REMEDIA workshop, Madrid, March 23rd -25th 2015

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

A holistic approach to capturing and quantifying Ecosystem Services trade-offs in Farming

The case of Llanada Alavesa, Basque Country

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Balbi, et al. 2015

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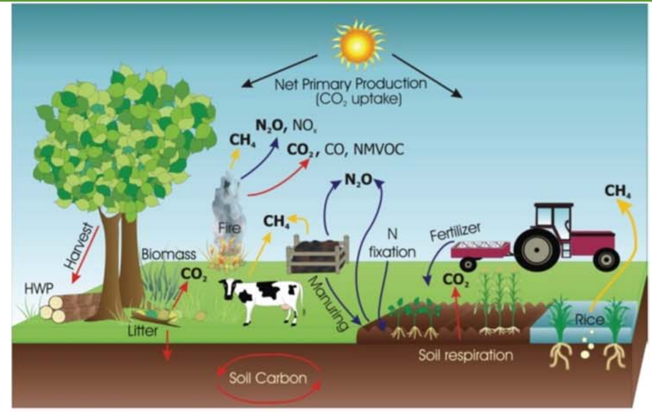
Key messages

- Demonstrate the importance of catering for the interdependence between agricultural production and other ecosystem services (ES), including **climate regulation**, air quality, water supply, water quantity.
- Capture and **quantify ES trade-offs in** the crop systems of Llanada Alavesa in the Basque Country.

> **trade–off** *noun* \'trād-ˌȯf\
>
> : a situation in which you must choose between or balance two things that are opposite or cannot be had at the same time
>
> : something that you do not want but must accept in order to have something that you want

- Apply a modelling technique enabling the flexible integration of models through semantics.
- Develop a spatially explicit application.

Ecosystem Services supported by Agricultural Systems

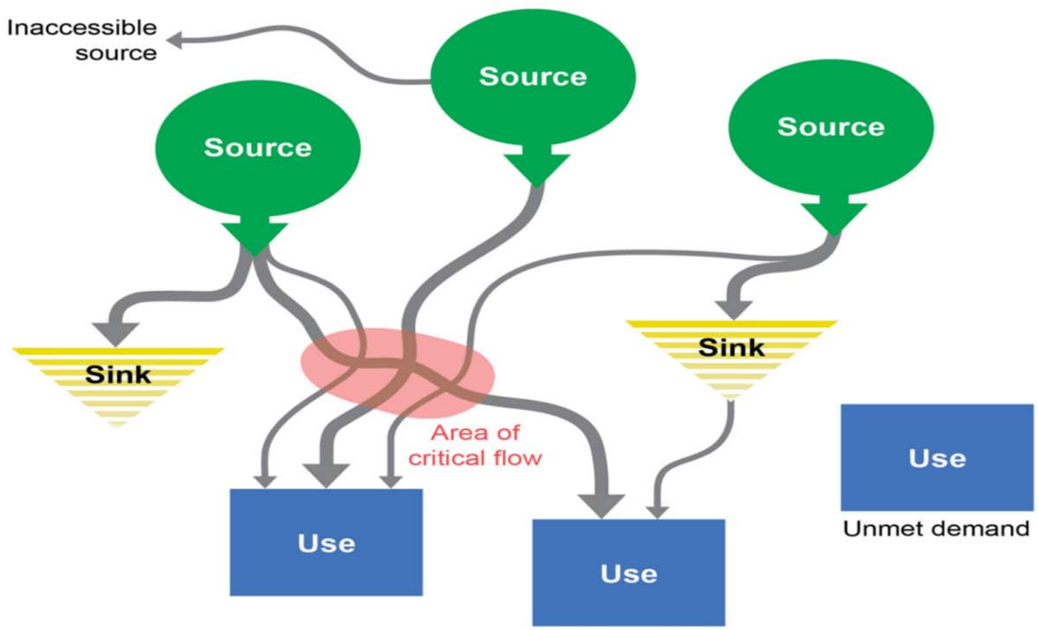


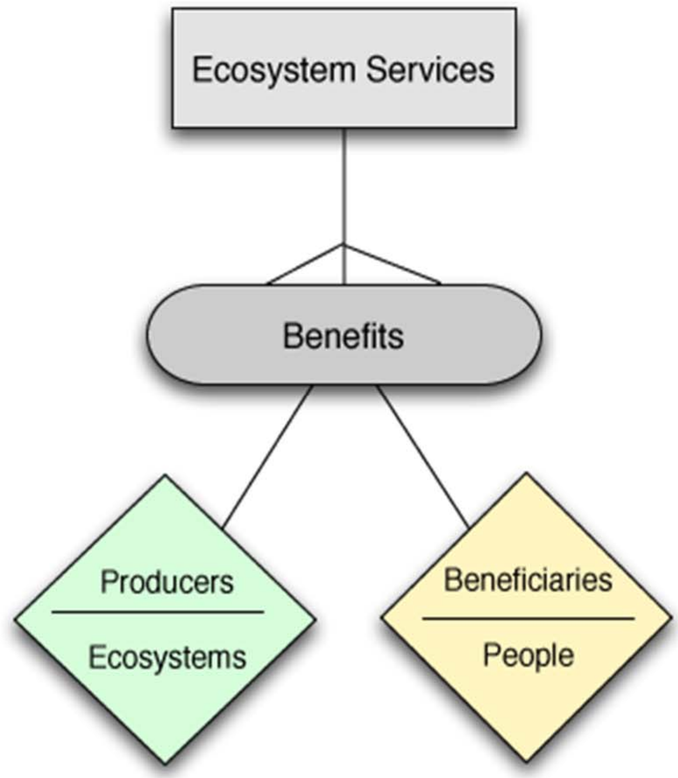
- Pollination
- Pest and disease management
- Fresh water, food, fibre, habitat, genetic resources
- Recreation and tourism
- Spiritual health, cultural identity

- Erosion prevention
- Protection from natural disasters
- Carbon sequestration and storage
- Air and water pollution control
- Nutrient cycling, soil fertility

http://www.bioversityinternational.org/research-portfolio/agricultural-ecosystems/

Artificial Intelligence for Ecosystem Services (ARIES) Modelling Framework



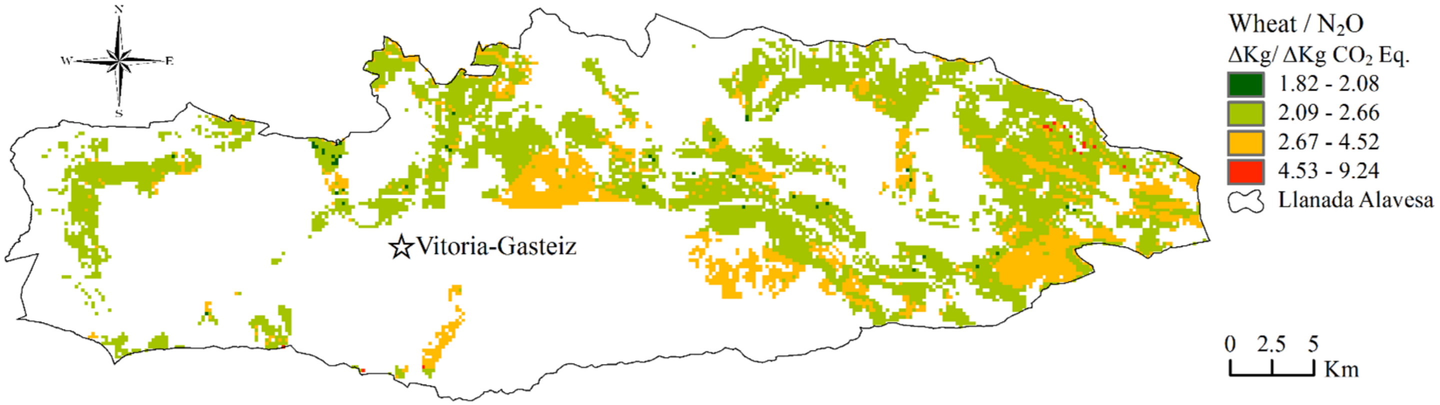


Ecosystem Services

the effects on human well-being derived from the flow of benefits from an ecosystem to human at given extents of space and time

Case Study

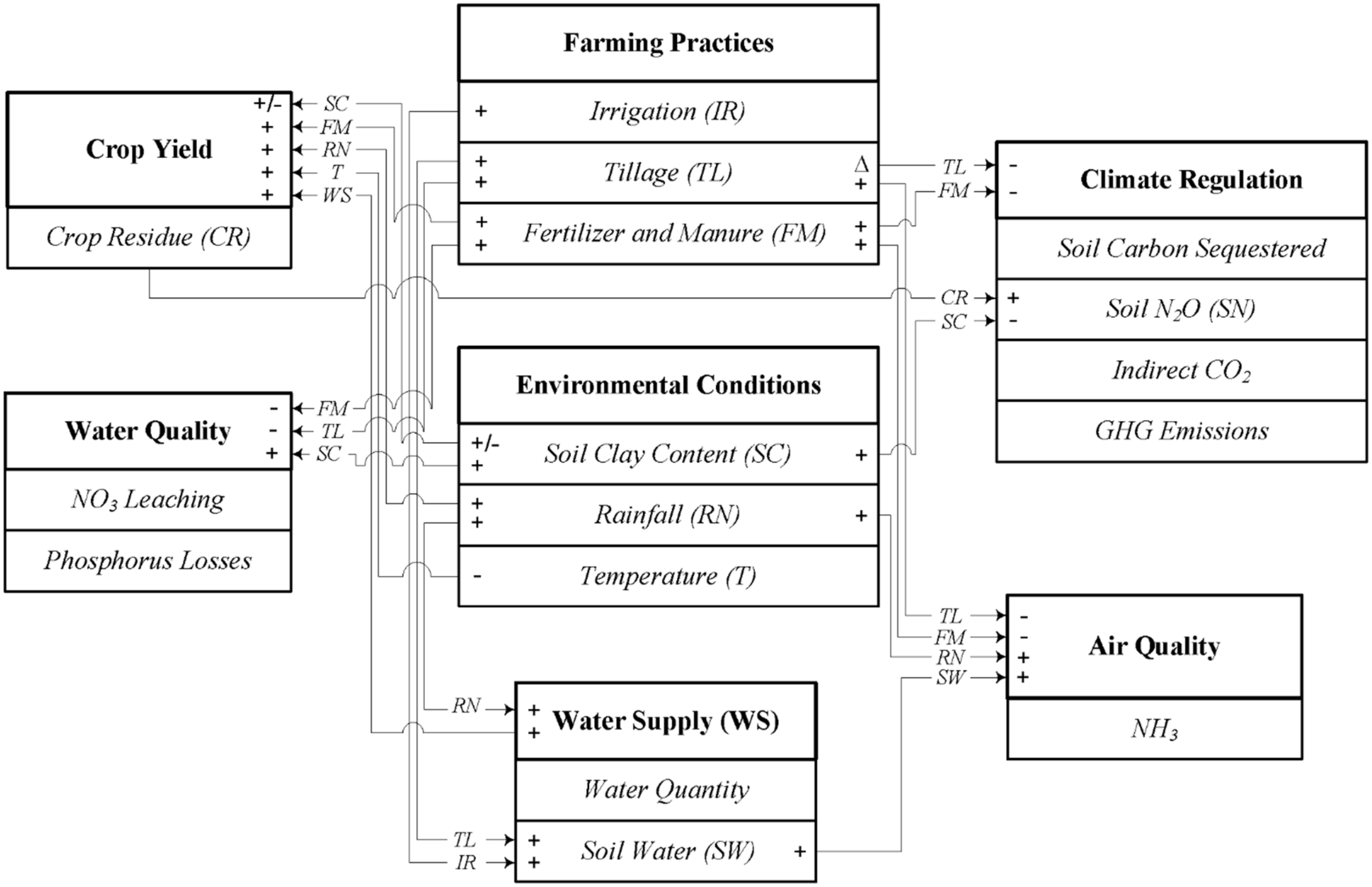
- Wide flatlands surrounded by mountains to the South and to the North
- 35% of land use is agriculture
- 92% of agriculture are rain-fed cereals
- 30% of the land is labelled as a NVZ



Model Output and relation to ARIES ES Framework

Output variables	Unit	Definition	Ecosystem Service	ARIES framework Role
Winter wheat yield	Kg/(ha*year)	The dry-matter yield of a crop per unit area of land cultivation	Food provision	Crop production - service source
Carbon stock change	Kg CO_2 eq / (ha*year)	Annual net effect of altered carbon sequestration and storage processes per unit area	Climate regulation	Vegetation and soil Carbon sequestration - service source
Nitrous oxide (N_2O)	Kg CO_2 eq / (ha*year)	Emissions of N_2O from agricultural soils	Climate regulation	Impacts users (global population and emitters)
Nitrate leaching concentration (NO_3)	mg/l	The concentration of nitrate transported through soil by water often to water bodies	Water quality	Nitrate leaching sources - service sinks
Phosphorus loss (P)	Kg / (ha*year)	Phosphorus is transported from agricultural land in particulate and dissolved forms. Dissolved phosphorus is lost in surface runoff water or, in certain cases, through leaching	Water quality	Sources of phosphorus losses - service sinks
Ammonia (NH_3)	Kg/(ha*year)	Ammonia produced during decomposition on the land that returns nitrogen to the aquatic system, which causes pollution above a certain level	Air quality	Sources of ammonia emissions – service sinks

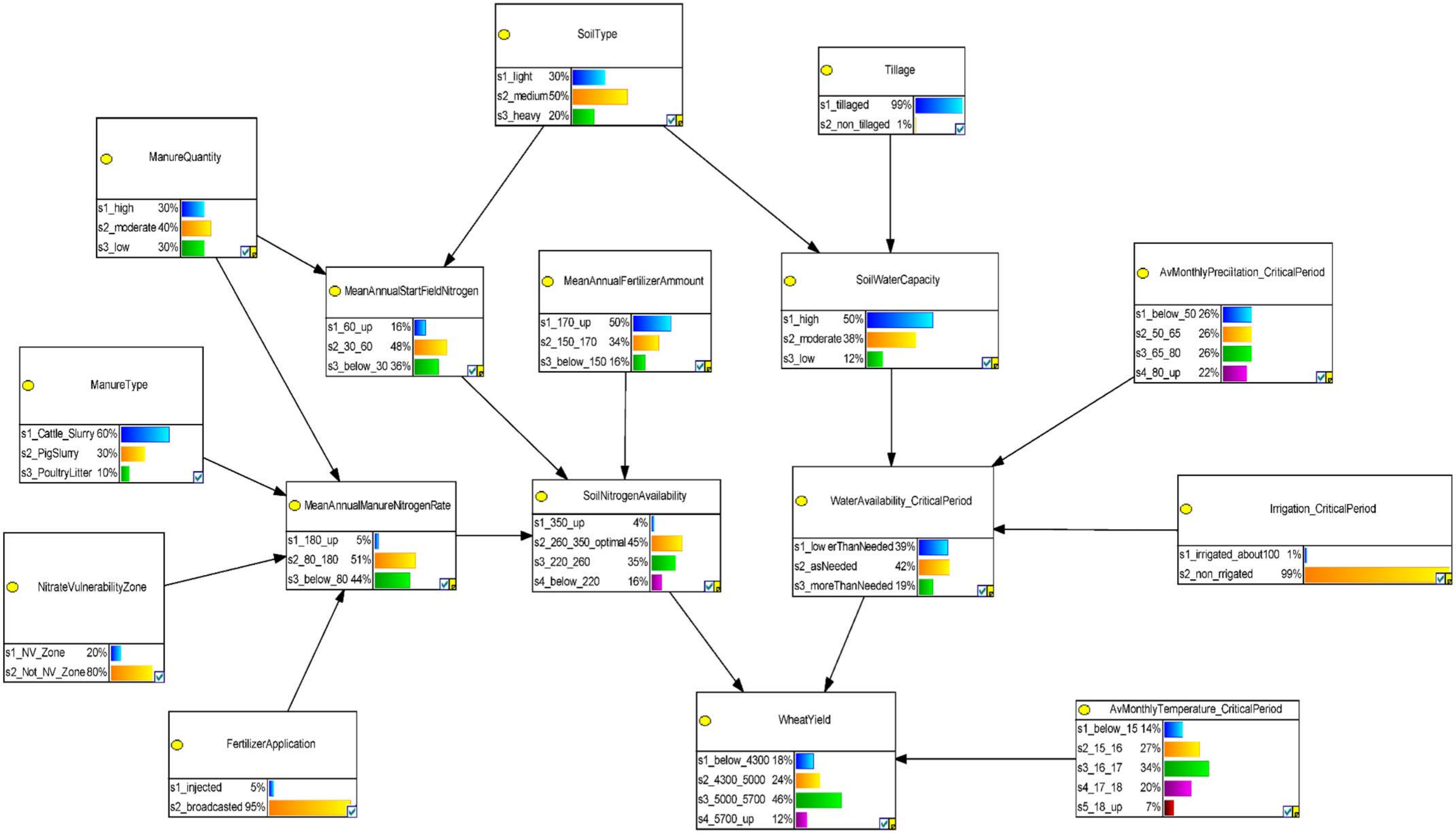
Conceptual Model



Modules (sub-models)

1. Crop Yield -> Bayesian model calibrated on empirical data
2. Climate Regulation -> Bayesian model re-implementing other approaches (IPCC Tier 1, Ecoinvent)
3. Water quality -> Bayesian model re-implementing other approaches ($SIMS_{NIC}$, Davison)
4. Air Quality -> Look up table (MANNER model)

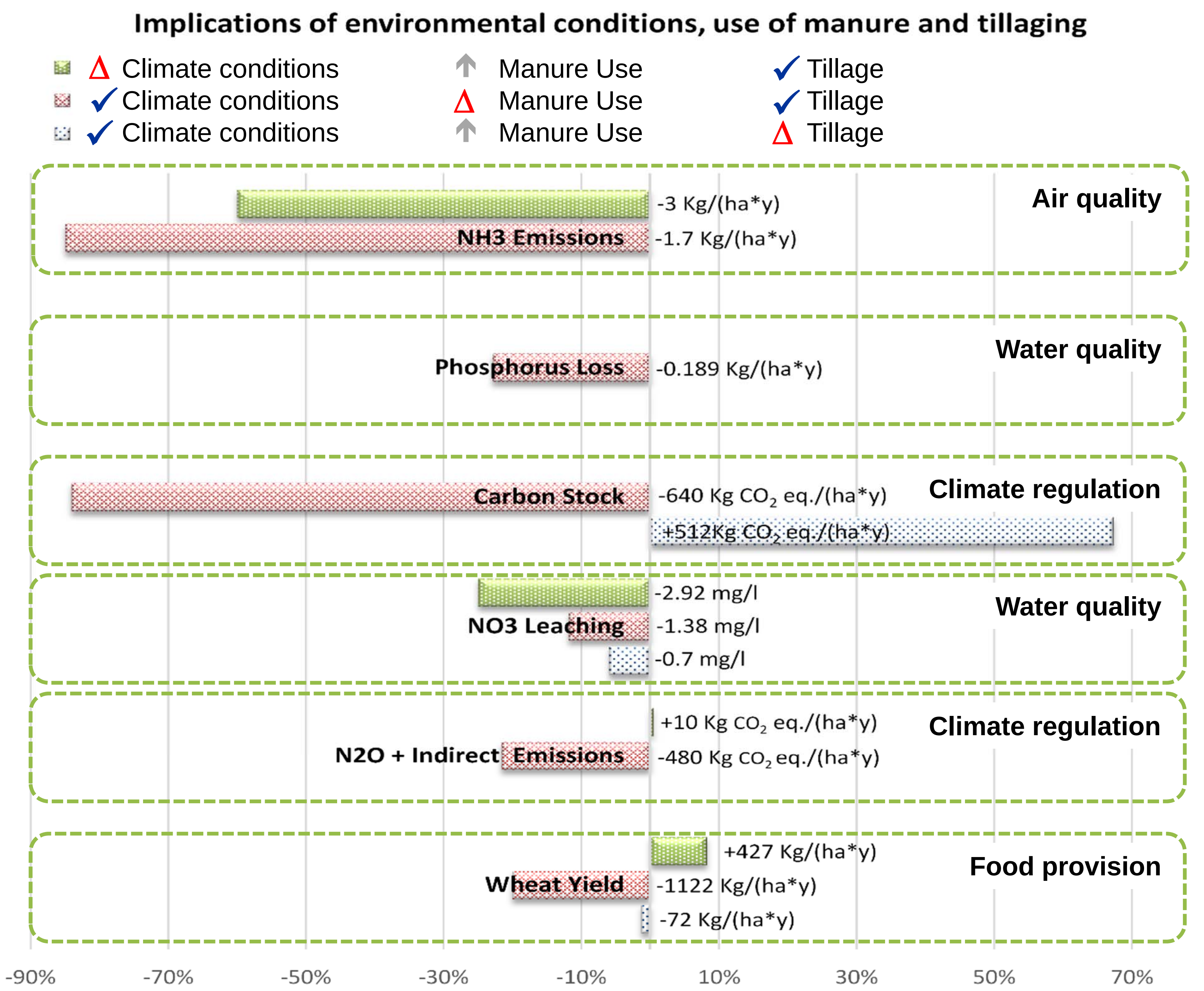
Crop Yield Module (winter wheat)



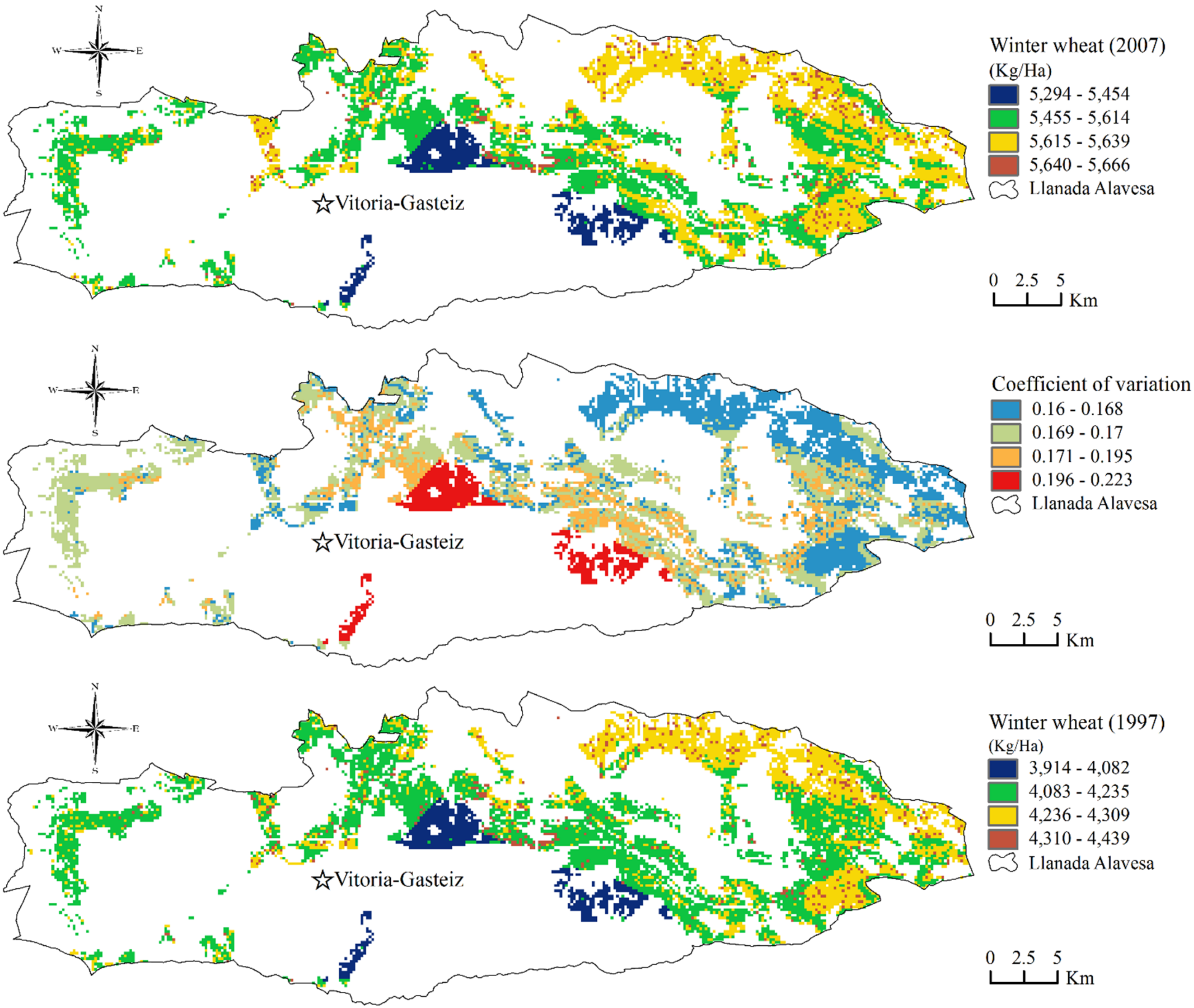
Scenarios

Factor 1				Factor 2	Factor 3
Year	Meteo conditions	Average monthly temperature during critical period	Average monthly precipitation during critical period	Manure use	Tillage practices
1997	Suboptimal (i.e. dry)	16.5 ^{0}C	45 mm	High (30-90 Kg-N/Ha)	Conventional
2007	Favorable	15.5 ^{0}C	90 mm	Low (0-10 Kg-N/Ha)	No-tillage

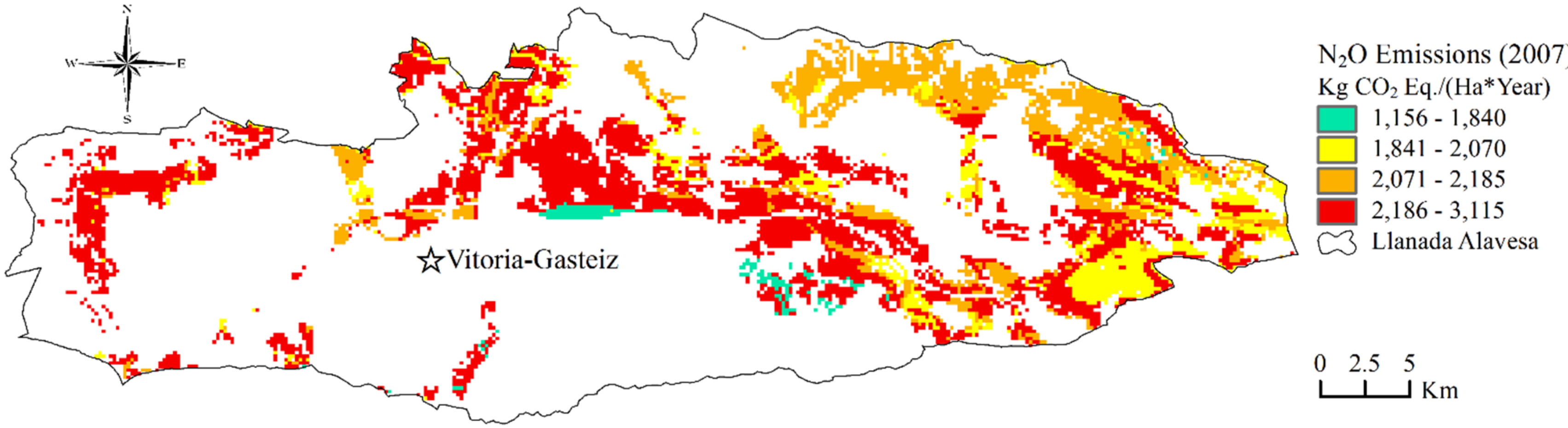
Aggregated trade-Offs

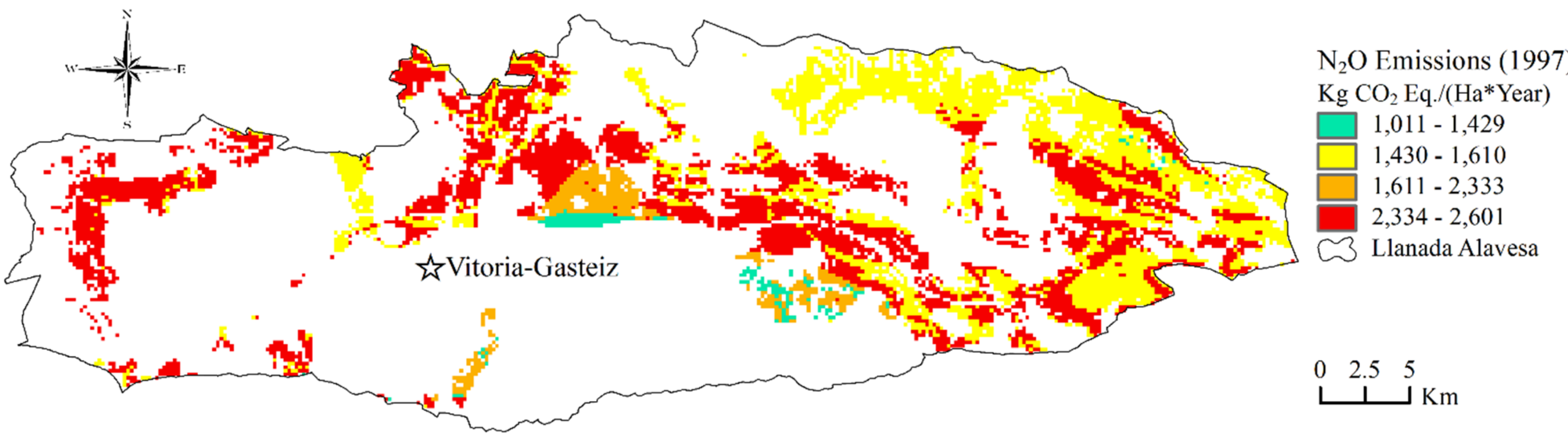


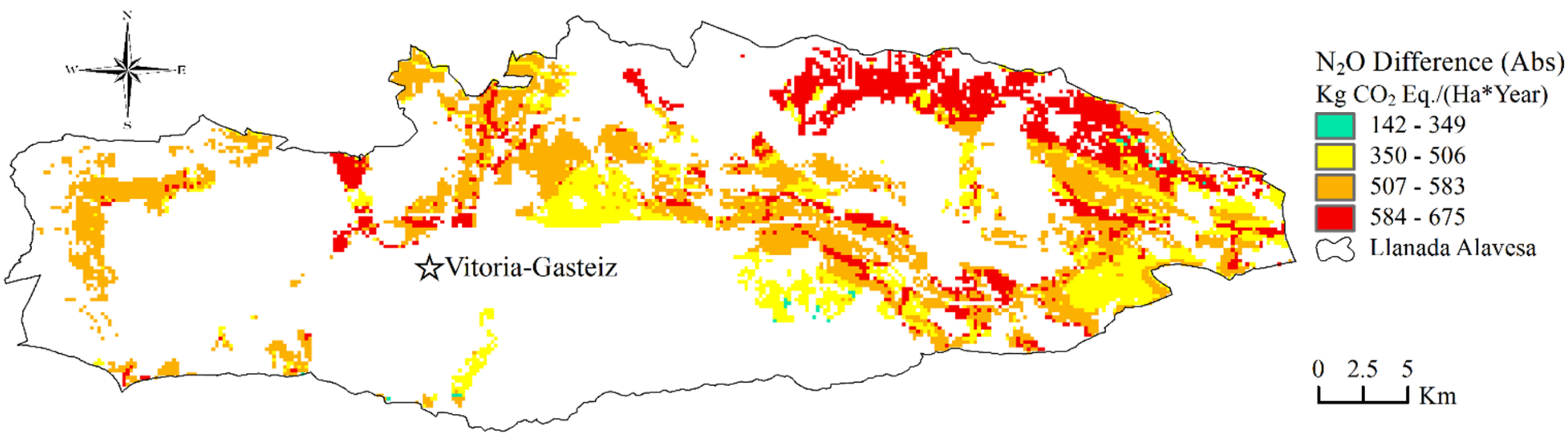
Spatially explicit outputs



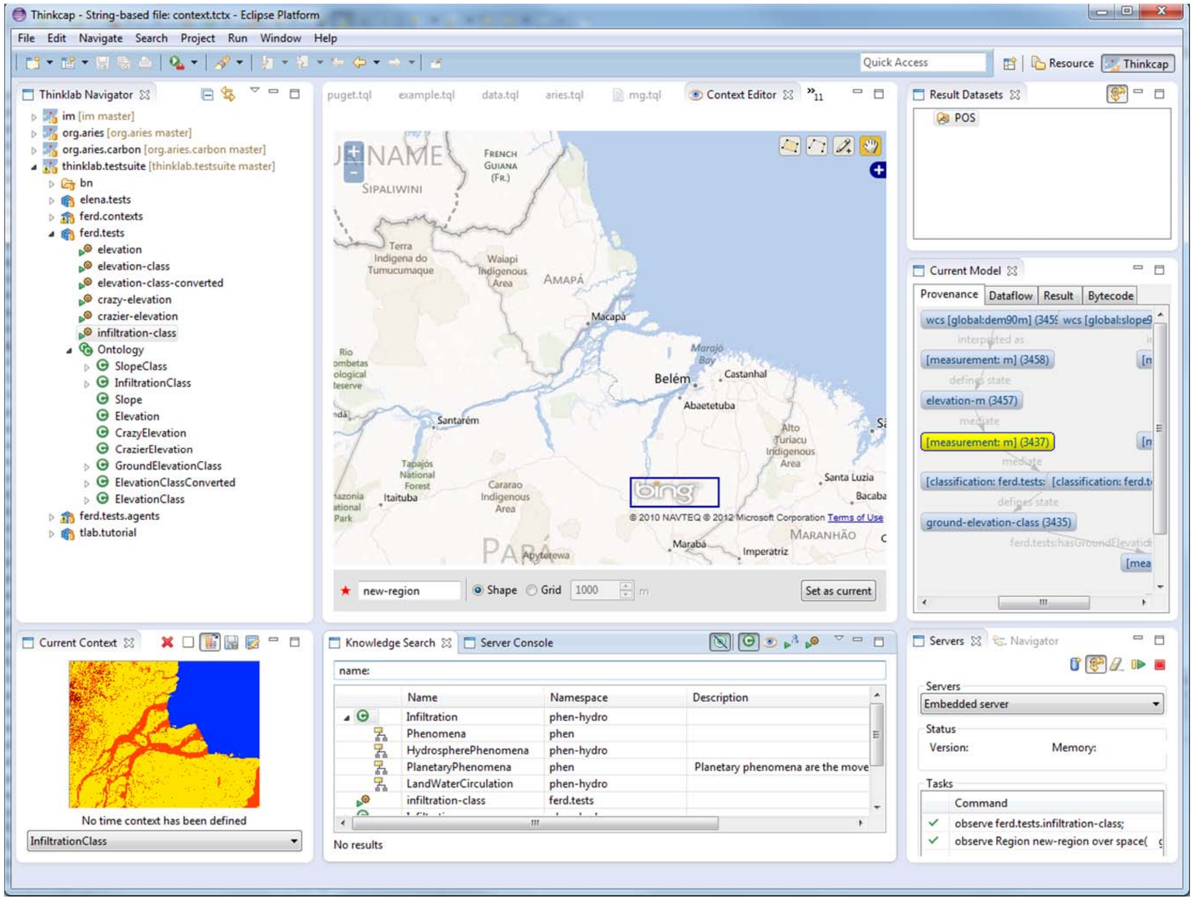
Spatially explicit outputs (cont'd)







Modeling software infrastructure



Models are building blocks not isolated solutions.

The **modelling framework** facilitates collaborative model development using advanced web-based technologies.

The ***Thinklab* software** is being taught to user groups worldwide.

The software handles every aspect of the model cycle, from data organization to model and scenario development.

Villa, F. et al. 2014. A methodology for adaptable and robust ecosystem services assessment. **PloS one, 9(3),** e91001.

Conclusions

- A more holistic approach to the predictions and management of agri-systems
  - **It is not effective to only think in terms of GHG emissions**

- Advantages:
  - Spatiality explicit
  - Probabilistic (BN)
  - Modular
  - Automated synchronization
  - Limited data demand

Limitations:

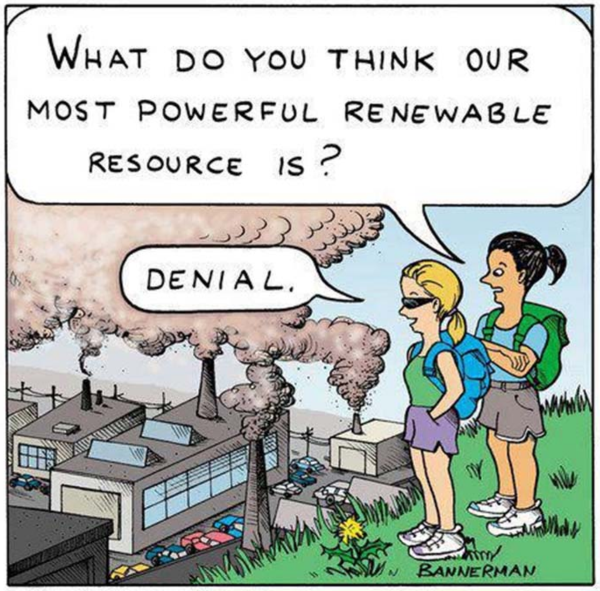
- Choice of ES
- Provision not demand
- Point Scenarios
- No dynamics
- One crop, No rotation

- Manuscript is available at

https://dl.dropboxusercontent.com/u/37283577/ManuscriptR1_submitted.pdf

- Details of the modelling platform

http://www.integratedmodelling.org/?page_id=86



BC3 Spring University - course on ES modelling

- The two previous editions April 2013 and 2014
- 2 weeks duration, held in Bilbao
- 30 highly skilled researchers and practitioners
- Participants come from every continent
- Many are recognised experts in their field
- Both the course programme and the synergies make it a unique experience in the global system modelling arena
- 3rd edition in 2015 between April 7th and April 17th

ANY QUESTIONS ???

http://www.bc3research.org/springuniversity

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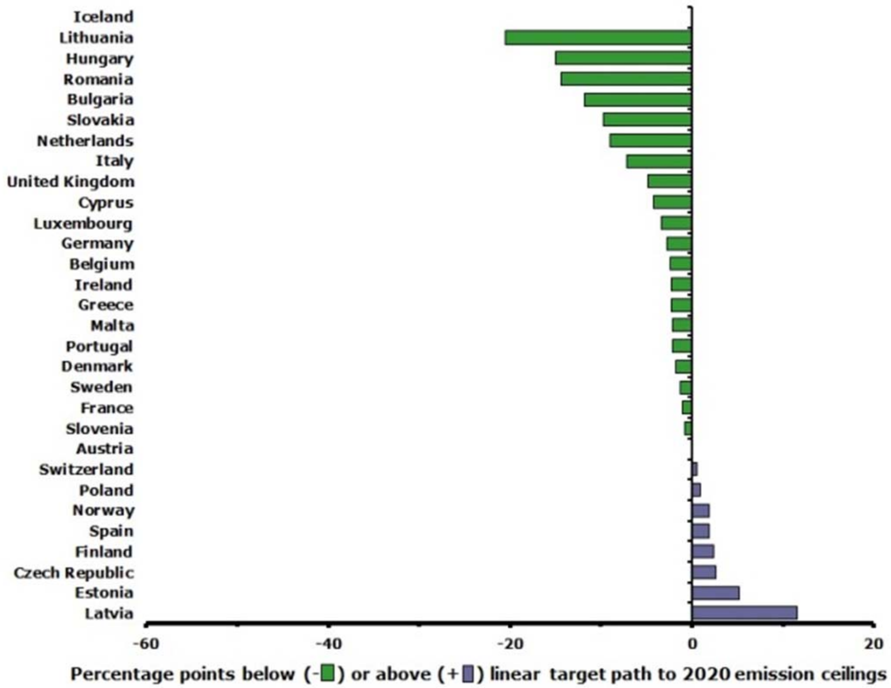
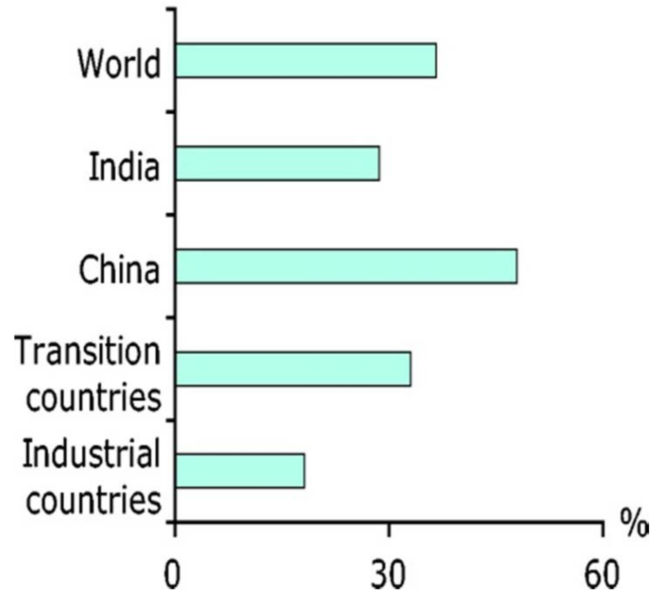
ADDITIONAL SLIDES

Impacts of Agriculture on Ecosystems



Ammonia emissions EU-27
(Distance-to-target for EEA member countries)



Change in fertilizer consumption 1997/99 to 2030

Impacts of Agriculture on Ecosystems

Farming practices

Water pollution

Soil Erosion