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“Climatic and socioeconomic drivers of land use change”

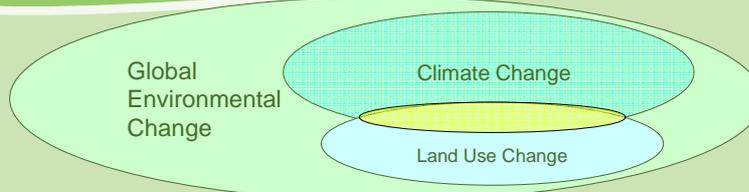
Research Project

Stefano Balbi

PhD in Analysis and Governance of Sustainable Development

Supervisors: **Carlo Giupponi, Silvio Giove.**

Research Area



Land use change is driven by the interactions in space and time between biophysical and human dimensions

- Land use as human activity, which responds to economic and political inputs, influences the climate in terms of atmospheric composition (emission/fixation) and terrestrial radiation.
- Conversely, climate change produces impacts on land use and in particular on coastal zones (sea level rise), river basins (flood/drought), agricultural production (volume/type), natural vegetation (ecosystems).

Research Objective

Explore patterns of land use change in a spatially explicit model that allows for the integration of environmental and socioeconomic components.

- Crucial roles are played by social agents (including decision makers and institutions), initial conditions of land cover, and the inter-level integration of processes at one level with those at other levels of aggregation.
- Need for modelling a socio-ecosystem.
- Policy is one of the elements that drive the society in interacting with the ecosystem.
- Call for models that are more sensitive to regional variability.

- Define the scale of interest and the related metrics of climate and land use change
- This is complicated by the various levels of interaction, also in terms of policy

Theoretical Framework

Land use models:

- Empirical statistical models
- Optimisation models
- Simulation models
- Equilibrium models
- Cellular automata models
- Agent based models

Our claims:

- Integrate ecologic and economic modelling
- Represent spatially
- Investigate the impact of the change in frequency of extreme climatic events
- Include adaptive capacity and feedbacks at various scales
- Focus on local consequences
- Public participation
- Couple with top-down CGE models

**Ecological
Economics**

**Aggregate
Complexity**

Potentially too demanding !!!

Research Topic

Agent Based Modelling of the impacts of Climate Change on Land Use

➤ Explore the potential of ABM for modelling human land use decisions

Strengths:

- High degree of **flexibility**, accounting for heterogeneity and interdependencies among agents and their environment.
- Feedbacks between socioeconomic and biophysical processes can be explicitly modelled.
- Interdependent behaviour leads to **emergent properties**.
- Explicit representation of spatial processes, spatial interactions, and multi-scale phenomena, when coupled with a cellular model.
- Hierarchical or nested structures.
- **Natural description of the system**.
- Match the scale and structure of the available spatial data.
- Simulated social laboratory.

Limitations:

- Verification
- Validation
- Prediction
- Computation intensive



Research Object

- **Paper 1. Methodological Paper.**

- ✓ "Is this modelling methodology able to capture emergent properties of socio-ecosystems with regards to land use change patterns?"

- **Paper 2. Developing a spatially explicit agent based model with regional detail (Micro Application).**

- ✓ "Which patterns of change emerge from the exploration of different climatic and socioeconomic scenarios?"

- **Paper 3. Coupling the model with a CGE model (Macro Application).**

- ✓ "Can we feed our model in a CGE?"
- ✓ "What is the outcome?"



Research Methodology

- I. Literature review
- II. Meta – Analysis of the literature
- III. Select the case study
- IV. Build the model (ABM)
- V. Collect data
- VI. Test the model
- VII. Explore scenarios
- VIII. Couple with CGE



Paper N. 1 ^{1/4}

“Bottom-up approaches to the simulation of socio-ecosystems for the exploration of CCA policy options: the role of ABM”

Integrated
Assessment

Climate Change
Adaptation



Land Use
Change

Top - Down VS. Bottom - Up



Paper N. 1 ^{2/4}

Top down analysis
of the human-environment system



Does not consider the emergence of
social behavioural patterns.

- unrealistic assumptions
- lacks the inclusion of stakeholders



flawed decision-making process

CCA Analysis:

- Complex
- Bottom Up
- Multi agent

Uncertainty

Scenarios VS. Predictions

Participated
Decisions

Resilience



Paper N. 1 ^{3/4}

ABM



ACE

- Learning
- Behavioural norms
- Bottom-up markets
- Economic networks
- Organizations
- Computational agents for automated markets
- Parallel experiments
- Programming tools

Mental models
and learning

Participatory
approaches

MAS/LUCC

- Natural resource management
- Agricultural economics
- Archaeology
- Urban simulations

Evolution of
cooperation

Diffusion
processes

CCA

- Few useful publications
- Lack of empirical applications
- Scepticism
- Aspatial
- Fresh topic
- Prevalence of climate change top down economics



Paper N. 1 4/4

Bridging the gap between top-down and bottom-up approaches

ABM is potentially an appropriate bottom-up methodology for the study of the specificities of CCA, especially in a local to regional context.

Explore the hypothesis of coupling ABM with traditional top-down modelling techniques, as a way to overcome their mutual limitations.

Paper 2

Paper 3



Paper N. 2

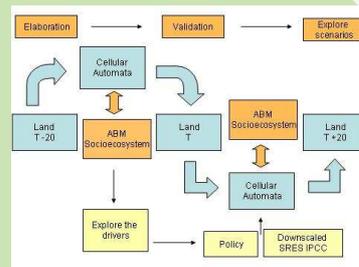
The case of a Ski Destination

Spatial relevance

- Ski-lifts networks
- Suitability (z)
- Connectivity (x,y)

Human adaptation

- Institutions
- Entrepreneurs
- Tourists



Thanks for your attention!

Stefano Balbi

PhD Candidate in
Analysis and Governance of Sustainable Development
School for Advanced Studies in Venice Foundation
University of Ca' Foscari, Venezia
San Giobbe, Cannaregio 873
30121 VE
Tel: 041 234 9125
Fax: 041 234 176

stefano.balbi@unive.it

