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”

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).

https://www.faccejpi.com/
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

- Livestock
- Vegetables and orchards
- Aquaculture
- Urban farming

(Ingram et al., 2008)
Examples of modelling attempts

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

(Ewert et al., 2011)
Examples of modelling attempts

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

Domains and scales to model indicators

Biophysical
- Global Earth system
- National Biosphere
- Regional Ecosystem
- Farm Community
- Field Population

Bio-Economic
- GTAP
- CAPRI
- FSSIM
- Dev. countries

Social
- Labour

Examples of modelling attempts
(Van Ittersum et al., 2008, Ewert et al., 2009)
Examples of modelling attempts

Strong focus on application

AgMIP Teams, Linkages, and Outcomes

Cross-Cutting Themes

- Uncertainty
  Contributions of each component to uncertainty cascade
- Aggregation across Scales
  Connecting local, regional, and global information
- Representative Agricultural Pathways
  Link to RCPs (Climate) SSPs (Economics)

AgMIP Teams

- Climate
- Crop Models
- Agricultural Economics Models

Key Interactions

- Soils
- Water Resources
- Pests and Diseases
- Livestock/Grassland

Information Technologies

- Online Project Guidance, Archive, and Clearinghouse

Expected Outcomes

- Improvements and Intercomparisons
  Crop Models
  Agricultural Economics Models
  Scenario Methods
  Aggregation Methodologies

- Assessments
  Regional
  Global
  Crop-specific

Capacity Building and Decision Making

- Regional Vulnerability
- Adaptation Strategies
- Trade Policy Instruments
- Technological Exchange

Rosenzweig et al., 2012
Enhance integration

- Models
- Scales
- Domains
- Research community
- Stakeholders
MACSUR conceptualization and structure

MACSUR 2

Enhance integration of linked models
Selected results - CropM

Lessons from MACSUR 1

- 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
- Specific issues (stresses, pest & diseases, ..)

(Ewert et al., 2015)
Importance of extreme events

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

Record breaking extreme events (2012-2015)

(Trnka et al., 2014)
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)
Importance of heat stress and simulation of canopy temperature

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 $>31^\circ C$ (wheat) or $>35^\circ C$ (maize).

(Siebert, Webber et al., 2017)
LiveM

Grassland Modelling

Whole farm modelling

Livestock health & pathogen modelling

Farm-scale impact models

Animal/field models

Permanent grasslands

Temporary grasslands

Management models

Emissions models

Set the European research agenda in the context of climate change

Explore specific topics

Modelling nutritive value of grasslands

Modelling impact of health on GHG emissions

Modelling adaptation to climate change

CropM

TradeM

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)

Challenges and needs of adaptation to climate change, mitigation of CC

Regional capacities

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

Overview on the research design.

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

Schönhart et al., 2016
### Impact Assessment for Europe

**Ewert et al., 2012**

**Webber et al., 2016**

**Climate change**

**Technology development**

**Simplice**

**Climate and technology effects on European crop yields**

**Global drivers**

**Global crop yield changes**

**Capri**

**Δ Yield**

**Δ Price**

**Δ Externalities**

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**Spatial application**

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**Reference Producer price**

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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

- Food & biomass production
- Soil organic carbon (SOC) pool
- Storing, filtering, transformation, recycling
- Habitat & gene pool

Number of cases (N=20)

- Positive
- Negative
- Not relevant
- Not known

Hamidov, et al., submitted
Other developments -political

MACSUR 1 Kick-off
October 2012

MACSUR 2 Kick-off
March 2015

MACSUR 2 Final conference
May 2017

Ewert, This paper
Other developments - technological

New technologies will influence experimental and modelling activities

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

BoniRob
depfield-robotics

Drone at ZALF
FLEX/Sentinel 3 Tandem Mission, Photosynthesis Study
Fluorescence from different vegetation (Rascher, 2014)
Future directions

Proposal for Phase 3
Future directions

Proposal for Phase 3

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

Degree of integration and stakeholder involvement

Approaches to modelling complex systems

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

Tress et al., 2005

Kelly et al., 2013
Output and impact

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

- Conferences
- Workshops
- Courses
- Seminars
- …
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.
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

1st Announcement

Landscape 2018
Frontiers of agricultural landscape research

12–16 March 2018
Müncheberg, Germany