Crop diversification as an adaptation strategy to climate change impact on ecosystem services provided by Pampean agroecosystems (Argentina)

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A**groecosystems** are vulnerable to climate events. If production intensification increases, agroecosystems´ vulnerability will also increase (Lin et al. 2008). However, Magrin (2007) states that agriculture has the ability to adapt to gradual changes, being extreme events those that pose a real threat to these systems. Then, c**rop diversification** may be considered as an adaptation strategy to **climate change**, due to its inherent characteristic of diminishing climatic and market risks.

Assessing climate change impact on **ecosystem services** provision is essential because they represent the outcome of a chain of interactions present in agroecosystems (Gosling 2013). Forsius et al. (2013) and Bangash et al. (2013) have recently assessed this relation on Finnish and Mediterranean agroecosystems, respectively. They have emcountered that certain ecosystem services respond positively to climate change, while others does not. Based on these examples, adaptation strategies to climate change impact are needed. Then, how would **ecosystem services** provided by **Pampean agroecosystems** (Argentina) respond to **crop diversification**? This could be answered by analyzing ecosystem services provision under two different crop diversification regimes: first, single crops and then, crop rotations.

The main objective of this research consists on assessing the provision level of a set of ecosystem services as a consequence of different single crops and climate change scenarios in the Pampa region (Argentina).

A) Ecosystem service: **Soil C balance**

B) Ecosystem service: **Soil N balance**

C) Ecosystem service: **Groundwater contamination control**

D) Ecosystem service: **N_2O emission control**

HOW DID WE OBTAIN ECOSYSTEM SERVICES PROVISION CONSIDERING FUTURE CLIMATE CHANGE SCENARIOS?

1º) Ecosystem services provided by Pampean agroecosystems: models development

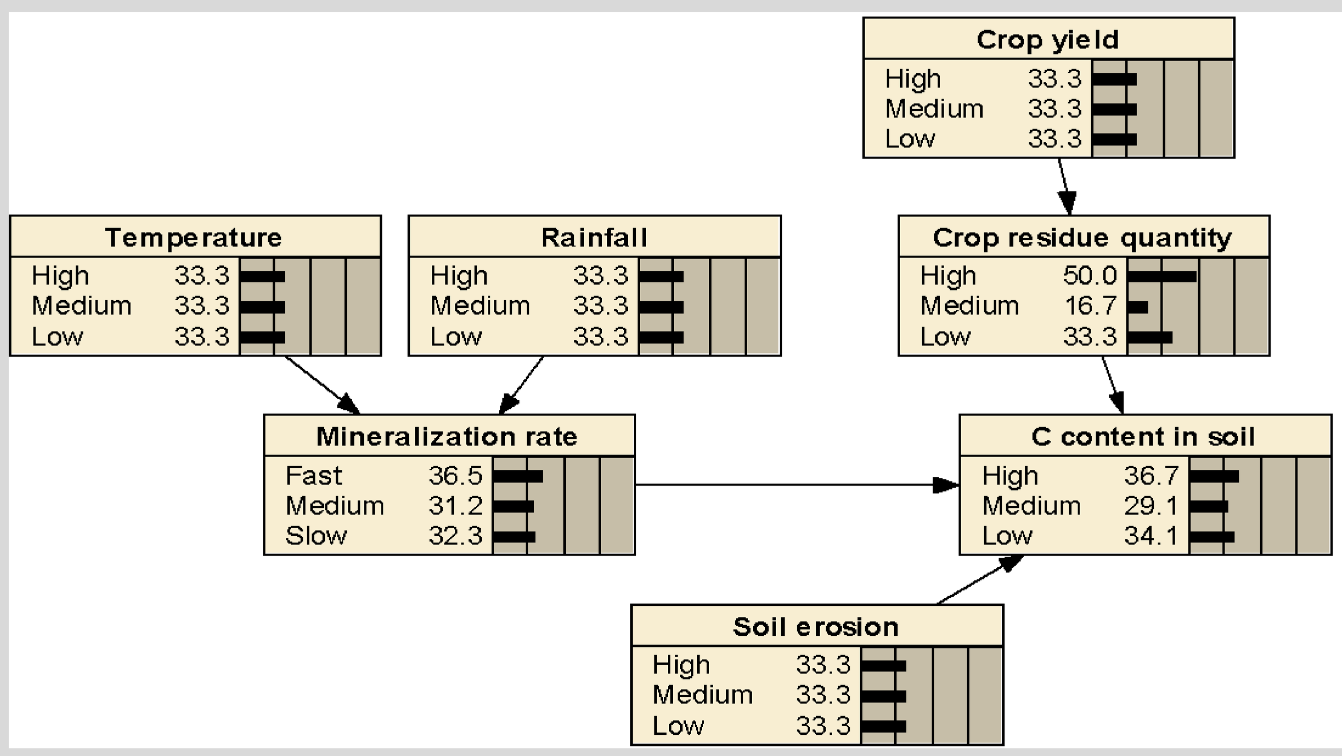
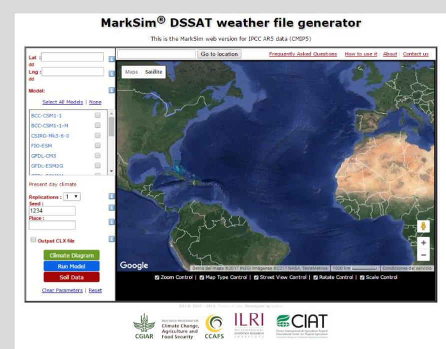


Figure 2: Bayesian Network representing Soil C Balance ecosystem service, and its outcome variable C content in soil (Based on Rositano and Ferraro, 2014).

2°) Models quantification: Population of climatic and productive variables (i.e. entry variables) with quantitative information

A) Climatic information: Temperature and Rainfall simulations with MarkSim software.



A1) RCP 2,6
A2) Three time periods: 2030-2035, 2060-2065, 2090-2095 (with 5 replicates each year)

B) Productive information: Crop yields simulations with DSSAT software.

B1) Four time periods: 1998-2003 (real climatic databases), 2030-2035, 2060-2065, 2090-2095
B2) Three single crops: soybean, maize and wheat

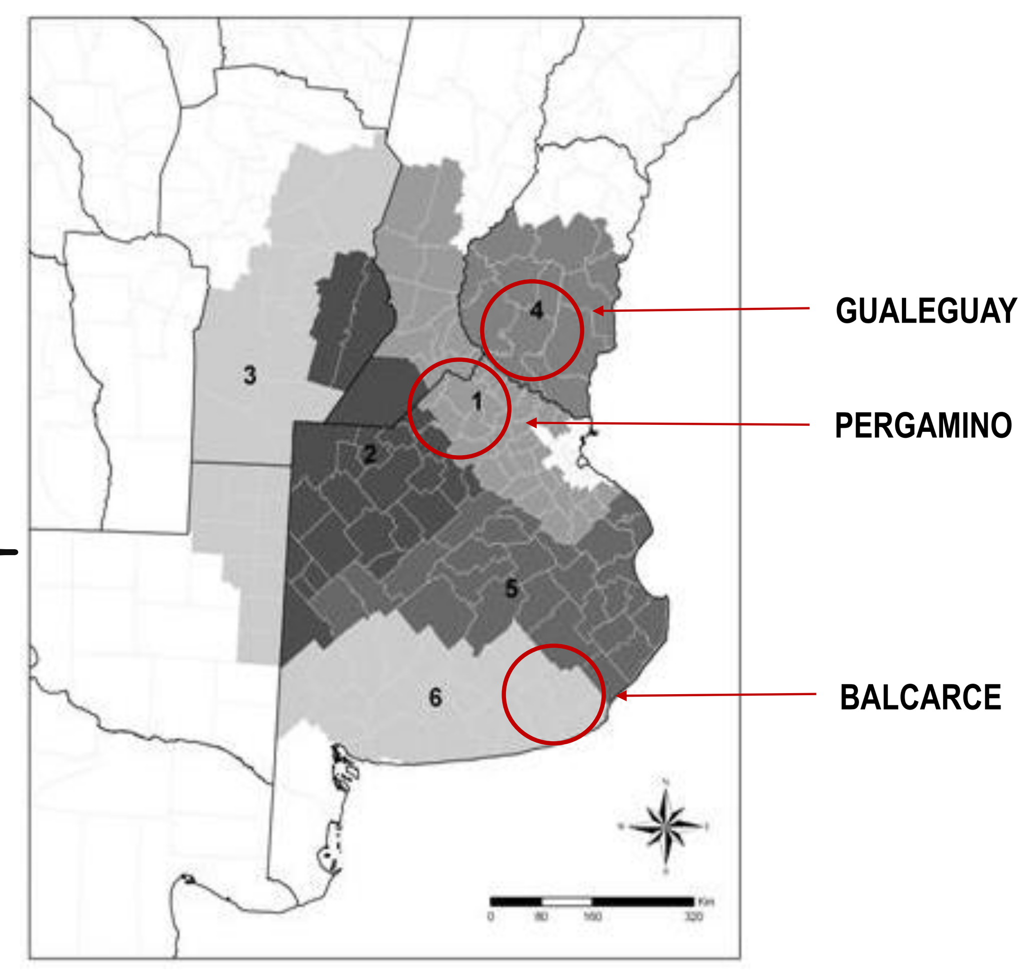


Figure 1: Location of the Pampa region (Argentina) and its sub-regions (grey shaded): 1) Rolling Pampa, 2) Inland Pampa, 3) Flooding Pampa, 4) Southern Pampa, 5) Semiarid Pampa, and 6) Mesopotamic Pampa.

HOW ARE ECOSYSTEM SERVICES AFFECTED BY CLIMATE CHANGE IN THE PAMPA REGION (ARGENTINA)?

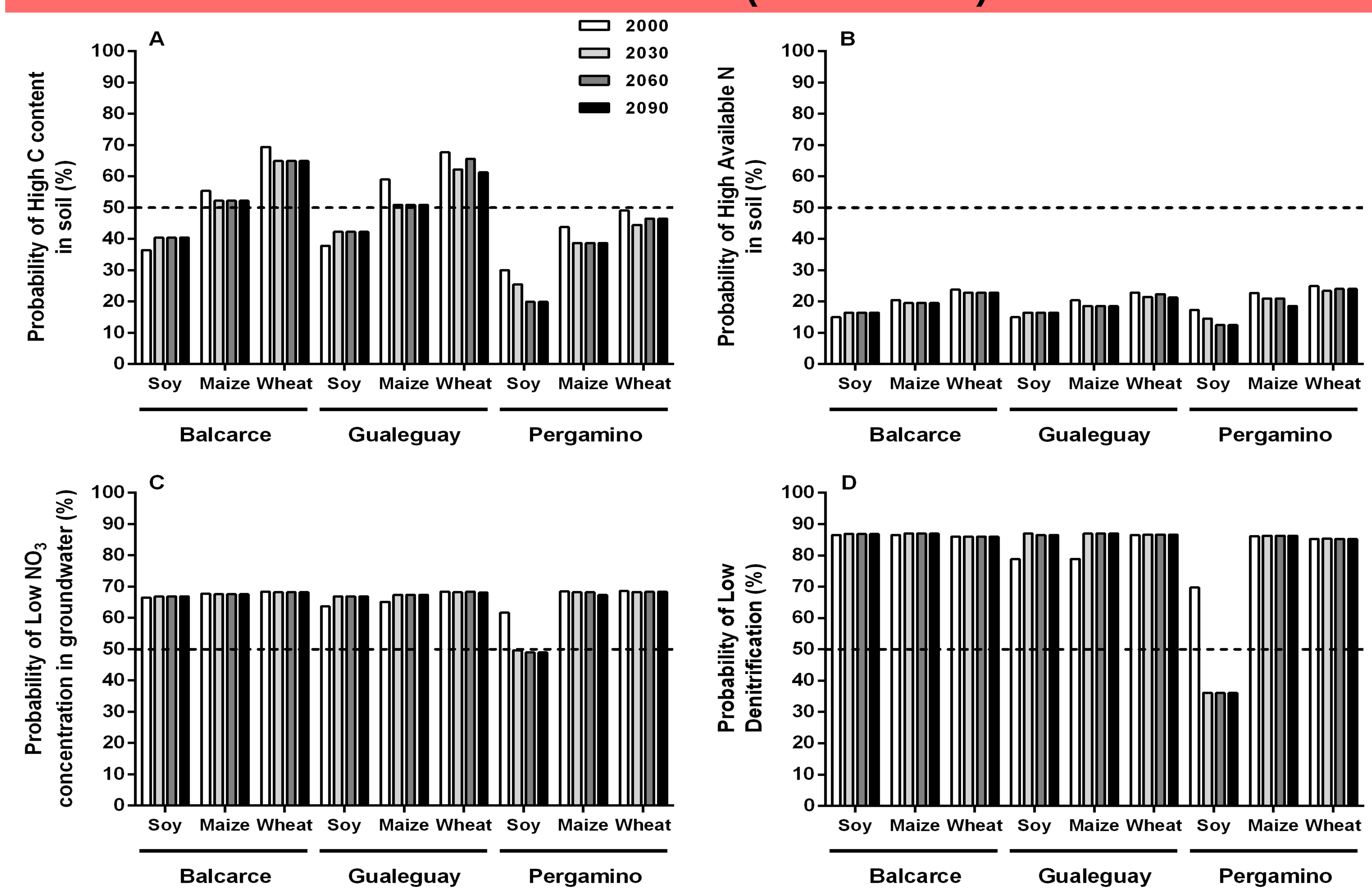


Figure 3: Probabilistic response of the outcome variable for each ecosystem service. The assessment was done for four time periods (1998-2003, 2030-2035, 2060-2065, and 2090-2095), three crops (soybean, maize, and wheat) and three agricultural regions (Gualeguay, Pergamino, and Balcarce). For achieving sustainable ecosystems, we were interested in one state of each output variable (i.e. the one that conferred desirable values for agroecosystems sustainability): A) High C content in soil, B) High Available N in soil, C) Low NO_3 concentration in groundwater, and D) Low Denitrification (Based on Rositano and Ferraro, 2014).

CONCLUSIONS

Each ecosystem service provision showed minimum differences among time periods. Greatest differences were obtained among single crops and agricultural regions (Figure 2). Provision differences were also observed among ecosystem services, being Soil N Balance the ecosystem service that presented the lowest values for its outcome variable (i.e. High Available N in soil) (Figure 2B).

RCP 2.6 assumes that global annual greenhouse gases emissions peak between 2010-2020, with emissions declining substantially thereafter. This could be the reason why we did not find marked differences among the four time periods considered. Climatic conditions considering RCP 6.0 and RCP 8.5 will also be included in our quantitative models.

Future work: Crop rotations influence on ecosystem services provision will be assessed. To do this, a set of crop rotations will be identified and compared in different environmental and productive simulated scenarios. Then, these crop rotations will be included into each ecosystem service quantitative model. Results will be a valuable contribution for planning sustainable strategies.

References:
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