Detecting regional food systems exposure to climate shocks

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California's climate apocalypse

Fires, heat, air pollution: The calamity is no longer in the future — it's here, now

Oregon residents standing ground

By Richard Read, Molly Hennessy-Fiske and Melissa Etehad

MOLALLA, Ore. — Christine VanOverere grabbed a bucket Saturday and lugged water from a neighbor's swimming pool to douse embers from a wildfire that threatened to merge with another blaze to cover an area as big as Los Angeles.

The 45-year-old mother of two and her husband, John, had helped beat back flames Friday that came within 500 yards of their house 45 miles south of Portland, Ore. On Saturday, after clearing ash from their

By Susanne Rust and Tony Barboza

In 2008, a team of international scientists projected that during the next 100 years, the planet's inhabitants would witness higher maximum temperatures, more hot days and heat waves, an increase in the risk of forest fires and "substantially degraded air quality" in large metropolitan areas as a result of climate change.

In just the past month, nearly two decades after the third United Nations Intergovernmental Panel on Climate Change report was issued, heat records were busted across California, more than 3 million acres of land burned, and air pollution has skyrocketed in major metropolitan areas such as Los Angeles and San Francisco.

"This shouldn't come as a surprise to anyone," said Michael Gerrard, director of the Sabin Center for Climate Change Law at Columbia University. "Maybe we underestimated the magnitude and speed" at which

Motivations

- The frequency and intensity of natural disasters such as droughts, floods, storms and the diffusion of invasive and unknown pests are year-by-year increasing all over the world (e.g., FAO, 2021)
- The increase of the spread and of the intensity of climate change induced disasters (e.g., Coronese et al, 2019), has started threatening production of the goods which are more exposed to climate change at the global level $\rightarrow$ The provision of food is particularly under threat
- In a world in which production is geographically spread and organized in international value chains, the toolkit provided by input-output analysis is particularly suitable for understanding the resilience of food systems with respect to climate shocks $\rightarrow$ but much more work is needed in terms of data construction and modelling

Aim of the project

Providing an assessment of the ex ante exposure of Italian regional food systems to climate shocks affecting food value chains

1. Estimating food systems stemming from a disaggregated demand for food, both at the regional and the national level
2. Reconstructing and analyzing the international, interregional and intraregional trade networks of intermediate inputs linked to the demand for food, so as to identify the sources of potential bottlenecks in the value chains
3. Performing a stress test analysis to assess the resilience of regional and national food systems to climate shocks

In this presentation

1. We estimate the value chain activated by Italian household expenditures on food
2. We assess the dependence from abroad in terms of value added by distinguishing: imports of final goods; imports of inputs
3. We present two case studies, providing a first assessment of the impact of the 2022 drought in the Po region and the 2023 flood in Emilia-Romagna
4. Sneak preview of most recent work (food satellite account)

Methodology & Data

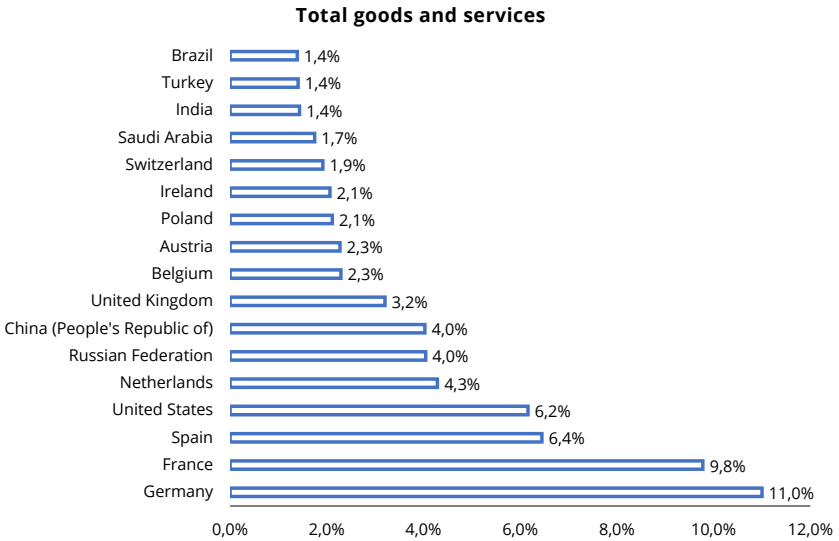
- The Italian interregional input-output database (IRPET-IRIOREG)
- Defining the food value chain
- The intermediate input network
- Climate shocks: sources of data

Exposure to international shocks (1)

Considering agricultural and processed food:

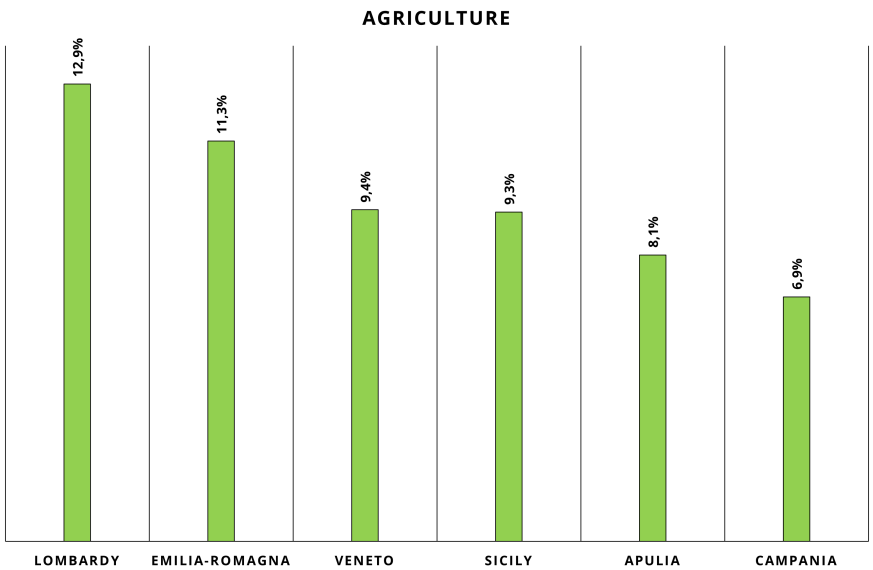
- For those kinds of final goods demanded by the Italian households, 80% is provided by Italian firms. The rest (20%) is imported from abroad
- In terms of value added, and considering the final products produced by Italian firms, the exposure to the rest of the world is 26% (upwardly biased estimation due to the role of leakages)
- Thus: for every euro spent on food by Italian households, 40 cents remunerate production factors localized abroad

Exposure to international shocks (2)



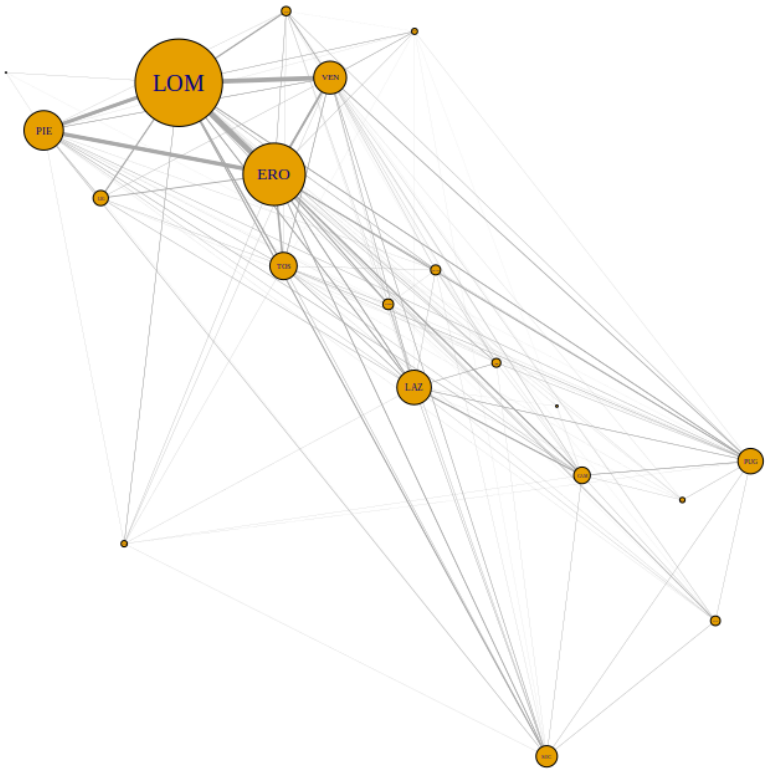
- European countries represent the most important suppliers (in terms of value added: notice that it might not be the best measure to capture dependence from emerging countries;
- however: 23% of agricultural value added stems from RoW production!

Regional contributions: agriculture vs. industry processed

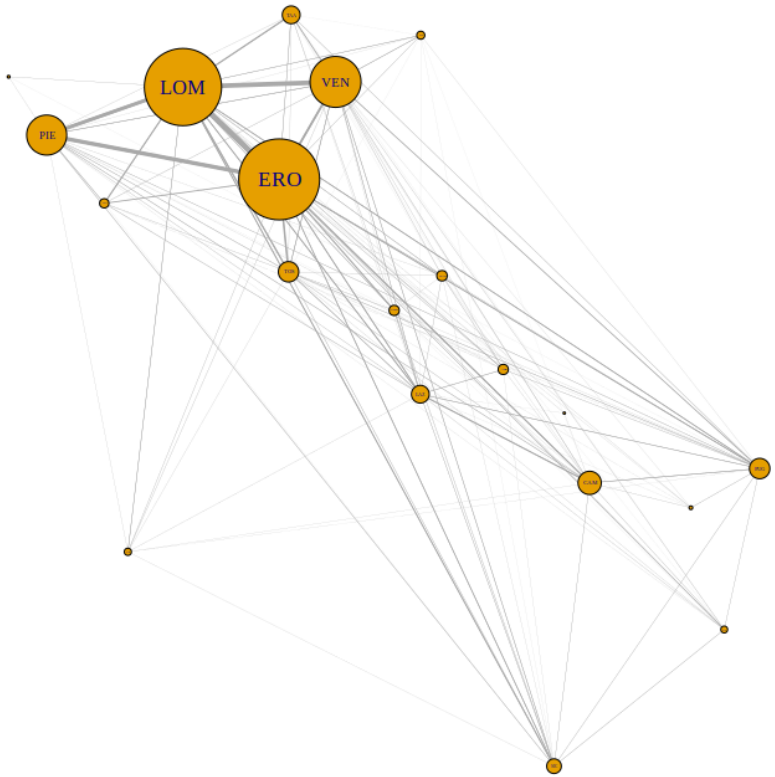


40% of agricultural contribution to meet the Italian household food demand stems from 4 regions in the North (Lombardy, Emilia-Romagna, Veneto, Piedmont)

The interregional network serving national food demand



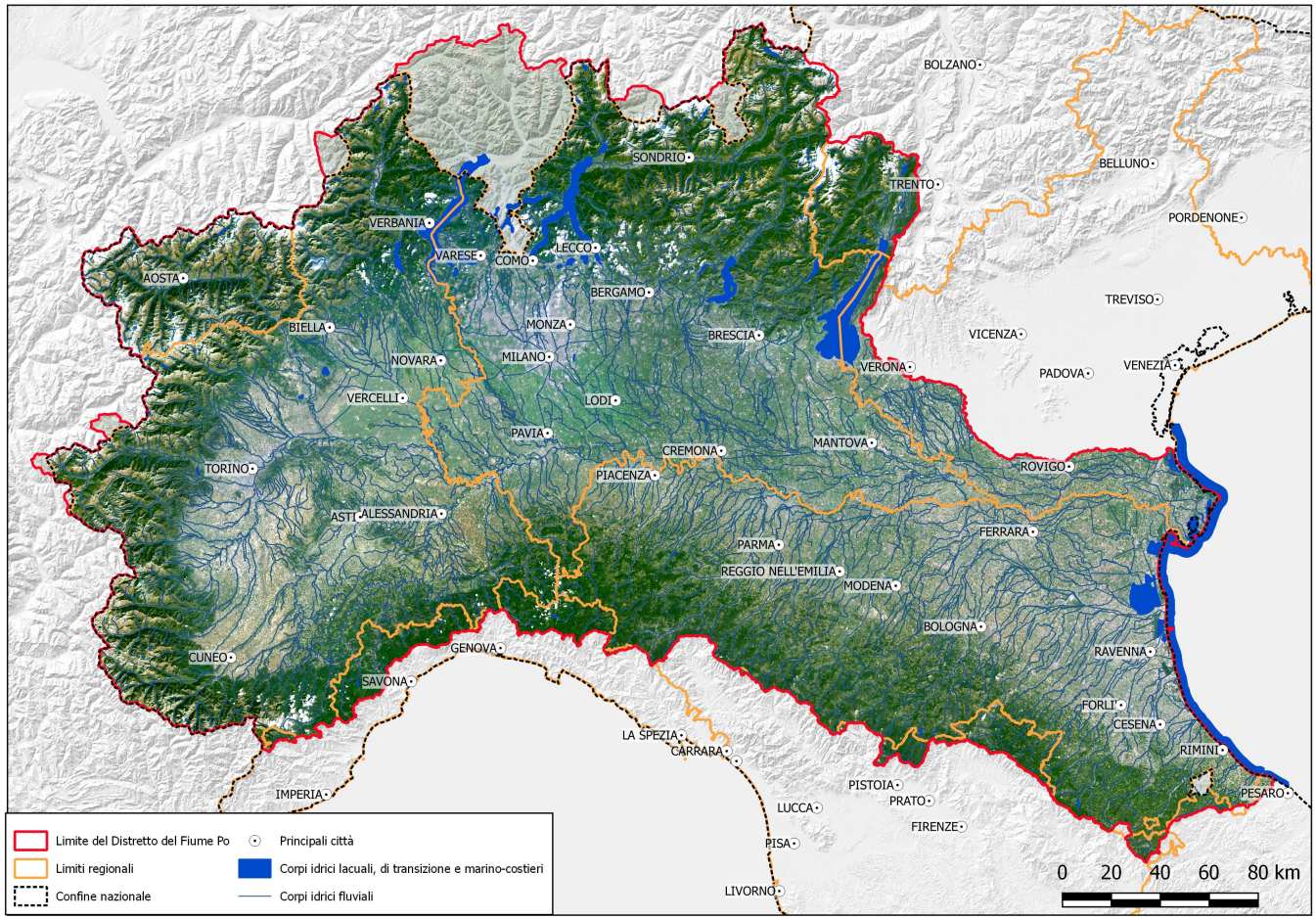
Out-degree



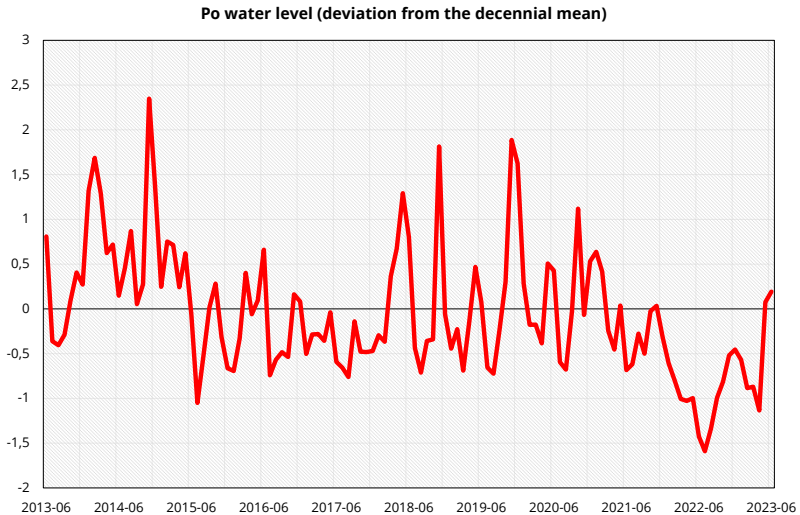
In-degree

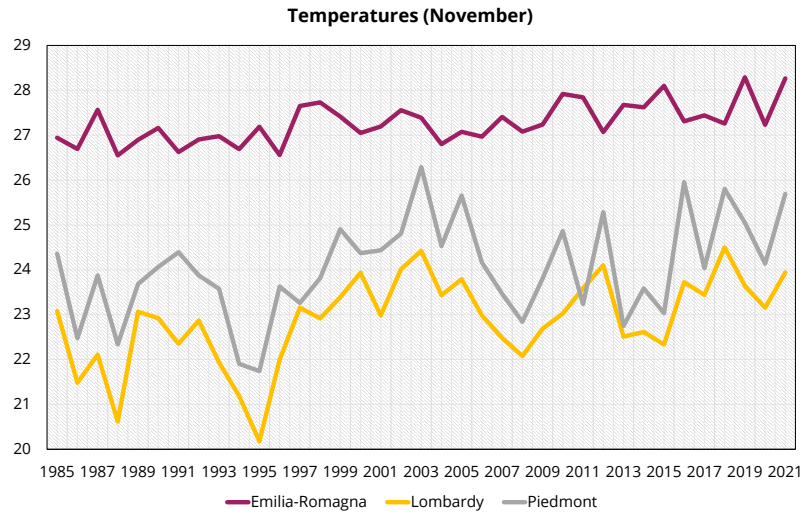
CLIMATE SHOCKS: CASE STUDIES

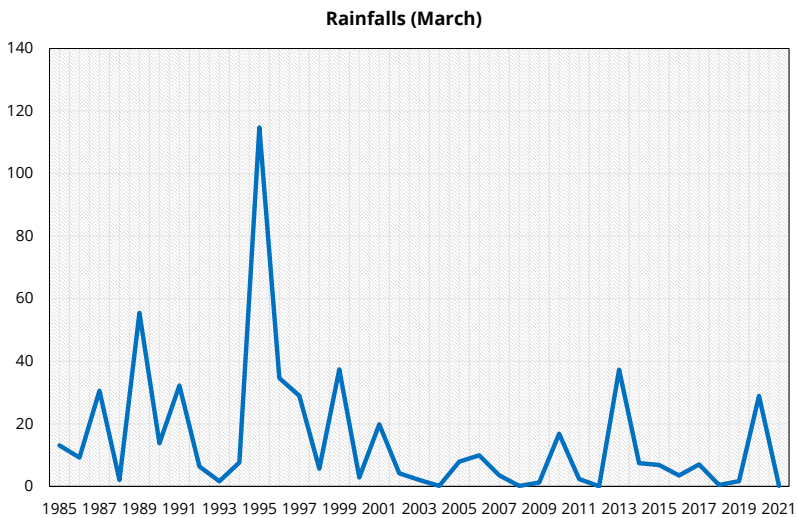
2022 drought in the Po region (1)



2022 drought in the Po region (2)

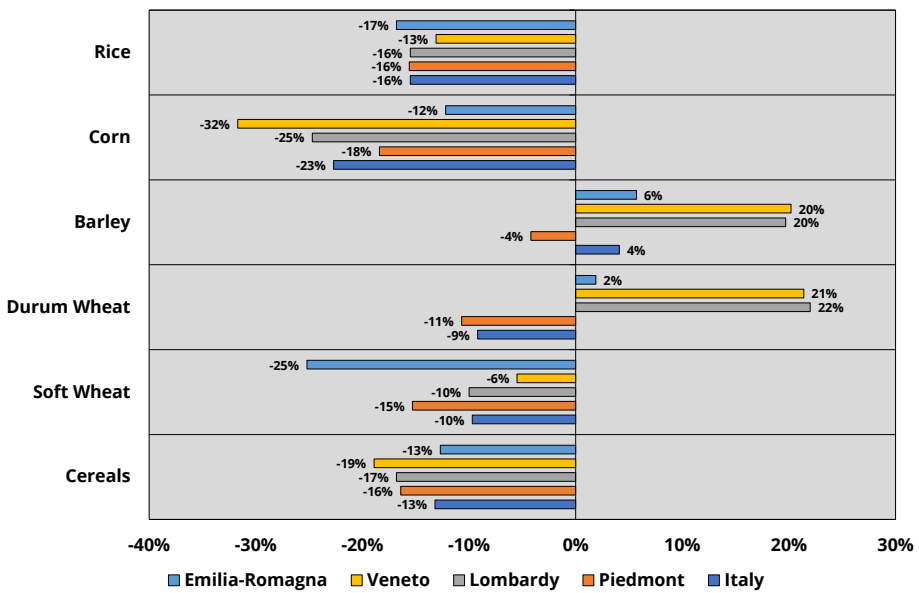






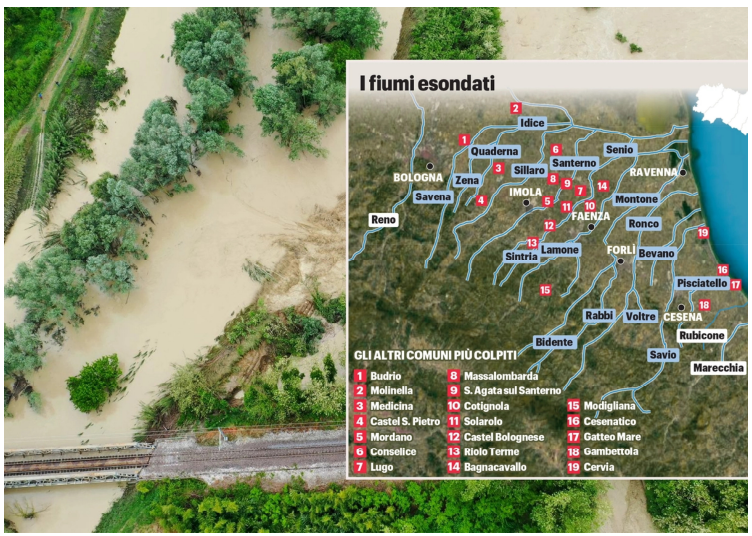
- The water level of Po has decreased over the last years
- The temperatures in the area have been showing increasing patterns
- The rainfalls have been decreasing over time

2022 drought in the Po region (3)



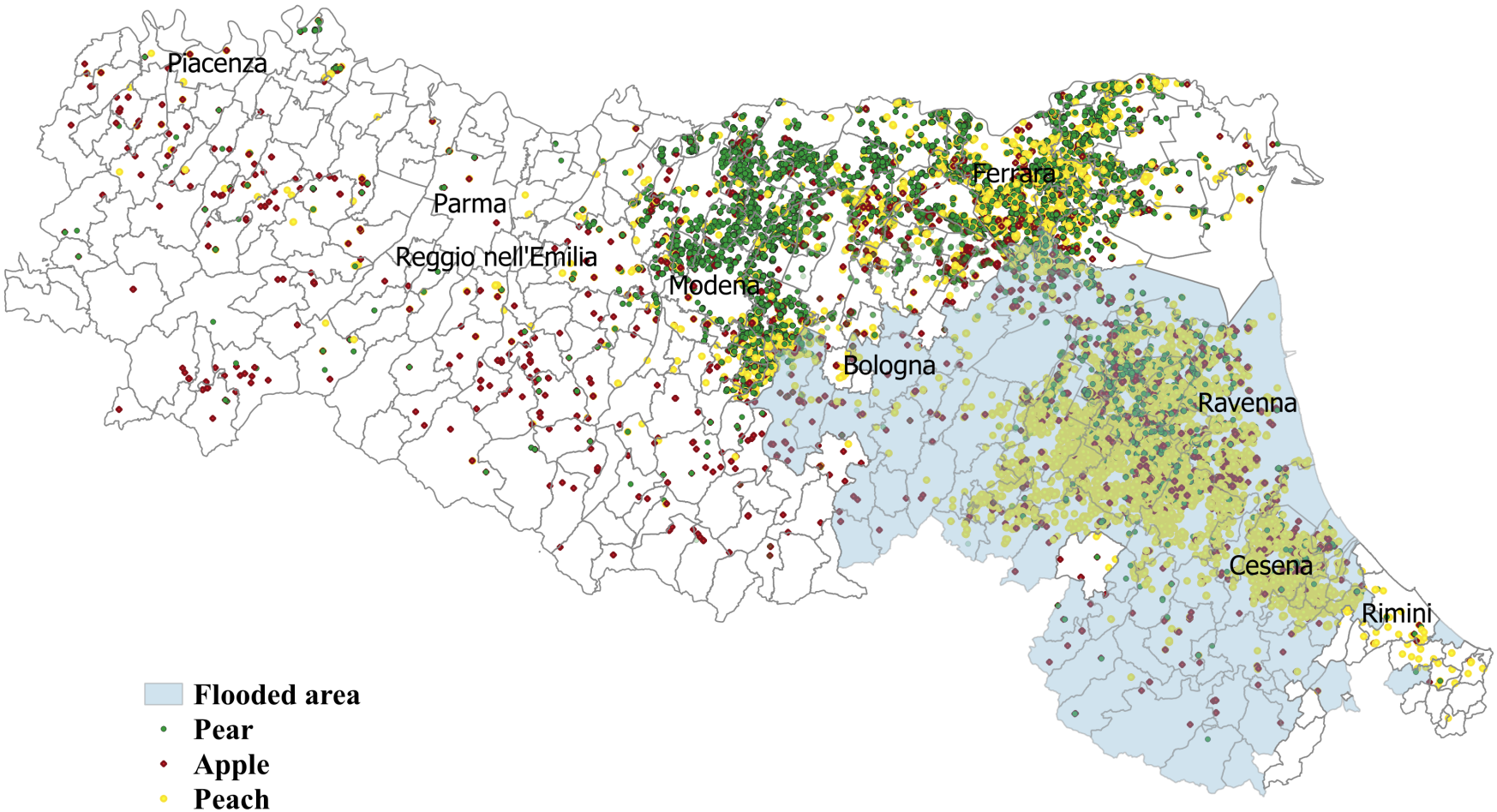
- Half of the cereals produced in Italy are cultivated in the hit regions
- In order to evaluate the impact of the decrease of production on food security, we need to estimate the share of cereals processed either in each region of Italy (interregional trade) or abroad

Climate shocks: 2023 flood in Emilia Romagna (1)



- A major flood hit the area of Romagna in May 2023
- The whole harvest of the season was threatened but long-term losses depend on damages on infrastructures and capital goods (e.g., perennial crops, quality of land)
- Orchards in this area are very diffused, with 45% of the farms harvesting fruits, accounting for 20% of the national production.

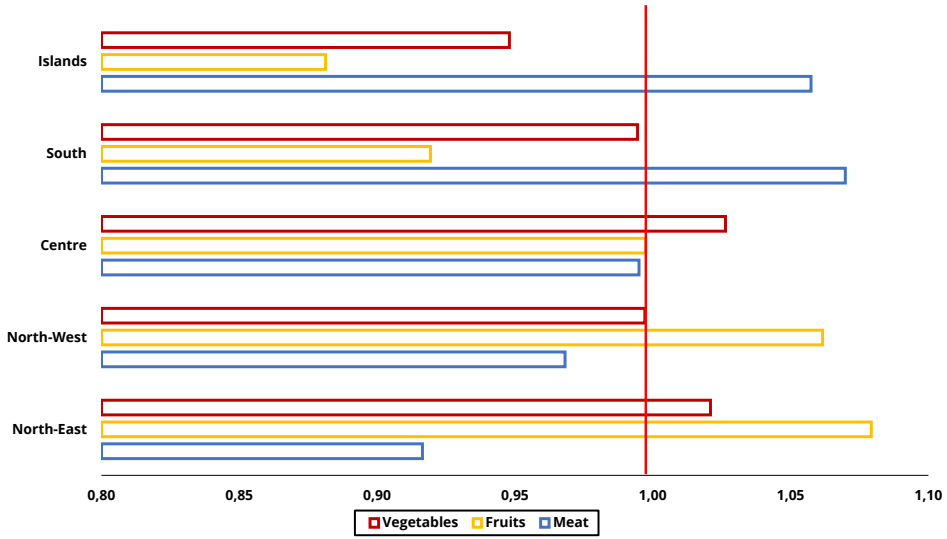
Climate shocks: 2023 flood in Emilia Romagna (2)

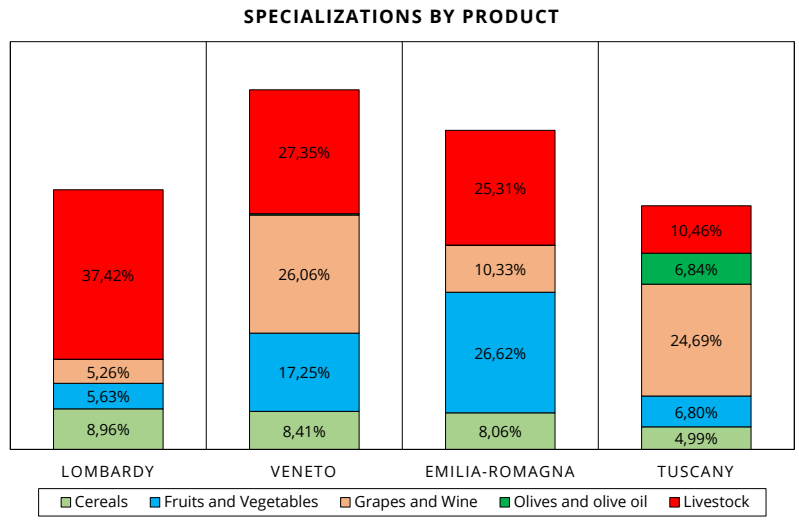


Climate shocks: 2023 flood in Emilia Romagna (3)

- Focus on three products: pears (Emilia Romagna produces two third of national production), apples and peaches
- On the basis of our estimates, the production exposed to flood has been: 21,4% for pears, 42,8% for apples and 93,4% for peaches
- POTENTIAL IMPACT ON NATIONAL PRODUCTION:
  - -13,9% of pears
  - -3% of apples
  - -13,5% of peaches

Work in progress (1): a food satellite account





So far: in order to estimate the impact of (climate or any other) shocks on the regional food systems, food demand has been disaggregated in 100 items as well as sectors and products of the food value chain (regional *SUT*s)

Work in progress (2): a food satellite account

Next:

- In order to estimate the final demand for each product, both commercial and transport margins at each stage of production and taxation have to be estimated
- Once estimated the share of production destined to final demand, we can estimate the share destined to industry (intermediate demand) interregional and international trade (integration between regional accounts and international accounts)
- Interregional and international trade (integration between regional accounts and international accounts)

Discussion

- Evaluating the impact of climate change on regional food system is becoming day-by-day more important. This assessment is naturally "nested" in input-output analysis given the length and the structure of food value chains
- Space matters... but also seasonality matters...
- Linking different climate events to different kinds of capital good, accounting for heterogeneous effects (e.g., irrigated vs. non irrigated agriculture; highlands vs. floodplains; indigenous vs. non-indigenous food)
- Capturing "essential" and "non-substitutable" items (e.g., the case of originally denominated products)

The interregional input output table

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Defining the food value chain




Value chain as the bundle of production steps ($Y_{z,i}$) stemming from a properly defined final demand shock (z) in region/country (i) and possibly taking place in different regions and countries.

$$Fd_{z,i} + AFd_{z,i} + A(A)Fd_{z,i} + ... + A(A)^n Fd_{z,i} = (I - A)^{-1} Fd_{z,i}$$

In our case, $Fd_{z,i}$ include the final demand of agricultural and industry processed food products stemming from all NUTS2 regions. Notice that you might have: international vs. quasi-interregional vs. quasi-intraregional value chains depending upon the the final good you are considering.

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The intermediate input network

- Given activated production $Y_{z,i}$, we reconstruct the network of intermediate input flows $A \times \hat{Y}_{z,i}$.
- We can then compute standard network analysis centrality indicators so as to identify the key production nodes. E.g., the degree of a node: $s_i = C_D^w(i) = \sum_j^N w_{i,j}$. Where w is the weighted contiguity matrix, w_{ij} is greater than 0 if node i is connected to node j, and the value represents the flow between the two.
- Oriented networks: incoming flows (in-degree) vs. outgoing flows (out-degree).

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Sources of data

- Piani Colturali Grafici AGREA at `https://agreagestione.regione.emilia-romagna.it/agrea-file/PianiColturaliGrafici/`
- Farm accountancy data network (FADN) at `https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html`
- Agriculture, forestry and fishing accounts released by ISTAT at `http://dati.istat.it/?lang=en&SubSessionId=fd980db4-ce89-43c4-ab8d-378720567eea`
- 2020 Census data at `https://www.istat.it/it/censimenti/agricoltura/7-censimento-generale/risultati`
- Survey on family expenditure released by ISTAT

Sources of data: climate shocks

- Po water level: hydrographic monitoring data retrieved at `www.agenziapo.it`
- Temperature at 2 meters above the surface of the earth: NASA POWER Project retrieved at `power.larc.nasa.gov`
- Rainfalls: NASA POWER Project retrieved at `power.larc.nasa.gov`

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