MODULATION OF FLOOD ECONOMIC LOSSES BY THE NORTH ATLANTIC OSCILLATION

Stefano Zanardo
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Does the North Atlantic Oscillation impact flood economic losses in Europe?

- NAO and Precipitation
- NAO and river flows
- NAO and losses – Data
- NAO and losses – Model
“The North Atlantic Oscillation describes the changes in sea level pressure between the Azores high and the Icelandic low”
“The North Atlantic Oscillation describes the changes in sea level pressure between the Azores high and the Icelandic low”

- The NAO correlates highly with European precipitation patterns
- During **positive NAO** phases, stronger and more frequent storms travel Northern Europe, causing **wetter** than usual conditions, while Southern Europe is **drier** than usual
- During **negative NAO** phases, storms tend to travel across Southern Europe, causing **drier** than usual conditions in Northern Europe while Southern Europe is **wetter**
NAO EFFECT ON WINTER PRECIPITATION

- Correlation between NAO and E-OBS data at monthly level
- Winter precipitation only – 1960 to 2010
- North-South seesaw pattern
The NAO displays long periods of positive or negative phase.
The NAO displays long periods of positive or negative phase

long periods of wet or dry conditions

Dual effect of NAO on flood process:

- Direct effect through precipitation
- Indirect effect through long-term wet/dry conditions
What is the NAO when rivers peak across Europe?

- NAO is on average **positive** when rivers peak in **Northern Europe**
- NAO is on average **negative** when rivers peak in **Southern Europe**

4260 stations
Period: 1960-2010

Mean NAO during river annual maxima

-1.20 - -0.60
-0.60 - -0.10
-0.10 - 0.00
0.00 - 0.10
0.10 - 0.60
0.60 - 1.20

[Bloschl et al. 2017, Science; Zanardo et al., 2019, GRL]
Do catastrophic flood events follow the same pattern?

- Distributions of NAO observed during historical flood events
- Winter flood events in Northern Europe occurred mostly during a positive NAO phase
- Winter flood events in Southern Europe do not show any particular trend

Hanze event dataset: 1950-2017 – data by country

[Paprotny et al. 2018, ESSD; Zanardo et al., 2019, GRL]
Do catastrophic flood events follow the same pattern?

- Winter flood events in **UK** occurred mostly during a positive NAO phase
- Winter flood events in **Spain** occurred mostly during a negative NAO phase
- Clear pattern of occurrence can also be seen at monthly level

**Hanze event dataset: 1950-2017**

[Paprotny et al. 2018, ESSD; Zanardo et al., 2019, GRL]
NEED FOR A FLOOD LOSS MODEL

Stochastic precipitation
- 50,000 years of continuous precipitation across Europe with correlation with NAO based on historical data

RRM and river routing model
- Stochastic rainfall is fed to a rainfall-runoff model and a river routing model

SWE inundation
- Rainfall and river inundation is calculated using shallow water equation

Vulnerability and exposure
- 50,000 years of flood events are used to compute damage from a vulnerability and exposure database

Losses
- Loss statistics for the whole European domain are derived
Impact of NAO on flood losses across Europe

- 4 large clusters of positive/negative effect of NAO on losses
- NAO variability is a strong source for loss correlation across countries
- Loss difference between opposite phases can reach 50%
CONCLUSIONS

- We examined whether the NAO has a significant impact on flood losses across Europe.

- Data show that the NAO has an impact on precipitation and flows.

- Catastrophic flood data show an NAO “signature” on the event occurrence, however loss data are scarce.

- The application of a probabilistic flood catastrophe model shows that the impact of NAO on losses is significant and it has specific spatial patterns.
THANK YOU