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Do public investments targeting hydrogeological risk mitigation increase firms' resilience to flood events? Evidence from Italy

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Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

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Introduction

- Climate change is increasing the **frequency and severity of floods**, amplifying their potential to disrupt economic activity. In particular, flood events can significantly impact firms, threatening their survival and performance.
- Preventive measures, such as **investments in flood mitigation**, are critical to reducing these risks.
- Many mitigation measures have characteristics of public goods, typically provided by the state or public administrations.
- This study examines whether and to what extent public investments in hydrogeological risk mitigation reduce the economic consequences of floods, with a focus on firms' survival and performance.

Literature Review

- Large literature on the economic consequences of extreme natural catastrophes such as earthquakes (Barone and Mocetti, 2024; Lackner, 2014; Porcelli and Trezzi, 2019).
- More recent literature on **climate-related disasters** such as floods:
 - while less extreme, they occur with greater frequency (IPCC, 2023);
 - some studies find significant (short run) decrease in survival rates and performance of firms situated in affected areas (Fatica et al., 2024; Clò et al., 2024; Benincasa et al., 2024).
- Evidence of the positive economic impact of **high-quality institutions** and **public financial aid AFTER** the catastrophic event (Felbermayr and Gröschl, 2013; Boudreaux et al., 2023).
- Role of **preventive measures** has not yet been analyzed.

Data sources

1 Watercourse maps

- DBPrior 10K
- ISPRA National Hydrography Network

2 Public investments targeted at mitigating hydrogeological risks

- OpenCUP
- BDAP-MOP
- Open Coesione
- ReNDiS

3 Flood events

- ISPRA annual reports on climate events
- Gatto et al. (2023)

4 Firm-level data

- ORBIS balance sheet data

Data

Hydrography network geospatial data

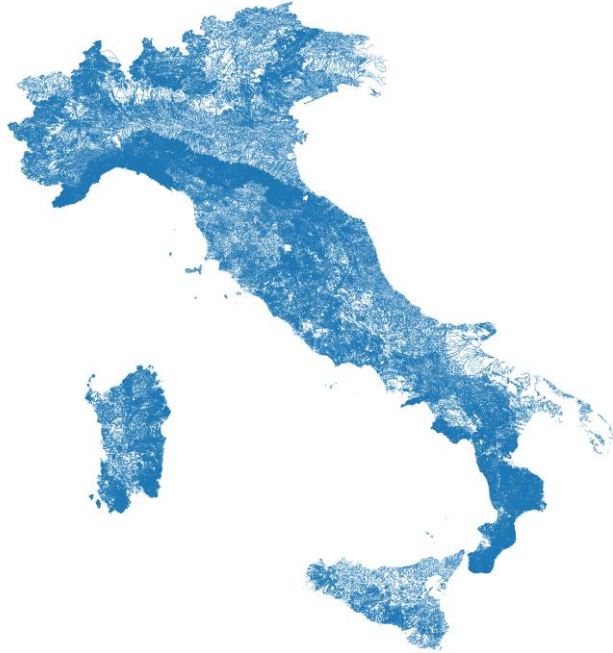
We collected geospatial data on the river maps to retrieve the **river geometries, river names**, and other distinguishing attributes (e.g., natural or artificial classification, type of water element, ...).

Data were gathered from the following two data sources:

- the "*Strati Prioritari di Interesse Nazionale*" (namely, **DBPrior10k**) project. The sample consists of 1,491,205 observations;
- the **ISPRA National Hydrography Network** dataset. The sample consists of 61,978 observations.

Data

Hydrography network geospatial data



DBPrior10K



ISPRA National Hydrography Network

Data

Hydrography network geospatial data

Creation of an integrated hydrography:

Starting from:

- DBPrior10k and
- ISPRA National Hydrography Network

Created a single hydrography with about **1.5M river geometries** while avoiding the creation of duplicated geometries.

Extensive cleaning of river names:

- Removed special characters;
- Substituted recurring abbreviations with their extended version;
- Standardized usage of common expressions (e.g., river);
- Removed common expressions.

Hydrography filtering:

After the extensive cleaning, many geometries remained with an empty name. These geometries have been removed.
The resulting cleaned hydrography consists of **600,791 geometries**.

River-municipality dataset:

Using the shapefile of Italian municipalities, rivers with the same name within each municipality were consolidated in a single observation.
The resulting municipality-river hydrographic network is made of **111,922 unique municipality-river combinations**.

Data

Public investments to mitigate hydrogeological risk

1 openCUP

- 1,801,163 (1,572,193 CUP)
- Focus on *"lavori pubblici"*
- Public and private, national and European funds

2

BDAP-MOP

Sistema di Monitoraggio delle Opere Pubbliche

- 595,543 (523,163 CUP)
- *Banca Dati delle Amministrazioni Pubbliche*
- Public infrastructure investments' data

3

Open Coesione

- 17,167 (11,297 CUP)
- Cohesion policy projects
- Focus on *"politiche di dissesto"*
- European and national funds

4

ReNDiS

Repertorio Nazionale degli Interventi per la Difesa del Suolo

- 22,484 (22,287 CUP)
- Only projects financed by MATTM
(*Ministero dell'Ambiente e della Tutela del Territorio e del Mare*)

Data

Public investments data integration to river-municipality

Merge of public investments DBs:

Merged the 4 databases using CUP (*Codice Unico di Progetto*) as communication key.

The resulting dataset main variables are:

- CUP;
- municipality;
- description;
- sector of intervention;
- type of intervention;
- total financing.

Public investments filtering:

Focus on investments against hydrogeological risks (sector set to "*Difesa del suolo*").

This results in **49,740 distinct CUP** and 74,226 CUP-municipality pairs.

Extraction of river names information:

We extract river names from the intervention description.

From **87% of investments we extract:**

- Regular expressions;
- **River names** in the affected municipality.

This results in 43,310 distinct CUP-municipality-river triples.

Integration with the river-municipality dataset:

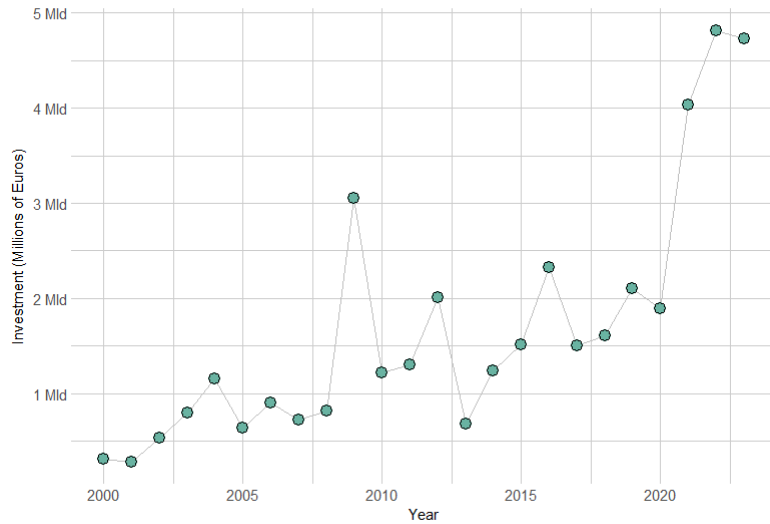
We employ river name and municipality data to associate **60.5% of investments to the river-municipality dataset.**

Distribution of total financing if investment affects multiple municipalities-rivers.

We compute annual total financing for each river-municipality.

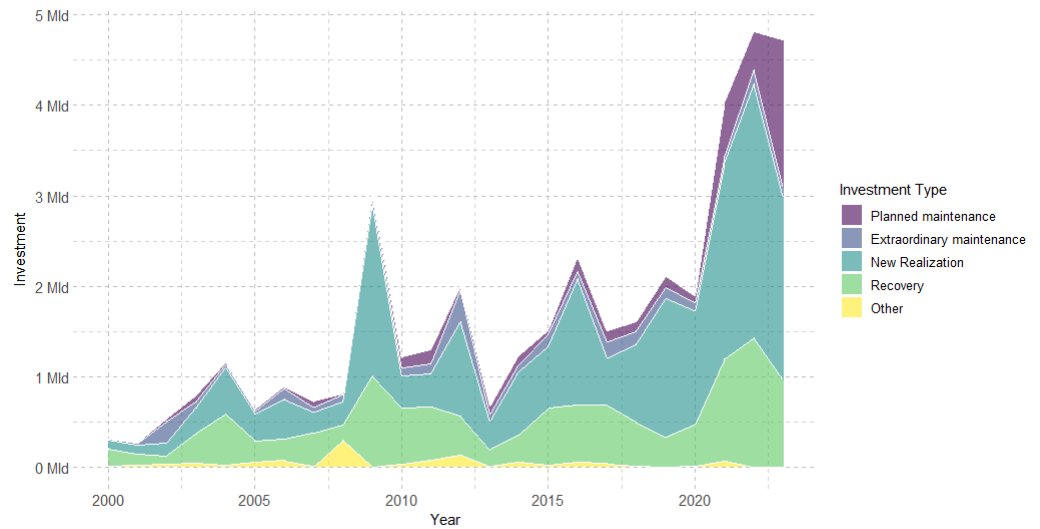
Preliminary results

Evolution of Public Investment



Time series of total investments

Evolution of Public Investment (by type)



Time series of total investments per type of investment

Data

Flood events data

- **ISPRA's annual reports on climate events**
 - years 2003–2021
 - only provincial level
 - info on whether a flood occurred within the province in a given year and affected rivers
 - able to link flood events to individual observations in river–municipality dataset
 - ASSUMPTION: all *municipality–river* combinations along the path of the flooded river within the affected province were impacted by the event
- Dataset by **Gatto et al. (2023)**
 - years 2013–2022
 - municipality–level
 - info on **landslides and floods** occurred in Italy, for which a **national-level emergency** was issued
 - no info on flooded rivers
 - no possibility to distinguish between landslides and floods

Data

Flood events data – ISPRA



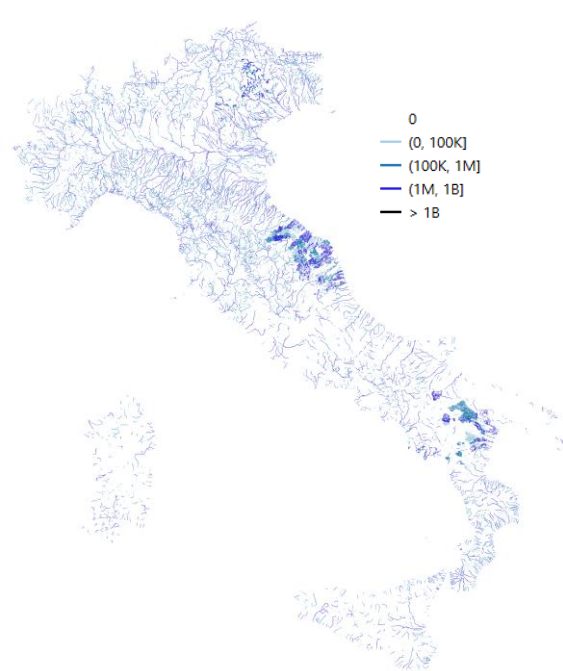
Time series of flood events from ISPRA

- Two events are considered different if the duration of the events differs

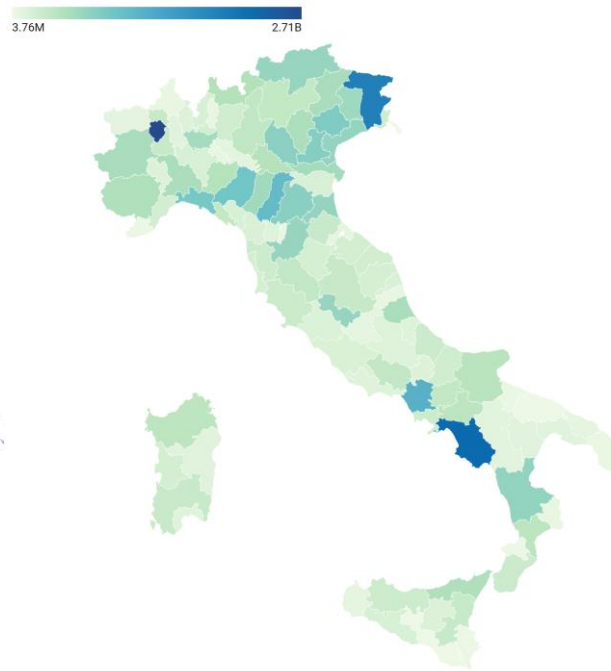
Final Dataset

- Years: 2000–2023
- Units of observation: river–municipality pairs (111,922)
- Time-invariant variables:
 - River name
 - Administrative information (municipality, province, region)
 - River geometry
- Time-varying variables:
 - Public financing (total and by investment type)
 - Flooded area dummy and number of floods according to ISPRA for the period 2003–2021
 - Flooded area dummy, number of floods, and number of floods to which an emergency state was associated according to Gatto et al. (2023) for the period 2013–2022

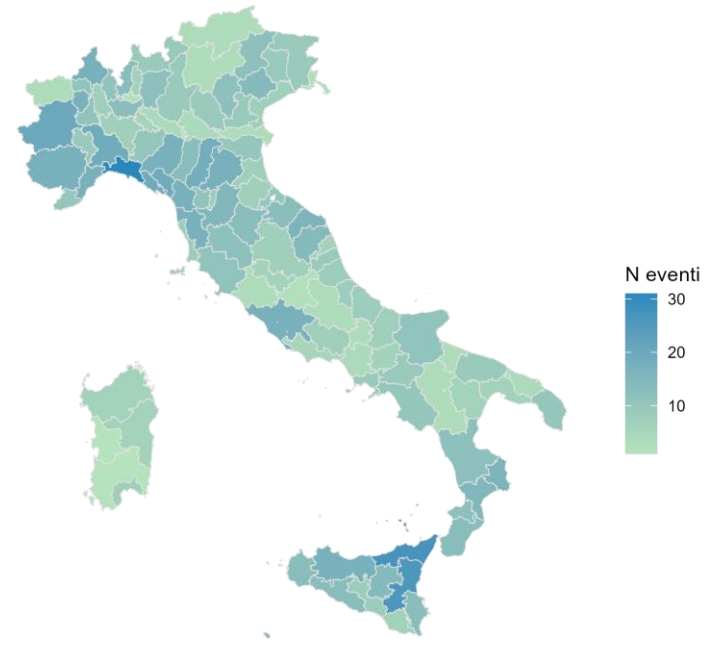
Preliminary results



Cumulated (2000–2023) public investments per river-municipality



Cumulated (2000–2023) public investments per province



Cumuiated (2003–2021) flood events per province

Data

Firm-level data

- We plan on using the following **ORBIS** data:
 - Address information to locate firms and associate them information regarding public investments and flood events;
 - Balance sheet data to evaluate flood impacts and public investments mitigating effects on firms' survival rates and firms' performance.
- We are still developing a **strategy to associate investments and flood event data to firms.**
- A possible strategy would be to
 - Create a buffer of a given size around a firm location
 - Associate to each firm the total yearly investment of municipality-river pairs intersecting the buffer
 - Consider the firm as flooded if at least one municipality-river intersecting the buffer results as flooded.

Potential applications

- Analysis of **public investments endogeneity** with respect to flood events (ex-ante vs ex-post public intervention)
- Analysis of whether (ex-ante) public investments against hydrogeological risks reduce the **probability of experiencing flood events**
 - o Such an analysis will require the integration of additional data such as pluviometric data from Copernicus
 - o This analysis could provide information regarding potential selection into treatment for the subsequent analysis
- Analysis of whether (ex-ante) public investments against hydrogeological risks reduce the **damages caused to firms by flood events.**
 - o by comparing flooded firms, do firms located in high-investment areas experience on average less damages (higher survival rates, better performance)?
 - o We could also explore whether ex-post public investments/compensation measures offset flood damages.

Where we are and what's next

Task	Main activities	Status
Hydrography	Review of available shapefiles and data retrieval	Completed
	Data cleaning	Completed
	Creation of the river-municipality dataset	Completed
Public investments	Download of the databases and merge	Completed
	Filtering of investments against hydrogeological risks	Completed
	River names extraction from investments descriptions	Completed
River-municipality-investments mapping	Mapping individual investments to river-municipality pairs	Completed
	Distribution of individual investments across multiple river-municipalities if needed	Completed
	Computation of yearly (total, by type) river-municipality financing	Completed
Flood events	Review of available datasets	Completed
	Data cleaning	Completed
	Association of flood events to individual river-municipality pairs	Completed
Firm-level data	Firms' geolocation	Completed
	Association of public investments and flood events to firm data	In progress
Applications	Dataset descriptives	In progress
	Development of econometric strategy	In progress
	Econometric analysis and indicators computation	To be done

Thank you for the attention

