SimulPast plenary workshop
11/03/2015

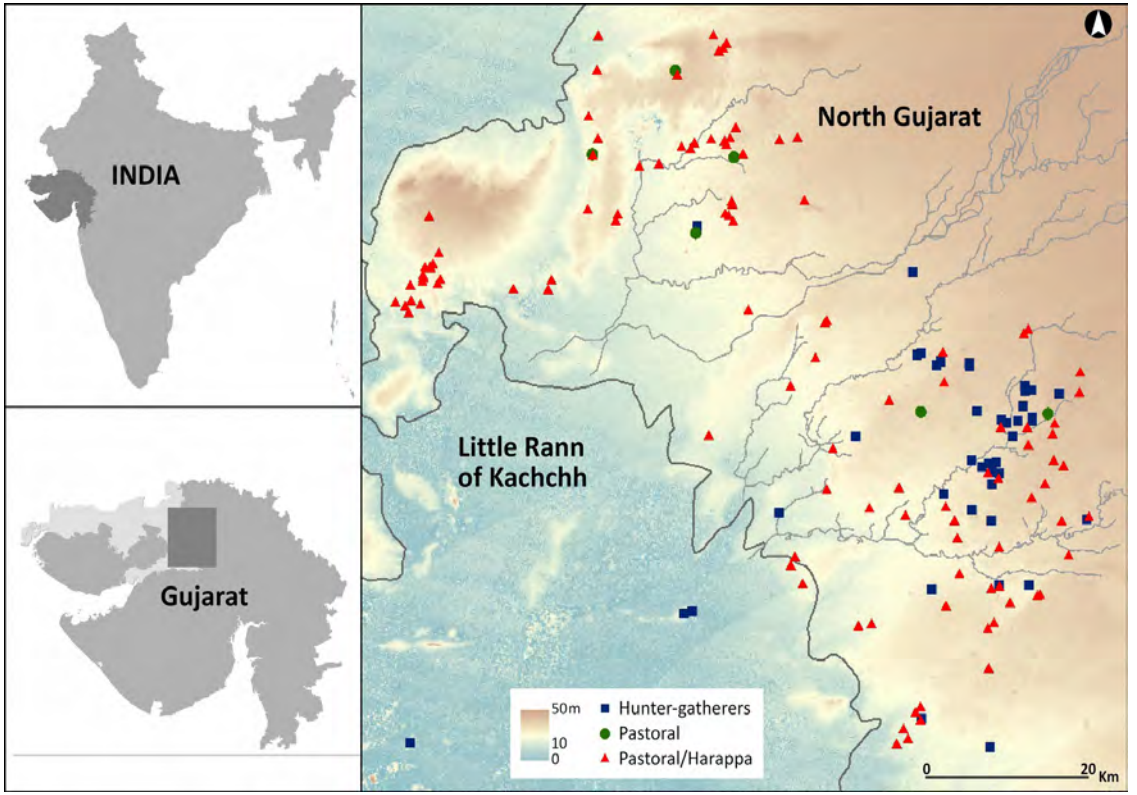
CS1: Hunter-Gatherer persistence in arid margins. The case of North Gujarat (India)

G1 – IMF-CSIC (J.Alcaina, A.Balbo, F.Cecilia, E.Crema, J.J García-Granero, M.Madella)
G5 – ICTA-UAB (M.Salpeteur)
G7 – BSC (X.Rubio, A.Torrano)
G9 – AI-UPF (G.Francés, H.Geffner, C.Lancelotti)

Outline of the presentation

- The CaseStudy
- Interactions between groups
- What has been done
- Plans for the last leg of the project
- Meta-research questions: possible areas of group overlap

The aim of this CS is to study the **trajectory of hunter-gatherer** groups in this region by modeling **resources management** and **decision making** to explore adaptive performances and resilience to environmental variability and the appearance of other specialized groups.

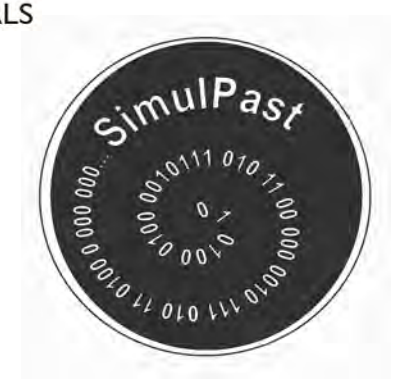


- ✔ Persistence of Hunter-gatherer in semi-arid margins:
  - ✗ Are HG well-adapted to the climate of this area?
  - ✗ Is AP a better adapted strategy?
  - ✗ Under what conditions reversion can emerge from the competition of HG and AP, when fitness is linked to population size?
  - ✗ What is the effect of different decision-making models on the performance of the agents?

Groups involved

G1

G7



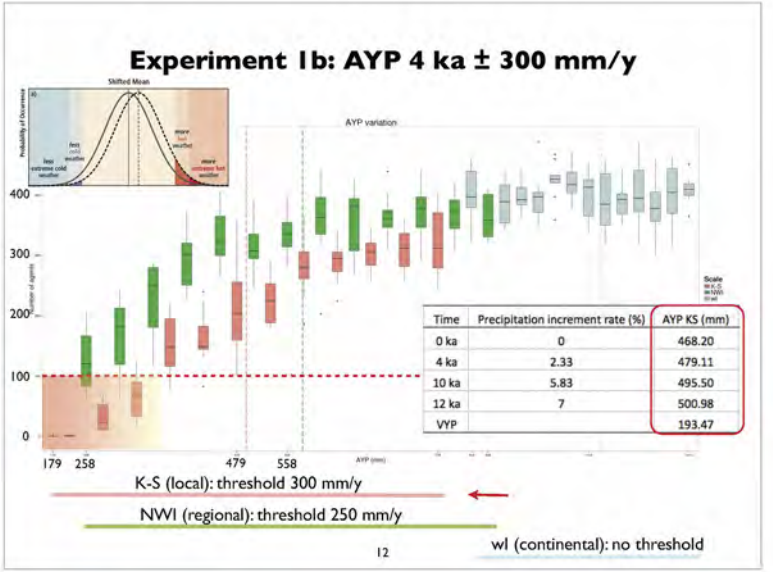
G5

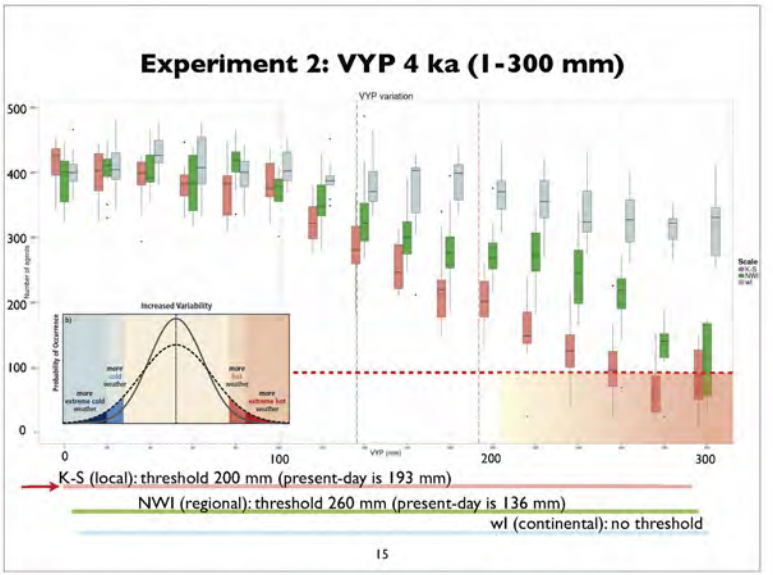
G9

Archaeological questions

Are HG well-adapted to the climate of this area?

- We explored:
  - Thresholds for HG in terms of adaptation to strong seasonality
  - Population dynamics relative to precipitation trends over the mid and long periods (AYP) and to variance in precipitations over the short period (VYP).
- Results:
  - Long-term persistence of HG populations is coherent with strong seasonality.
  - AYP is not sufficient to explain the disappearance of HG.
  - At the local level, VYP is the main parameter affecting overall dynamics.



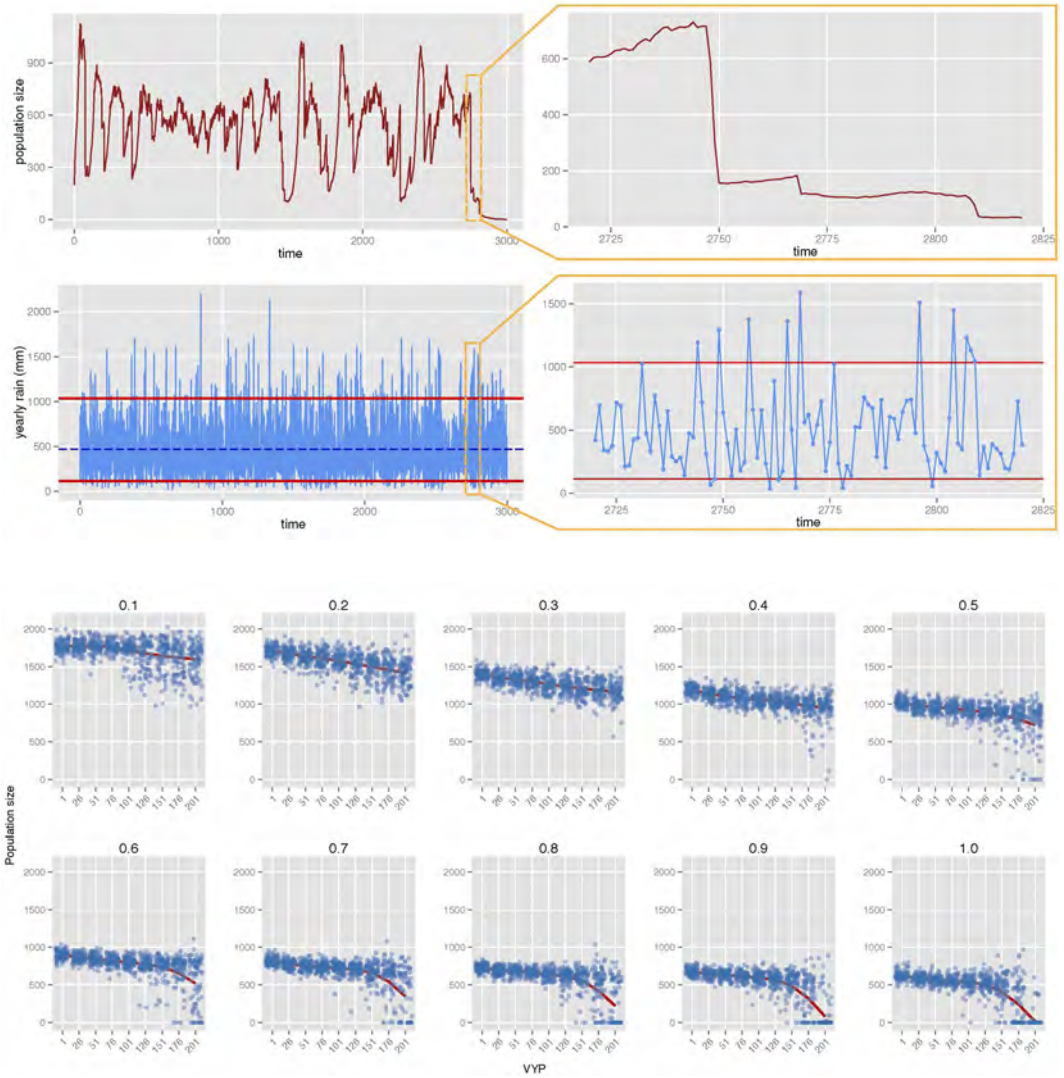


- Outputs:
  - Balbo A. et al. (2014). Agent-Based simulation of Holocene monsoon precipitation patterns and hunter-gatherer population dynamics in semi-arid environments. *Journal of Archaeological Methods and Theory 21:* 442–446

Is AP a better adapted strategy?

- We modeled incipient AP that cultivate local plants and consume domestic animals in an environment with the same characteristics as the previous HG model.

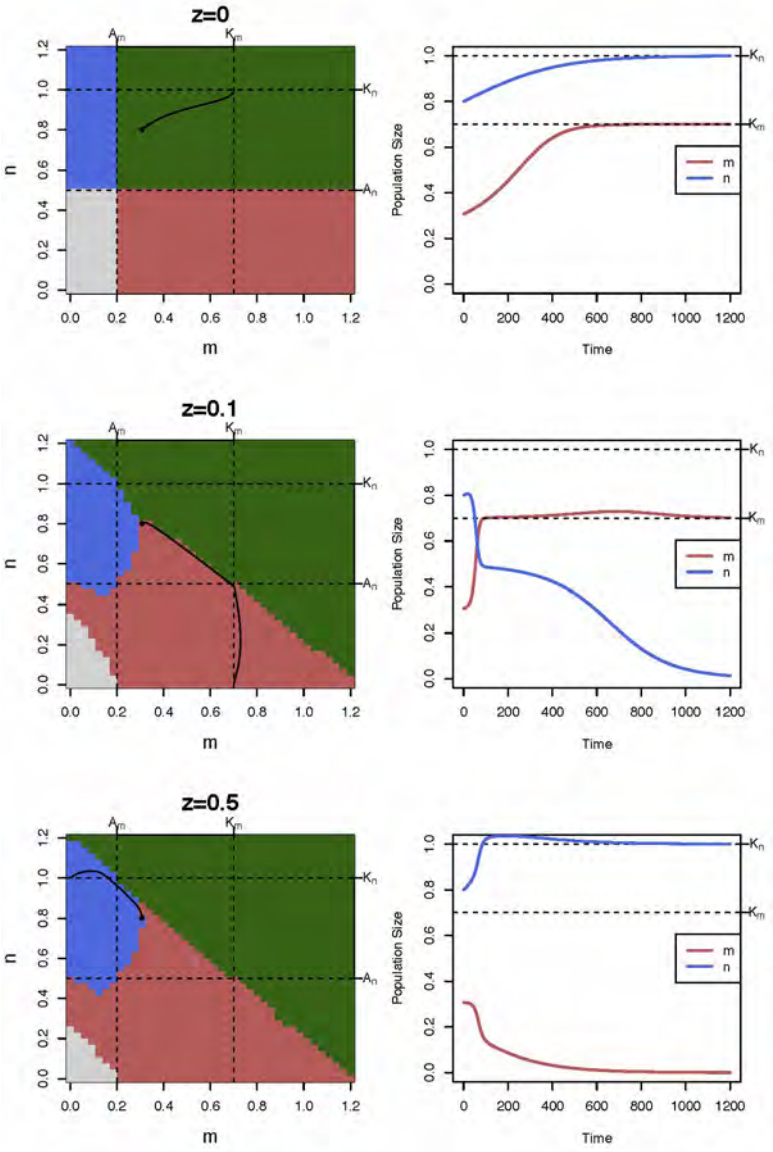
- Results:
  - A pure AP strategy is not sustainable
  - 40% of the calories need to be covered trough alternative sources



- Outputs:
  - Lacelotti C; Rubio-Campillo X; Salpeteur M; Balbo A; Madella M (in prep). Sustainability of incipient agro-pastoralism in semi-arid ecotones

Exploring the Allee Effect in the Cultural Transmission of Subsistence Strategies

- The fitness of subsistence strategies show an Allee effect with respect to carrying capacity (K).
- We explore how the long-term equilibrium is affected by different degree of reliance on social learning (z)
- Difference equation model with two populations (m,n) starting at different sizes
- Results:
  - We identified several basins of attraction (i.e. initial conditions leading to the same equilibrium).
  - The same initial conditions can develop into three different ultimate equilibrium as a function of z.
  - If the system is located near the boundary, small changes in behavior or external perturbation have drastic effects.



- Outputs:
  - Crema E; Rubio-Campillo X (in prep). Allee Effect in Cultural Evolution

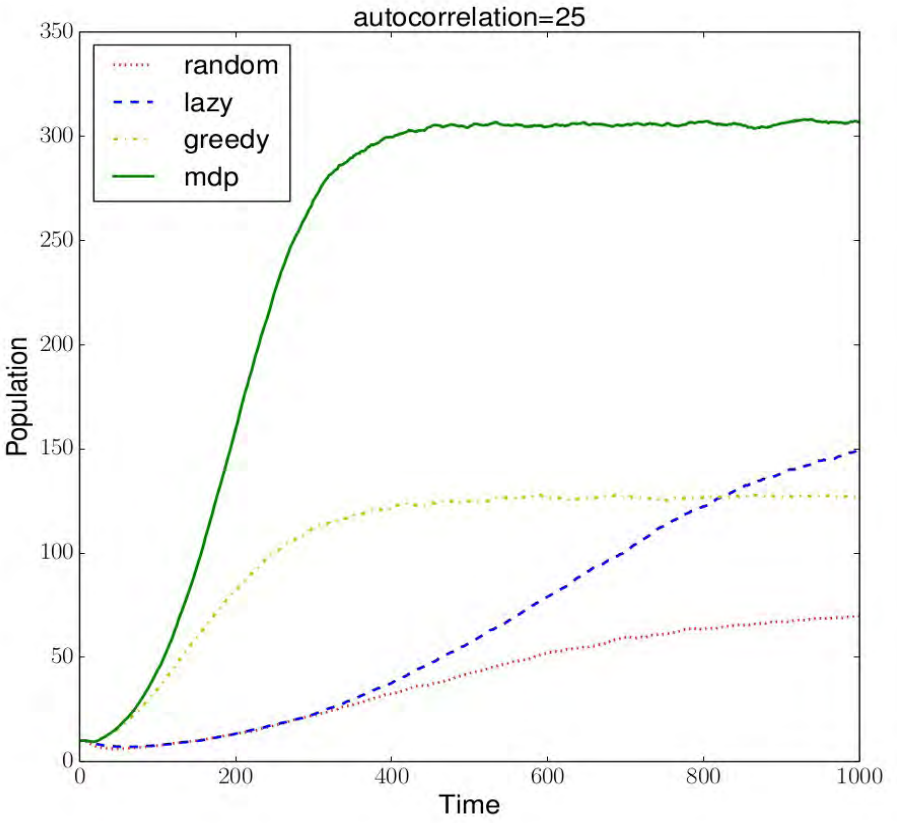
Methodological aspects

Decision-making

- Agents in Social Simulation ABMs are traditionally programmed to behave following a simplistic set of reactive rules.

- We have explored the impact of using more sophisticated AI decision-making models comparing:
  - Different types of rule-based agents
  - MDP agents

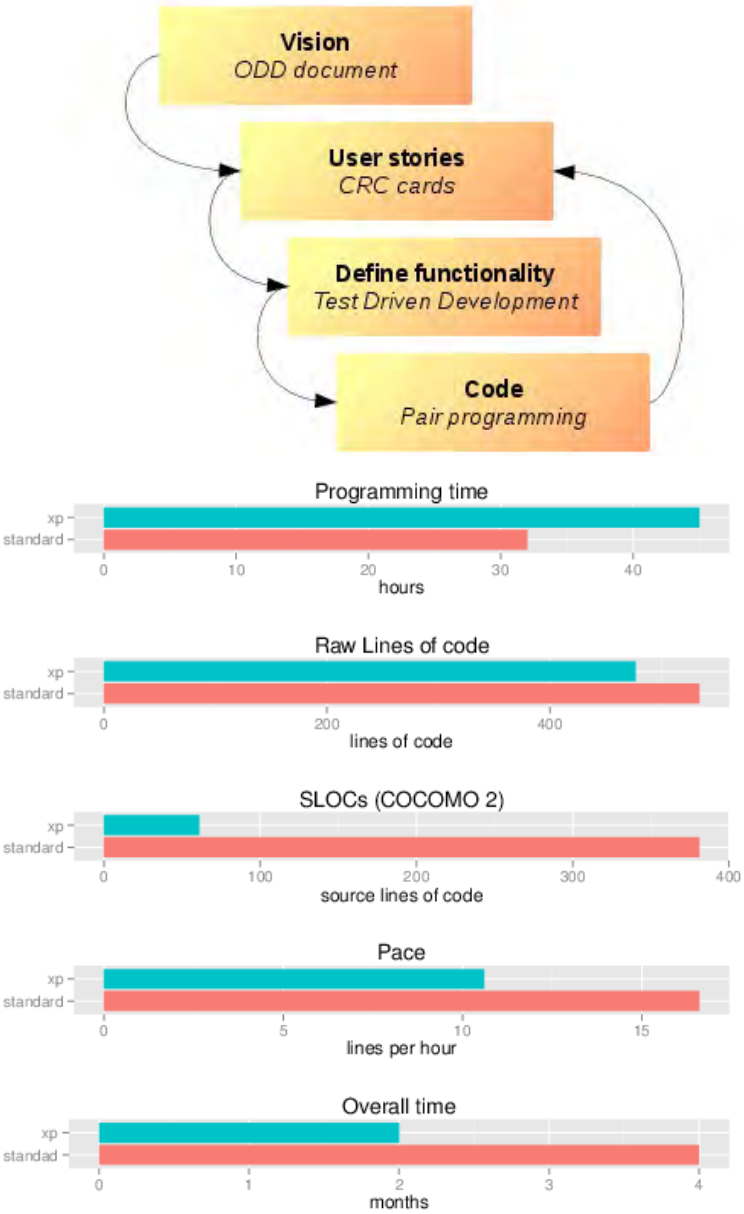
- Their use results in widely different outcomes in metrics such as carrying capacity of the simulated systems.



- Output:
  - Francès, G.; Rubio-Campillo, X; Lancelotti, C. and Madella, M. (in press) *Decision Making in Agent-Based Models*. LNAI, Proc. 12th European Conf. on Multi-Agent Systems, Prague.

eXtreme Programming

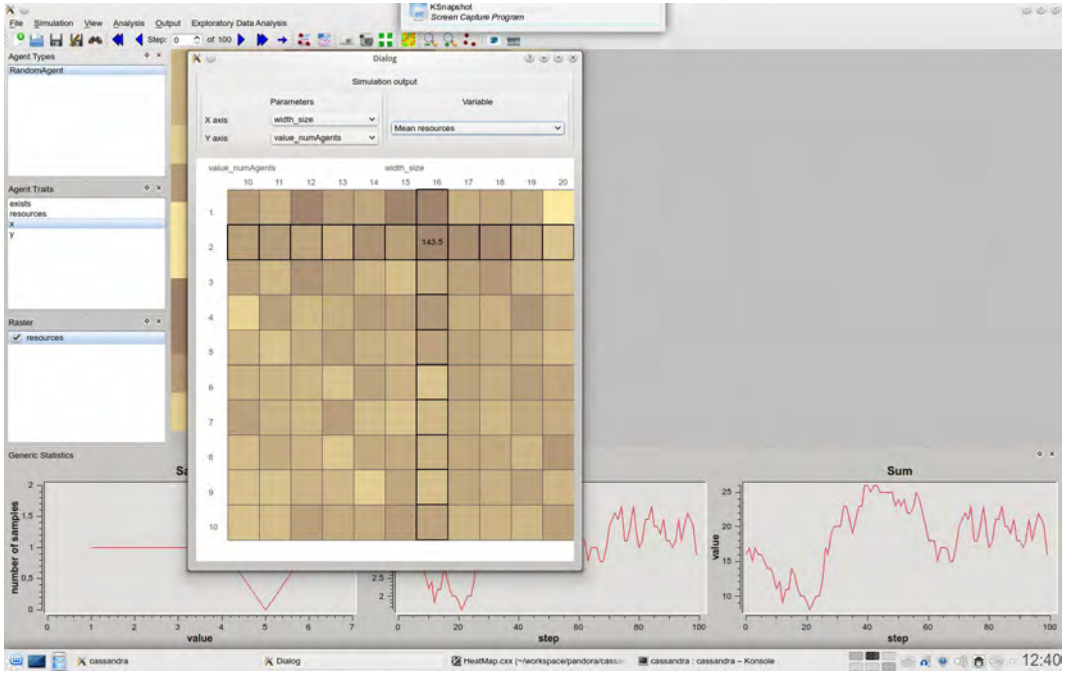
- The AP model was developed in Python using eXtreme programming techniques:
  - Test-driven development
  - Pair-programming
- Results:
  - a reduction in the total time devoted to the implementation
    - less lines of code
    - faster and better communication between the developer (computer scientist) and the domain expert (archaeologist
    - Domain expert: much deeper understanding of the implementation phase, its problems, limitations and strengths



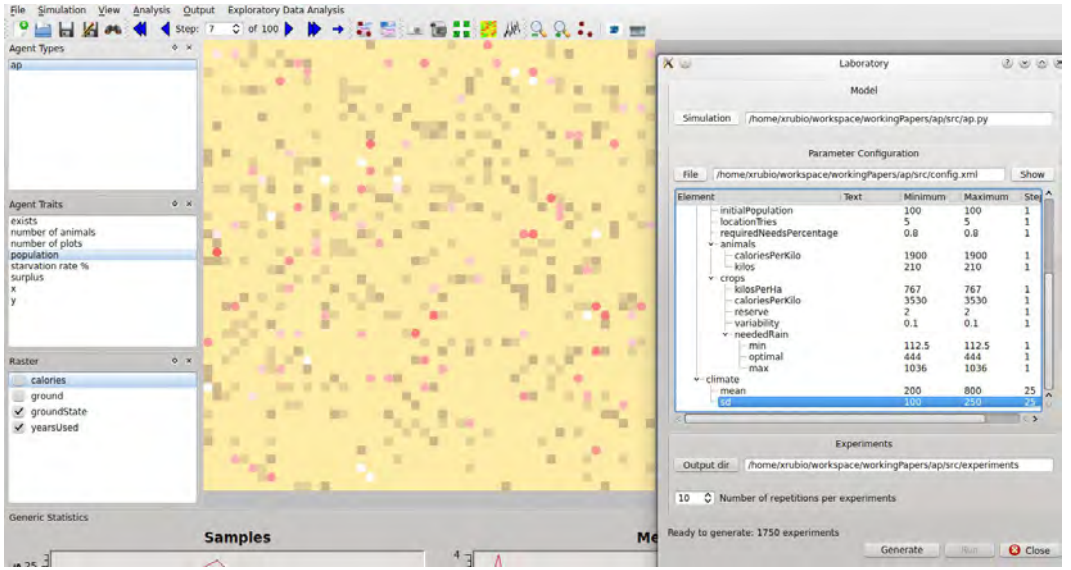
- Outputs:
  - Rubio-Campillo X; Lancelotti C (in prep). Extreme Modelling: developing social simulations with agile practices.

Pandora

- Open-source versatile platform for ABM
  - C++/Python interface
  - Tool for experiment and EDA
  - Parallel execution



- Outputs:
  - Rubio-Campillo, X. (2014). "Pandora: A Versatile Agent-Based Modelling Platform for Social Simulation". *Proceedings of SIMUL 2014, The Sixth International Conference on Advances in System Simulation*, 29-34.



Next steps

AI-based agents

- Shifting Baseline Syndrome (SBS, Pauly 1995) refers to a shift over time in the expectation of what a healthy ecosystem baseline looks like.
  - Generational amnesia: there is a loss of perception of change that occurs when each generation redefines what is "natural".
  - Individual amnesia: Individuals forget about past state of ecosystems
- By attempting to model the dynamics of SBS as a case study, we plan to simultaneously explore:
  - The interplay between knowledge transmission, decision-making, and ecological changes
  - The need for cognitively more sophisticated decision-makers in ABM simulations (interplay memory/experience).

Plants-humans co-evolution

- Existing models:
  - ABM of plant evolution
  - ABM on resource exploitation

Proposal: how do changes in human behavior affect the rate of phenotypical change in plants given a co-evolutionary context?

- "Human" and "plant" agents
- Possible human activities to be taken into account are:
  - Mobility
  - technological innovation (storage facilities/tool availability)
  - group-size (by proxy of settlement-size?)

Possible areas of group overlap

- ✔ Theory
  - ✗ Resilience
  - ✗ Cultural evolution
  - ✗ Niche construction
- ✔ Concepts:
  - ✗ Social learning
  - ✗ Adaptation
  - ✗ Co-evolution mechanism
- ✔ Methods
  - ✗ ABM
  - ✗ Programming
  - ✗ AI
  - ✗ Multi-agent systems