Global projections of river flood risk in a warmer world

Lorenzo Alfieri

Disaster Risk Management Unit

European Commission - Joint Research Centre

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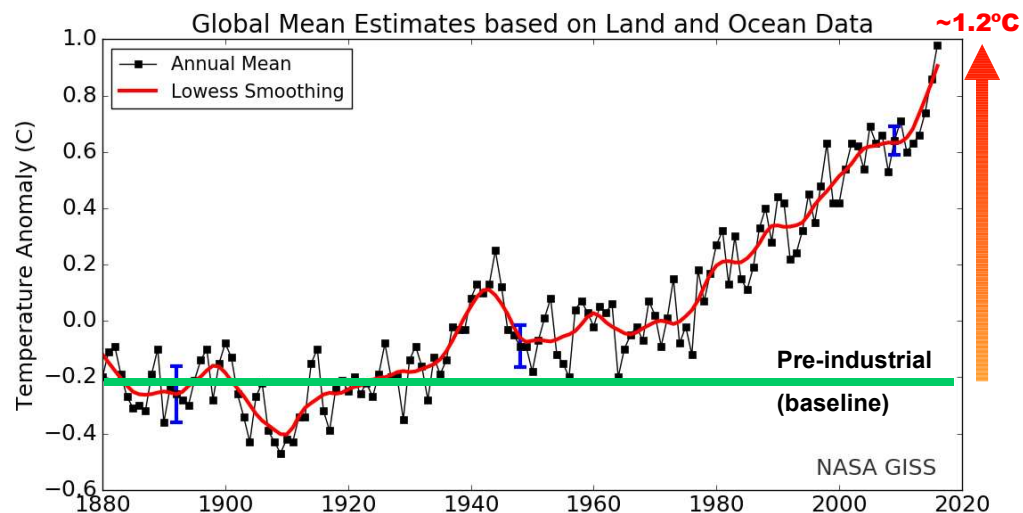
1

Floods risk:

Hazard x **Vulnerability** x **Exposure**

Introduction

At the current emission rate, the target set in the Paris Agreement (2015) of limiting the global warming to 1.5ºC by 2100 seems more and more unrealistic

Reuters

Need to explore the consequences of different global warming scenarios (1.5-4ºC) on the future global flood risk

GloFAS - The Global Flood Awareness System

Global-scale ensemble-based flood forecasting system.
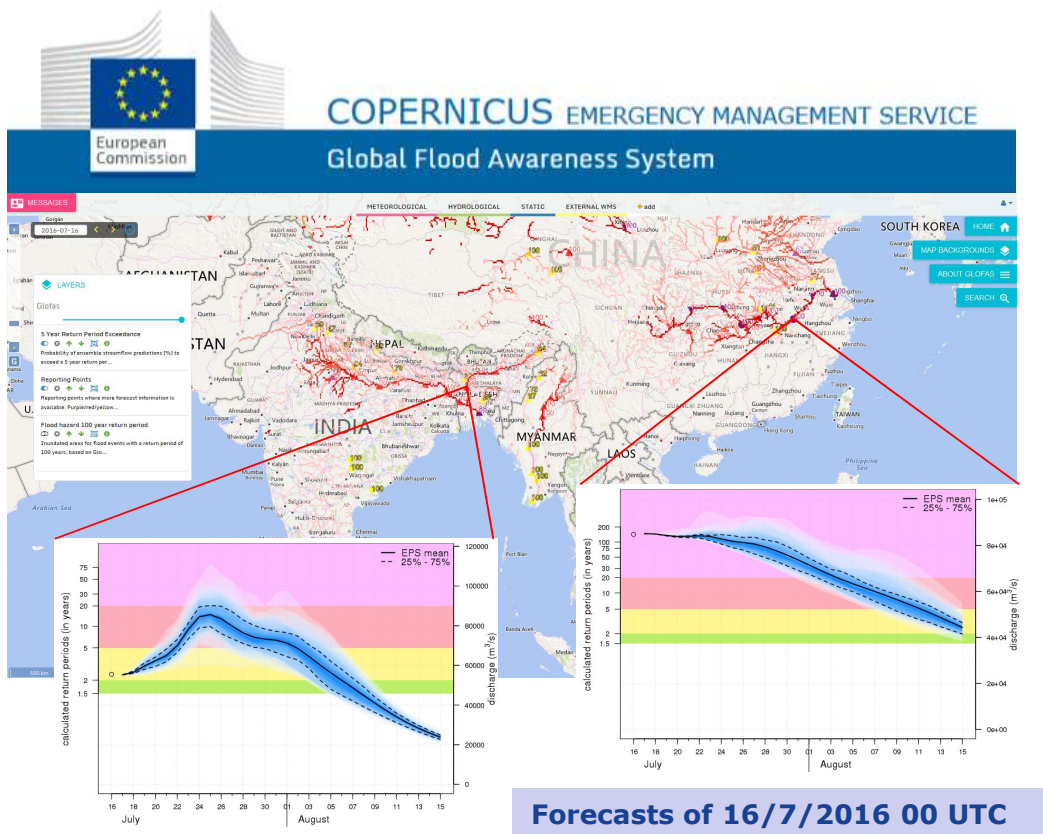
A collaboration product between the JRC and ECMWF.

Forecast frequency:
Updated daily

Forecast lead time:
Up to 30 days

Forecast variable:
River Flow

Forecast type:
Probabilistic

Forecast resolution:
Daily and 0.1 degree

Forecasts of 16/7/2016 00 UTC

www.globalfloods.eu

Alfieri et al. (2013)

4

Meteorological input data

Ensemble forecasts

ECMWF - Variable Resolution Ensemble Prediction System (ENS)

- 51 ensemble members
- 30-day forecast horizon
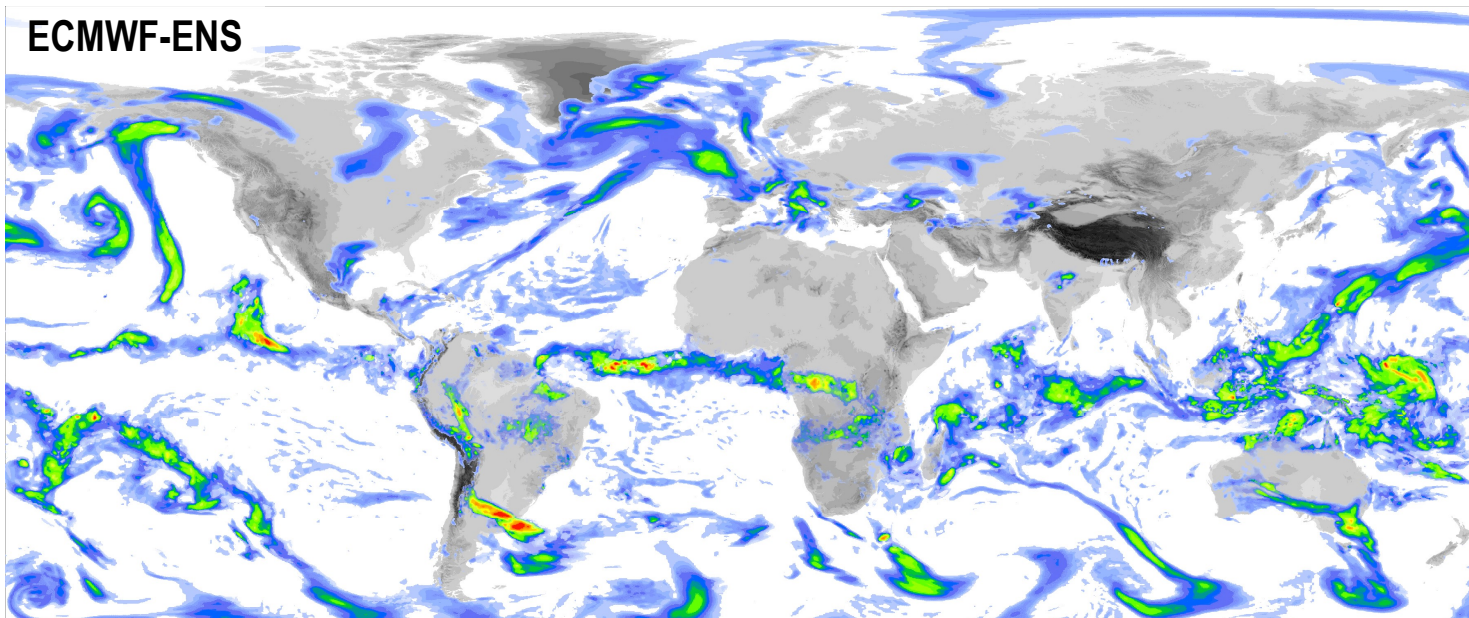- Resolution: ~ 18 km for the first 10 days, ~ 36 km from day 11 onward

Long term climatology
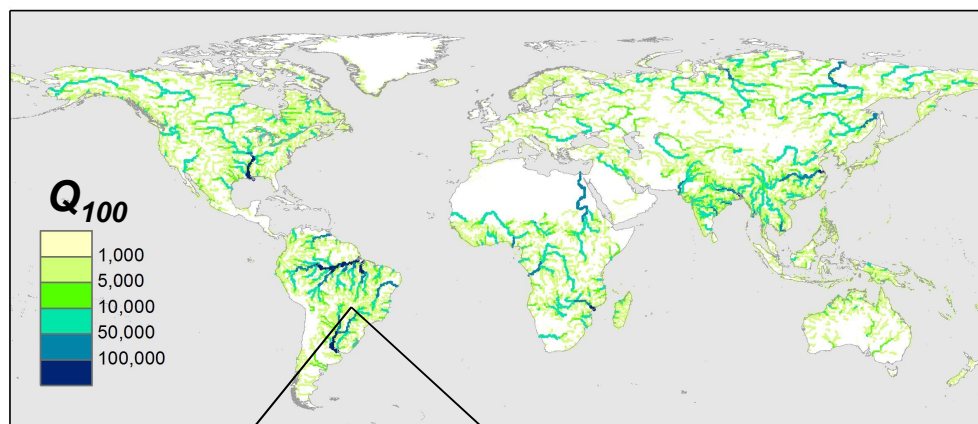
ERA Interim + GPCP bias correction of precipitation

Global atmospheric reanalysis by ECMWF
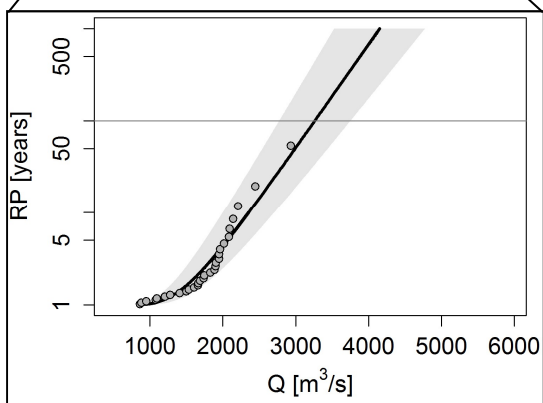
**covers the period from 1/1/1979 - present**

Resolution: ~ 79 km

ECMWF-ENS

Baseline simulation and EV fitting

Q_{100}

1,000
5,000
10,000
50,000
100,000

- 34-year hydrological simulation with Lisflood (1980-2013) based on ERA-Interim input

- Extreme value distribution fit on the annual maxima:
  $Q = f(RP)$

- Design flood hydrographs

- Floodplain hydraulic simulations

Flood frequency analysis

t_C

Q_{100}

Flood hydrographs

2D inundation modelling
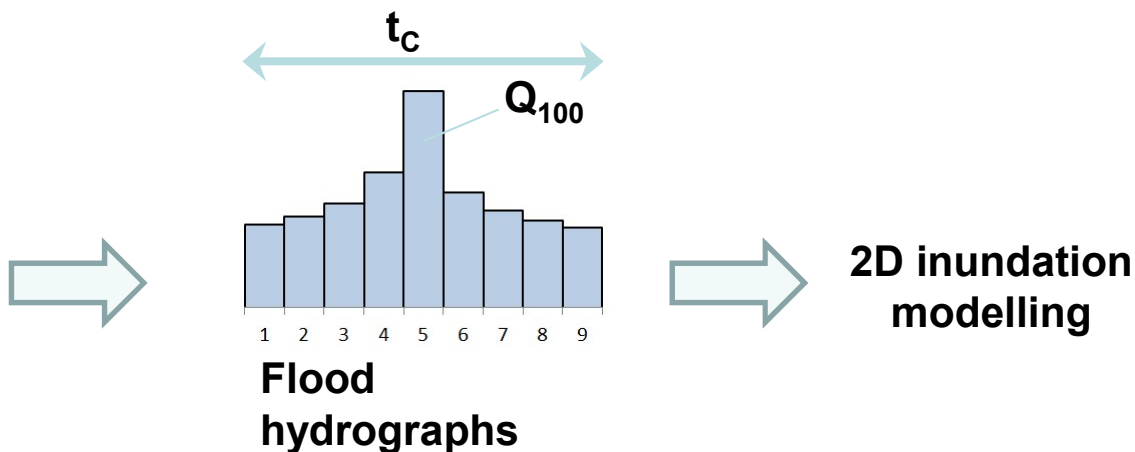
Linking GloFAS to global flood inundation maps

- 6 flood return periods (10-500 y)
- ~190k 2D hydraulic simulations each
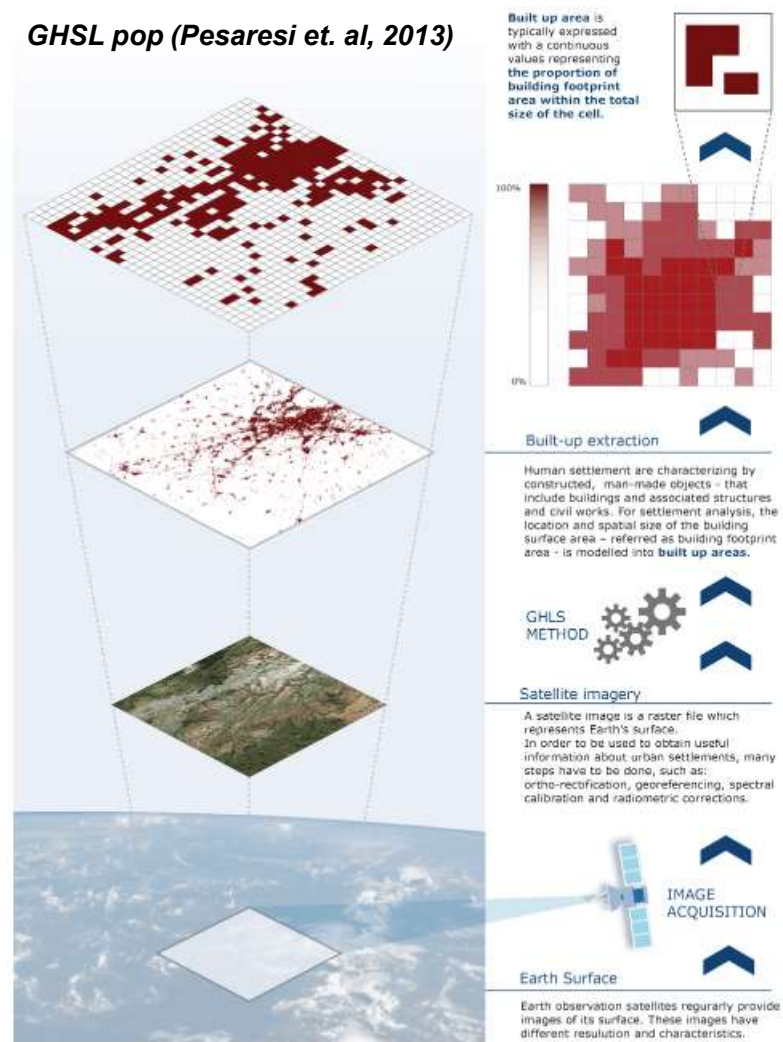
Exposure and vulnerability

- Population maps from Global Human Settlement Layer (GHSL)
- Land use from GlobCover 2009
- Global flood damage functions at continental/country scale
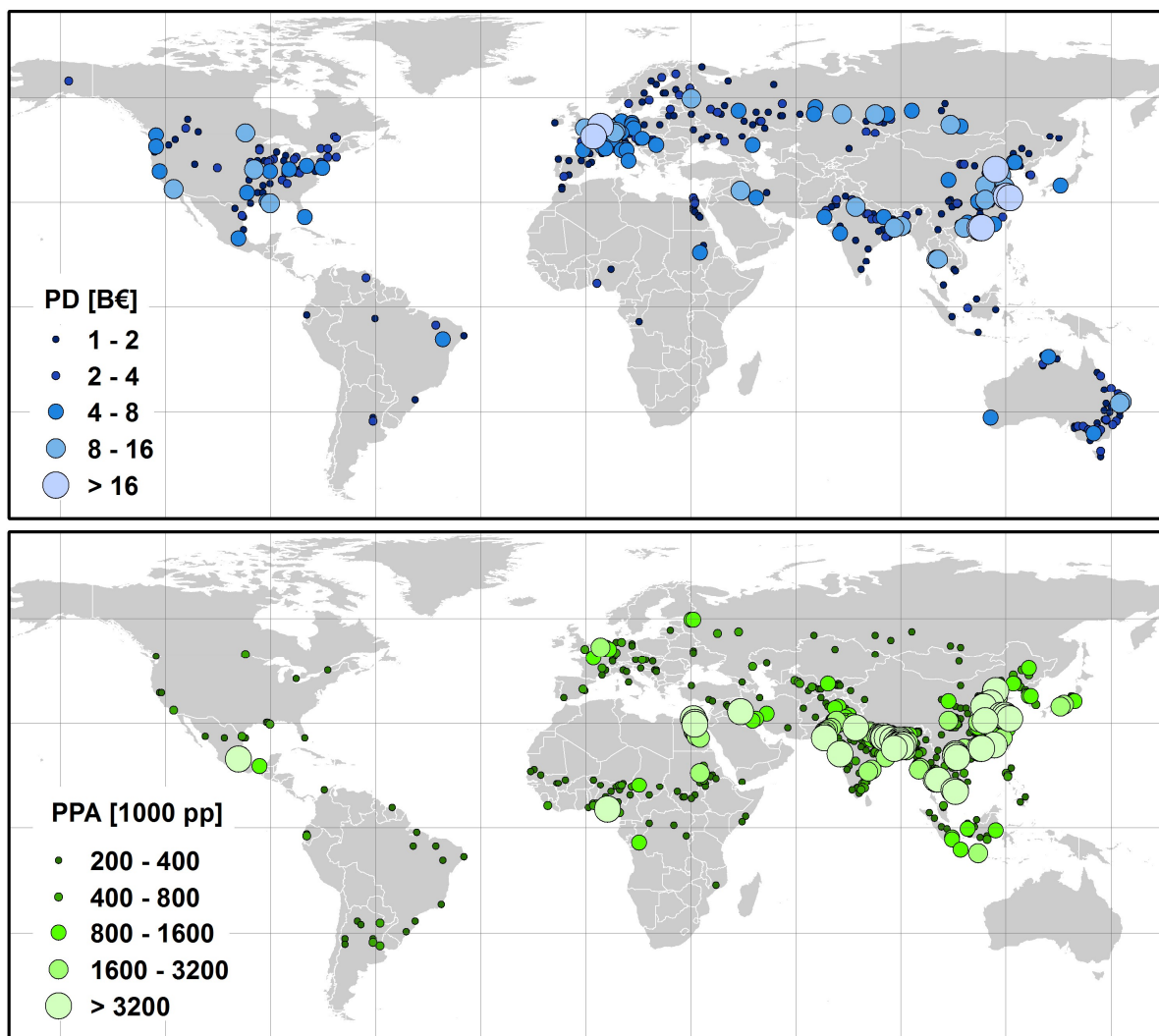- Flood defence information (FLOPROS)

GHSL pop (Pesaresi et. al, 2013)

GHSL basic concept. From Earth's surface to built-up area
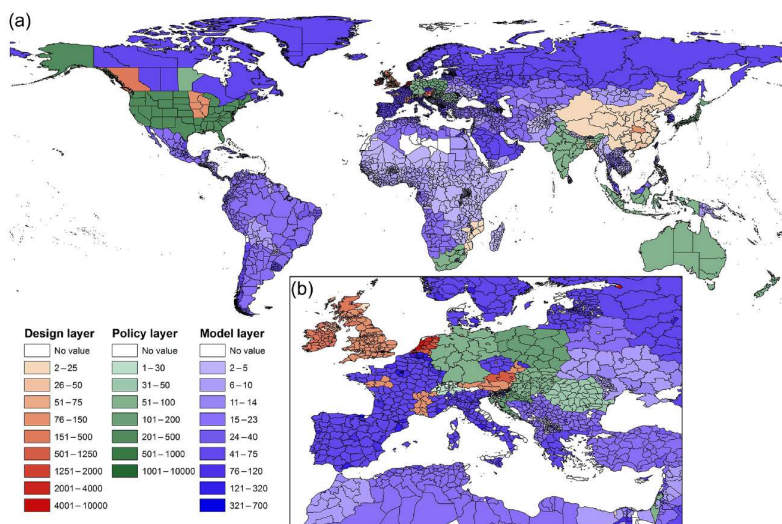
*FLOPROS (Scussolini et. al, 2016)*

Potential impact of floods

Global maps of potential **damage** and **population affected** following a 1 in 100 year flood event, assuming no flood protections

Climate projections

Table 1. Climate Projections Downscaled With EC-EARTH3-HR and Corresponding Year of Exceeding 1.5, 2, and 4°C Warming

|	Forcing Model	Ensemble Member	Data Availability	1.5°C	2°C	4°C
1	IPSL-CM5A-LR	r1i1p1	1971–2120	2015	2030	2068
2	GFDL-ESM2M	r1i1p1	1971–2100	2040	2055	**2113**
3	HadGEM2-ES	r1i1p1	1971–2125	2027	2039	2074
4	EC-EARTH	r12i1p1	1971–2100	2019	2035	2083
5	GISS-E2-H	r1i1p1	1971–2130	2022	2038	2102
6	IPSL-CM5A-MR	r1i1p1	1971–2100	2020	2034	2069
7	HadCM3LC	r1i1p1	1971–2100	2003	2020	2065
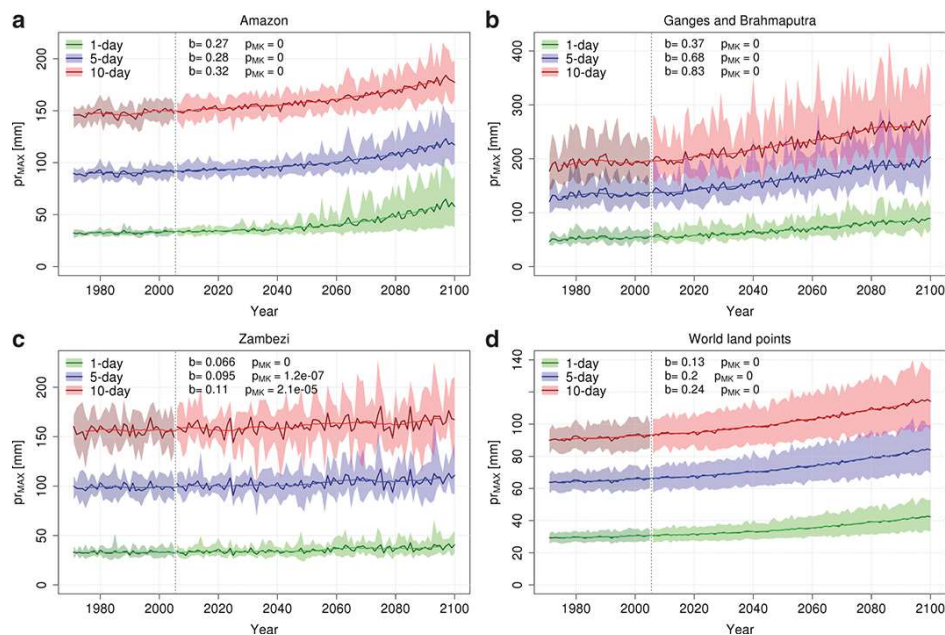
- Ensemble of 7 climate projections downscaled with EC-EARTH
- SST and Sea-Ice from the original GCM
- Historical run: 1970-2005
- Future scenario: 2006-2130
- RCP 8.5 W/m^2
- 0.35º grid resolution

Ensemble projections of annual maximum precipitation over 1, 5, and 10 days under RCP 8.5

11 July 2017

Flood Frequency and Magnitude at SWLs

- Global hydrological simulations with Lisflood (~1000 years, daily, 0.5º)
- EV distribution fitting on the historical runs (L-moments)
- Peak over threshold selection of extreme events
- Aggregation over 30-year time windows around the SWLs
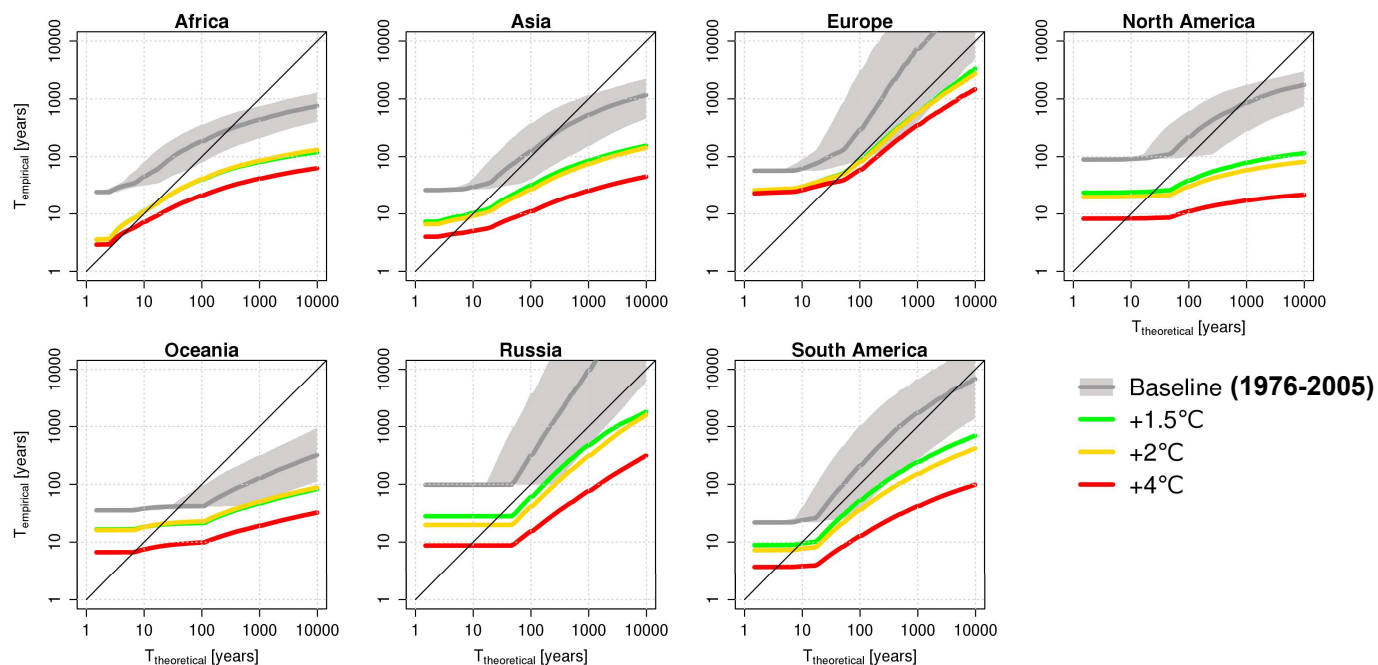
Global Projections of Flood Risk
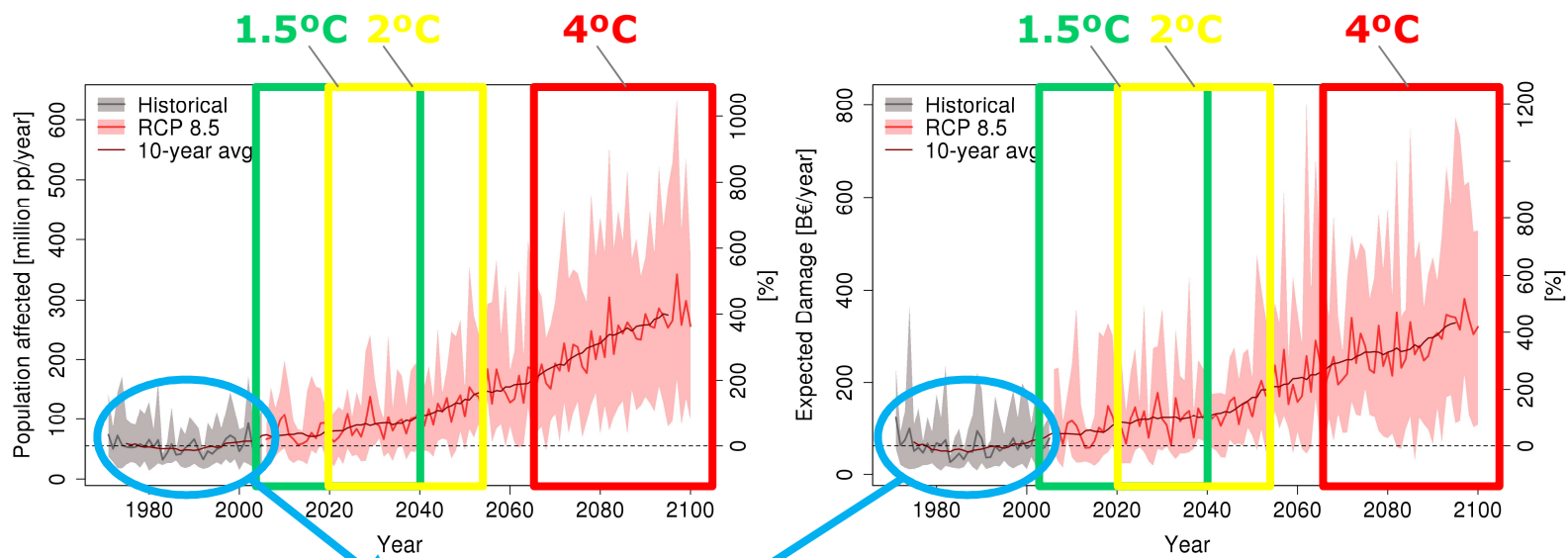
	Population Affected	Damage					
	[millions/year]	[B$/year]	Agriculture	Residential	Commercial	Infrastructure	Industrial
Africa	16.5	8.5	13%	36%	33%	0%	17%
Asia	35.0	46.7	7%	39%	32%	1%	21%
Europe	0.5	5.9	1%	45%	32%	1%	21%
North America	0.8	2.4	2%	46%	27%	6%	20%
Oceania	0.1	6.3	1%	48%	32%	0%	19%
Russia	0.2	4.1	1%	43%	34%	0%	22%
South America	1.1	1.9	7%	39%	31%	1%	22%
World	54.1	75.7					

Global Flood Risk at Specific Warming Levels

- Direct damage and population affected by river floods at specific warming levels
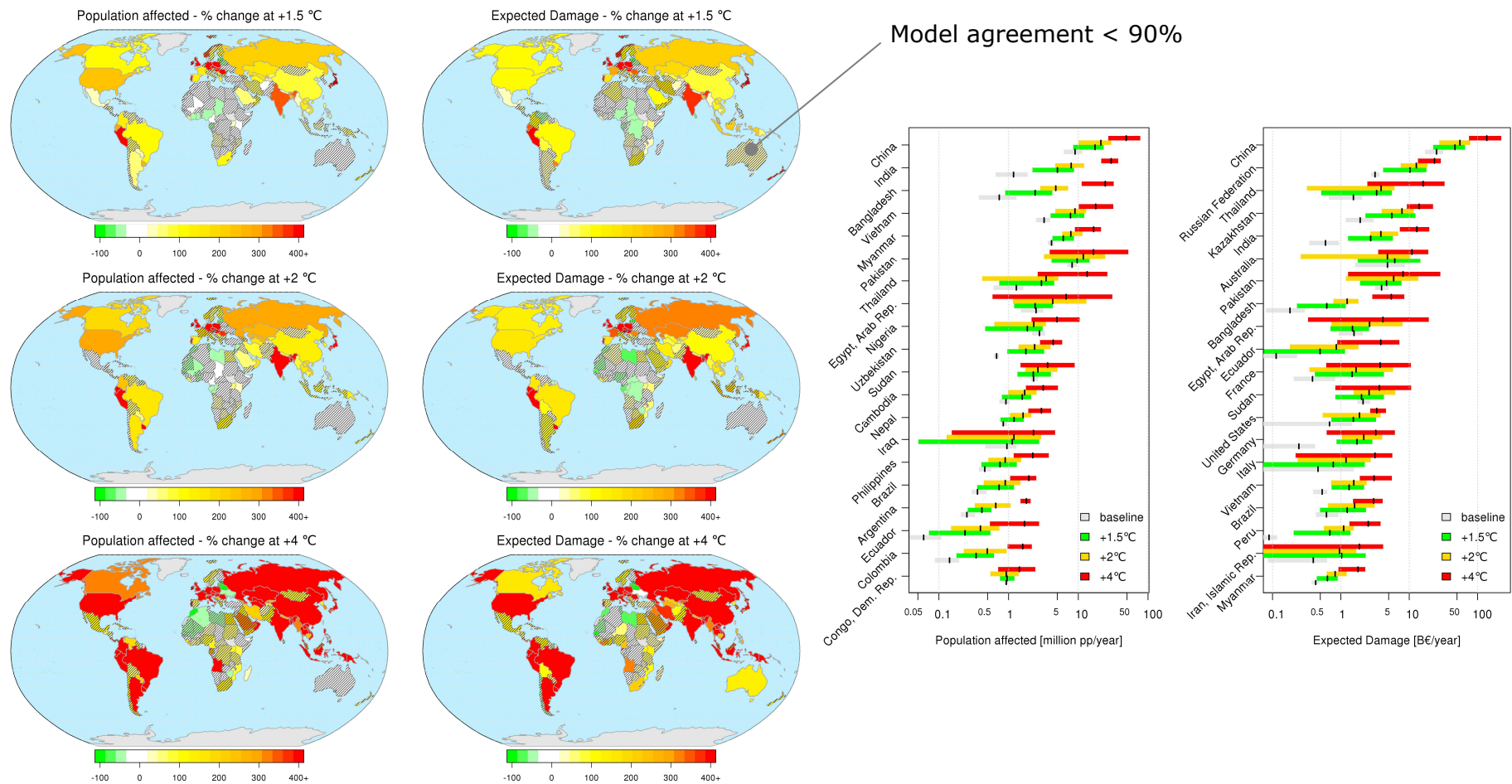
Conclusions

- We used state of the art global datasets on hazard, exposure and vulnerability to assess the socio-economic impacts of river floods under global warming of 1.5, 2 and 4°C

- At 4° C global warming, countries representing 73% of the world population and 79% of the global GDP will *very likely* experience increasing flood risk at an average 580% increase in population affected and 500% increase in damage, as compared to 1976-2005.

- These figures reduce to 100% (170%) increase in population affected and 120% (170%) increase in damage for a warming level of 1.5° C (2° C)

Lorenzo.Alfieri@ec.europa.eu