FACCE MACSUR: Modelling Agriculture with Climate Change for Food Security

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contributions by M. Köchy, F. Brouwer, F. Sinabell, G. Dono, K. Helming, R. Kipling, H. Lehtonen, P.P. Roggero, E. Saetnan, M. Schönhart, A. Zimmermann, F. Ewert, R. Rötter, M. Banse, N. Scollan, and many other MACSUR-ers

FACCE-JPI core themes

1. **Integrated assessment of food security**
2. Sustainable intensification
3. Tradeoffs with ecosystem services
4. Adaptation to climate change
5. GHG mitigation

FACCE-JPI core themes

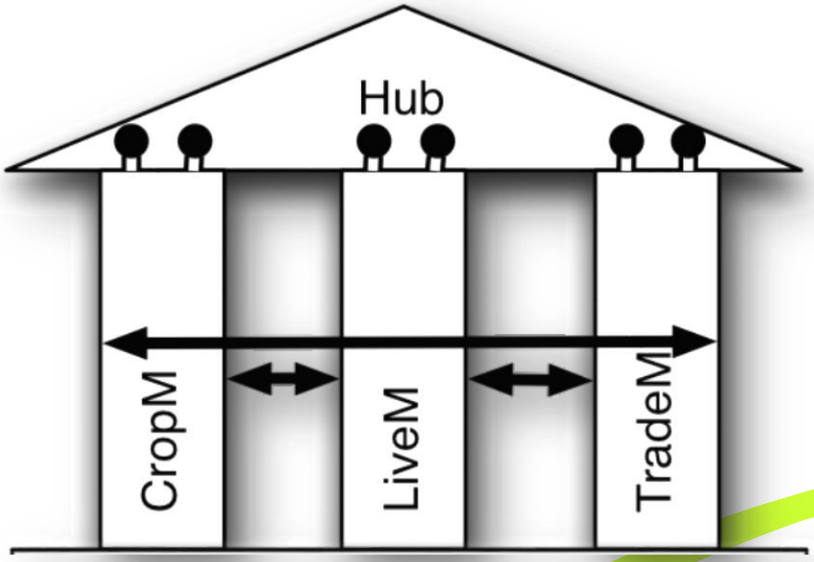
1. Integrated assessment of food security

MACSUR:
Modeling Agriculture with Climate Change for Food Security

Phase 1 from June 2012 to May 2015; phase 2 from June 2015 to May 2017

MACSUR: a knowledge hub

- An instrument building on the concept of “networks of excellence”
- Research teams are ***already funded*** in a thematic area
- National support for **additional** activities: coordination costs, travel expenses and thematic workshops
- Countries may choose to support research and/or mobility



MACSUR partnership

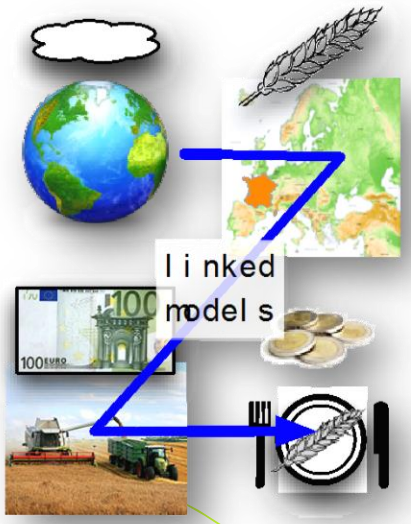
18 countries:

- Austria
- Belgium
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Hungary
- Israel
- Italy
- Netherlands
- Norway
- Poland
- Romania
- Spain
- Sweden
- United Kingdom

➔ 71 organizations, 300 scientists

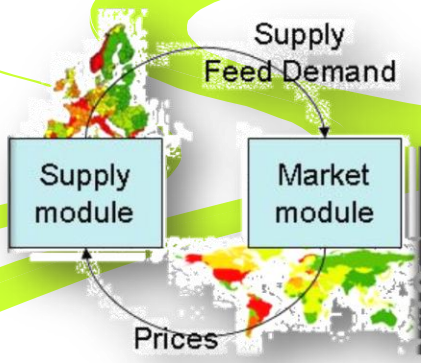
MACSUR aims

- To improve and integrate models
  - crop and livestock production, farms, and national & international agri-food markets
- To demonstrate integration & links
  - of models for selected farming systems and regions
- To provide hands-on training
  - to junior and experienced researchers in integrative modelling
- To identify risks and consequences of adaptation and mitigation in agriculture
  - for better availability, accessibility & affordability of food



Different scales – different models

- Farm-level models, diverse approaches
  - mathematical farm investment models
- Regional and national models
  - optimization of investment, resource use, or food security
- International and global models
  - international trade and policies
- Sector models (farm-EU-global)

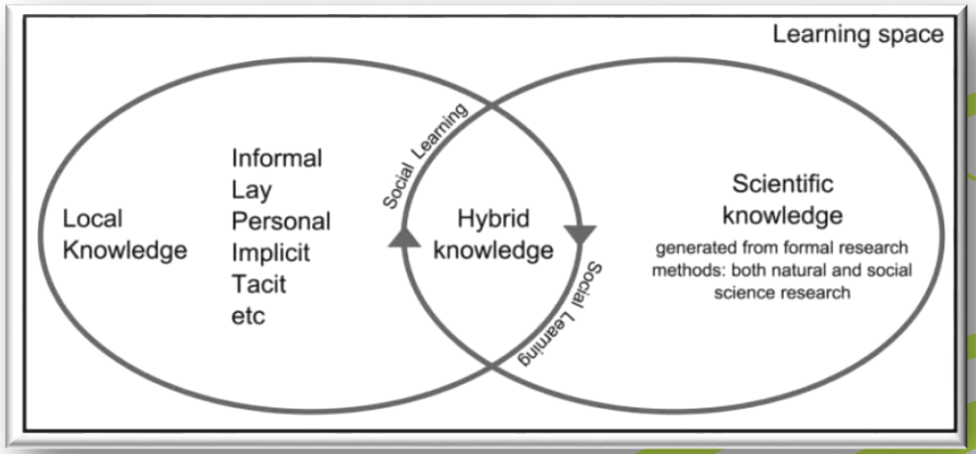


Research meta-question(s)

- How to support effective adaptive responses to climate change and stimulate proactive attitudes of farmers, policymakers & researchers?
- How to co-construct the nature of the issues about climate change adaptation?
  - i.e.: How to identify the right questions to engage pathways within the **adaptive space**?
- Hybrid knowledge rationale: climate change adaptation is a socially-constructed concept, where conceptualized background experience informs…

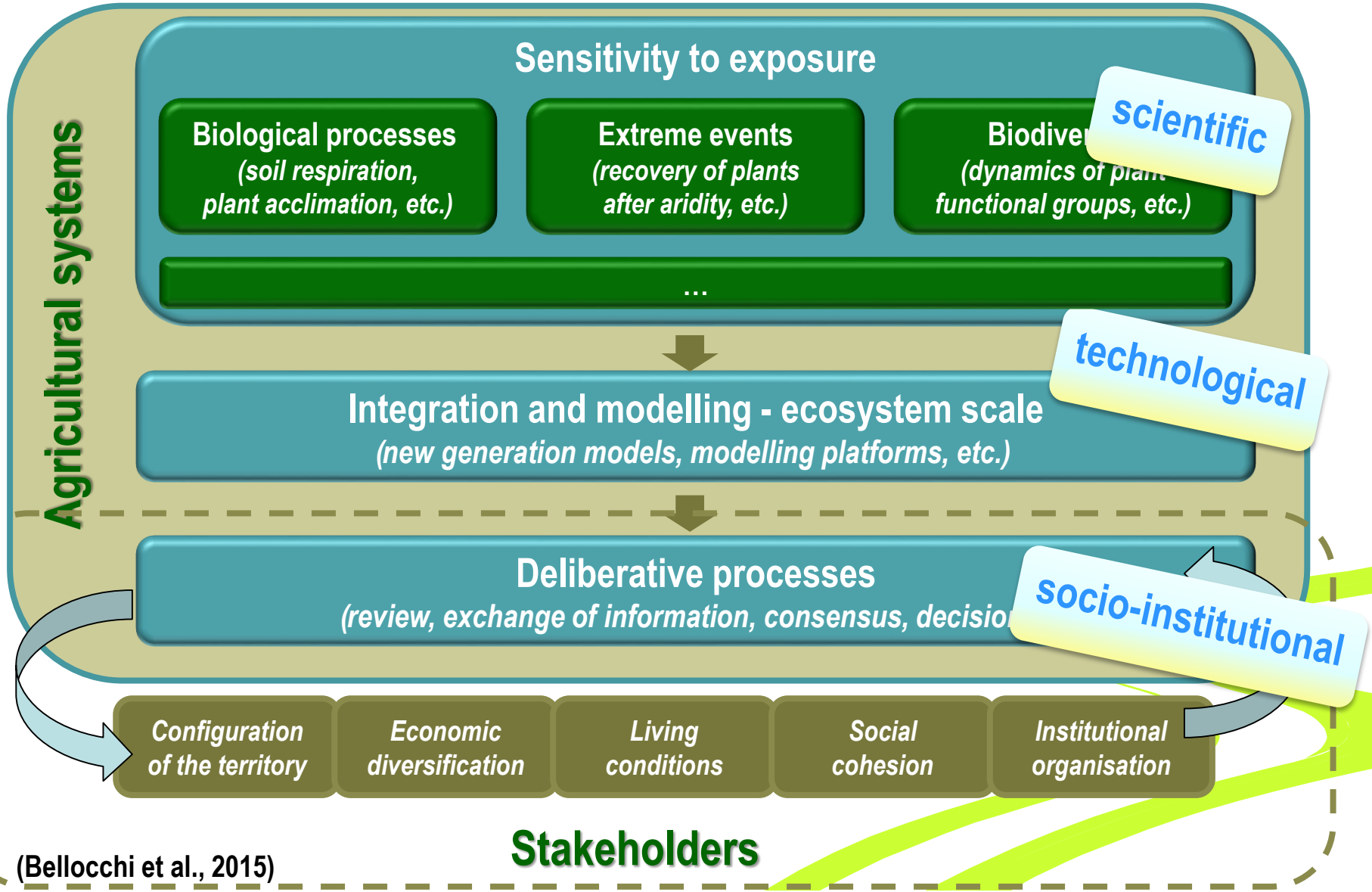
… climate change understanding and response-abilities/capacities

… farmers' climate change perception driving changes in practice

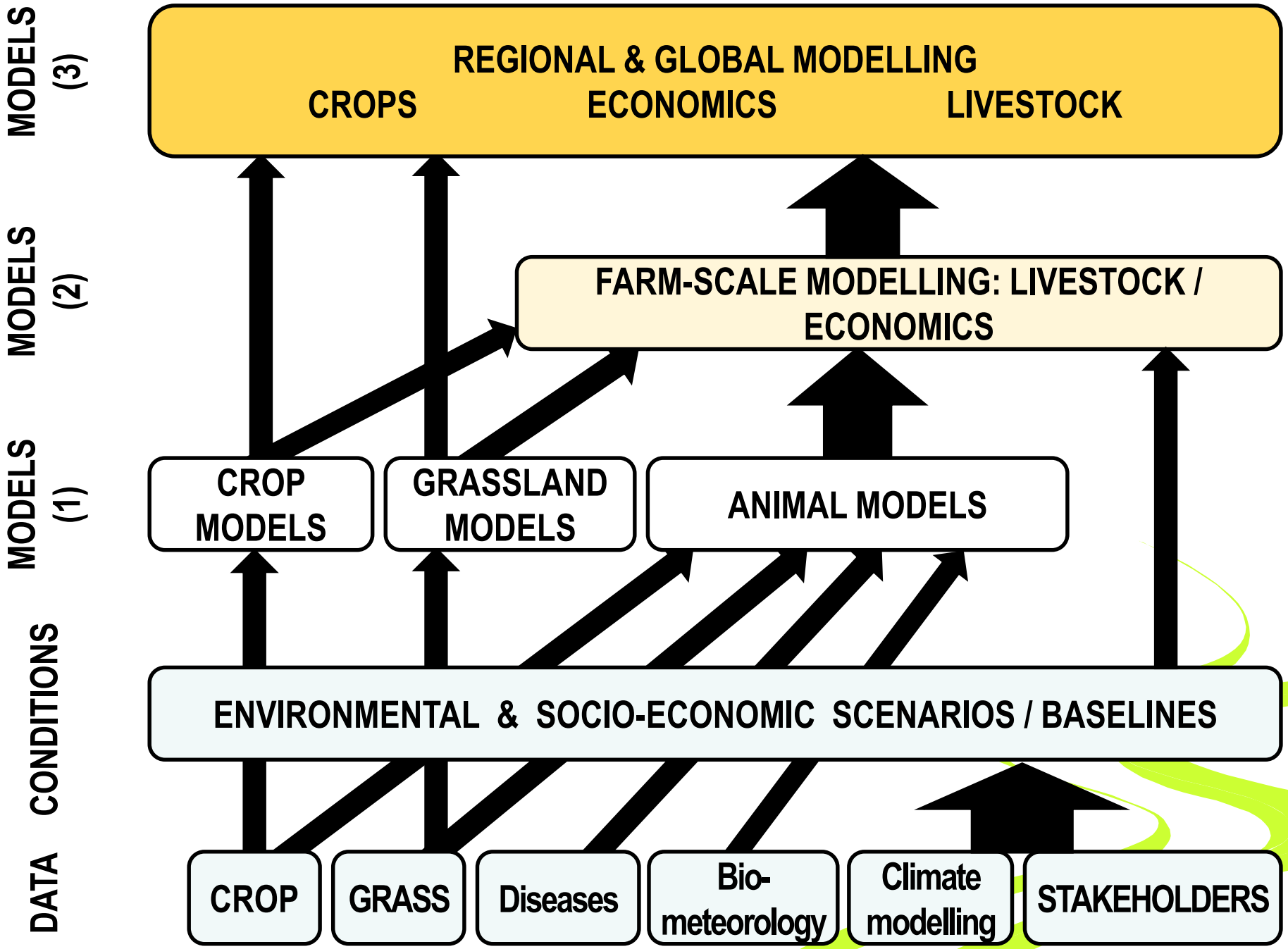


(Wise et al., 2014)

Vulnerability assessment framework



(Bellocchi et al., 2015)


MODELS (3)
REGIONAL & GLOBAL MODELLING
CROPS
ECONOMICS
LIVESTOCK
MODELS (2)
FARM-SCALE MODELLING: LIVESTOCK / ECONOMICS
MODELS (1)
CROP MODELS
GRASSLAND MODELS
ANIMAL MODELS
DATA CONDITIONS
ENVIRONMENTAL & SOCIO-ECONOMIC SCENARIOS / BASELINES
CROP
GRASS
Diseases
Bio-meteorology
Climate modelling
STAKEHOLDERS

Grassland model inter-comparison

Contents lists available at ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

Application note

Vuln-Indices: Software to assess vulnerability to climate change

R. Lardy [1], G. Bellocchi *, R. Martin

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Modelling the impact of environmental changes on grassland systems with SPACSYS

L. Wu[1†], A. P. Whitmore[2] and G. Bellocchi[3]

Agron. Sustain. Dev. (2015) 35:589–605
DOI 10.1007/s13593-014-0271-0

REVIEW ARTICLE

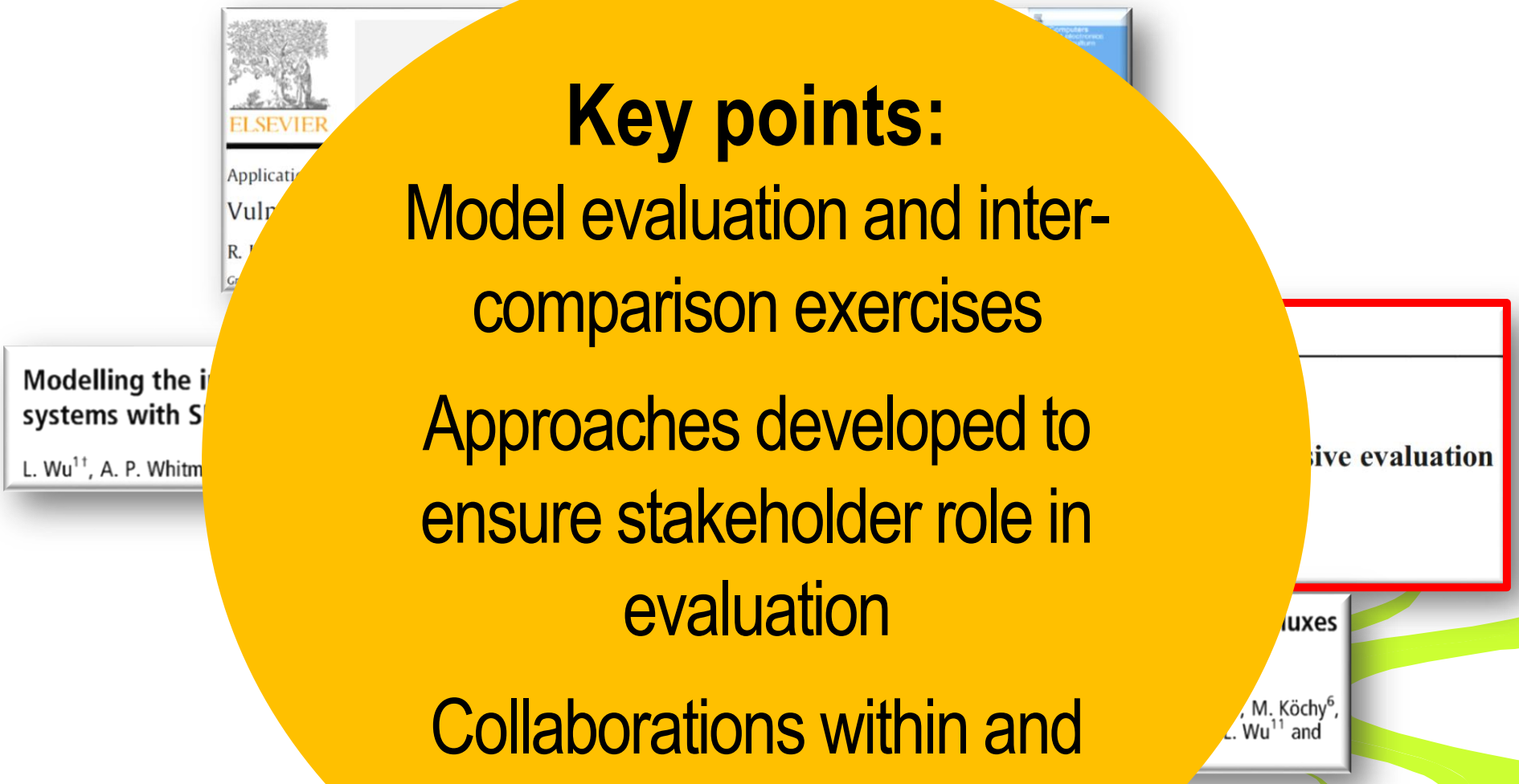
Deliberative processes for comprehensive evaluation of agroecological models. A review

Gianni Bellocchi · Mike Rivington · Keith Matthews · Marco Acutis

Uncertainty in simulating biomass yield and carbon–water fluxes from grasslands under climate change

R. Sándor[1], S. Ma[1], M. Acutis[2], Z. Barcza[3], H. Ben Touhami[1], L. Doro[4], D. Hidy[5], M. Köchy[6], E. Lellei-Kovács[7], J. Minet[8], A. Perego[2], S. Rolinski[9], F. Ruget[10], G. Seddaiu[4], L. Wu[11] and G. Bellocchi[11]

Grassland model inter-comparison



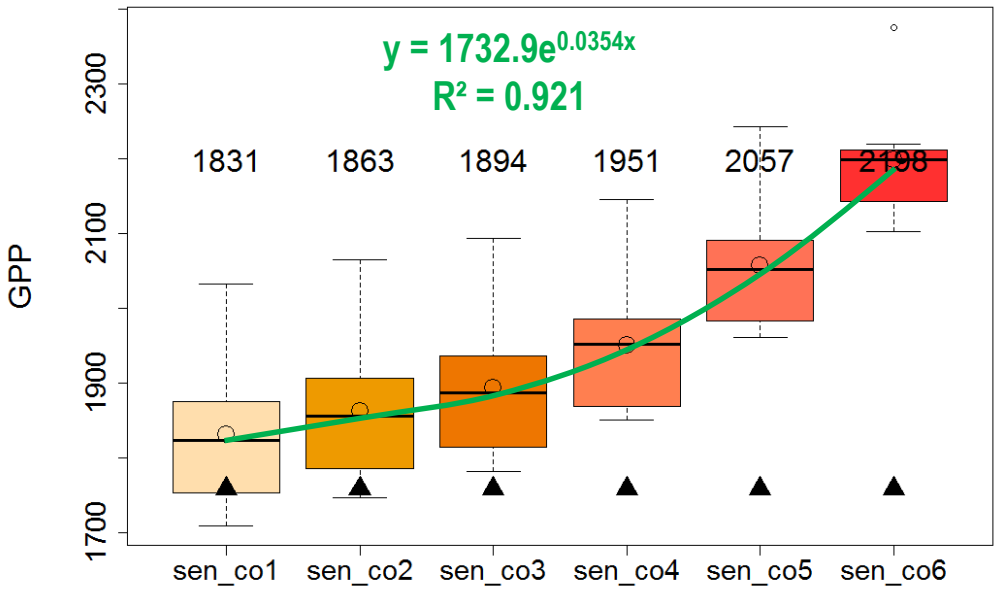
Key points:

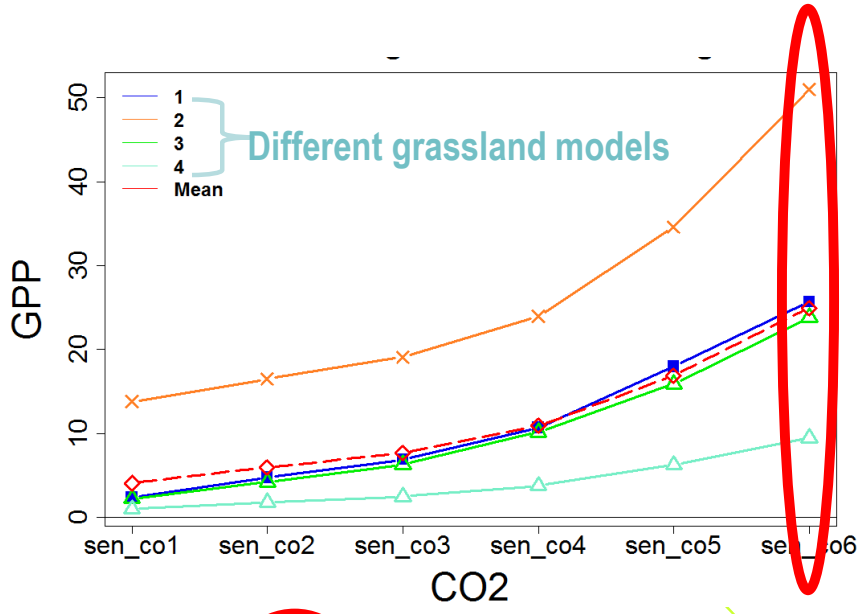
Model evaluation and inter-comparison exercises

Approaches developed to ensure stakeholder role in evaluation

Collaborations within and beyond MACSUR

Sensitivity of grassland productivity to [CO_2]





Baseline: 380 ppm

+5% CO_2 (399 ppm) → +4%

+10% CO_2 (418 ppm) → +6%

+15% CO_2 (437ppm) → +8%

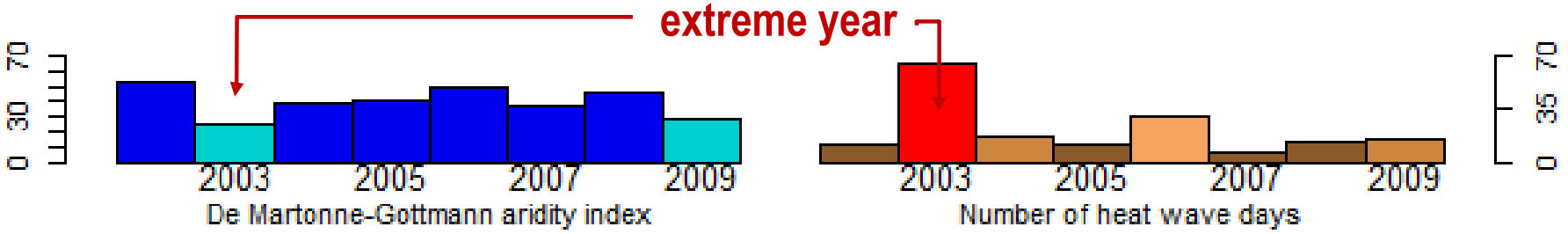
+25% CO_2 (475 ppm) → +11%

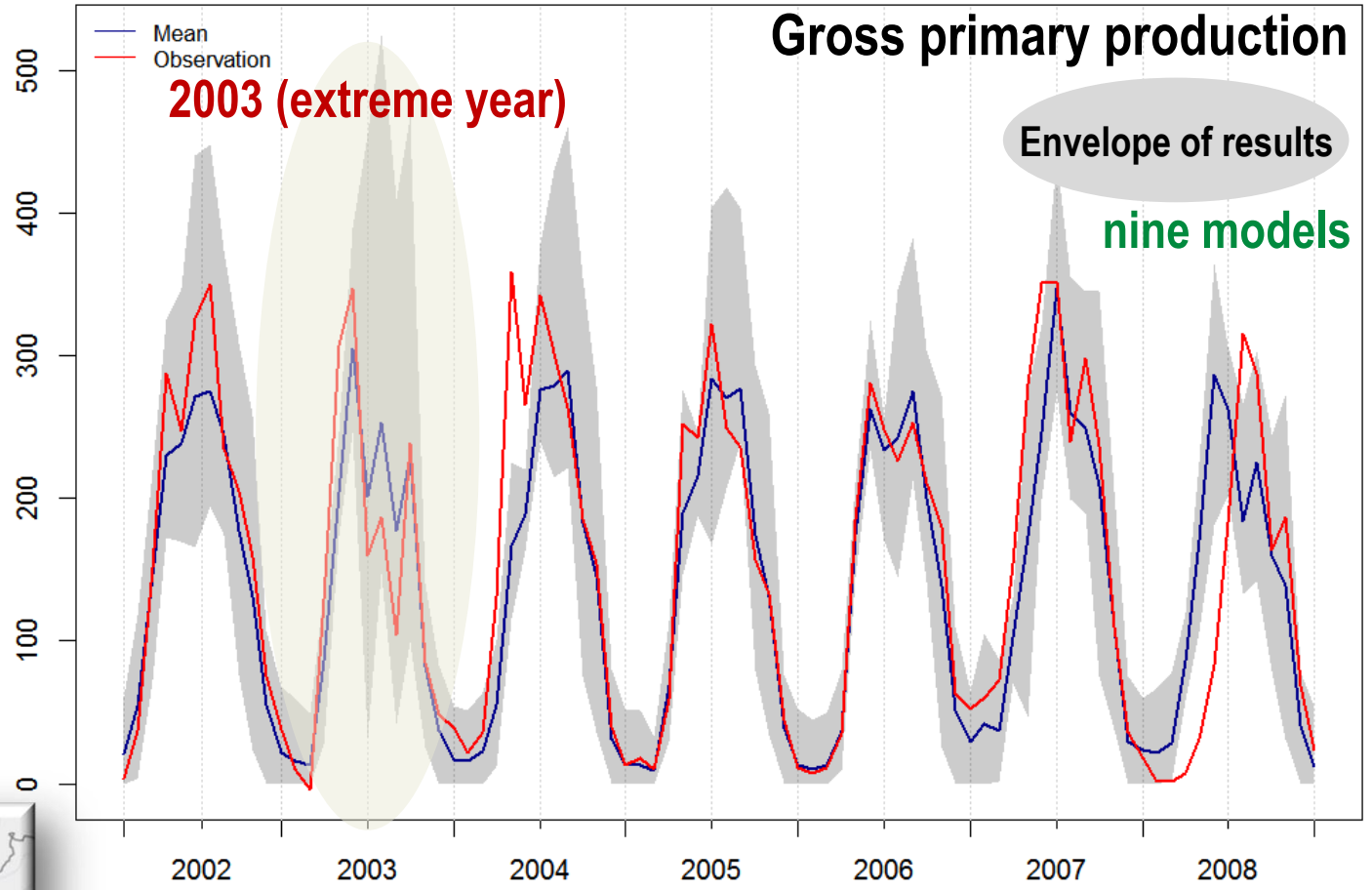
+50% CO_2 (570 ppm) → +17%

+100% CO_2 (760 ppm) → +25%

Different CO_2 scenarios

(Sándor et al., 2015)

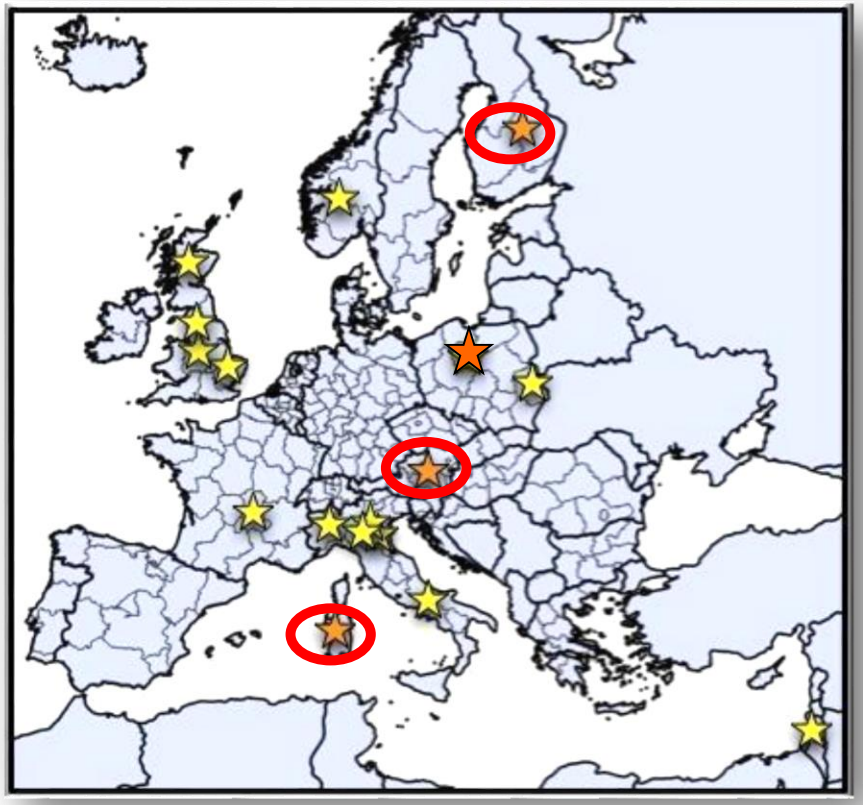

extreme year
0
30
70
2003
2005
2007
2009
De Martonne-Gottmann aridity index
0
35
70
2003
2005
2007
2009
Number of heat wave days


Gross primary production
Mean
Observation
2003 (extreme year)
Envelope of results
nine models
0
100
200
300
400
500
2002
2003
2004
2005
2006
2007
2008


Oensingen

(Ma et al., 2014)

Regional case studies



Finland: Northern Savonia

Austria: Mostviertel

Italy: Sardinia

Focus: 2020, 2030, 2050

Integration of models; participation of stakeholders; global economic and climate scenarios (SSPs, RCPs)

Northern Savonia (Finland)

- Observed climate change
  - — longer growing period, higher mean temperatures, more total rain
  - — greater variability, summer droughts, less snow cover, feed quality losses, wet conditions more frequent ⇒ soil compaction by machines
- Adaptation in cultivars, fertilization, pest management., farm machinery, drought risk management, silage storage, crop rotations, sowing dates
- Increasing grass growth benefits dairy and beef
  - limited by EU N directive, greening rules; national land buying regulations
- Increase in yield potential of cereals and oilseeds is uncertain: more frequent summer droughts
- Positive market development and more flexible and encouraging policies (N, land) needed for adaptation

Mostviertel (Austria)

North: dairy, vineyards

South: cereals

- Impacts from policy scenarios > climate change impacts
- Farmers may benefit from climate change, although effects seem to be mixed for farmers specialised in crop production
  - not everyone is a winner
- Climate change induces intensification of land by removing landscape elements and increasing use of fertilizers
- Productivity gains from climate change will increase the payment level at which farmers accept compensations in environmental programs

Sardinia (Italy)

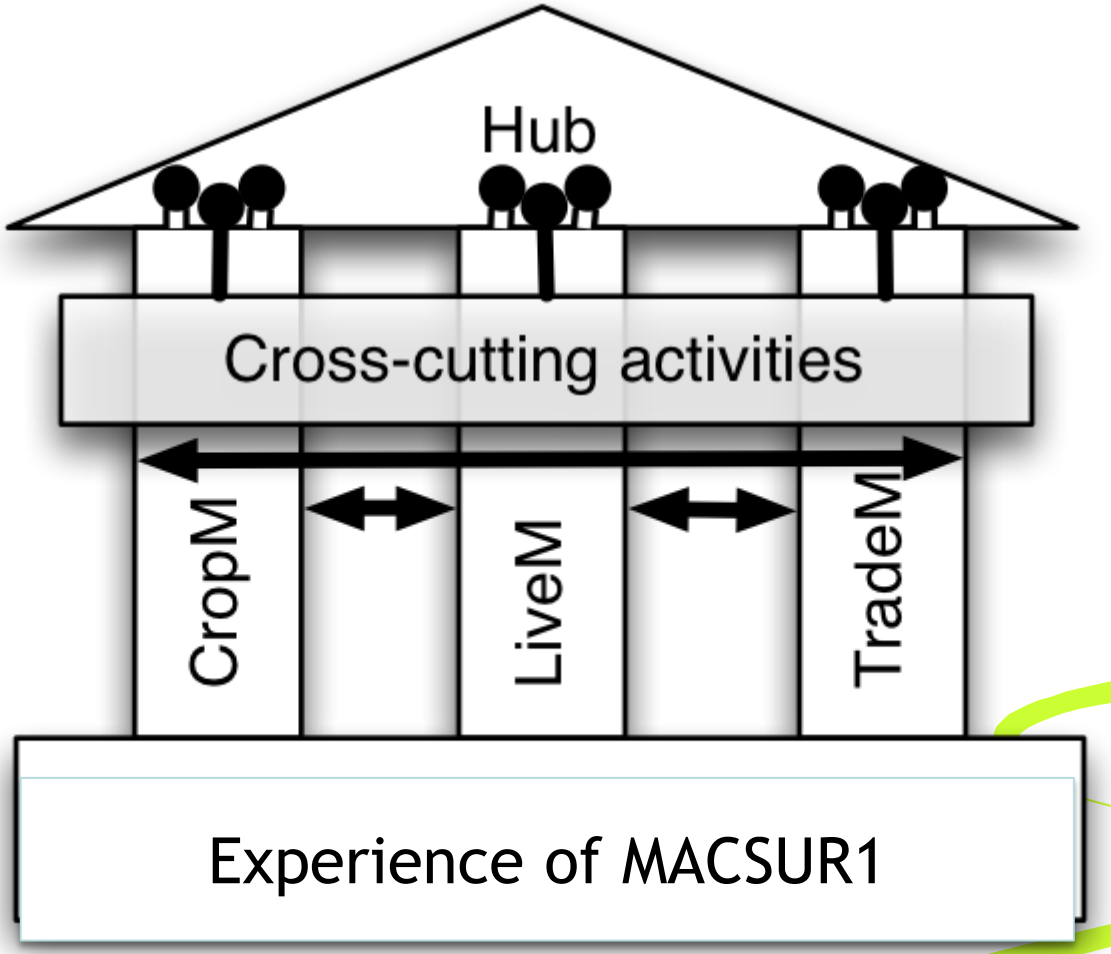
dairy *extensive grazing* *vegetables* *cereals (rice), forage*

- –30% rainfall, $\Delta\bar{T}$ = +1 °C in 2030
  - Yields of forage crops are reduced, ⇒ notable income drops for livestock farming
  - Rainfed hill sheep farming under threat of abandonment
- Irrigation costs increase in regions with volumetric water pricing; use and salinization of groundwater will increase elsewhere
- More heat waves will affect welfare, milk quality and quantity and mortality of dairy cows
- Higher temperatures during autumn and winter will provide other income opportunities, but farmers need to understand the crop yield changes
- The dairy cattle cooperative is developing a new win-win pathway linking hi-input dairy cattle farming with low input beef cattle grazing systems

Conclusions from regional studies

- Livestock systems likely to be hit the hardest by climate change
- Variability of yields is bad for farm incomes, beyond average changes
- The impacts of CC are heterogeneous among farm types and regions (winners and losers seem to be observed everywhere)
- Improving health and welfare is an important adaptation and mitigation strategy
- Economic responses tend to level down and smooth out CC impacts on production
- Bringing together direct and indirect impacts of climate change is vital
- Linking models from field to global scale is important to support policy decisions
- Learning between sectors carries potential for novel solutions and methodological advances
- Adaptation to climate change is easy compared to adaptation to policies

MACSUR2


Hub
Cross-cutting activities
CropM
LiveM
TradeM
Experience of MACSUR1

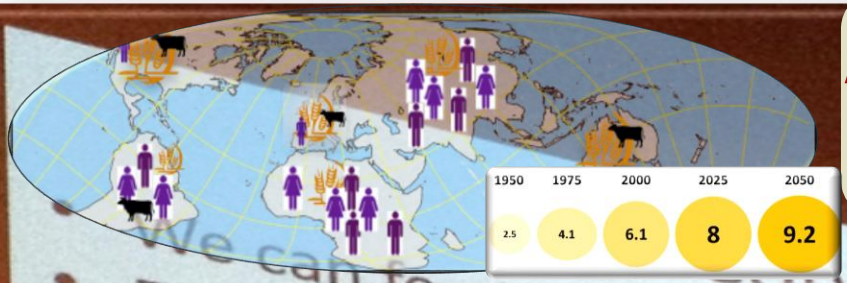
MACSUR2: work in cross-cutting activities / 1

- Model comparison & improvement
- Uncertainty and risk assessment
- Capacity building
- Regional case studies
- Impact assessment for Europe
- Overall scenario development

MACSUR2: work in cross-cutting activities / 2

- Variability and extreme climatic events
- Identifying sustainable opportunities to reduce yield gaps in Europe
- Feeding livestock
- Impact on ecosystem services and rural development
- GHG mitigation from agriculture

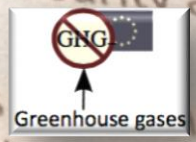
Adaptation of agriculture to (more than) climate change



Conclusions

- We can feed 9-10 billion people
- Food supply needs to be increased whilst reducing environmental impact of agriculture
- Need to find options and policies that co-deliver improved food security and improved environmental outcomes
- Some promising supply-side measures (e.g. efficiency improvements) improve food security and reduce environmental impact

- Demand-side measures (e.g. changing diets, waste reduction) are under-researched, for food security and for potential to reduce environmental impact



- We need to change consumption patterns (demand-side measures) – techno-fixes are not enough to make the necessary changes

CLIMATE-SMART Agriculture 2015

Smith (2014a)

For further information: http://macsur.eu

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