Combining modelling and participation to build agricultural adaptation scenarios in water stressed territories

Nina Graveline, Alexandre Alix, Marta Debolini, David Dorchies, Katrin Erdlenbruch, Juliette Le Gallo, Sébastien Loubier, Jean-Marc Touzard
UMR Innovation, Univ of Montpellier, INRAE, CIRAD, Institut Agro, Montpellier, France & UMR G-EAU, UMR Emmah

Problem statement

Identifying and assessing robust adaptation strategies of the farming sector in face of climate change are needed :

- climate change increases significantly the water needs by crops & induces developments of irrigation areas
- while water resources are getting scarce because of reduced and distributional shifts of rain patterns, particularly in the Mediterranean region

Classical approaches in economics are not well suited to model and represent, alone, behaviour of actors or markets in far from the reference setting.
Climate change adaptation calls for **empirical research** that aims at **supporting communities or sectors** to increase resilience of individuals, companies and territories; also to increase the speed of adaptation and mitigation.
This approach & project aims at producing knowledge on alternative strategies but also ambitions to take part and foster adaptation and participate to the ecosystem of adaptation.

Research questions

- What are the robust and efficient strategies that would satisfy both the challenges of climate change adaptation by the farming sector and water management ?
- How to build and assess future scenarios and pathways of agricultural development and water demands and robust adaptation strategies ?

The downstream and medium Aude river basin (France)

➢ **Water** uptakes are estimated to be at least 130 Mm3 in 2020

➢ 70% of water uses are for agriculture - irrigation
➢ The Water Management Plan (« Plan de Gestion de la Ressource en eau ») estimated the unbalance between resource capacity and uptake by - 33 million cubic meter (Mm3) during low flow season (in 2011)

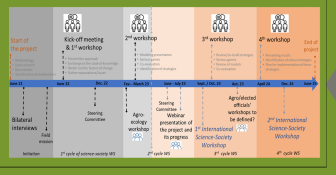
Agriculture

➢ 4987 farms over 89 000 ha of arable land of which 19 000 ha are irrigated (91% for winegrowing)
➢ Irrigated areas increased by 50% between 2010 and 2020 (>90% on vine)
➢ Other irrigated crops are fruit trees, vegetables, olive trees and grassland
➢ Wine growing is characterized by a strong heterogeneity in vine and/or wine production farm types

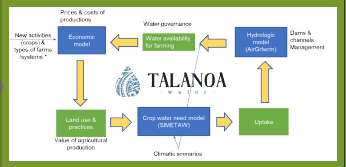
3288 km²

Method : Participative research & modeling

Participative multi-stakeholder platform

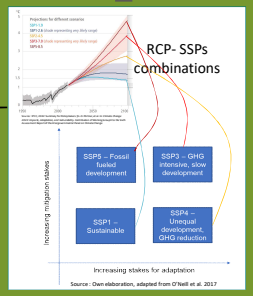


Integrated modeling : agro-hydro-economic modeling



I - Downscaling Shared Socio-economic Pathways SSPs (O'Neill et al. 2017)

1. Drafting of 4 scenarios in line with the SSPs
   - Resorting to local grey and scientific literature & foresight studies
   - Facilitation of a participative session in workshop I on main driving forces to agricultural land use and supply
   - Specifying 4 items : International context / local economy / agriculture / water management
2. Facilitation of a participative workshop with the stakeholder group (40 part. / 9 March 23)
   - 4 tables / SSP : Tour de table, exchanges on coherence (registering & Sketchnoting)
   - Attempt to quantify land use for 4 (partial) sectors in 2050 (Minervois, Narbonnais, Berre, Corbières)
   - Detailed minutes
3. Finalisation : Rewriting of the narratives for the 4 scenarios



II – Quantification

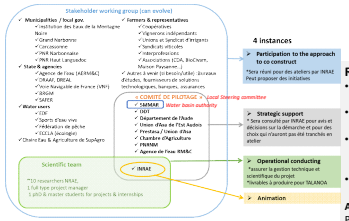
1. Internal coherence of translation of scenario narratives in land use in area per crop & irrigation
2. Running agronomic model to estimate water use change per unit land and estimating total water demand

III- Defining measures & scenarios

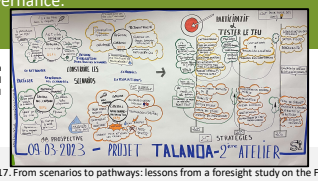
1. Brainstorming during workshop I and II with (i) participative focus group session and (ii) a serious game played in each respective downscaled-SSP
2. Articulation in time (2023,2025, 2035,2050) in workshop II (serious game) in reaction to downscaled SSPs

Combination of different measures in time
(i) new water supplies,
(ii) optimise technologies and network,
(iii) agro-ecology and agricultural practices
(iv) economic and regulatory instruments and governance.

Stakeholder group & governance of the project



Example of a sketchnoting panel during workshop II



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Results

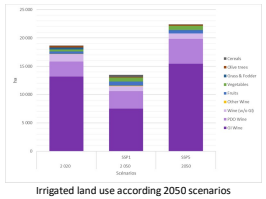
1. Four contrasted scenario narratives

- The four narratives differ along two main dimensions that have been reinterpreted from initial SSPs (O'Neill et al. 2017) :
  - The extend of regionalization versus liberalization that determines the level of protection and locally determined public investments
  - The extend of internalization of GHG mitigation concerns in the economy
- Consequences in terms of **agricultural supply** : wine sector decrease in relation to cost of trade (export) and the capacity of public support ; redevelopment of fruits & vegetables local food systems ; and other land use options such as solar energy production
- Consequences in term of **water management & governance** from control & common pool resource management to open access resource

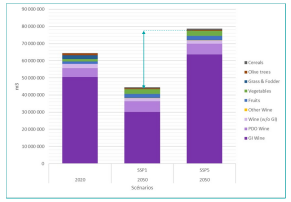
Detailed narratives online

2. Irrigated land use "quantification" :

✓ Different levels of vulnerability to climate change and water stress are identified by stakeholders per area

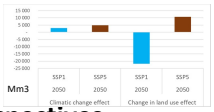


Irrigated land use according 2050 scenarios



Calculation of water demands by combining agronomic model results & scenarios

Fig Decomposition of changes in evolution of water demand according to (i) climatic change (increase in per unit land water demand) and (ii) land use changes



=> water demand by farming differ drastically according the evolution of international, national and local driving forces : **uncertainty associated to the socio-economic developments are higher than the one associated to climatic factors** on the estimation of future water demand

Conclusion & perspectives

- Putting stakeholders at the core of the research is demanding but is successful (>40 professional participants/workshop) even though some don't participate (e.g. wine professionals)
- transformational adaptations are needed to address water balance between users and resources: concretely speaking land use and agriculture development are to be questioned e.g. the development of irrigation on vines - and that incremental and individual adaptations – e.g. the optimization of networks or technologies - will not be enough in the long term.

Perspectives :

- The evolution of land use will also be modeled with a micro-economic programming model accounting for the four scenarios and specific instruments and prices to enable increase coherence and confidence (e.g. Graveline, 2016)
- The strategies, including instruments for water management will be further integrated with scenarios to explore their performance and enabling conditions of scenarios