Flood-induced mortality across the globe: Spatiotemporal pattern and influencing factors

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Contents

Background and significance

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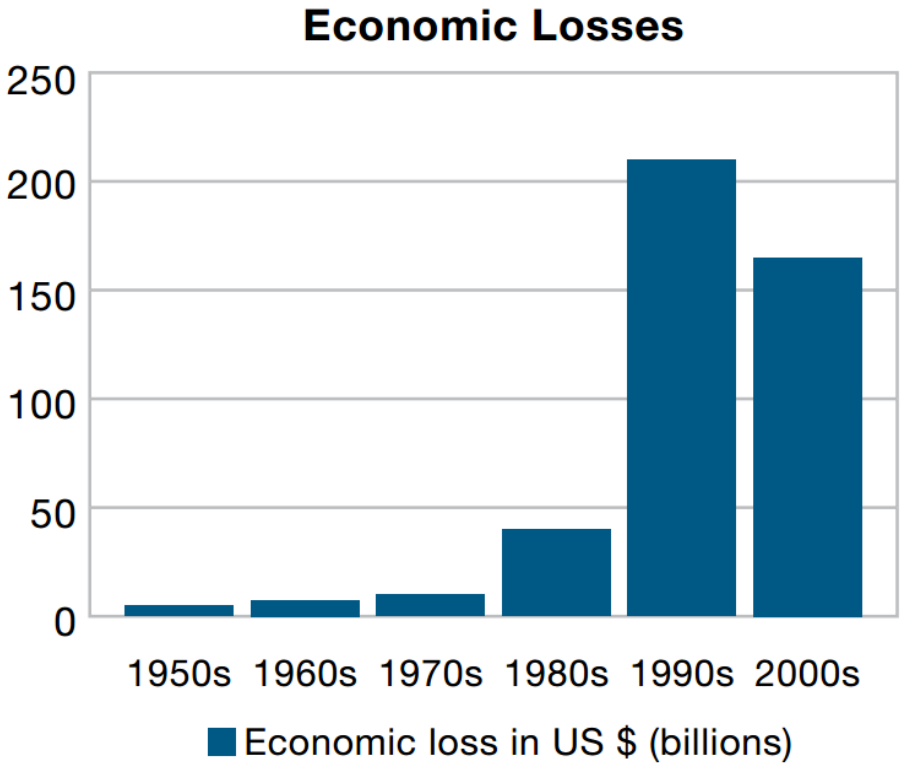
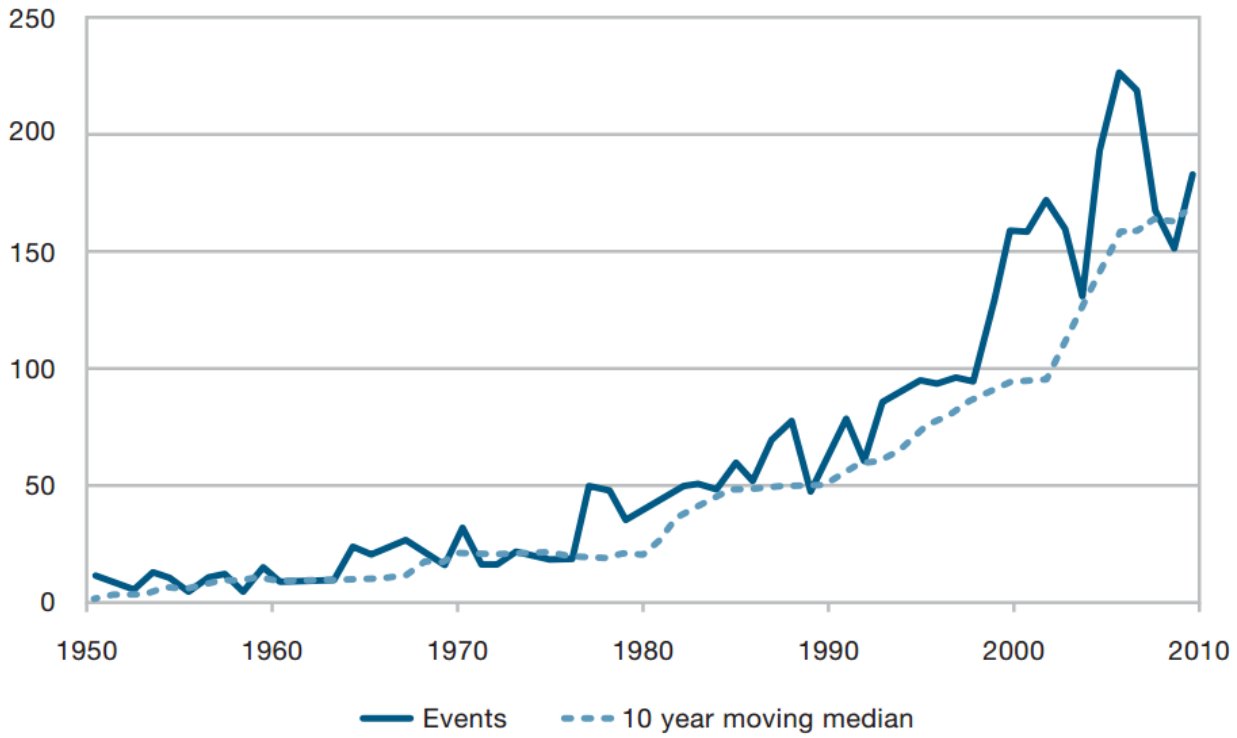


Economic losses from global flood
(Data source: EM-DAT/CRED)



Frequency of flood disasters
(Data source: EM-DAT/CRED)

- **Climate change accelerates the water cycle;**
- **Extreme rainfall and flooding events increased in frequency;**
- **Population and economic exposure persistently increase.**

Background and significance

Regional and global scale studies:

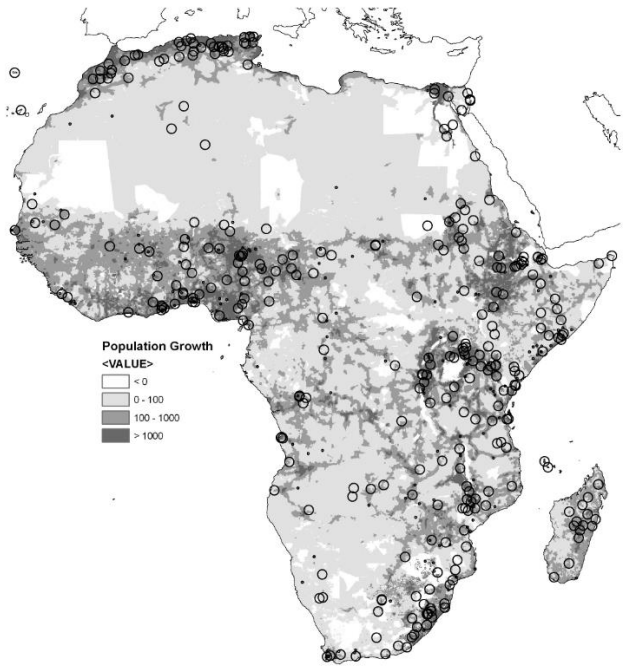
➢ Influencing factors

Factors were not considered in a right way:

- Topographic factors (slope, plains, etc.)
- Meteorological factors (tropical cyclone activity, ENSO, Water vapor flux etc.)
- Human factors (land use, impermeable surface etc.)

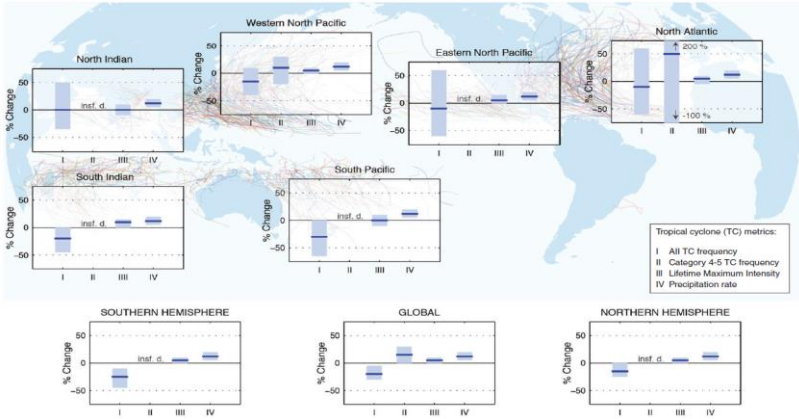
➢ Factors triggering flood disasters

- Extreme precipitation, extreme runoff, tropical cyclones, etc.
  - ✓ Regional differences were discernable, and discrepancy in conclusions still stands
  - ✓ Few studies were done at global scale



Di Baldassarre, G. et al., 2010.

Spatial distribution of population growth and location of flood disaster



IPCC AR5, 2013

Tropical cyclone trends (2081-2100 and 2000-2019)

Background and significance

Major flood disaster database:

- **Global disaster database**
  - EM-DAT, NatCat, Sigma
  - DFO
- **Regional disaster databases**
  - HANZE
  - DesInventar
- **National disaster database**
  - China meteorological disaster database

EM-DAT
The International Disaster Database
Centre for Research on the Epidemiology of Disasters - CRED

Dartmouth Flood Observatory

Global Active Archive of Large Flood Events

Swiss Re Institute
sigma

desinventar
Disaster Information Management System

中国气象局
CHINA METEOROLOGICAL ADMINISTRATION

Background and significance

Scientific issues to be addressed

➢ **More investigations are necessary at global and regional scales**

- Few studies stand with focus on flood disasters at both global and regional scales. Besides, limited studies were found working on causes behind spatiotemporal patterns of flood disaster-induced mortality.

➢ **More driving factors should be involved**

- More driving factors behind flood disasters such as topography, land use should be taken into account;
- More attentions should be paid to multiple factors behind flood disasters besides precipitation extremes and high flow. High flow does not necessarily mean flood disaster.

➢ **The quantitative attribution analysis is necessary**

- Fractional contribution of various meteorological components (extreme rainfall, rainfall intensity, etc.), geographical factors (land use changes, altitude, slopes, etc.) and human activities (urbanization, flood prevention projects, etc.) to flood disasters at different spatial scales.

Contents

Data and Methods

Data

- Emergency Disasters Database (EM-DAT, CRED)
- Dartmouth Flood Observatory (DFO)
- International Best Track Archive for Climate Stewardship (IBTrACS)
- Global land Digital Elevation Model (1km)
- World Economic Outlook Database (IMF)

Methods

- Modified Mann-Kendall (MMK) trend test
- Kendall-Theil Sen Siegel nonparametric linear regression

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Results

Statistical characteristics of global flood disaster and flood-affected population loss

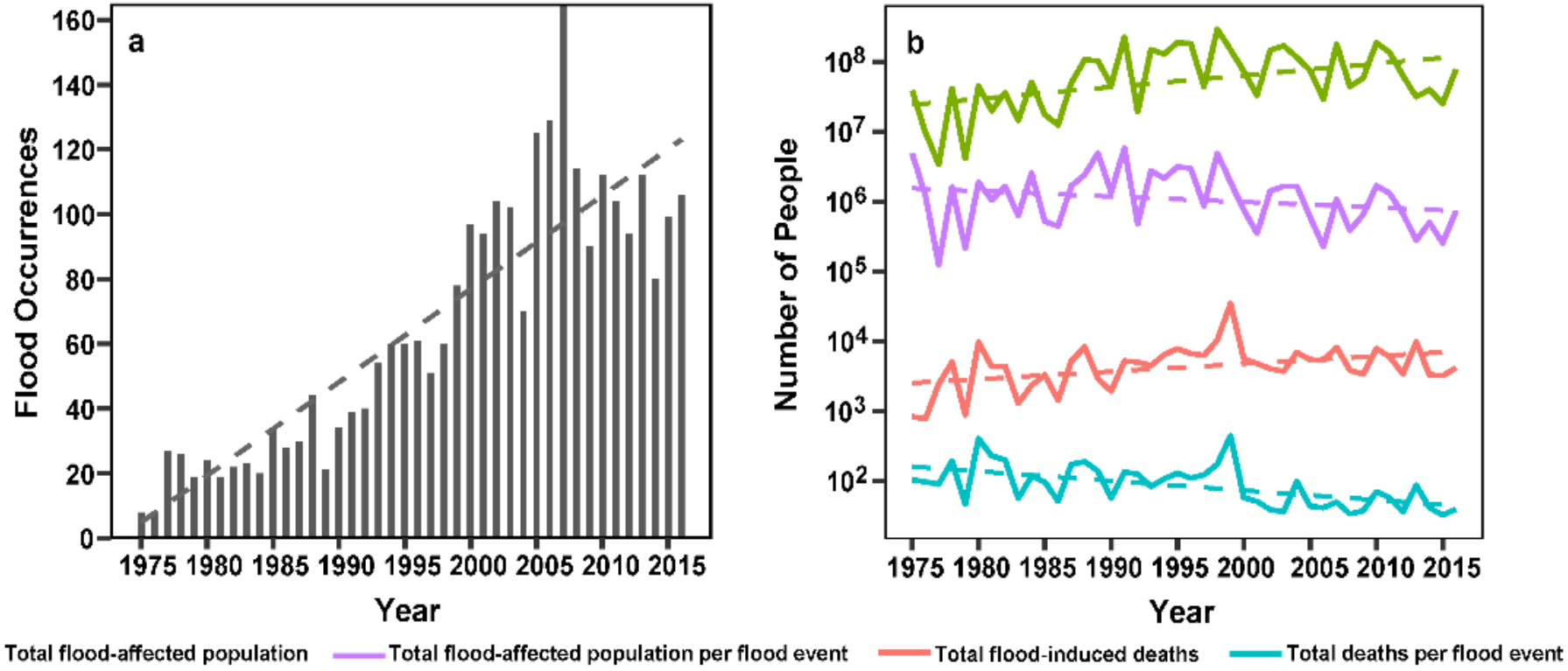
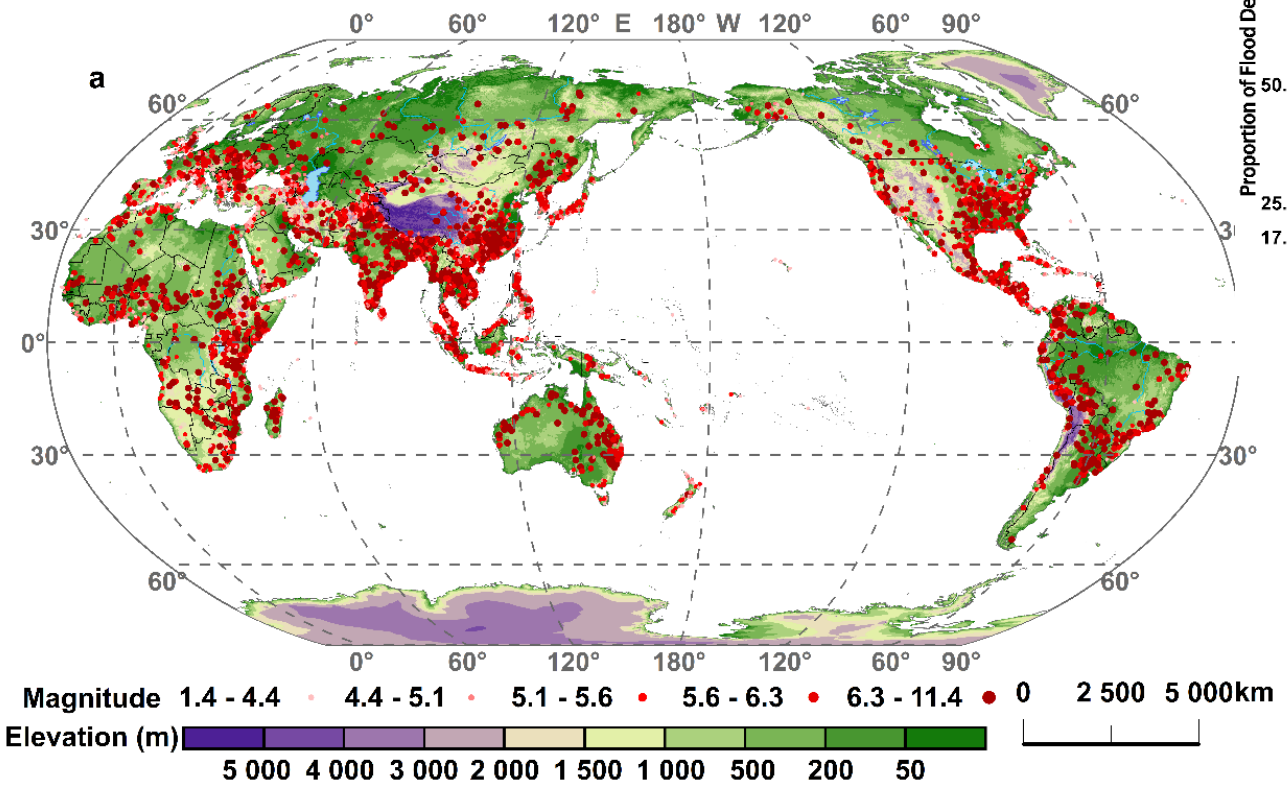
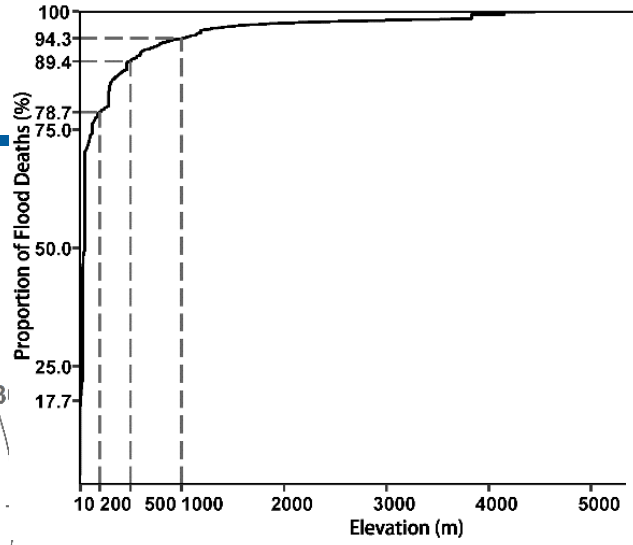


Fig. 1 Flood frequency (a), flood-induced loss of human life (b: flood-induced deaths, flood-affected population, deaths per flood event, flood-affected population per flood event over the globe

- **While floods were increasing across the globe during 1975-2007, occurrences of floods decreased during 2008-2016.**
- **Slight increase can be found in annual flood-induced mortalities and in flood-affected people. However, flood-induced deaths and flood-affected people per flood event were in slow decrease.**

Results





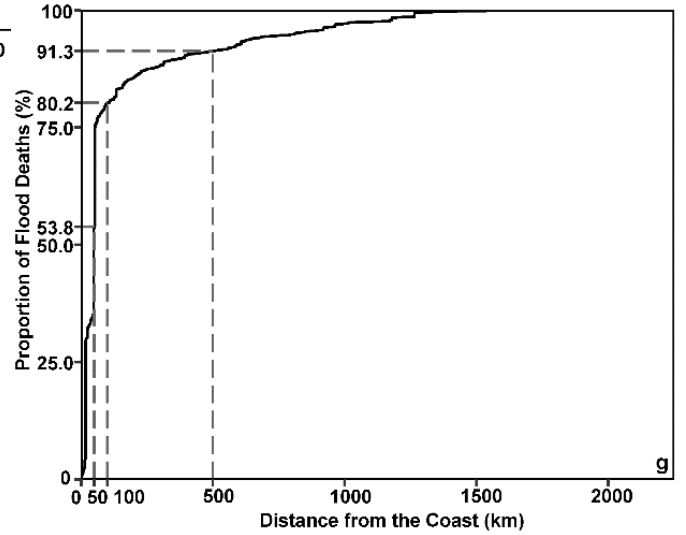


Fig. 2 Spatial pattern of flood magnitude over the globe (1985-2016, Dartmouth Flood Observatory). (a): cumulative distribution of the flood frequency, flood-induced deaths; (b)-(g): percentage of floods occurred in regions with different elevations, slopes and distances from coast regions and also related percentage of flood-induced mortalities.

- **Flood events occurred in areas with elevation between 0-10m only accounted for 4.9% of the total floods, but caused 17.7% of the total flood-induced deaths.**
- **46.1% of the flood events occurred within the regions being 100km far from the coasts, causing 80% of total flood-induced death tolls.**

Results

The spatial and temporal characteristics of flood disaster in each continent and flood-induced mortality

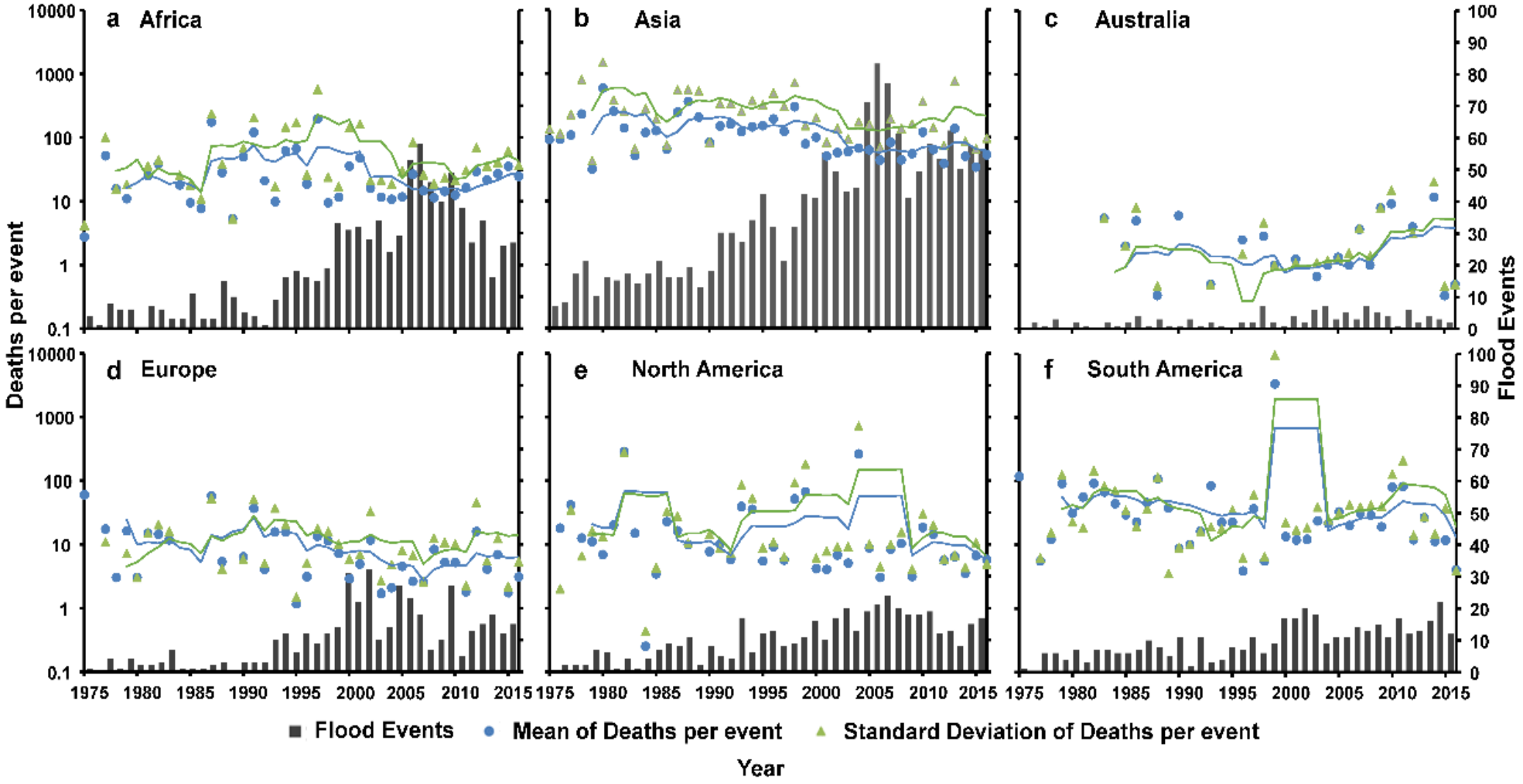


Fig. 3 Occurrence rates of flood events across the Africa, Asia, North America, Europe, South America, and Australia and related flood-induced deaths per flood event and standard deviation.

Results

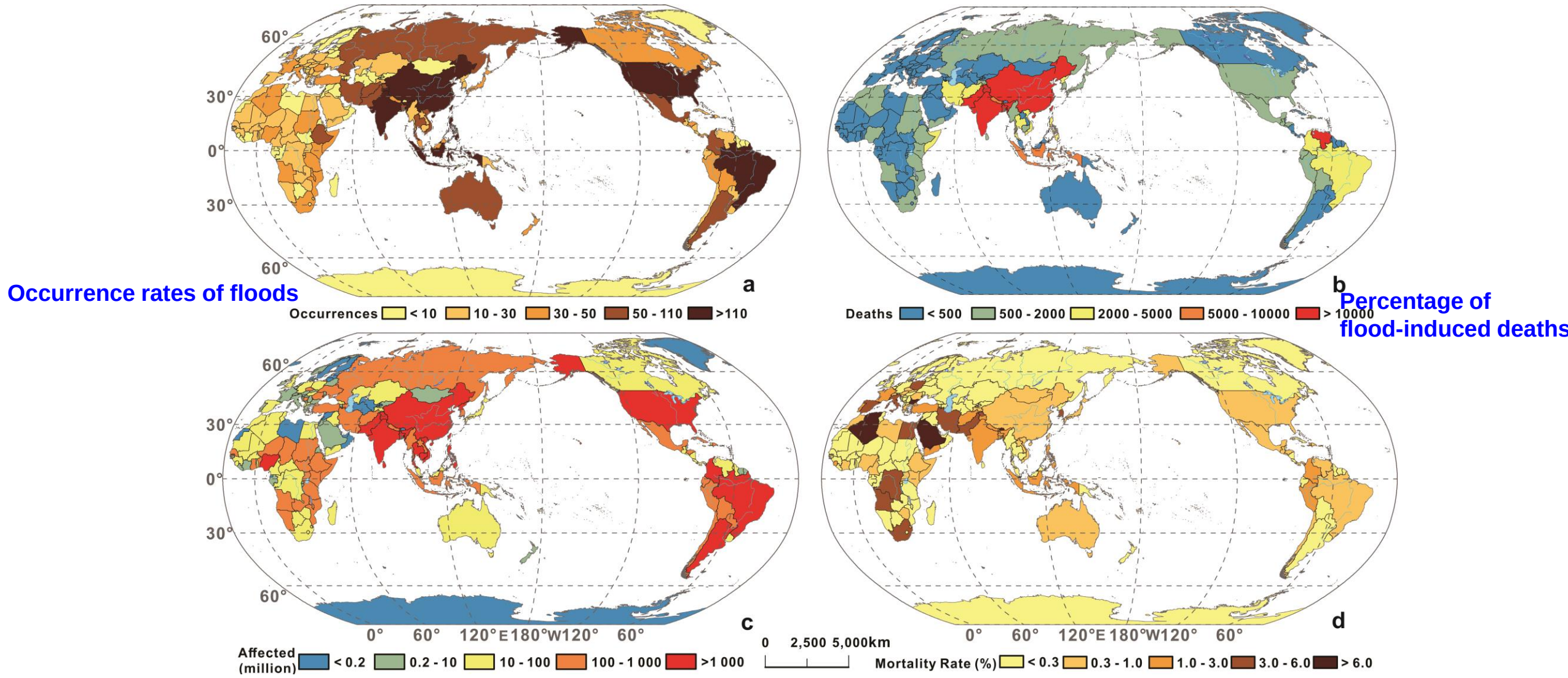


Fig. 4 Occurrence rates of floods, percentage of flood-induced deaths, flood-affected population, and flood-induced mortality rate across the globe (1975-2016).

Results

Spatial and temporal characteristics of flood disaster and loss of flood population in various countries

annual average flood-affected population

annual average flood-affected population per flood event

annual average flood-induced loss

annual average flood-induced loss per flood event

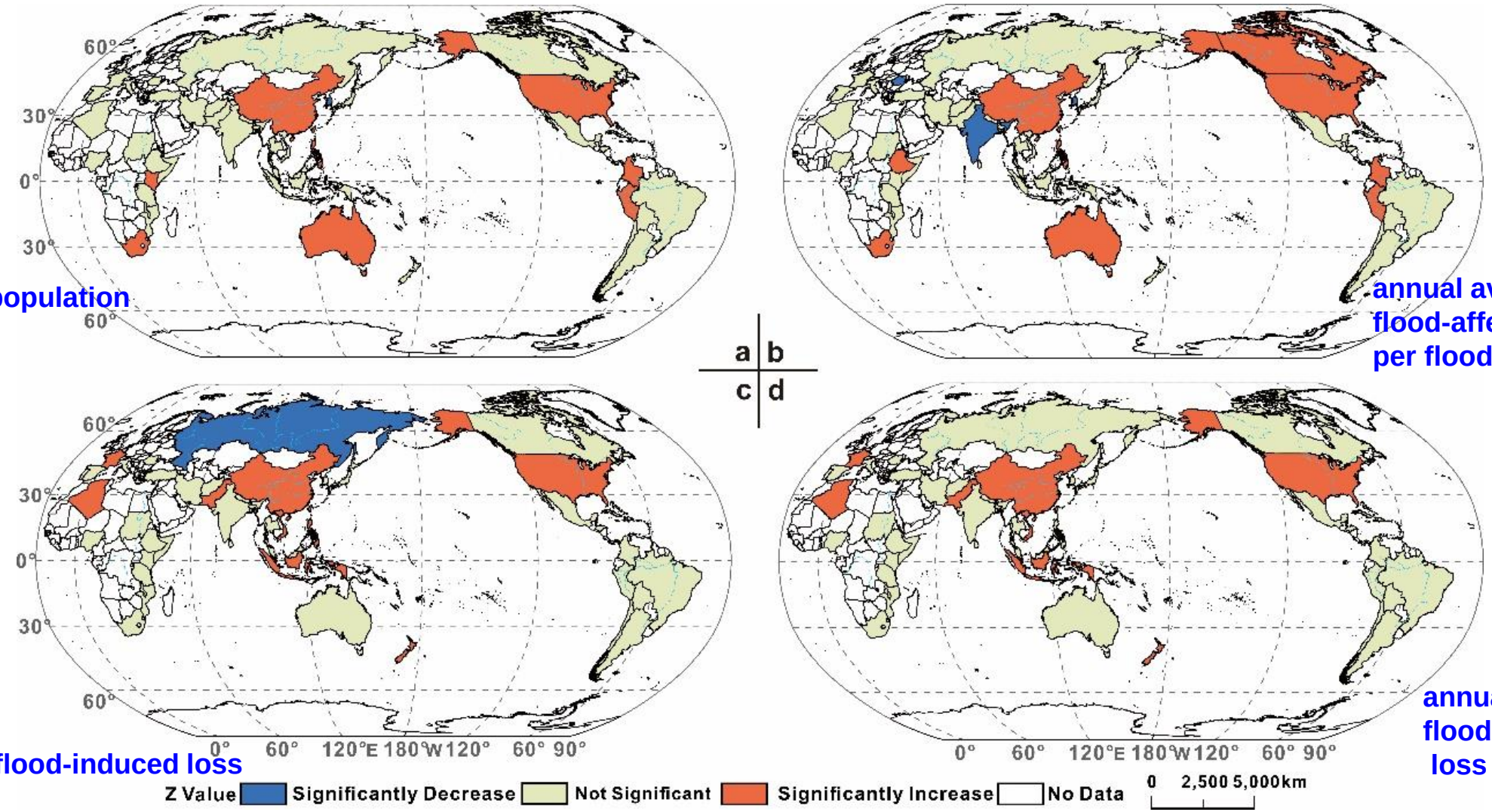
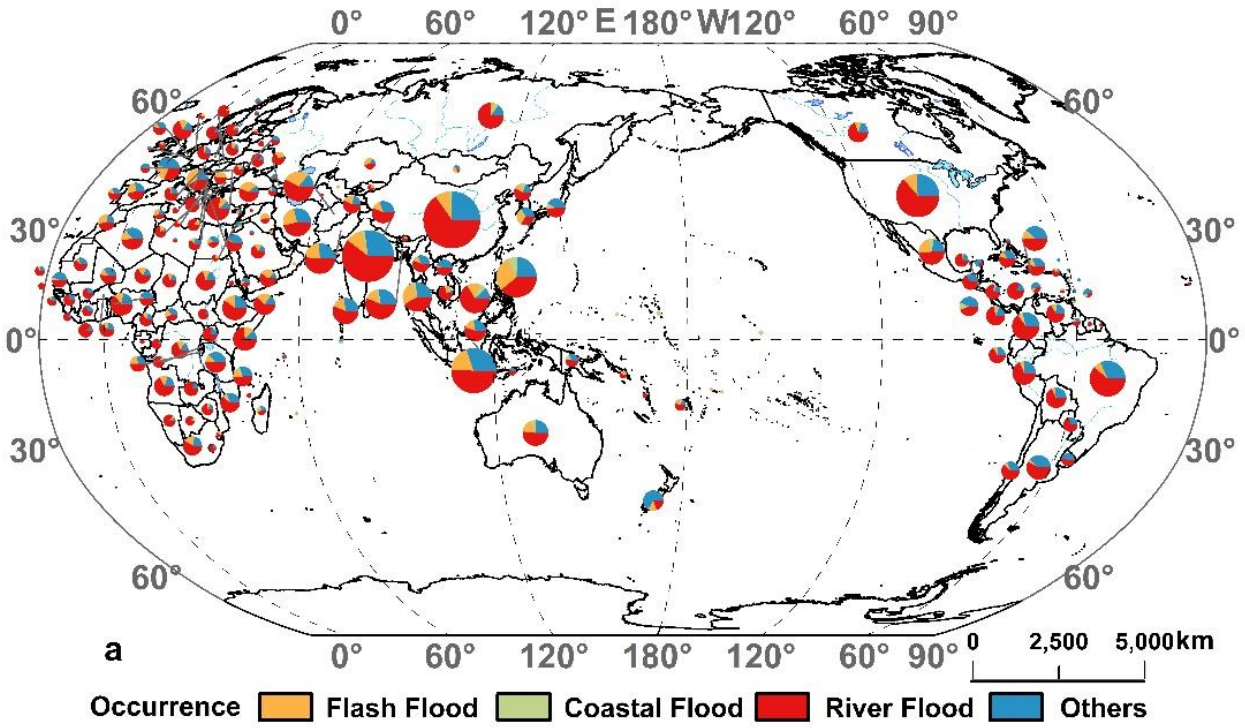


Fig. 5 Trends in annual average flood-affected population (a), annual average flood-affected population per flood event (b), annual average flood-induced loss (c) and annual average flood-induced loss per flood event (d).

Results



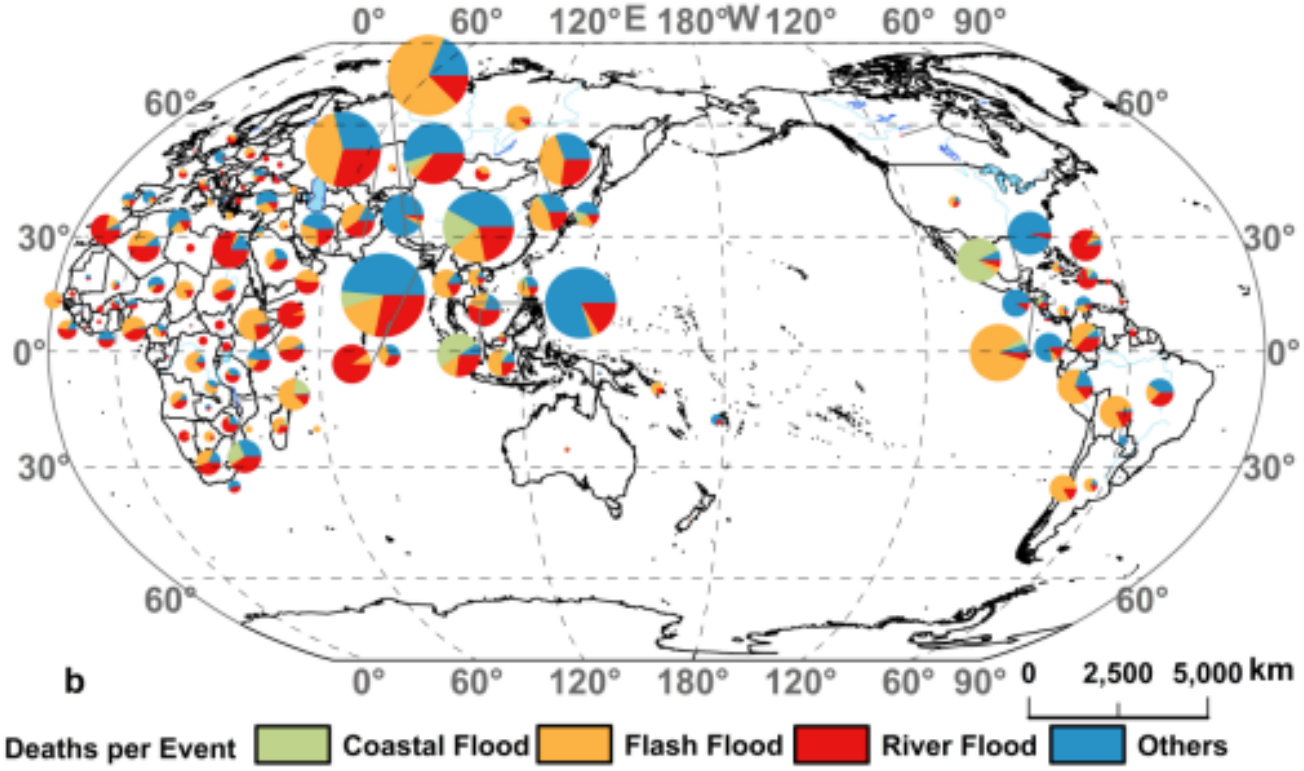


Fig. 6 Percentage of flood frequency (a) and mortality per flood event (b) to total over the globe.

Results

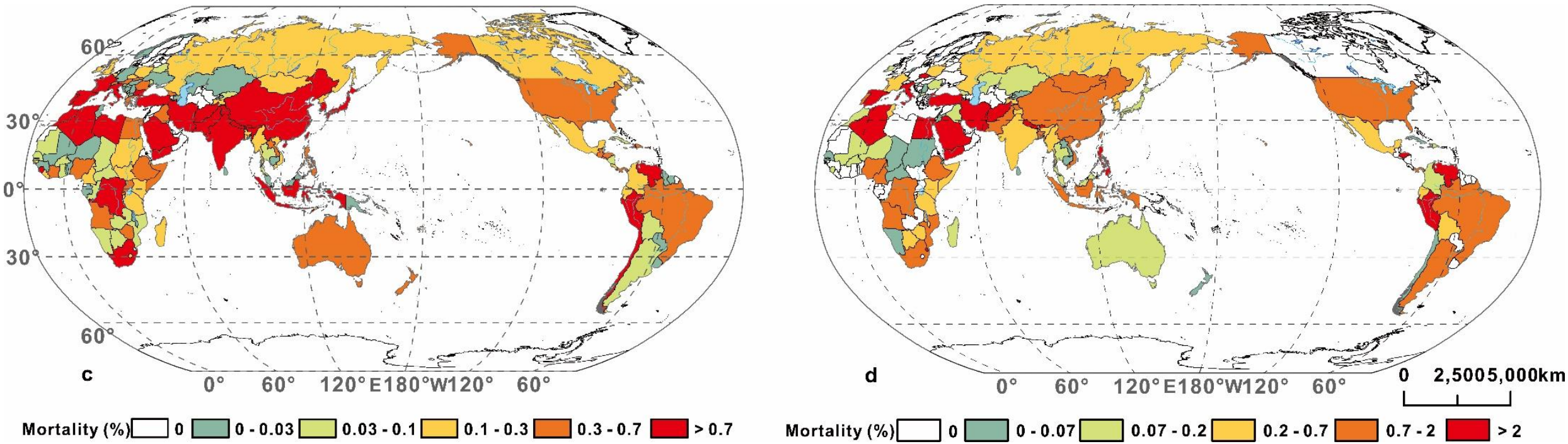


Fig. 7 Average mortalities by riverine floods (a) and flash floods (b).

- **The highest flood-induced mortality can be observed in West Asia, North Africa and South Europe.**
- **Flash floods caused a large proportion of flood-induced deaths specifically in Africa, South Asia, West Asia and South America, whereas coastal floods caused a considerable deaths in East Asia, South Asia and Central America.**
- **The highest river flood-induced mortality was found to be along the Mediterranean coast and west Asia.**

Results

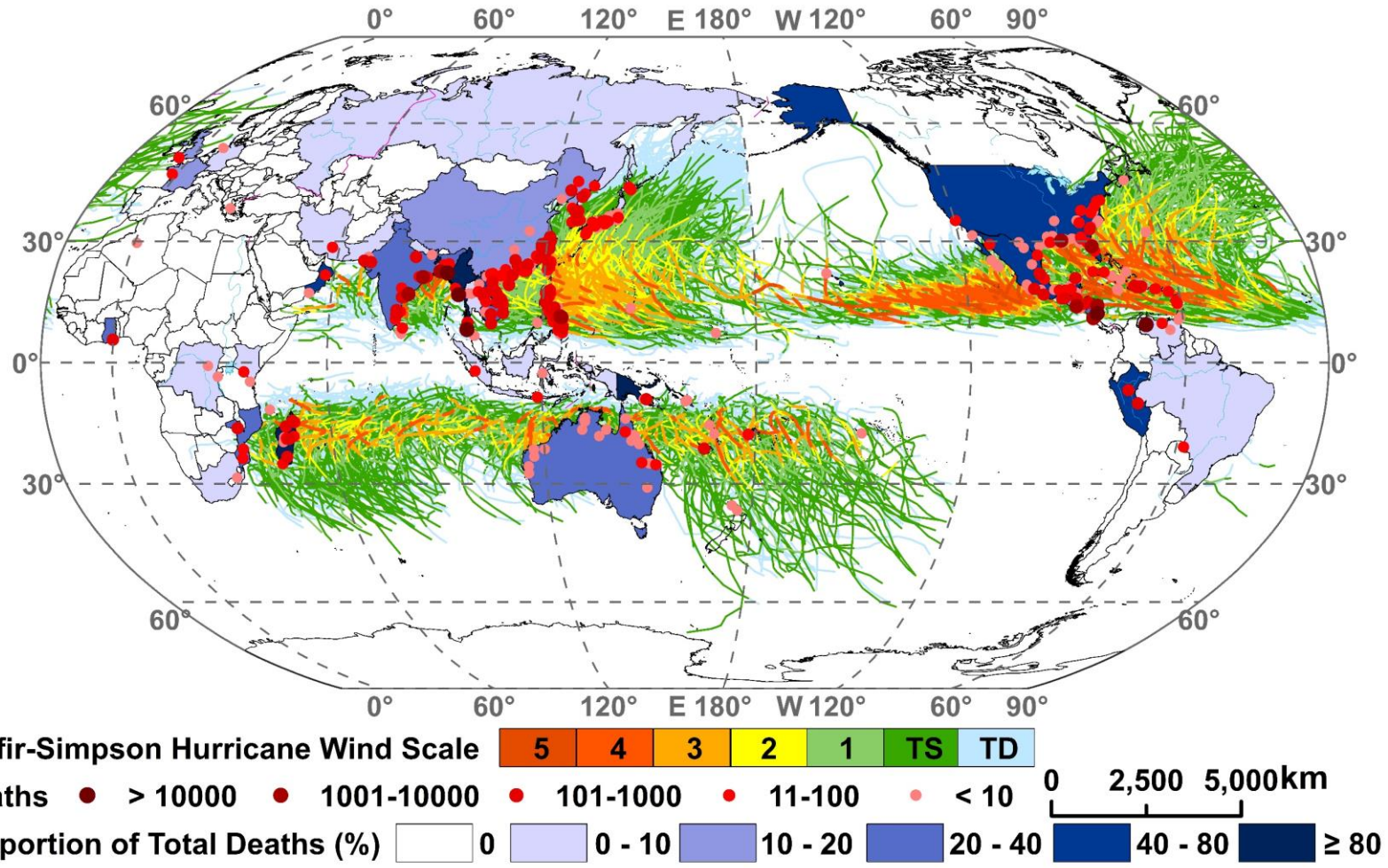


Fig. 8 Spatial connections between paths of tropical cyclones of different intensities and flood-induced deaths caused by tropical cyclones, the proportion of flood-induced deaths caused by tropical cyclone in the total deaths caused by all kinds of floods.

- **Climate change and rapid economic development in the coastal cities and ports have caused the annual increase in loss of human life and increased exposure of property to floods.**
- **Mortalities were the highest in Eastern India Peninsula, the East coast of the United States, the Gulf of Mexico and the Caribbean, followed by the West coast of Pacific.**

Results

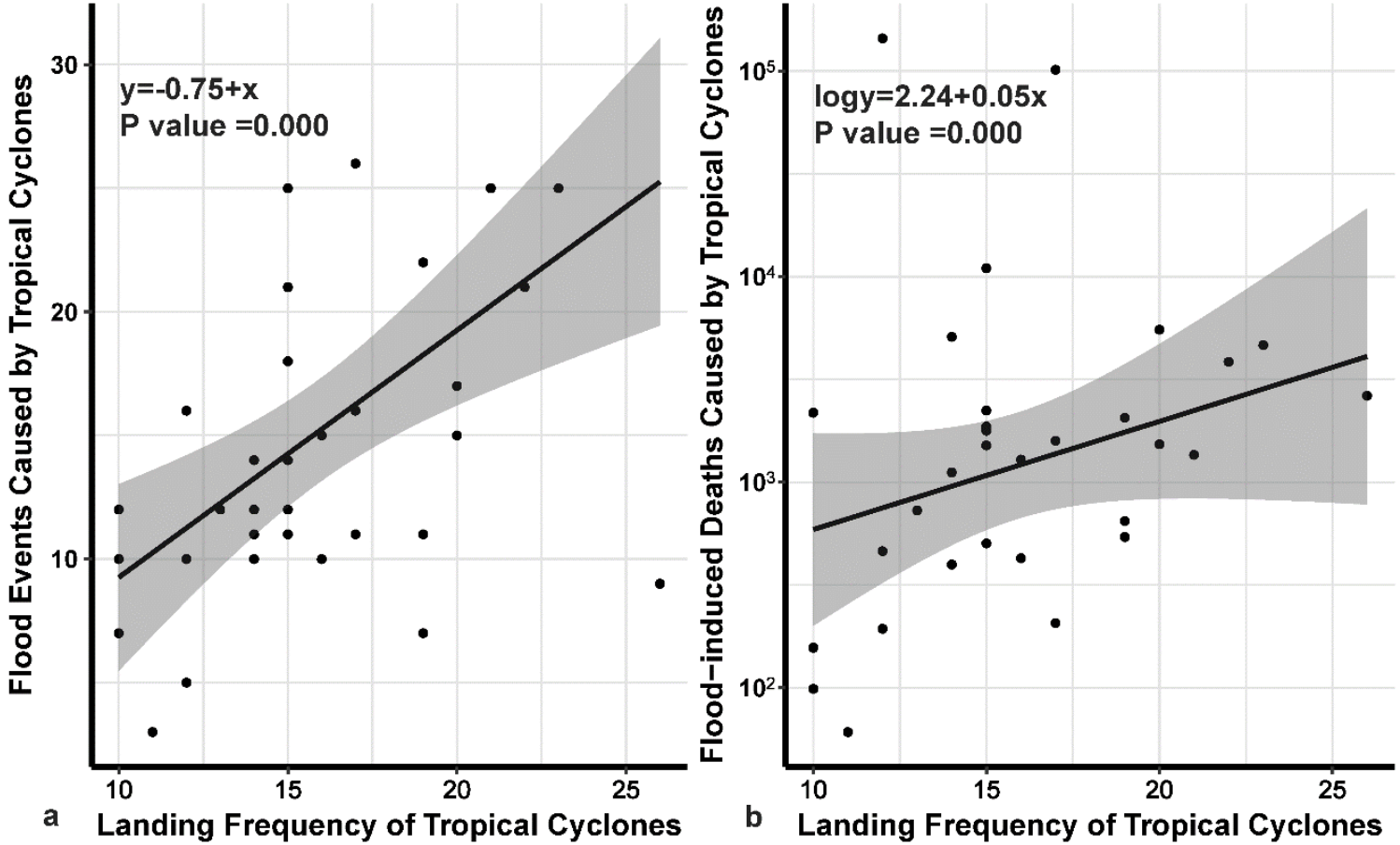
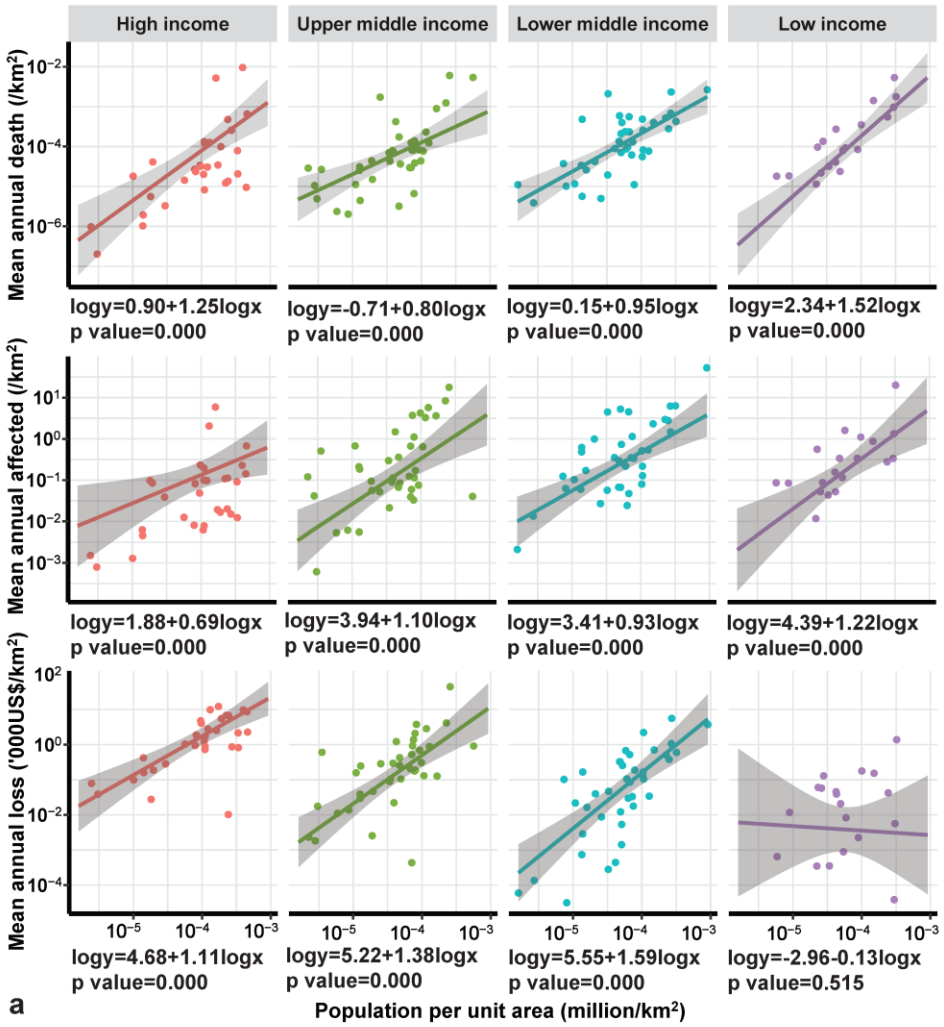


Fig. 9 Relations between landing frequency of tropical cyclones and flood events caused by **tropical cyclones** (a) and **flood-induced deaths caused by tropical cyclones** (b).

- **It identified significantly positive relationships between tropical cyclone-induced flood events, flood-induced deaths and tropical cyclone landfalls, indicating that landfall frequency of tropical cyclones has strong impact on flood frequency and causes considerable number of deaths.**

Results



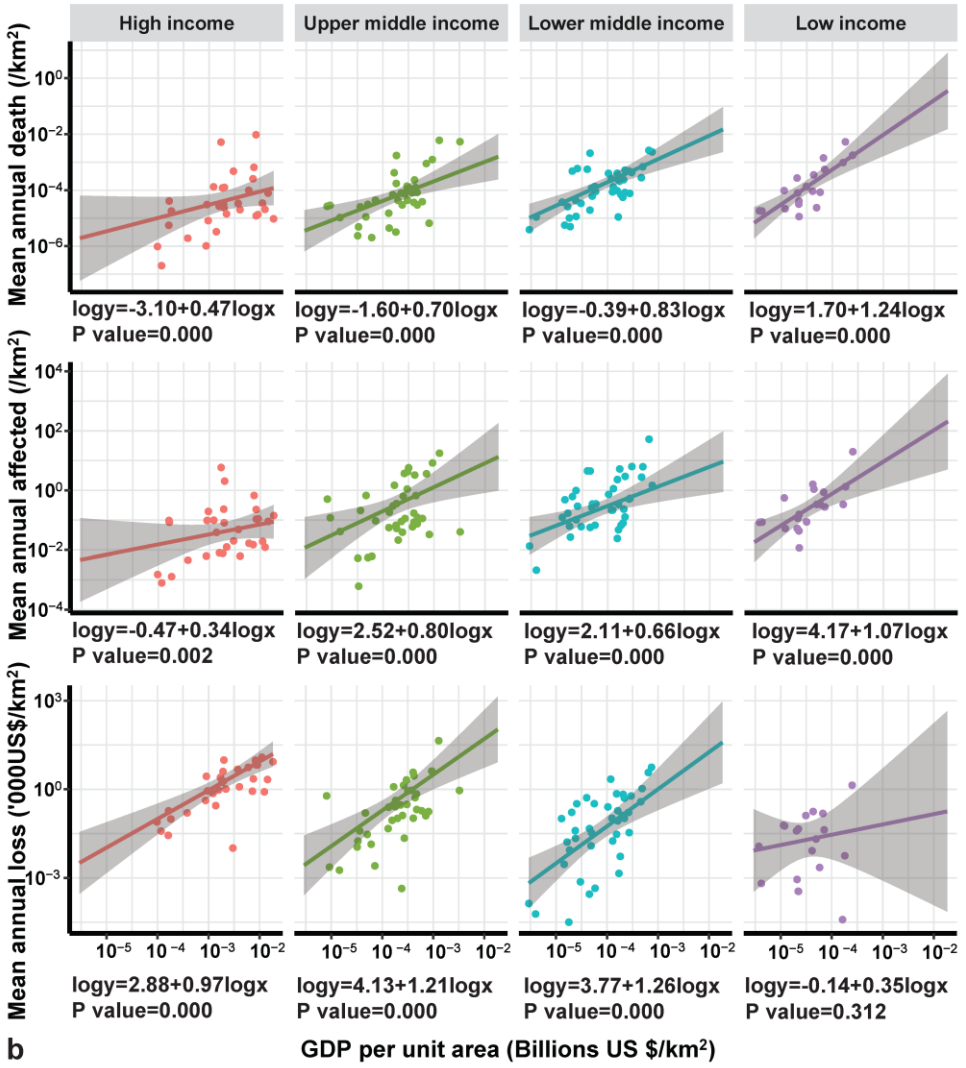


Fig. 10 Correlations between population (a), (b) GDP per unit area and flood-induced deaths, flood affected population and loss.

Contents

Conclusions

- **Findings about increased flood-induced affected people and deaths due to increased flood frequency but not enhanced flood intensity at global scale**
- **Linkages between topography and occurrences of floods, relationships between GDP, population density and flood induced mortality**
- **Tropical cyclone-induced floods had strong impacts on global flood-related mortality particularly for regions along the west coastal countries**

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Flood-induced mortality across the globe: Spatiotemporal pattern and influencing factors

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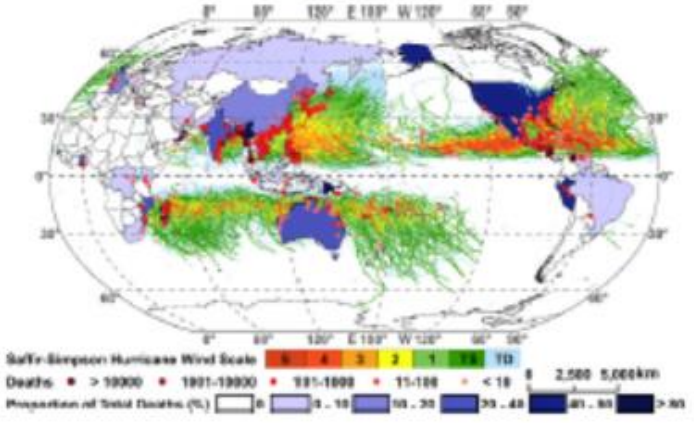
HIGHLIGHTS

- New findings about increased mortality due to increased flood frequency but not enhanced flood intensity
- New light on linkages between topography and occurrences of floods
- Novel viewpoints pertaining impacts of TCs on floods along the coastal regions of the globe

GRAPHICAL ABSTRACT



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ABSTRACT

Impacts of floods on human society have been drawing increasing human concerns in recent years. In this study, flood observations from EM-DAT (Emergency Events Database) and DFO (Dartmouth Flood Observatory

http://hydromet-zq.top/

Comments and suggestions

Will be greatly appreciated!