Modelling European Agriculture with Climate Change for Food Security

Agriculture, food security and climate change

Progress and challenges in systems research and integrated assessment and modelling

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Contributing partners

MACSUR community

- *Project Leadership Team*
- *Project Steering Committee*
- *Project and Themes Management Team/s*
- *Theme leaders*
- *Activity/Task leaders*
- *Partners*

Partners

- > 300 scientists
- > 80 organisations
- 18 Countries

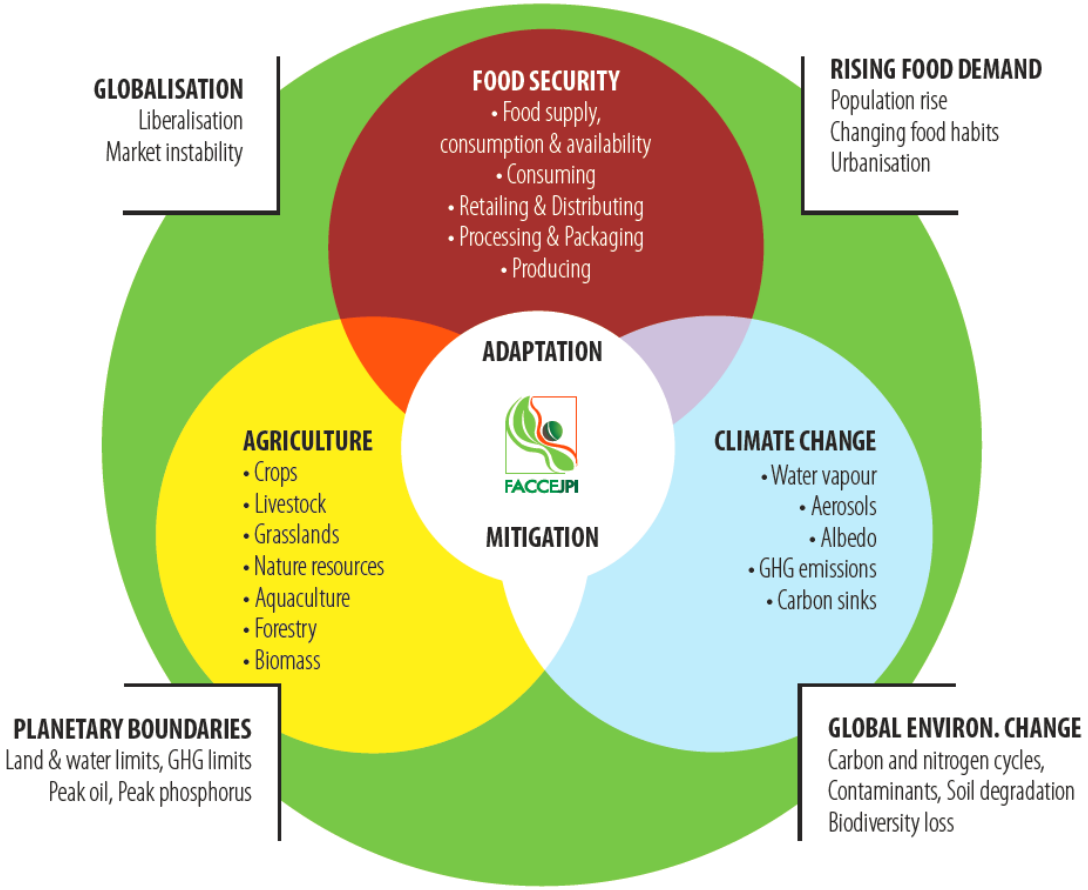
MACSUR – (more than a network)

a Knowledge Hub of FACCE-JPI

Joint Programming Initiative (JPI) on "Agriculture, Food Security and Climate Change"

FACCEJPI Agriculture, Food Security and Climate Change

https://www.faccejpi.com/

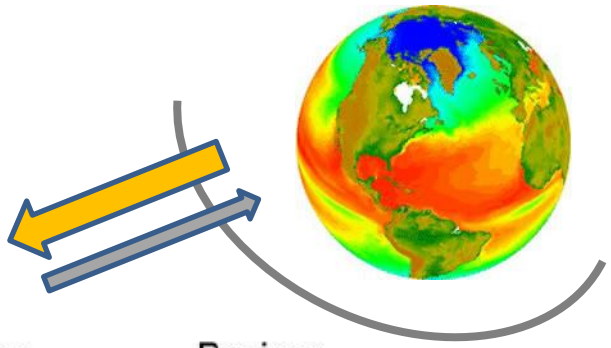


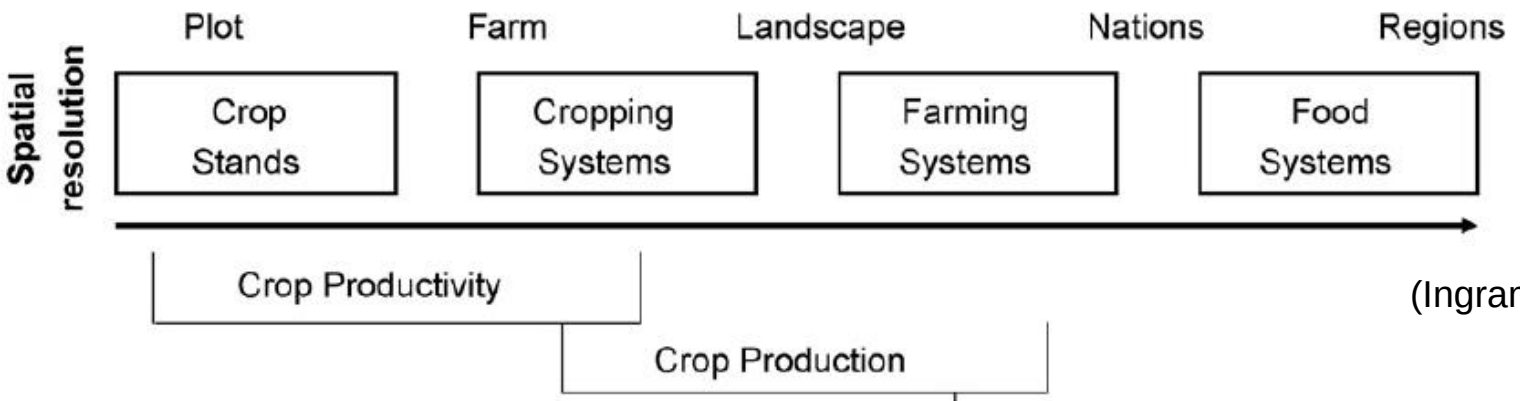
Joint programming is a concept introduced by the European Commission in July 2008 and is one of five initiatives aimed at implementing the European Research Area (ERA).

Outline

- A systems perspective
  - Examples of modelling attempts
- MACSUR 1 and 2
  - Selected results
- Other developments and challenges
  - Political efforts, new technologies, …
- Future directions
- Output and Impact
- Concluding remarks

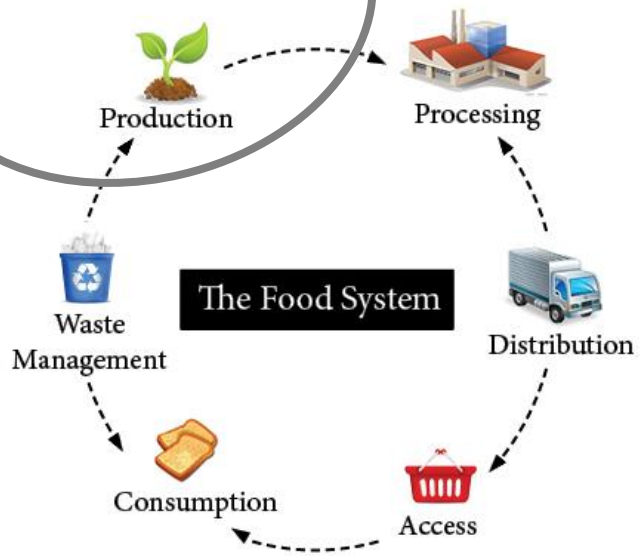
A systems perspective





(Ingram et al., 2008)

- Livestock
- Vegetables and orchards
- Aquaculture
- Urban farming

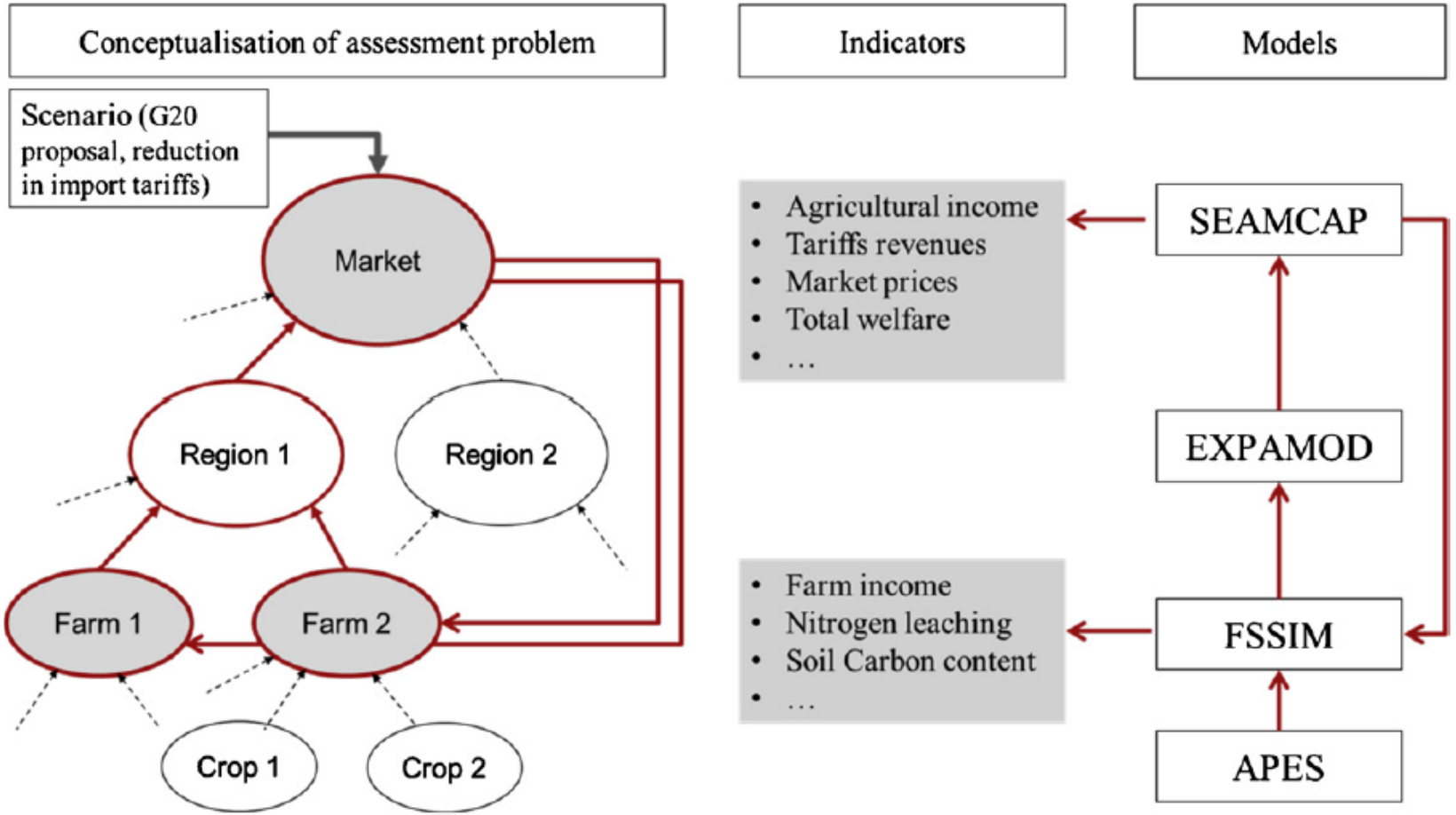


Examples of modelling attempts

seamless

System for Environmental and Agricultural Modelling; Linking European Science and Society

Conceptualisation, selected indicators and models for a test case (G 20 proposal)



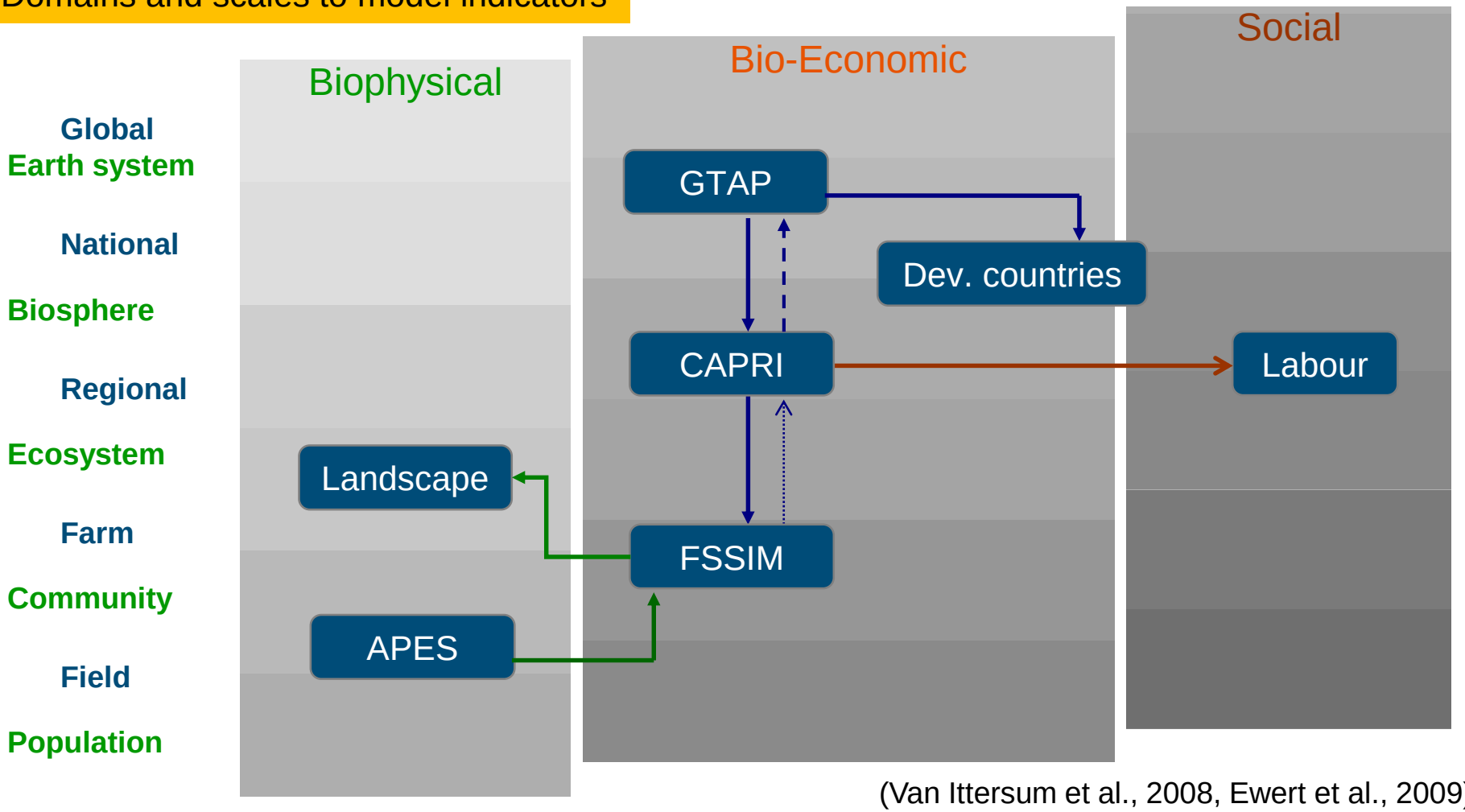
(Ewert et al., 2011)

Examples of modelling attempts

seamless

System for Environmental and Agricultural Modelling;
Linking European Science and Society

Domains and scales to model indicators

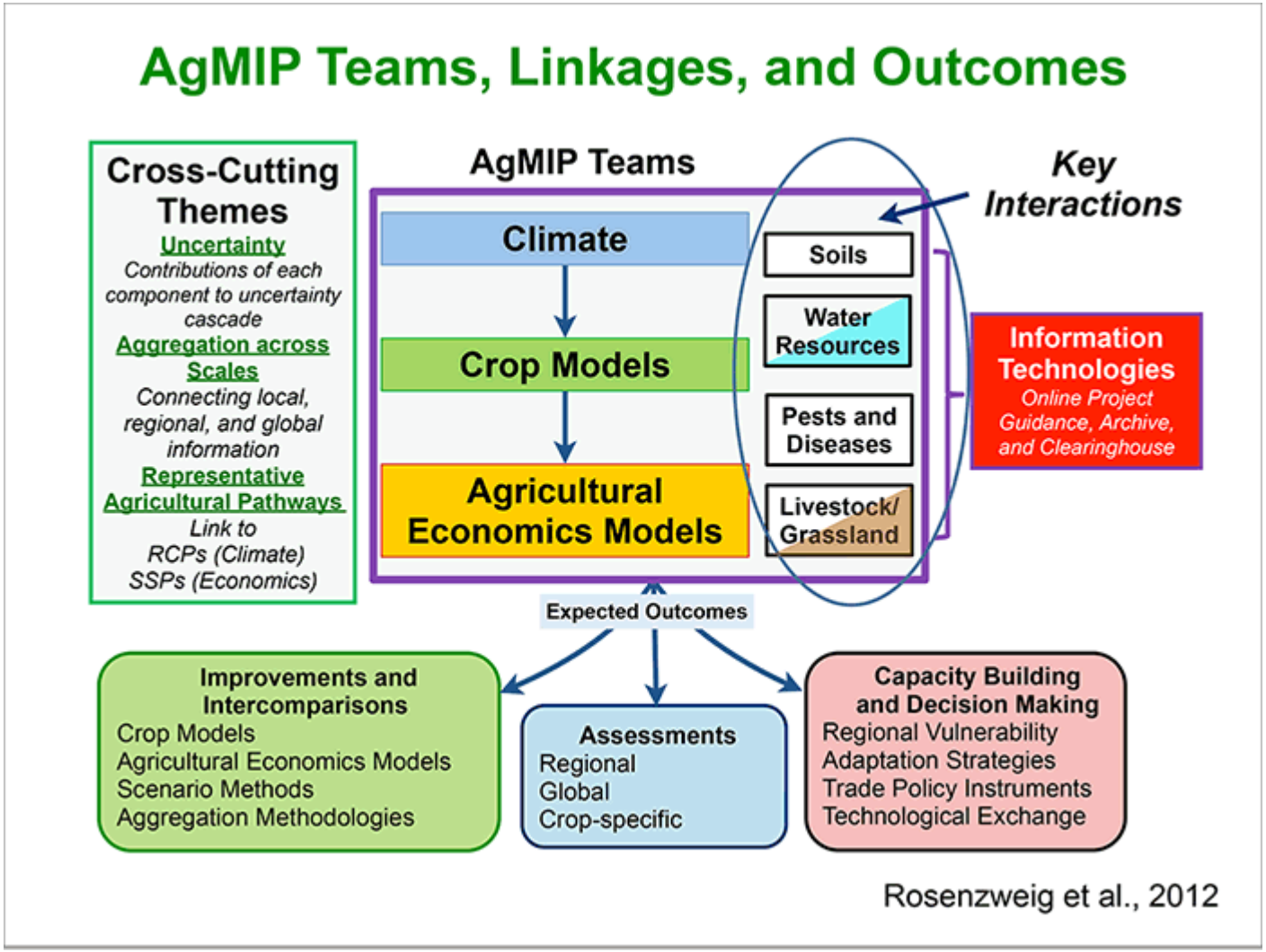


(Van Ittersum et al., 2008, Ewert et al., 2009)

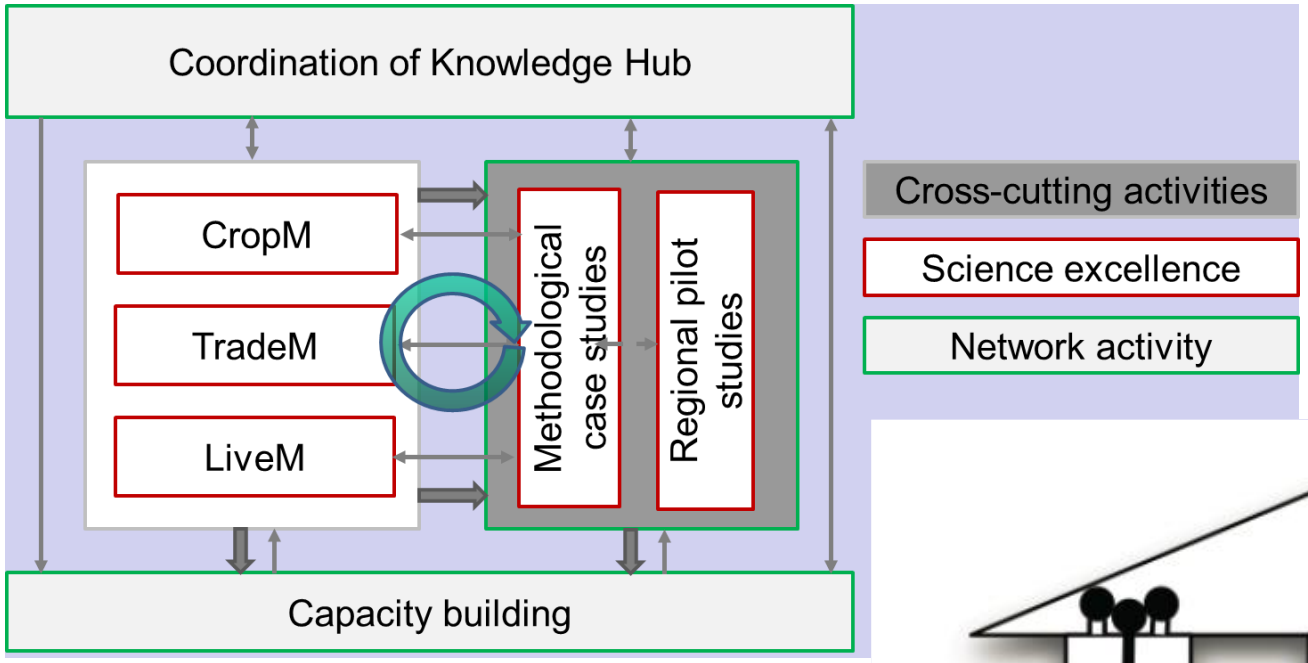
Examples of modelling attempts

AgMIP The Agricultural Model Intercomparison and Improvement Project

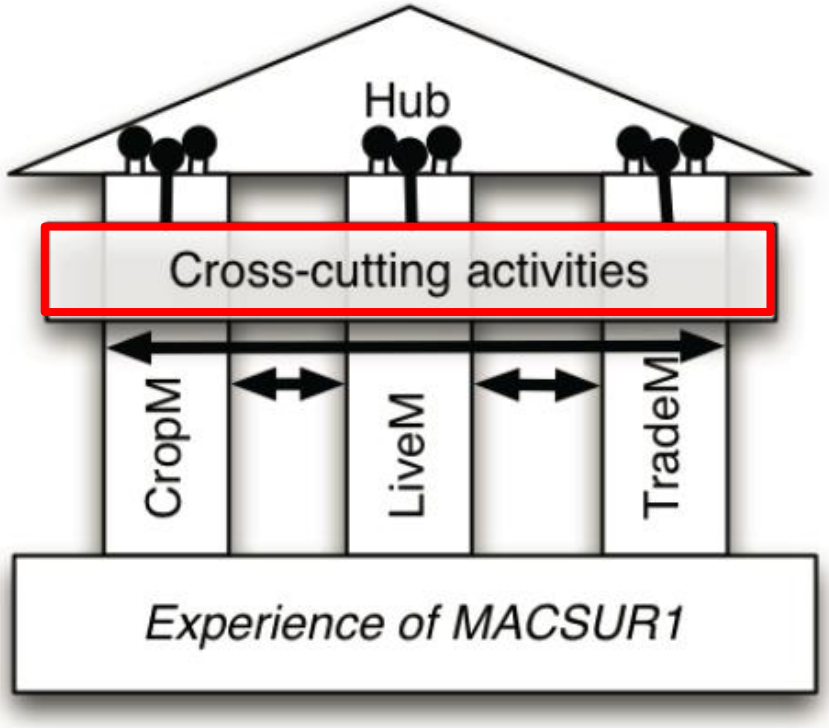
➔ Strong focus on application



MACSUR 1



MACSUR 2

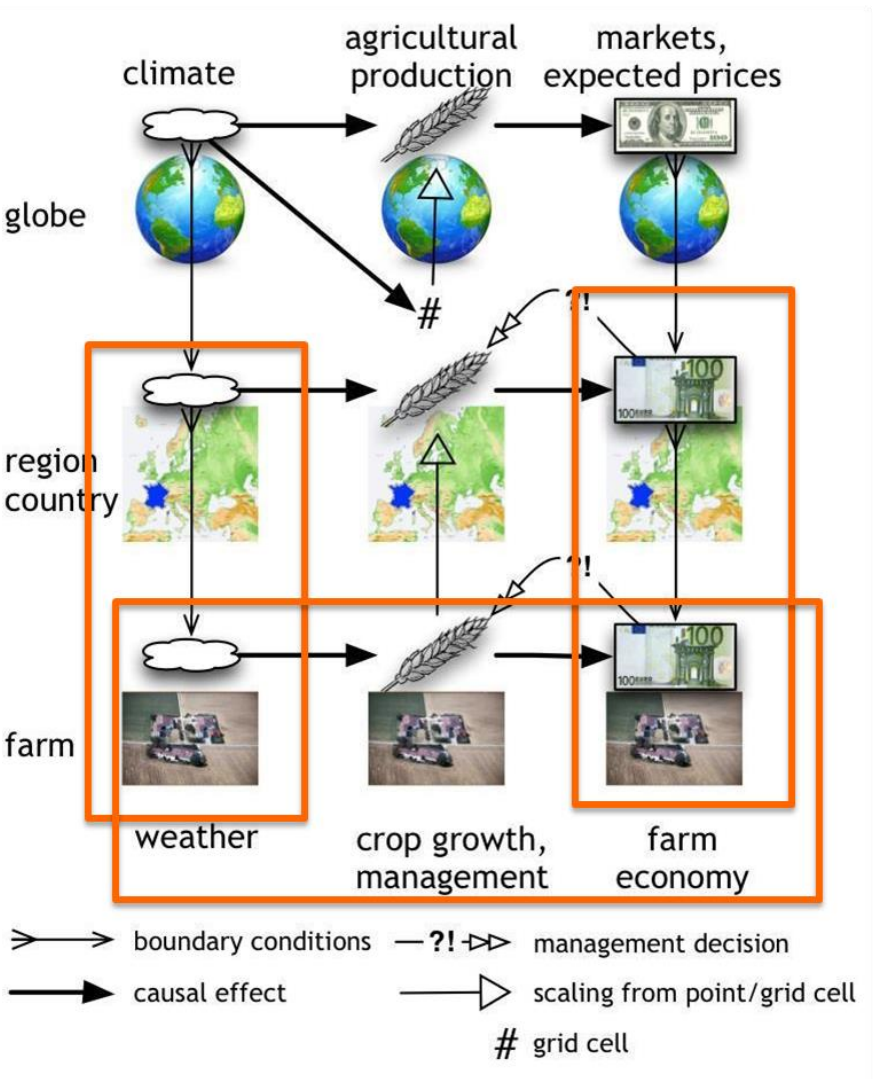


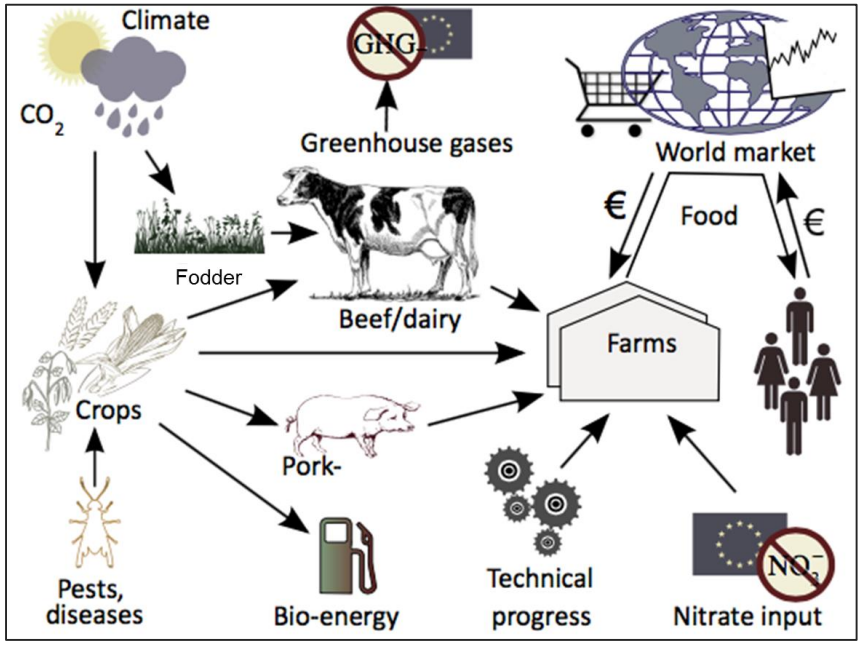
➔Enhance integration

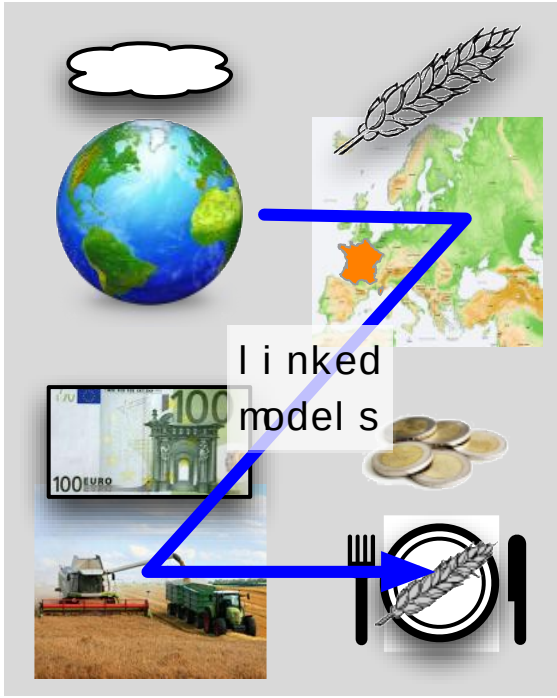
- Models
- Scales
- Domains
- Research community
- Stakeholders

MACSUR 2

MACSUR conceptualization and structure

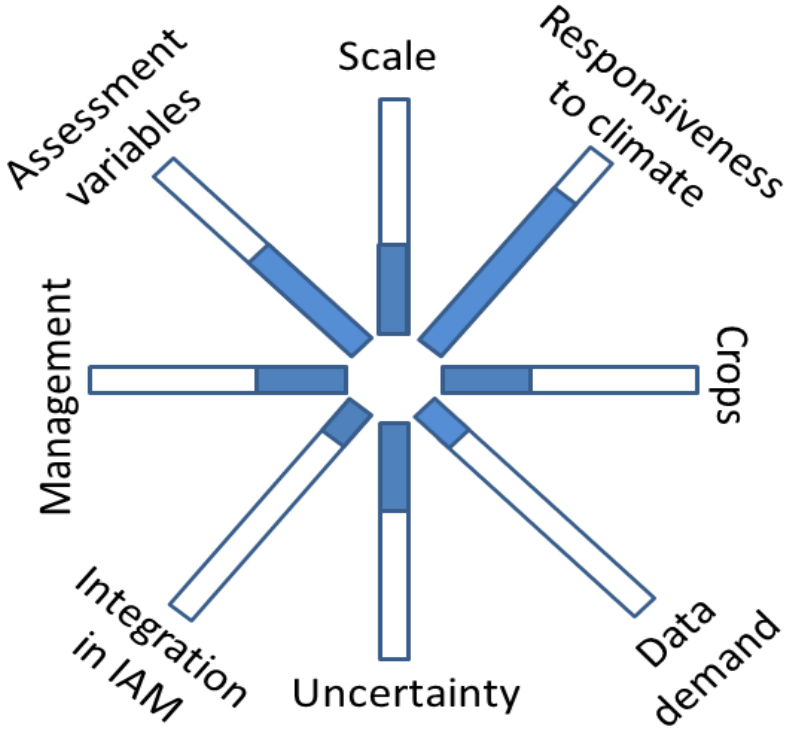




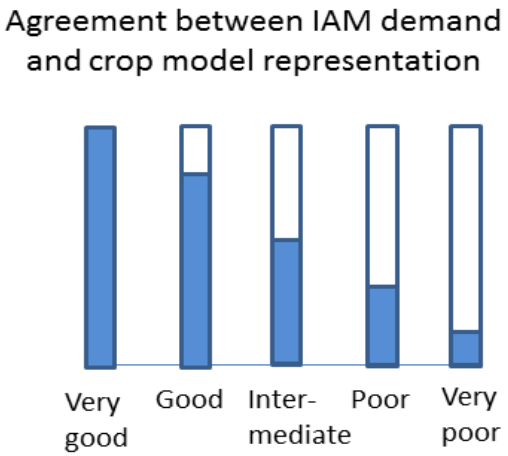


Selected results - CropM

Lessons from MACSUR 1



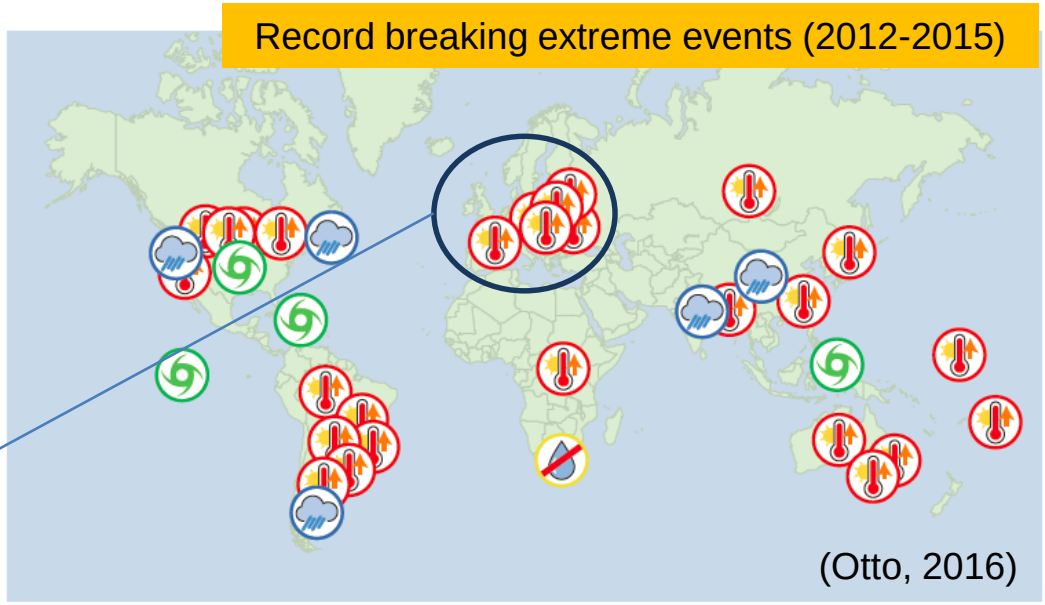
(Ewert et al., 2015)

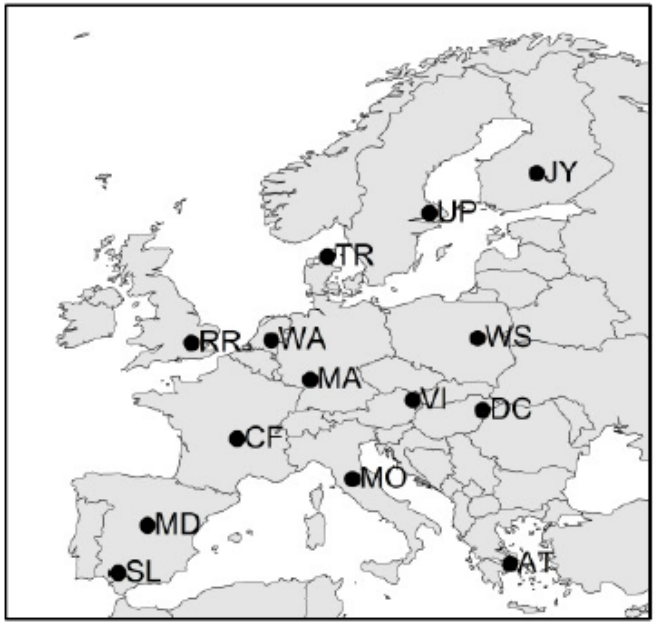


- Limited integration for integrated CC risk assessment
- Limited range of crops and crop rotations
- Scaling of management and generalisation of scaling rules
- Complex uncertainties (inputs, models, scaling, parameters)
- Limited impact variables
- Specifc issues (stresses, pest & diseases, ..)

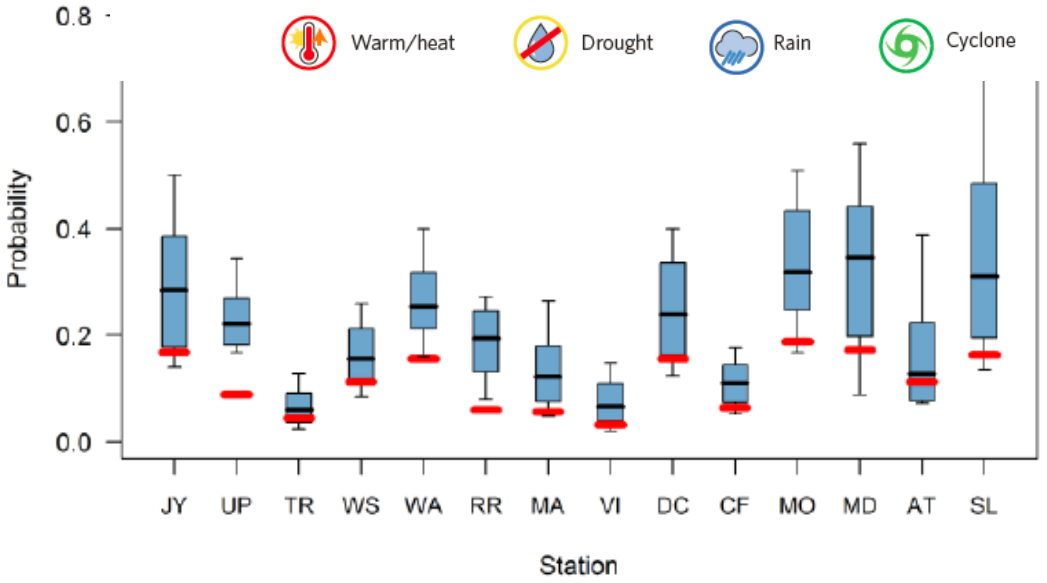
Selected results - Cr

Importance of extreme events





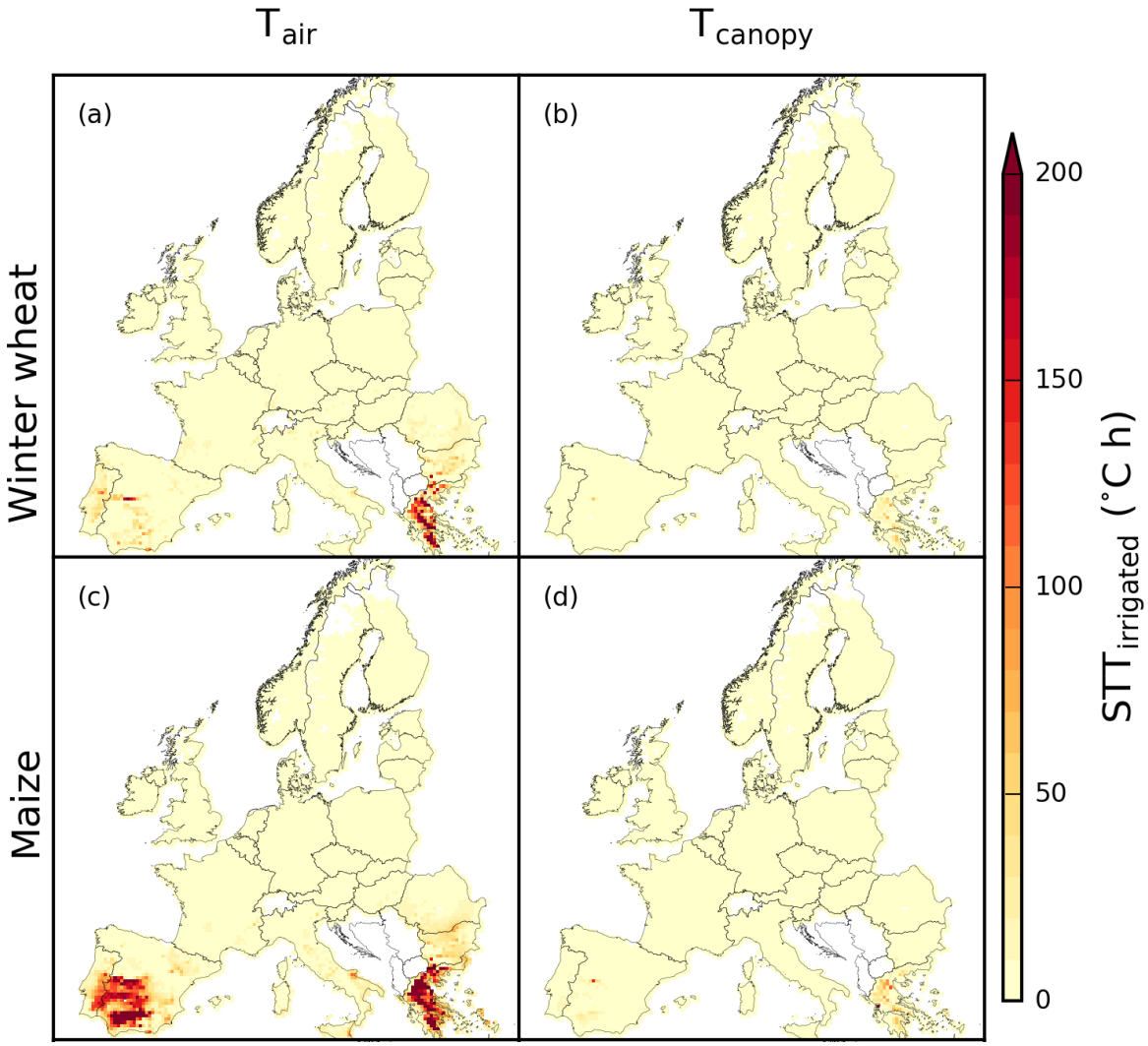
(Trnka et al., 2014)



Probabilities of occurrence of adverse events from sowing to maturity causing major threats for wheat production are projected to increase all over Europe under climate change.

Selected results - CropM

Importance of heat stress and simulation of canopy temperature



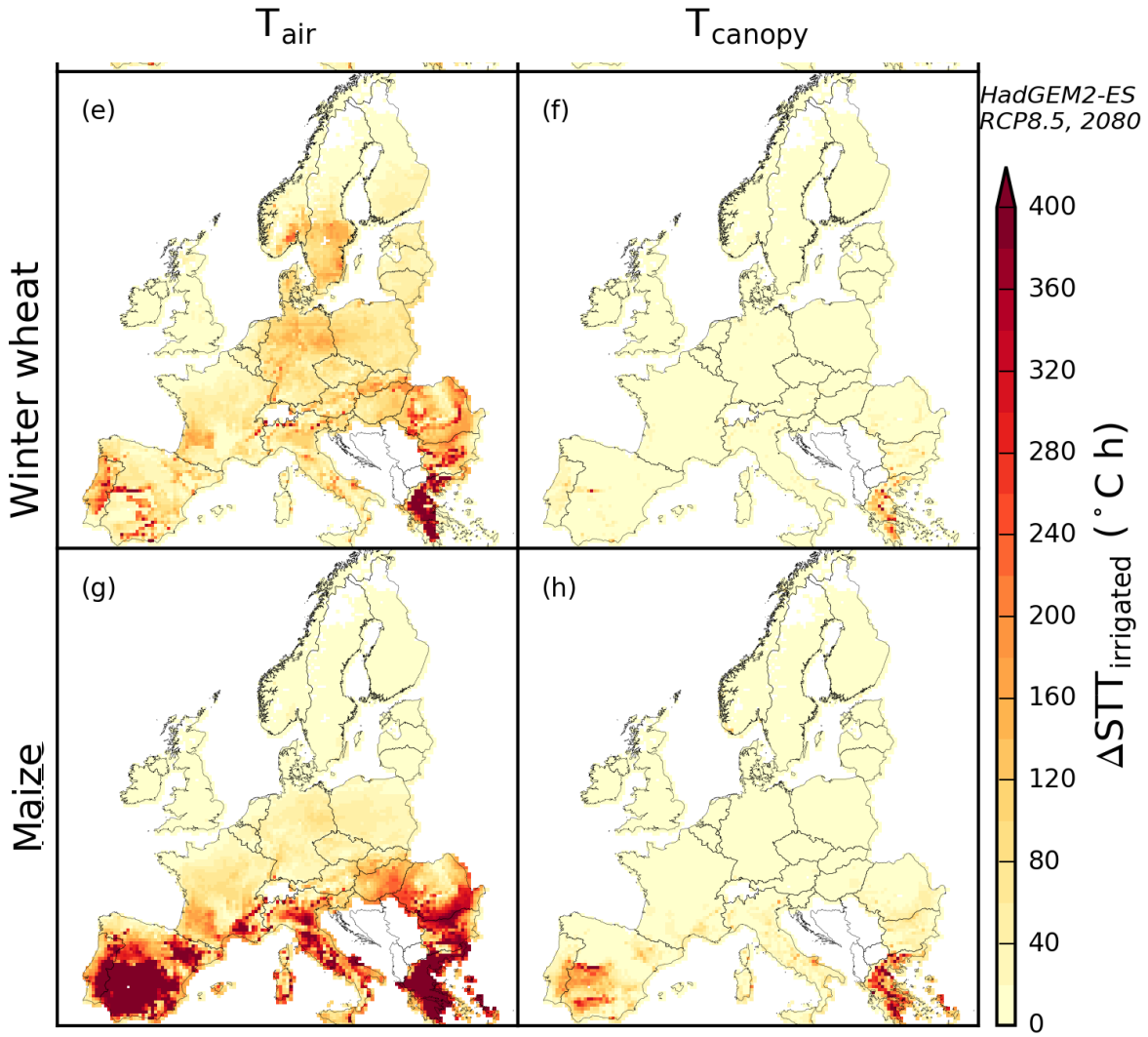
Baseline

Heat stress intensity around anthesis (STT) for baseline climate (a-d) and change of STT under future climate (RCP8.5 2070-2100) (e-h) for irrigated winter wheat and irrigated grain maize when using air temperature (a, c, e, g) or canopy temperature (b, d, f, h). STT is the sum of hourly max temperatures >31°C (wheat) or >35°C (maize).

(Siebert, Webber et al., 2017)

Selected results - CropM

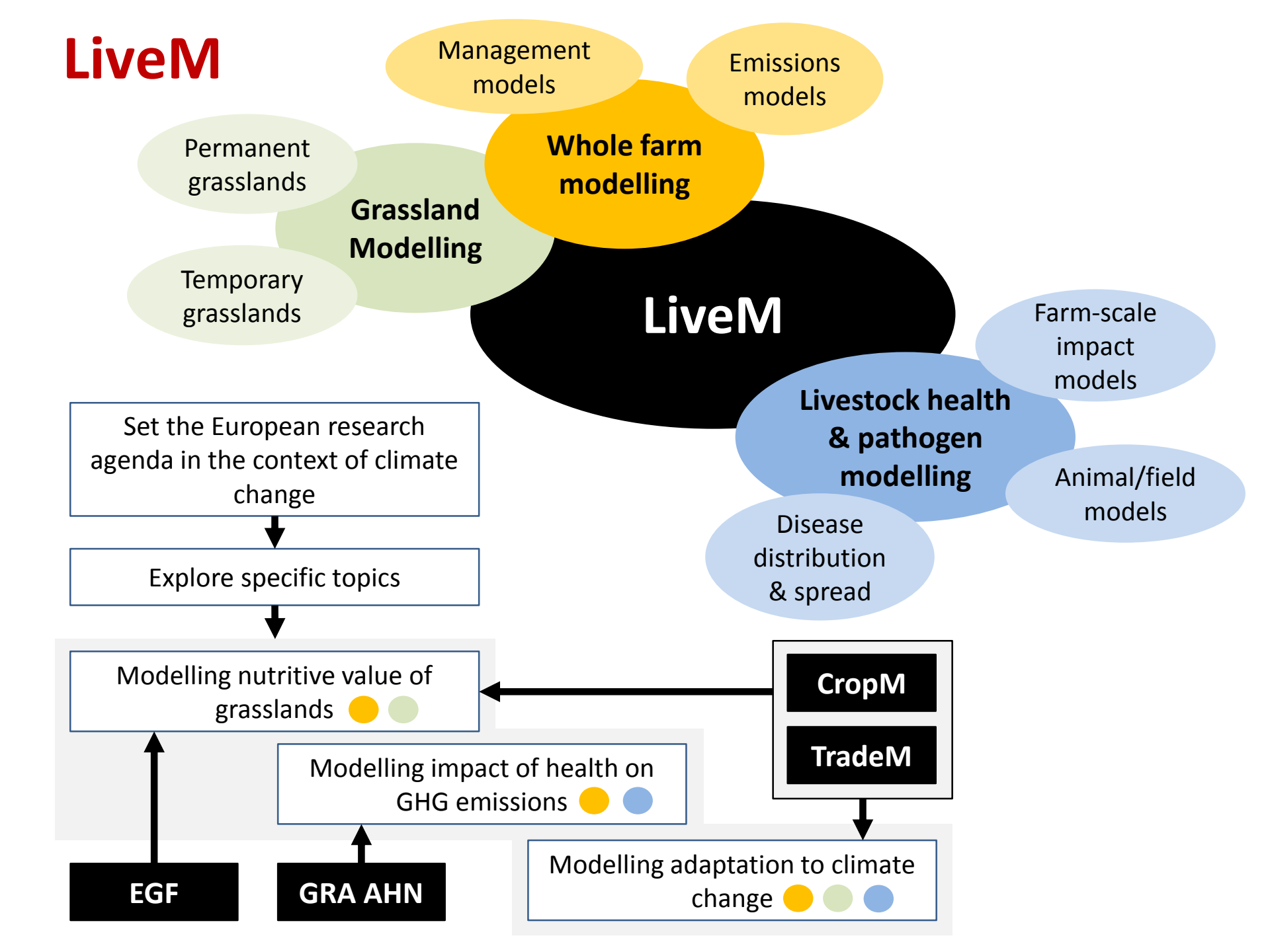
Importance of heat stress and simulation of canopy temperature



RCP 8.5, 2080

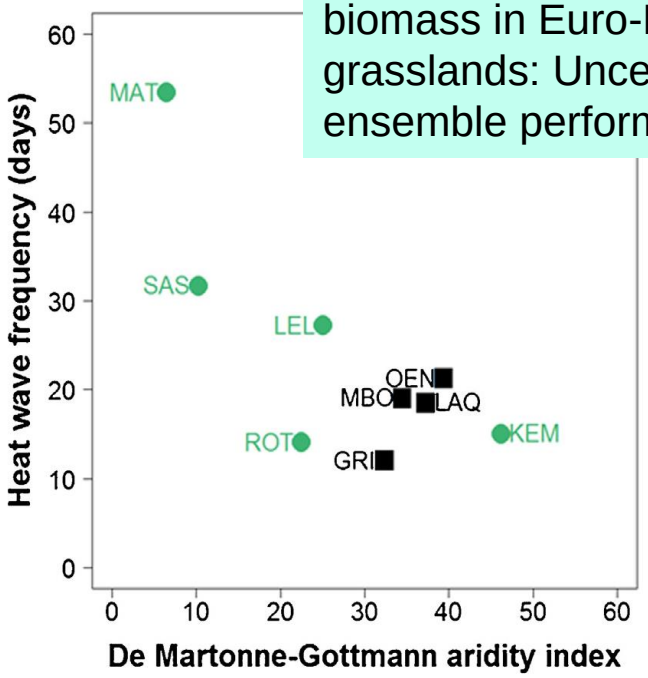
Heat stress intensity around anthesis (STT) for baseline climate (a-d) and change of STT under future climate (RCP8.5 2070-2100) (e-h) for irrigated winter wheat and irrigated grain maize when using air temperature (a, c, e, g) or canopy temperature (b, d, f, h). STT is the sum of hourly max temperatures >31°C (wheat) or >35°C (maize).

(Siebert, Webber et al., 2017)

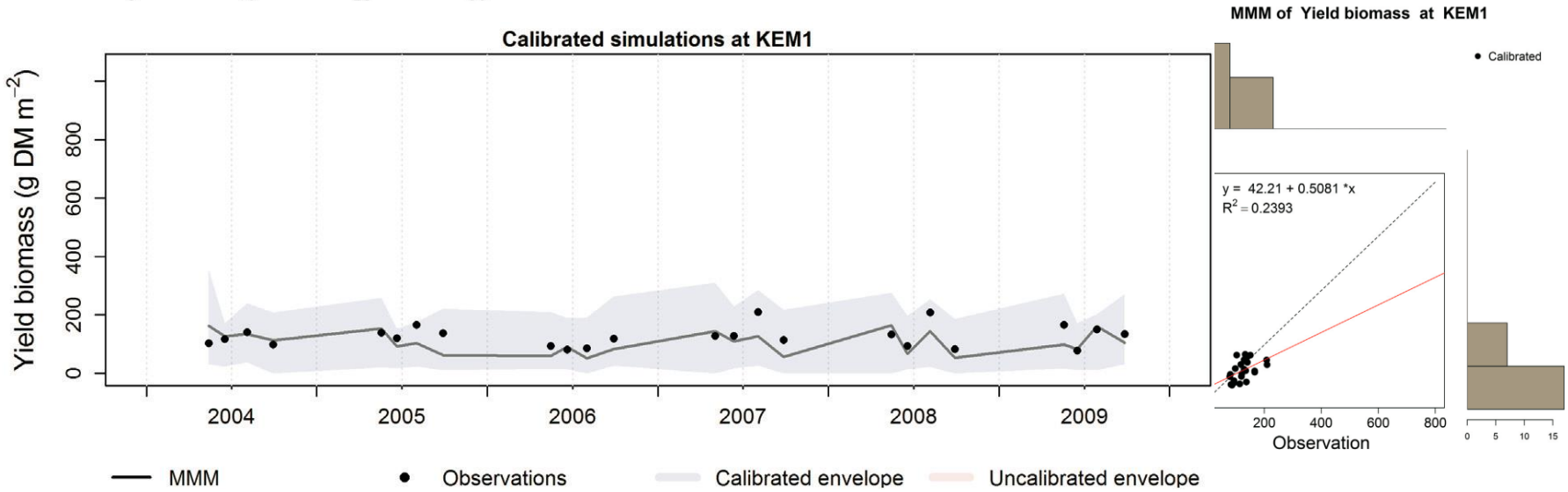

LiveM
Management models
Emissions models
Whole farm modelling
Permanent grasslands
Grassland Modelling
Temporary grasslands
LiveM
Farm-scale impact models
Livestock health & pathogen modelling
Animal/field models
Disease distribution & spread
Set the European research agenda in the context of climate change
Explore specific topics
Modelling nutritive value of grasslands
CropM
TradeM
Modelling impact of health on GHG emissions
Modelling adaptation to climate change
EGF
GRA AHN

Selected results - LiveM

Multi-model simulation of soil temperature, soil water content and biomass in Euro-Mediterranean grasslands: Uncertainties and ensemble performance

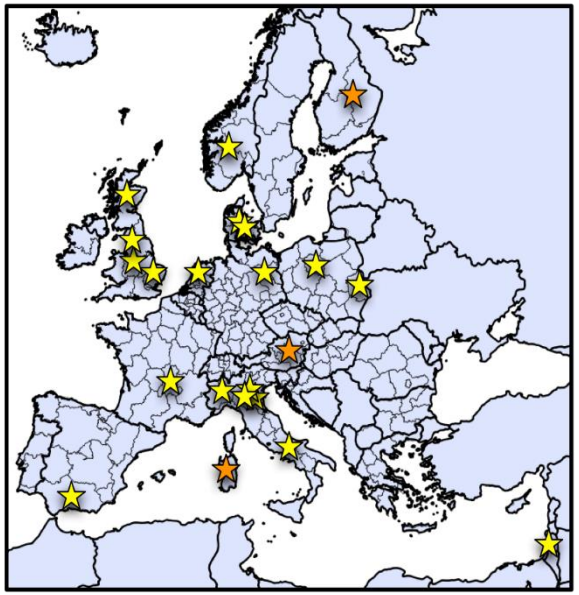


(Sandor et al., 2016)



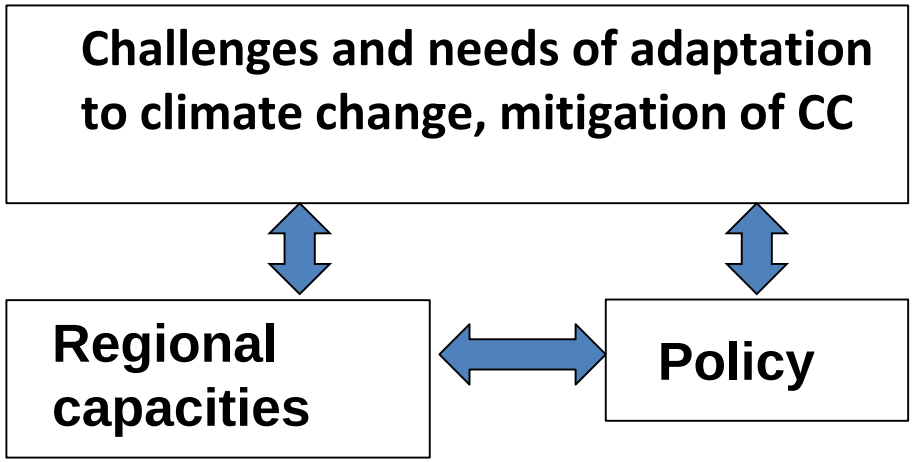
Selected results - TradeM

- Baseline scenario for CAPRI for use in the regional pilot studies
- Work on European CC policies for mitigation and adaptation in MACSUR regions
- Develop Representative Agricultural Pathways in MACSUR
- Science-policy interaction: MACSUR - JRC - DG CLIMA
  ➔ need to address mitigation



Case studies under focus: (from north to south)

- North Savo (FI)
- Norway (NO)
- Denmark (DK)
- Brandenburg (DE)
- Poland (PL)
- Flevoland (NL)
- Mostviertel (AUT)
- South Tyrol (IT)
- Oristano, Sardinia (IT)
- Guadalquivir Valley, Spain (ES)



Selected results – Cross-cutting Issues

XC1 Model comparison & improvement

XC2 Scaling

XC3 Uncertainty and risk assessment

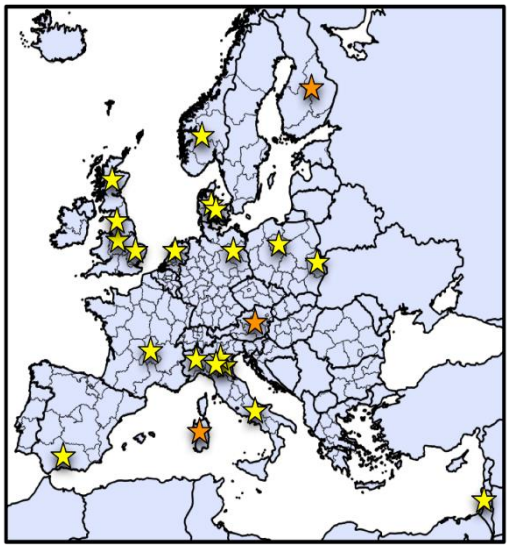
XC4 Capacity building

XC5 Interaction with stakeholders

XC6 Regional case studies

XC7 Impact Assessment for Europe

XC8 Variability and extreme climatic events



XC9 Identifying sustainable opportunities to reduce yield gaps in Europe

XC10 Contributions of new technologies to adaptation and mitigation

XC11 Feeding livestock: forage produktion, feed quality, efficiency of feed resource use and animal protein produktion

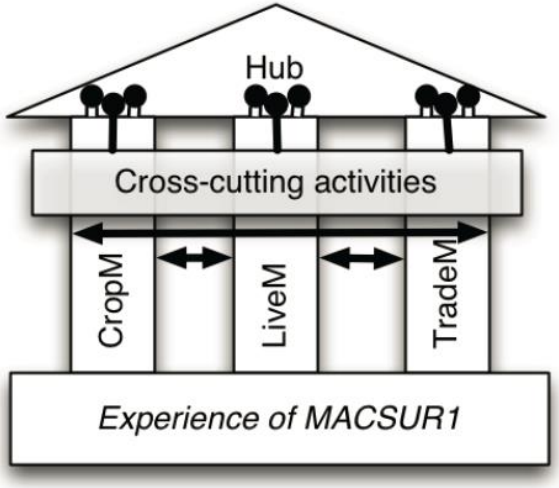
XC12 Farm-scale risk assessment

XC13 Impact of consumer behaviour

XC14 Impacts on ecosystem services and rural development

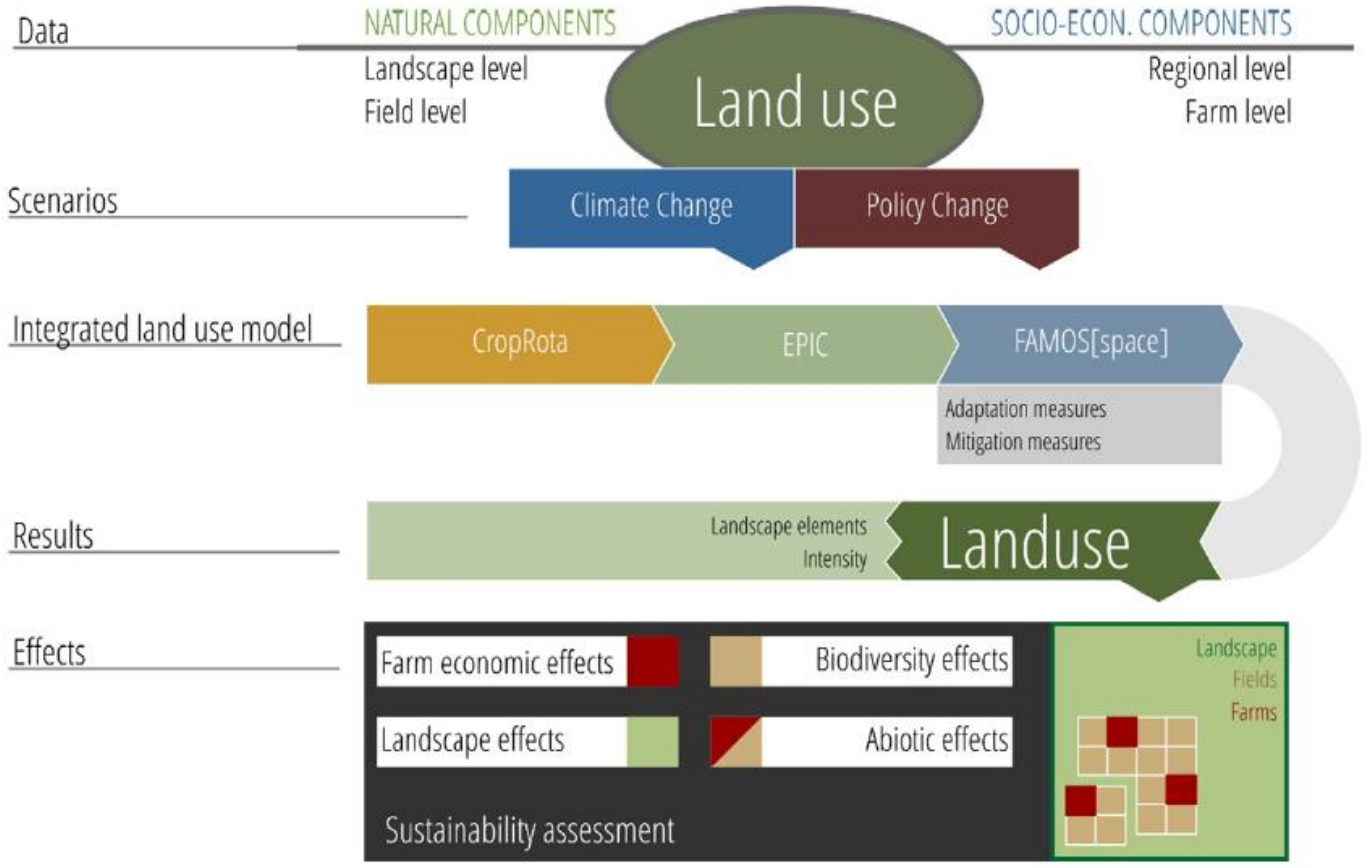
XC15 GHG mitigation from agriculture

XC16 Overal scenario development



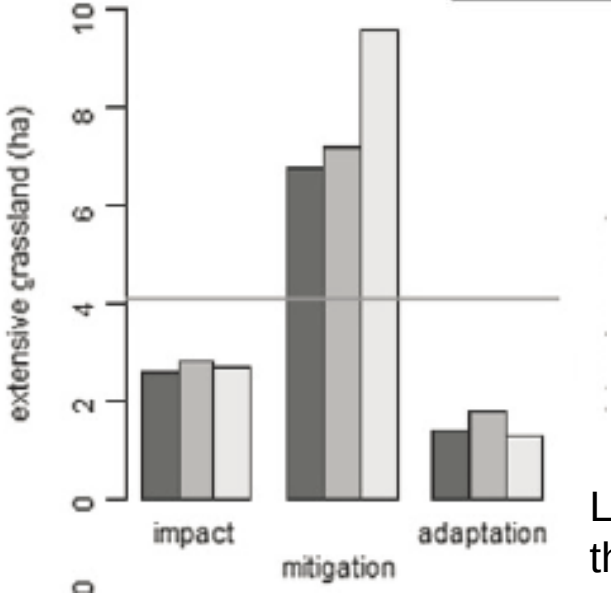
Policy scenario results from an integrated field-farm-landscape model in Austria

Mostviertel in Austria



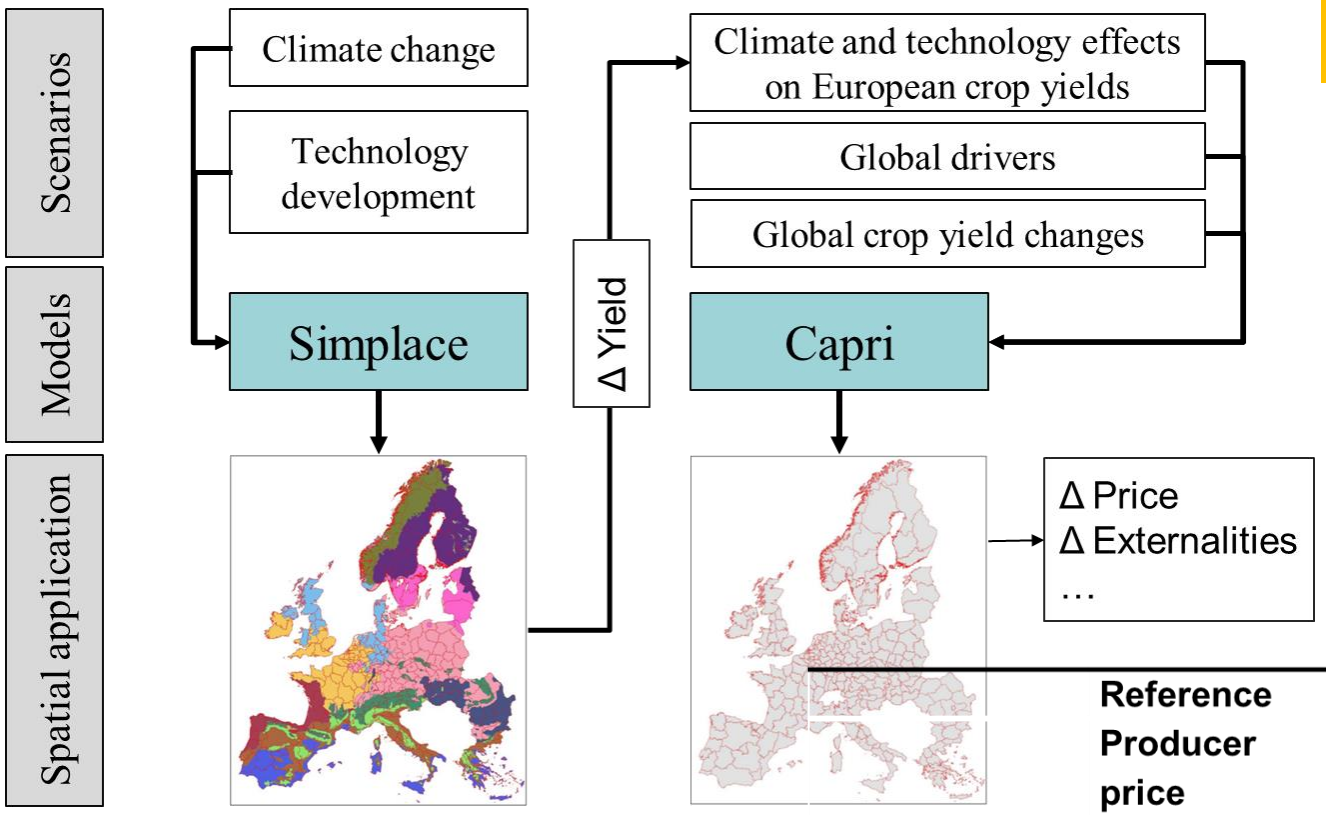
Overview on the research design.

Schönhart et al., 2016



Land use change (ha) at landscape level for three policy and three climate scenarios (grey line= result from REF_2040).

Impact Assessment for Europe



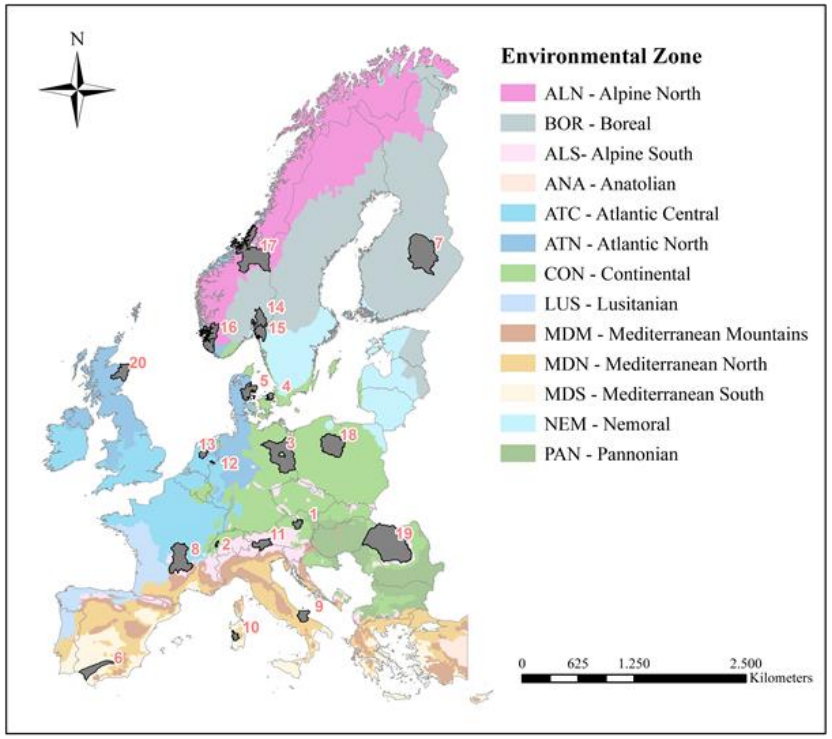
Ewert et al, 2012

Crop	Reference Producer price [Euro/t]	% change relative to reference A1B Opt	A1B Act	B2 Opt	B2 Act
Wheat	258	17	11	-2	3
Barley	245	14	13	-7	1
Grain maize	277	23	12	1	9
Potato	325	-5	6	-14	1
Oilseeds	640	20	10	12	26
Rapeseed	688	19	10	12	24
Sugar beet	22	2	11	-15	-10
Meat	4237	27	27	-17	-15
Cow milk	600	23	24	-29	-27

Webber et al, 2016

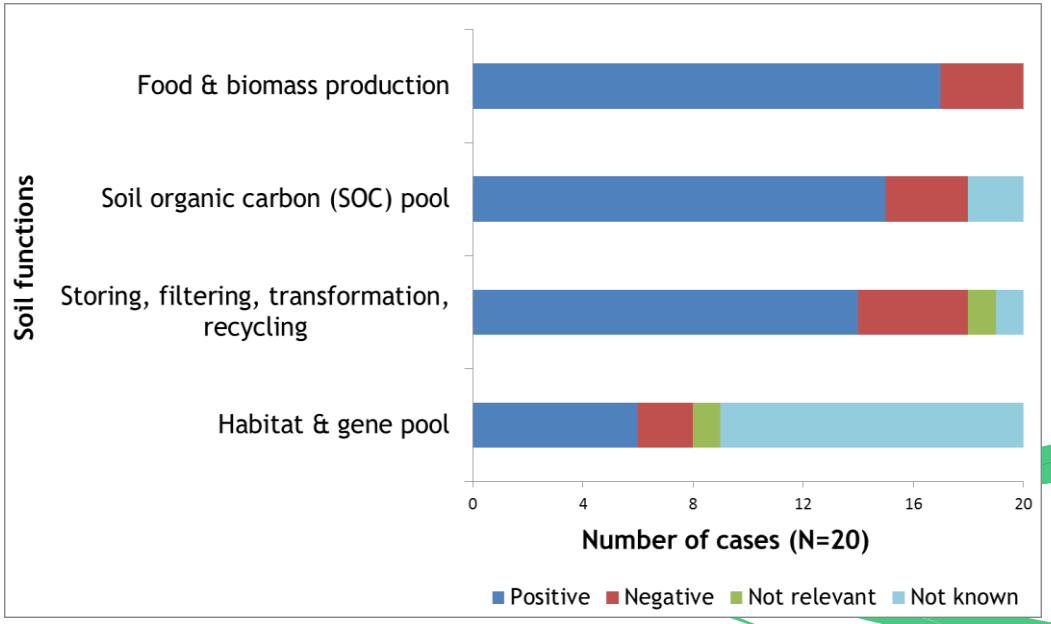
Impact on ecosystem services and rural development

A Meta-Study of 20 case studies in Europe



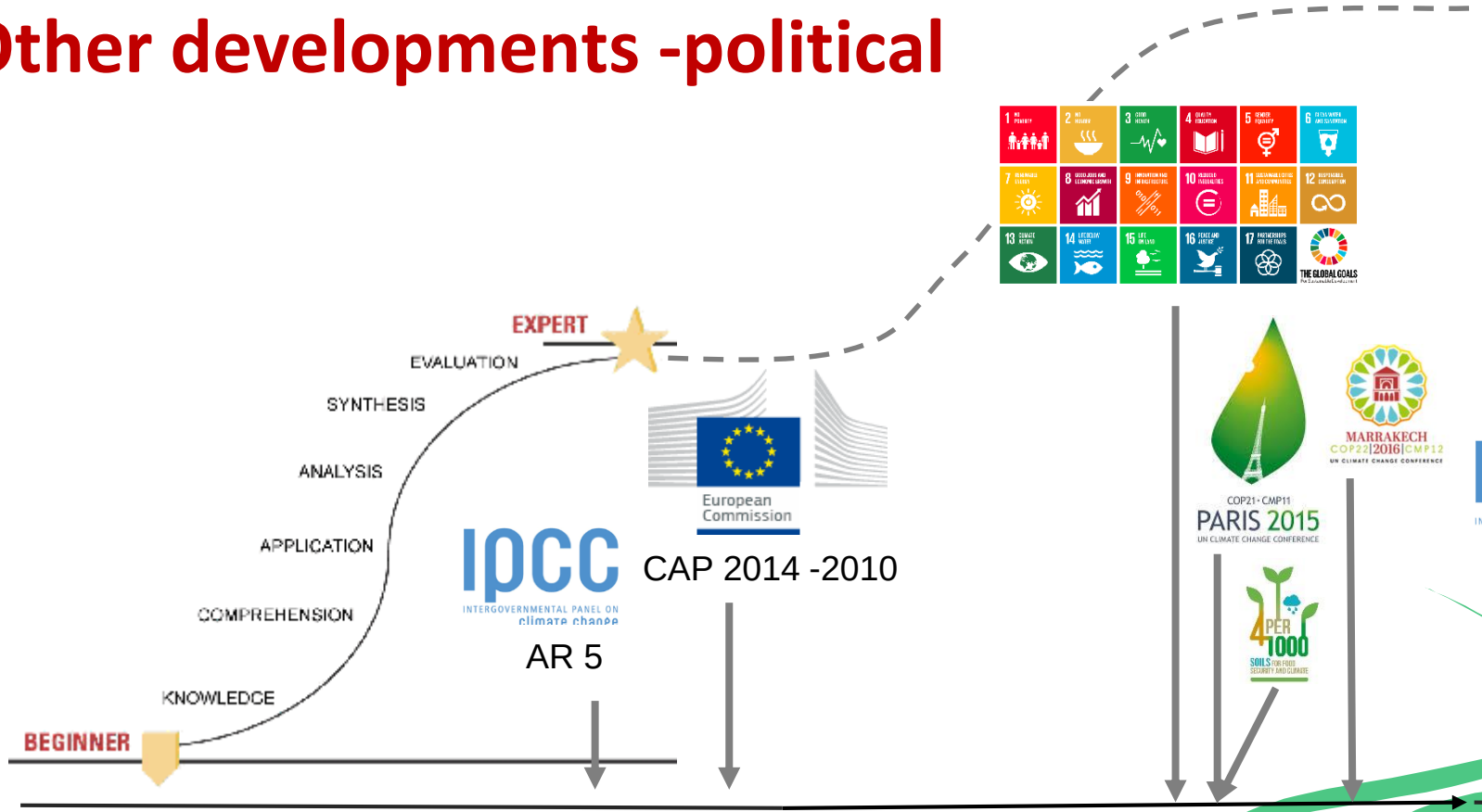
Map adapted from Metzger et al., 2005

Anticipated impacts of future agricultural adaptation pathways on soil functions



Hamidov, et al., submitted

Other developments -political



Ewert, This paper

Other developments -technological

New technolgies will influence experimental and modelling activities

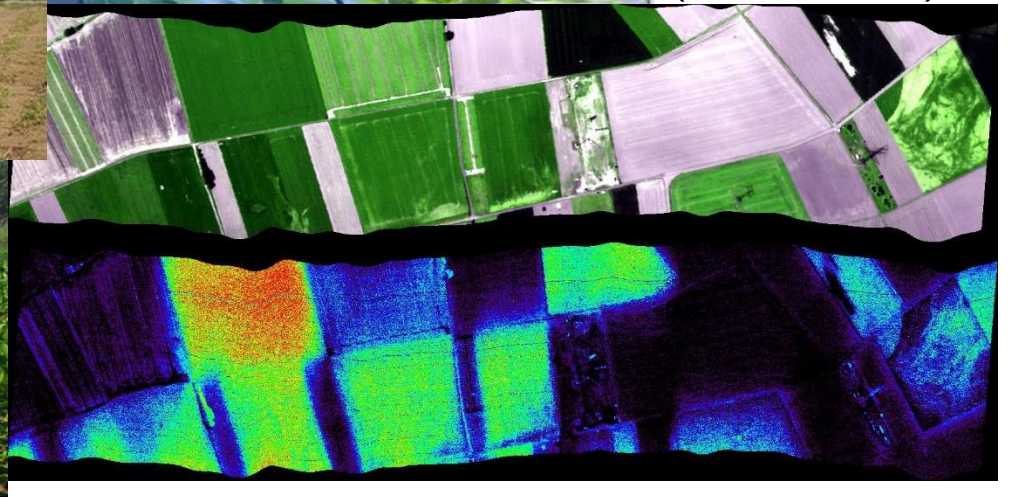
- Sensing (near and far)
- Robotik
- IT (soft- and hardware)
- Data assimilation
- Big data
- …

Drone at ZALF

FLEX/Sentinel 3 Tandem Mission, Photosynthesis Study

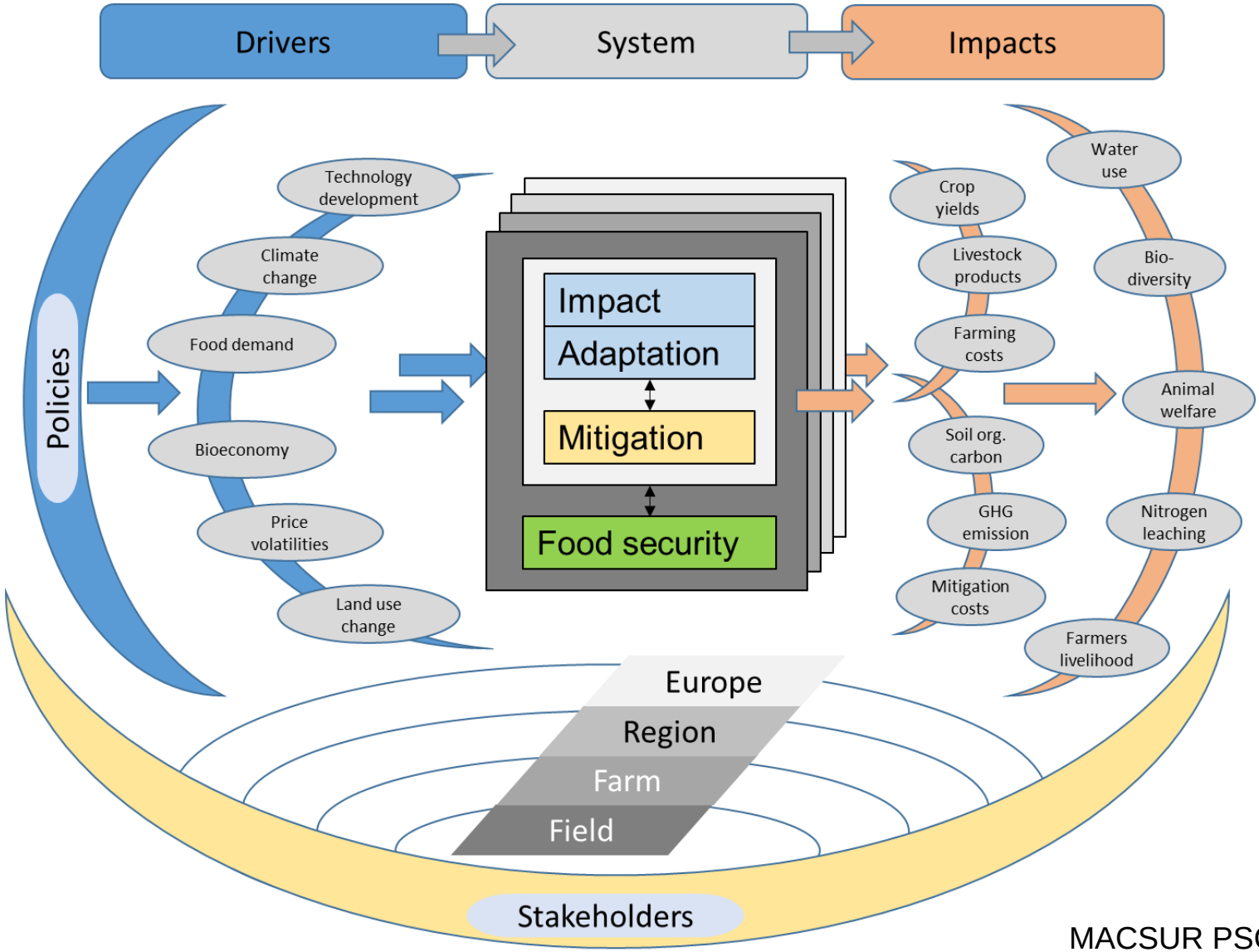
Fluorescence from different vegetation (Rascher, 2014)

BoniRob
deepfield-robotics



Future directions

Proposal for Phase 3

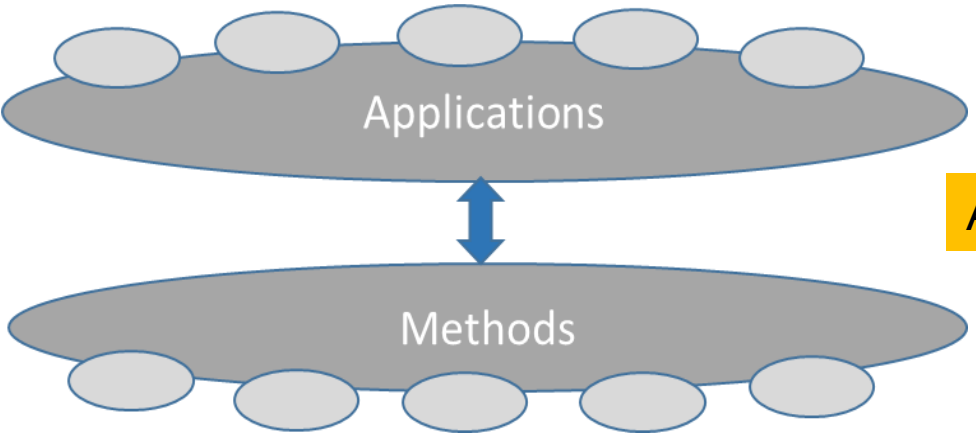


MACSUR PSC, 2016

Future directions

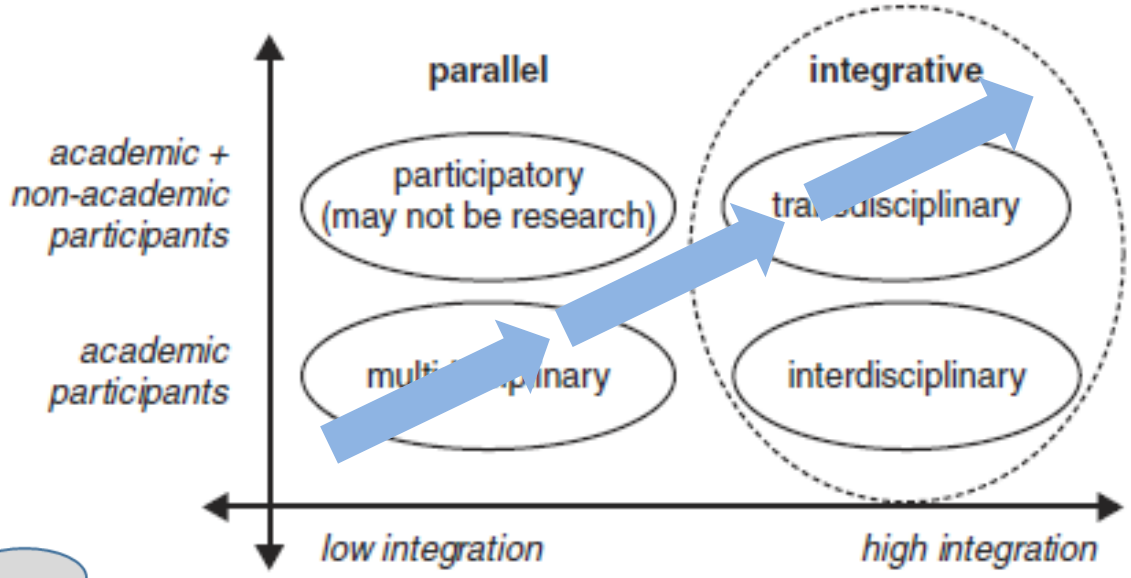
Proposal for Phase 3

- Advanced regional (to global) assessments
- Enhanced stakeholder involvement
- Improved methods for integration



- Big data
- Machine lerning, SVM
- Deep learning
- Synthesis

Degree of integration and stakeholder involvment



Tress et al., 2005

Approaches to modelling complex systems

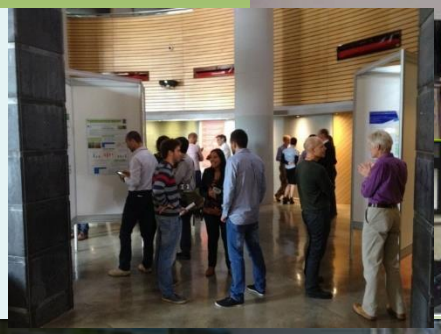
- Systems dynamics
- Bayesian networks
- Couples component models
- Agent-based models
- Knowledge-based models

Kelly et al., 2013







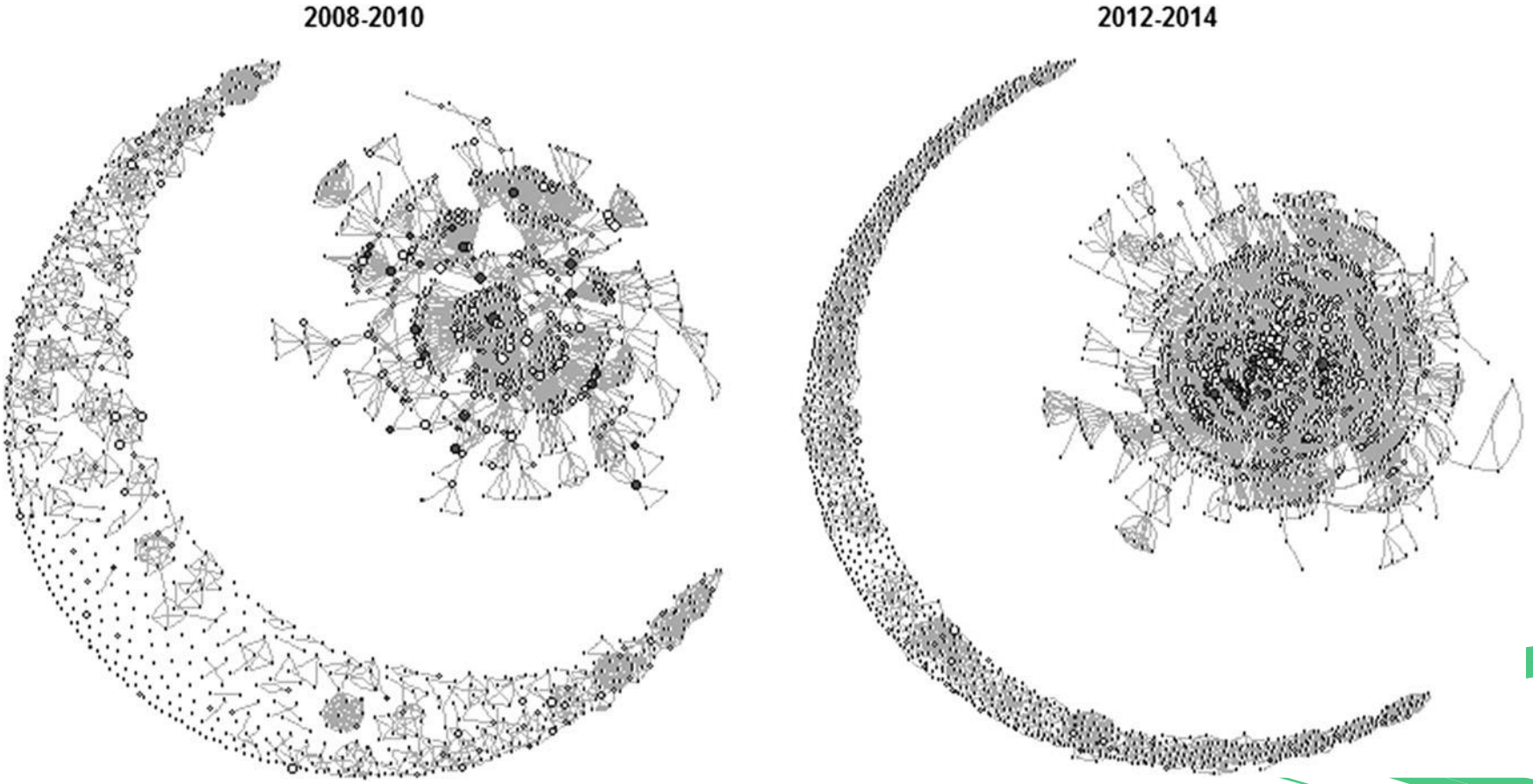



Output and impact

- Journal articles
- Books and book chapter
- Conference papers
- Policy briefs
- Flyers
- Reports
- Theses

- Conferences
- Workshops
- Courses
- Seminars
- …

Output and impact – Community building



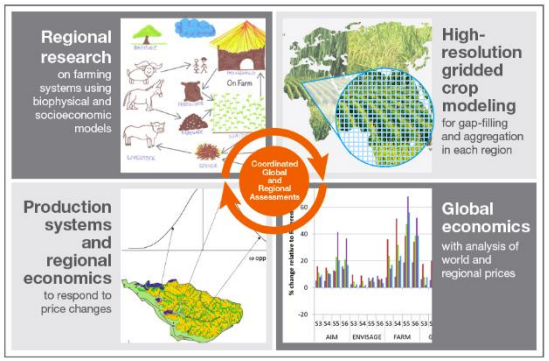
A network graph representing the whole community in the first period (2008–2010) and the final period (2012–2014) of the analysis. Each node represents an author, with lines connecting nodes representing co-authorship links. Nodes representing MACSUR members are highlighted in black

Saetnan and Kipling 2016

Concluding remarks

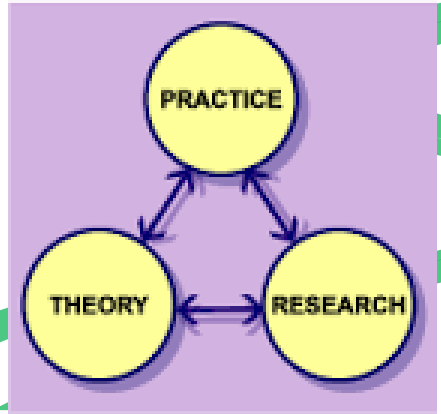
- Great progress in modelling European agriculture for with climate change for food security ➔ tremendous outcome and considerable impact
- Ready to perform regional to European (to global) impact and risk assessments

Next:



- Expand applications to more region ➔ link to EU
- Anticipate multiple goals from policy agendas
- Better involvement of stakeholders
- Develop and consolidate modelling and data activities
- Standardization of scenarios, protocols, …
- Demand for theory building on integration
  - Integration of models, methods (modelling and data analysis), frameworks, …

- "There is nothing more practical than a good theory" (Boltzmann, Einstein, Lewin, ...)
- … but be clear about integration of what for what



General Programme (main sessions)

Landscape Functioning
Element Cycles and Microbiomes

Land Use and Governance
Managing Ecosystem Services and Biodiversity

Landscape Synthesis
Towards a Landscape Theory

Rationale and Aims

Agricultural landscapes are shaped by human activities and are subject to permanent change through the interplay of natural processes, land use and societal developments. Knowledge about the underlying processes of landscape dynamics at all relevant spatial and temporal scales is the prerequisite for sustainable landscape management.
The aim of the conference is to present recent advances in landscape research to enhance the development of sustainable agricultural land use and landscape strategies. The particular objective is to bring together key findings from relevant disciplinary and interdisciplinary approaches as well as from basic and application-oriented research.

Scope

The conference focuses on recent scientific work related to:

- The functioning of landscapes, with a focus on element cycles and microbiomes including approaches to scale up from individual processes to the landscape scale.
- Sustainable land use practices and appropriate governance systems, which secure the provision of food and fibre as well as other ecosystem services and biodiversity.
- Advances in science toward the development of an integrated landscape theory.

General Symposium Structure

DAY 1

- Satellite workshops

DAY 2

- Keynotes
- 3 parallel sessions with oral presentations and discussions
- Guided Poster Session
- Conference dinner

DAY 3

- Keynotes
- 3 parallel sessions with oral presentations and discussions
- Final plenary session

DAY 4

- Satellite workshops / field trips

Conference Chairs

F. Ewert (ZALF),
Mark Rounsevell (IMK-IFU, KIT, Garmisch, GER)

Conference Host

K. Helming (ZALF)

Website

http://www.land2018.eu

zalf Leibniz Centre for Agricultural Landscape Research (ZALF)

1st Announcement

Landscape 2018

Frontiers of agricultural landscape research

12–16 March 2018
Müncheberg, Germany