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Integrating agent-based modelling and behavioural data analytics: A case study of climate change farmers' perception in Italy

Sandra Ricart[1], Paolo Gazzotti[1,3], Claudio Gandolfi[2], Andrea Castelletti[1,3]

[1] Environmental Intelligence for Global Change Lab, Department of Electronics, Information and Bioengineering, Politecnico di Milano, Italy
[2] Department of Agricultural and Environmental Sciences, University of Milan, Italy
[3] RFF-CMCC European Institute on Economics and the Environment (EIEE), Centro Euro-Mediterraneo sui Cambiamenti Climatici, Milan, Italy

Track 1

Using qualitative data to inform behavioural rules in agent-based models

INTRODUCTION

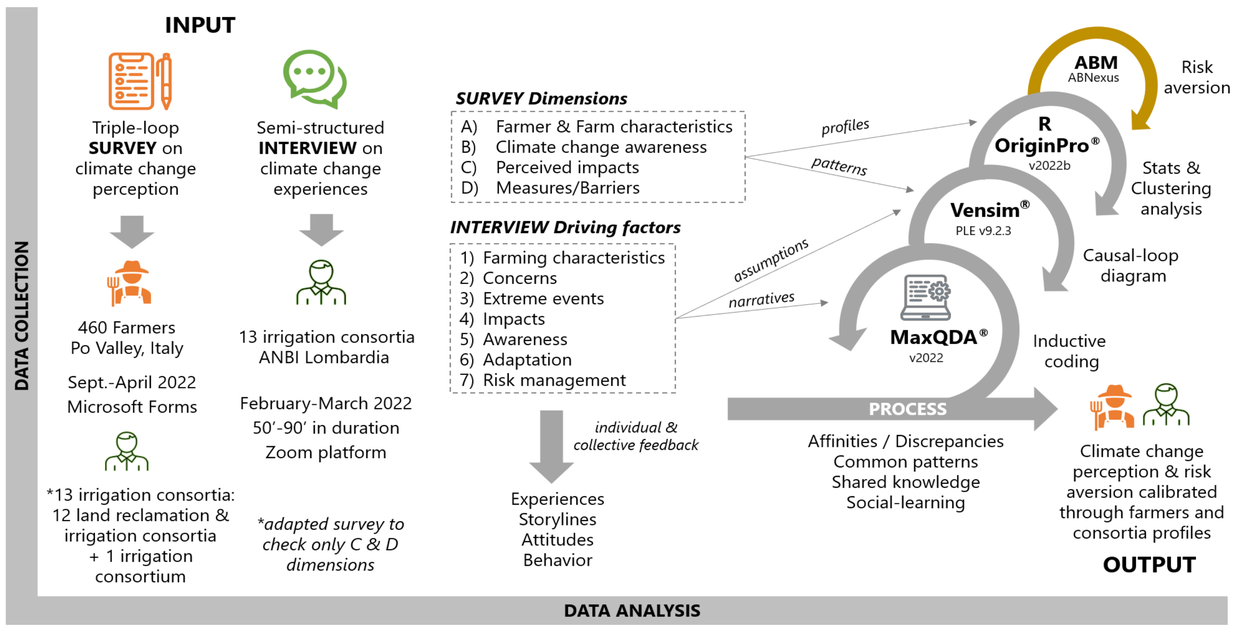
- **Agricultural systems** are adversely influenced by **climate change** through increased **water stress, change in run-off patterns, seasonality fluctuation, and temperature variations.**
- **Farmers and irrigation consortia are valuable sources of first-hand observations** of climate change as they may provide a deeper understanding of their manifestation, relevance, and effects, but also promote adaptation measures.
- **Perception is a complex process** that encompasses a range of **psychological constructs** such as previous knowledge, beliefs, attitudes, and concerns about if and how climate changes.
- **Social learning from bottom-up approaches and tools** (survey, interviews) can **reinforce system dynamics** and Agent-Based Models (ABM) through individuals' and stakeholders' narratives, and map the social network with agents' interactions.

CASE STUDY: THE LOMBARDY REGION

- **An agricultural cluster:** ≈52,000 farms distributed in less than 600,000ha (25% of the irrigated area at the national level).
- **An intricate system** of rivers, lakes, regulated reservoirs, and channels.
- **Subalpine hydrometeorological regime:** dry periods in winter/summer & peaks in late spring/autumn fed by snowmelt and rainfall.
- **Extreme events:** hydrological (flash floods), climatological (convective storms, droughts) & meteorological (cold and heat waves).

AIM & METHODS

To analyse **behavioural data on climate change from farmers' and irrigation consortia's perceptions** as the first step **to build risk aversion profiles** for coupling an agent-based model with a distributed agrohydrological model (ABNexus) that covers the irrigation district of the **Adda river, Lombardy region, Italy.**



RESULTS

Farmer dominant profile

Man, 45-64y, higher education, experience >30y, union farm and consortia membership, non off-farm activity, no succession intention

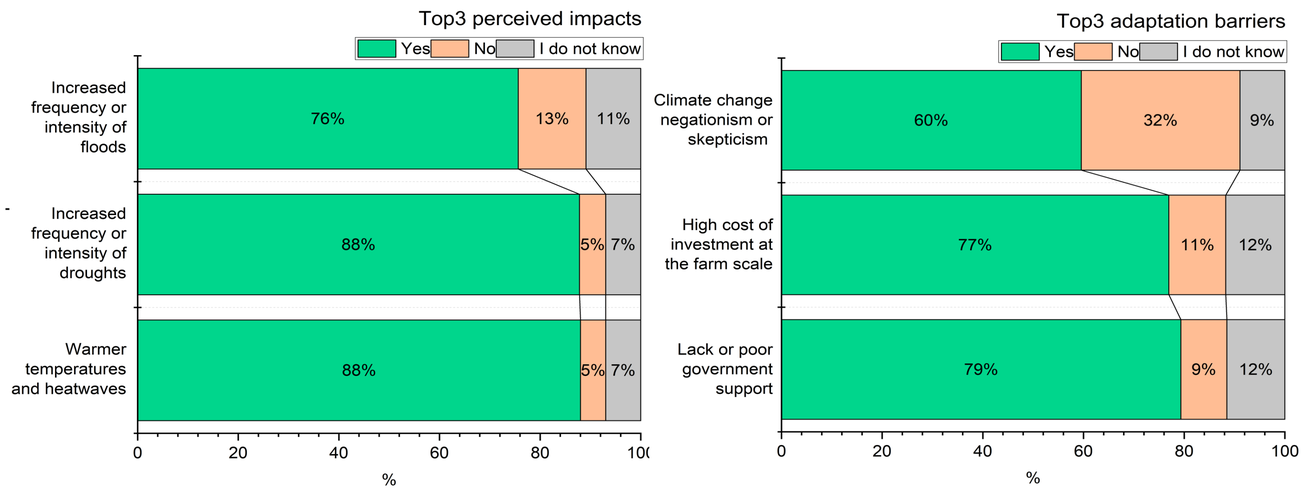
Farm dominant characteristics

Size >20ha, irrigated, conventional crops (maize), livestock, fertilizers use, irrigation canal as water source, non renewable energy use

CLIMATE CHANGE AWARENESS

- Climate change is the single most **serious problem** (85%)
- **Multifunctionality** is slightly **more exposed** to climate change than rainfed and irrigated **crops & livestock**
- **Individuals are more responsible** than EU and economic sectors for tackling climate change adaptation

CLIMATE CHANGE PERCEPTION AND ADAPTATION

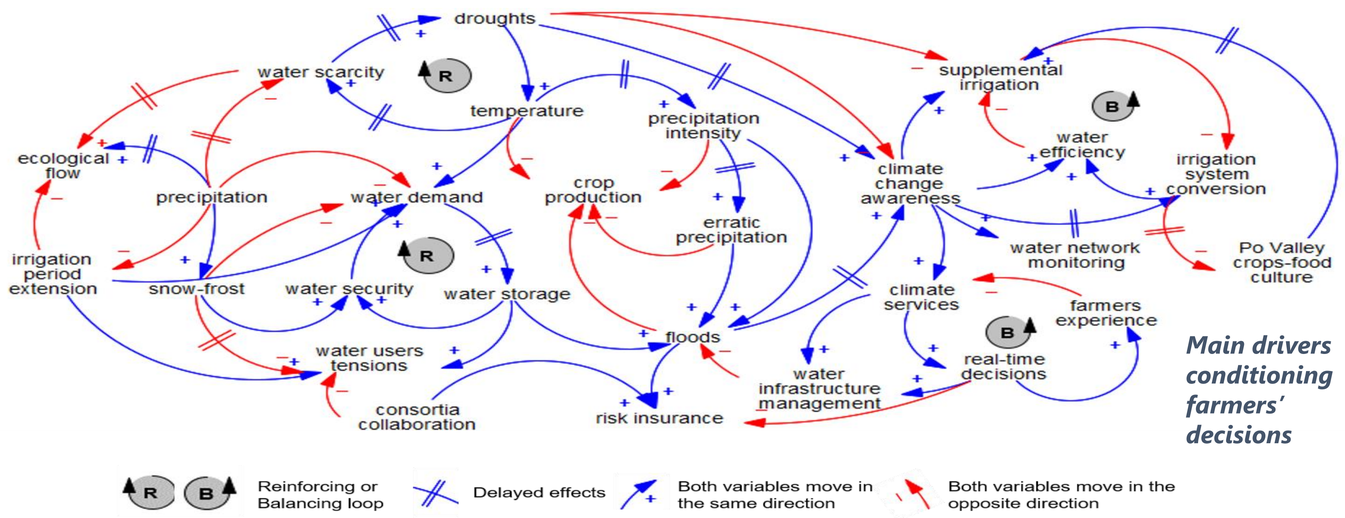


Most promoted adaptation measures

1) Weather services (79%)
2) Reduce fertilizers' use or improve their efficiency (70%)
3) Crop diversification and rotation (67%)

Irrigation consortia's perspectives – Farmers heuristics

- **A neighbourhood effect:** small farmers **(C4)** in proximity exhibit similar risk adaptation preferences, especially by introducing water-saving practices or supplying supplementary irrigation.
- **Farmers are conservative**, and their **attitudes tend to change depending on** personal **experiences** through the **years**, and notably after suffering economic losses in a mid-term period.
- Young farmers **(C2-C4)** lead the **modernisation and innovation process**, eminently in water efficiency techniques.



Main drivers conditioning farmers' decisions

FEEDBACK

reinforcing

Social focus

- Education, age & farming experience
- ❖ *Succession intention* (no consensus)
- ❖ *Consortium membership* (no concensus)

Agricultural focus

- Farm size, production system, fertilizers use & irrigation method
- ❖ *Crops/Livestock* (no consensus)

SURVEY CLUSTERING

- ○ **C1 Medium farms** (46%) old, low education, high experience
- ○ **C2 Rainfed** (16%) young, high education, low experience
- ○ **C3 Big farms** (31%) old, low education, high experience
- ○ **C4 Small farms** (7%) young, high education, low experience

- ○ **C1/C3**: annual forages
- ○ **C2**: vineyards & grasslands
- ○ **C4**: vineyards & vegetables
- ❖ Maize + livestock (all)

- ❑ **AWARENESS: C4** is the most concerned / small differences between clusters
- ❑ **PERCEIVED IMPACTS**: **C4** highest perception / **C1-C4** more floods / **C3-C4** pest infection
- ❑ **ADAPTATION MEASURES**: **C3-C4** highest application / **C2** asking for cooperation
- ❑ **ADAPTATION BARRIERS**: **C3-C4** highest barriers / **C4** negationism-skepticism
- ❖ **"I do not know" answer: C2** (the 'doubtful' cluster) / **C4** (the 'self-confident' cluster)

REMARKS AND FUTURE RESEARCH

- **Surveys** & **interviews** recap qualitative data to **reinforce ABMs.**
- **Farmers and consortia's heuristics** can be used to determine **risk aversion** in ABMs.
- Farmers and consortia are **aware of climate change**, **perceiving similar impacts** (t° increase and extreme events), **but differing about adaptation strategies**: **soft measures by farmers** (e.g., crops, insurance, weather services) or **hard measures by the consortia** (e.g., water storage).
- **Causal Loop Diagrams** can be used to **identify drivers and interactions** between climate change impacts and adaptive capacity.
- **Future research** should target how **farmers' imitation attitudes** can increase adaptive capacity and how consortia, together with farmers' unions, can serve as peer groups for **social-learning and knowledge transfer.**

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Contact information
Sandra Ricart
sandra.ricart@polimi.it
www.modfabe.deib.polimi.it
@modfabe