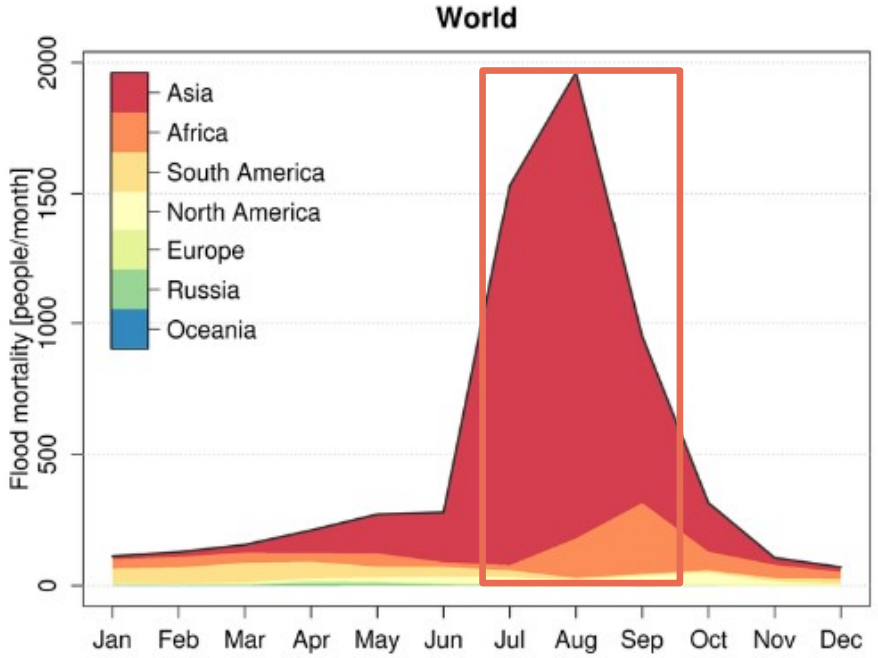
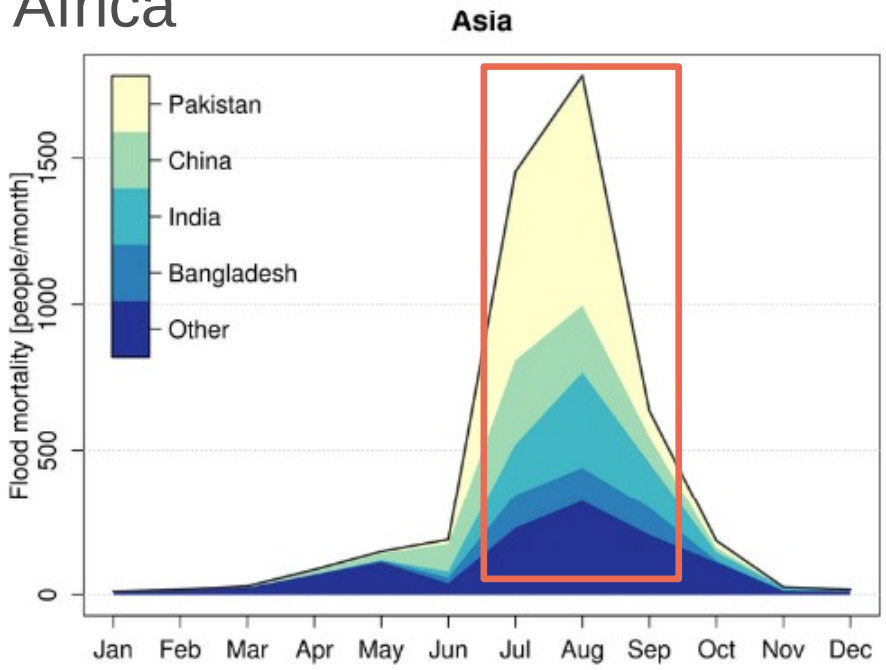
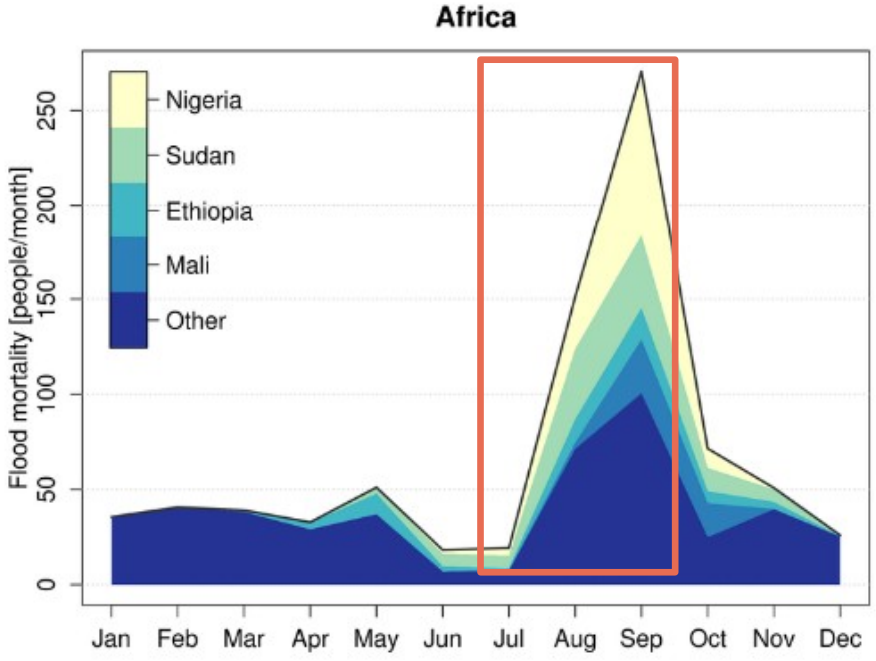
Average monthly mortality

- 4,440 casualties or 73% of global annual mortality from river floods is concentrated between July and September
- 4,600 casualties or 75% of the total occur in Asia; 13% in Africa

- Pakistan >1500
- China >750
- India > 700
- Bangladesh >350







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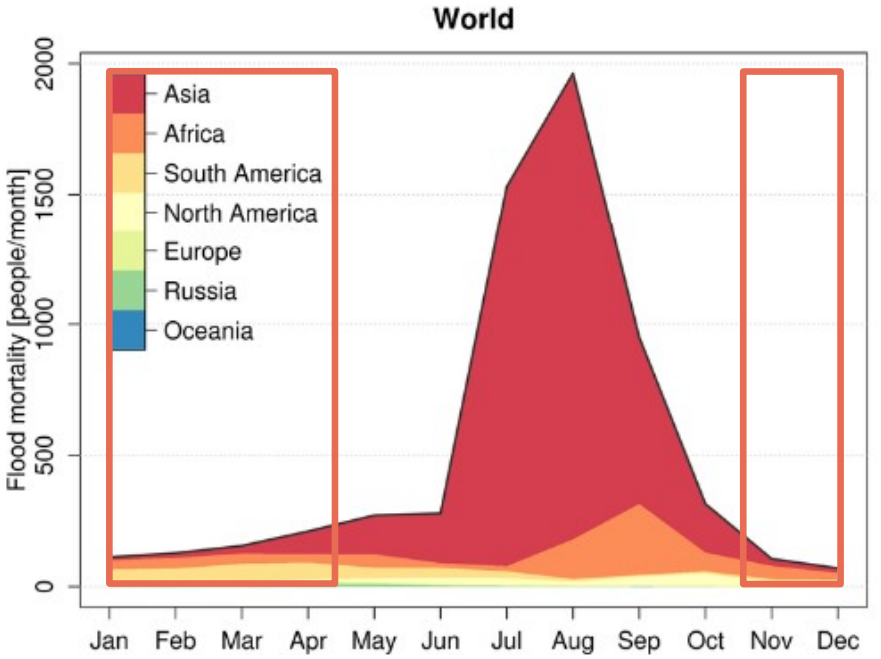
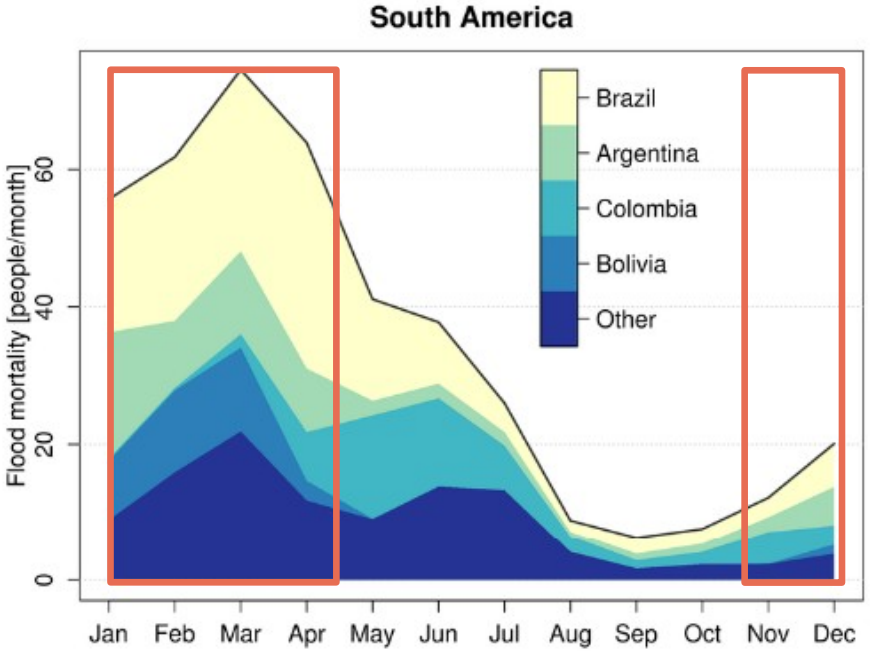
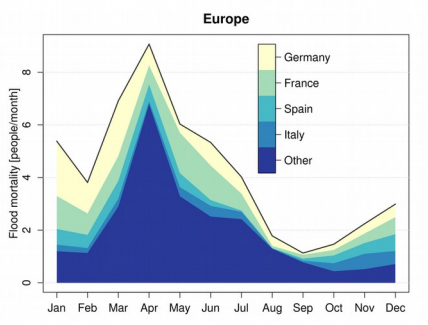
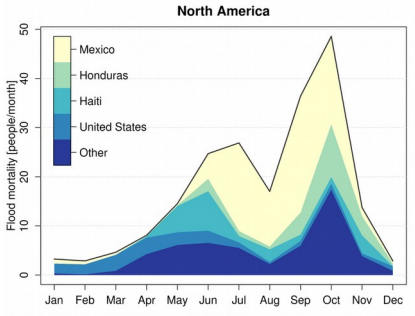
Average monthly mortality

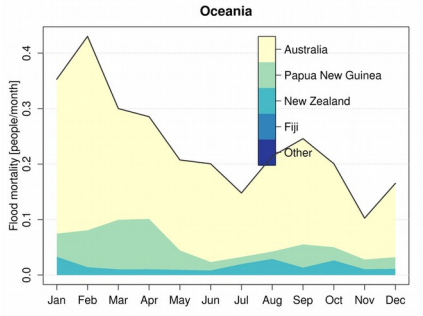
- The six months between November and April contribute to only 13% of global mortality, mostly due to floods in South America and Africa.
- Contribution of other continents is minor due to lower exposure and vulnerability











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Take home messages

- On average, river flooding **affect 54 million** people and **kill 6,120** every year
- **Summer floods in Asia** are the main cause of mortality, with **63%** of the total
- Only **13%** of global mortality in the 6 months **November-April**
- **40%** of annual victims are **in 1 month** (countries average)
- How to use this information to improve global flood awareness?

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Early warning – early actions

United Nations Nations Unies

Office for the Coordination of Humanitarian Affairs

NEWS RELEASE

UN helps monsoon-affected river communities in Bangladesh before peak flooding hits

Release is the fastest funding allocation from the Central Emergency Response Fund in UN history

In an innovative approach to dealing with the effects of severe flooding in Bangladesh, the United Nations is using the latest in data and predictive analytics to forecast the next major monsoon floods, gauge likely impacts – and take action – *before* possible disaster hits.

STEP BY STEP: HOW IT HAPPENED

On 4 July, the Global Flood Awareness System (GloFAS) 10-day probabilistic forecast predicted that the areas targeted with the pilot have a greater than 50 per cent chance of experiencing a severe flood between 14 and 16 July. This activated the first stage of the pilot, releasing funds and allowing agencies to ready for an activation.

Population Fund (UNFPA) to enable them to prepare to distribute cash, livestock feed, storage drums, and hygiene, dignity and health kits.

On 11 July, the activation trigger was reached when forecasting predicted the floods would reach critical levels in five days. At this point, aid workers began distributing the aid.

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Thank you

More details in Alfieri et al., 2020, https://doi.org/10.1029/2020EF001541

Contact: Lorenzo.Alfieri@cimafoundation.org

Data availability

- GloFAS website: https://www.globalfloods.eu/
- GloFAS-streamflow Reanalysis v3.0 and seasonal flood mortality data: https://data.jrc.ec.europa.eu/collection/id-00288
- Global flood hazard maps: http://data.jrc.ec.europa.eu/collection/floods
- Population: GHS-POP 2015: https://ghsl.jrc.ec.europa.eu/ghs_pop.php
- Reported flood mortality: the EM-DAT (www.emdat.be) and the Munich-RE database (natcatservice.munichre.com).

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