Leibniz Centre for Agricultural Landscape Research (ZALF)

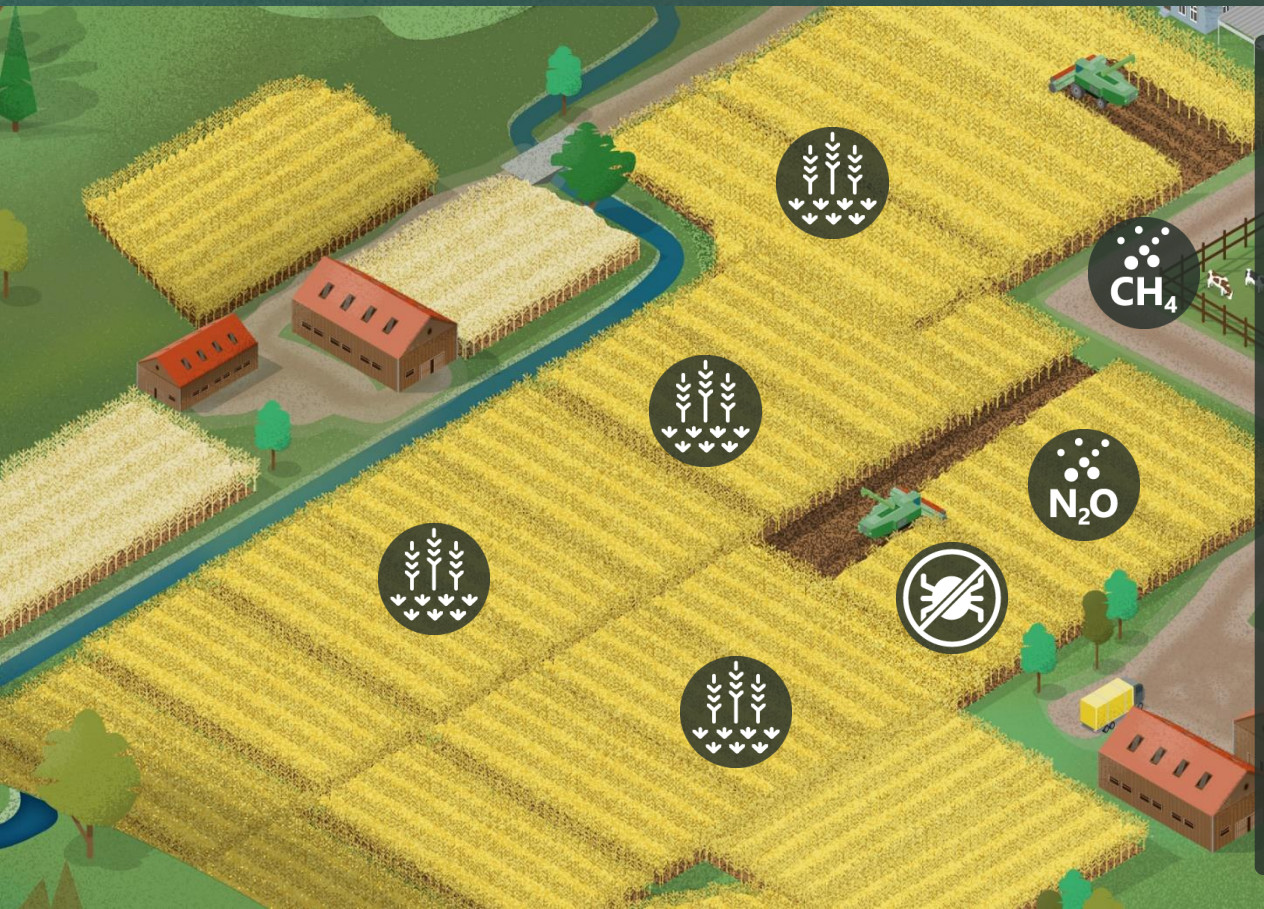
A social-cyber-physical system for planning and managing ecosystem services in agricultural landscape: Digital agricultural knowledge and information system (DAKIS)

Cheng Chen

Ariani Wartenberg, Nahleen Lemke, Sonoko Bellingrath-Kimura

Date: 11.10.2022 Session 14a: Integrative digital systems for planning and managing ecosystem services: State of the art and future prospects

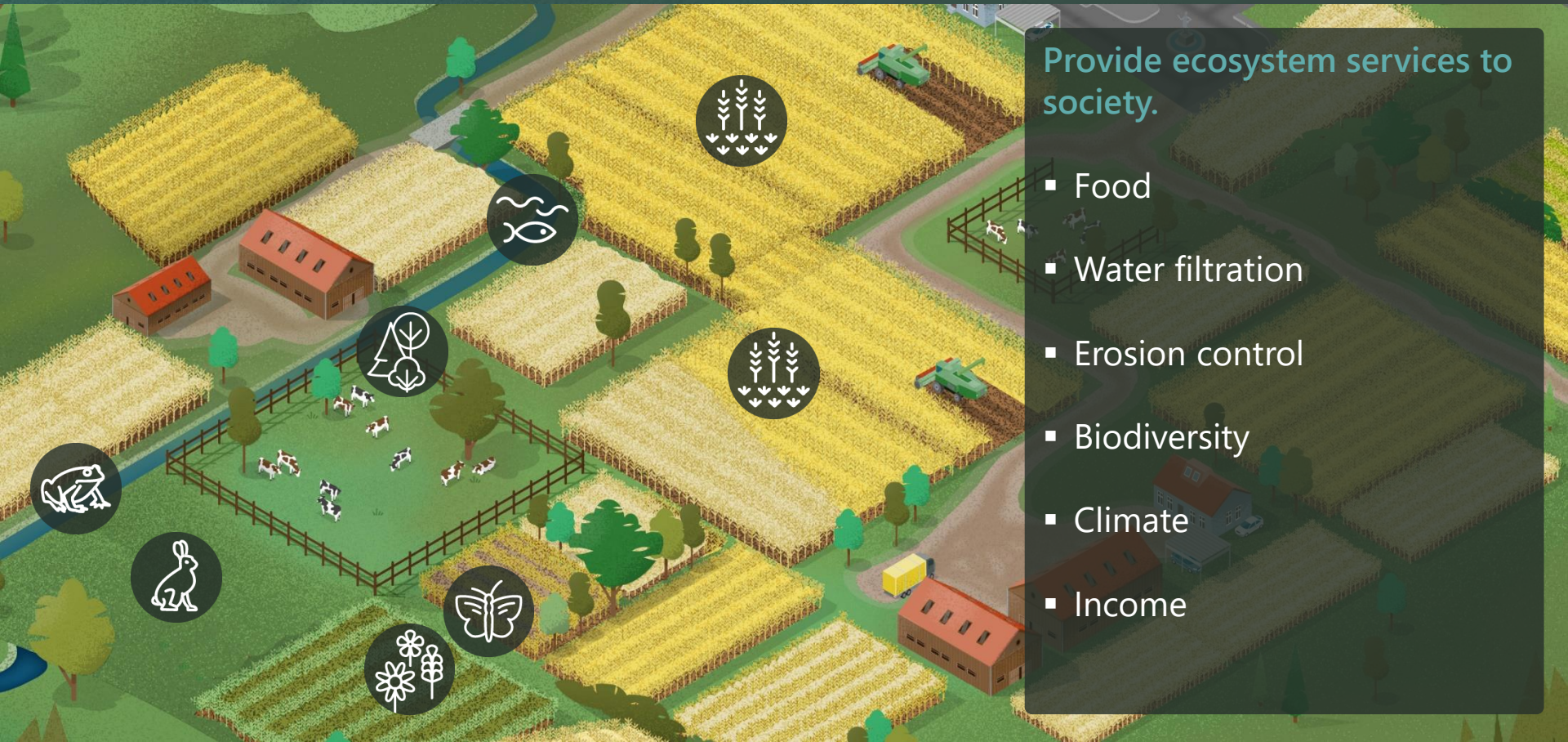
Agricultural landscape



Today's agriculture
is increasingly facing major challenges:

- It leaves little room for biodiversity.
- It consumes resources at the expense of sustainability.
- It is often not prepared for the impacts of climate change.

Planning and managing ecosystem services in agricultural landscape



Provide ecosystem services to society.

- Food
- Water filtration
- Erosion control
- Biodiversity
- Climate
- Income

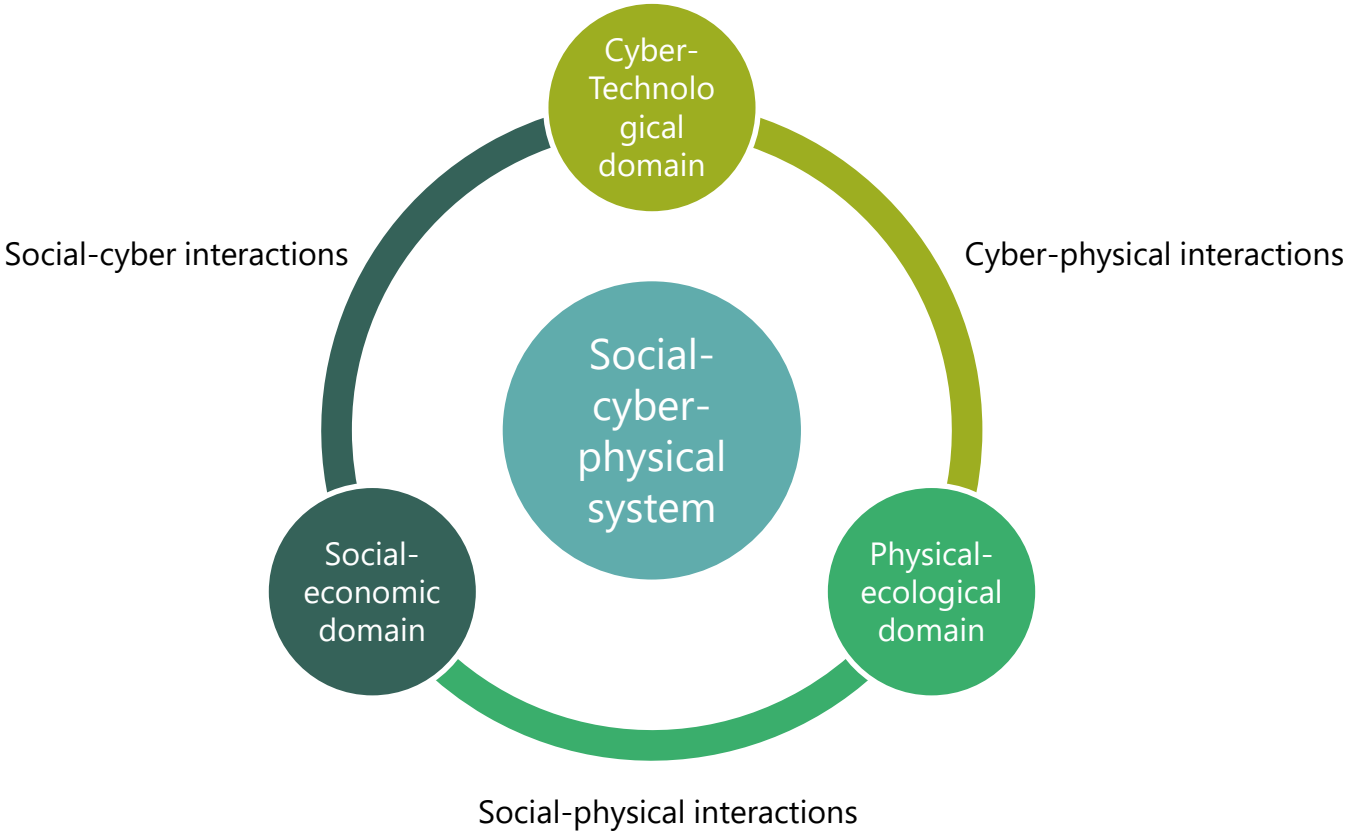
Digitalization and new technologies open up new possibilities

Our vision

Agricultural landscapes of the future:

- combine environmental and climate protection with food security,
- replace large, uniform fields with diverse landscape structures,
- use the advantages of new knowledge-based and digital production systems.

A social-cyber-physical system lens



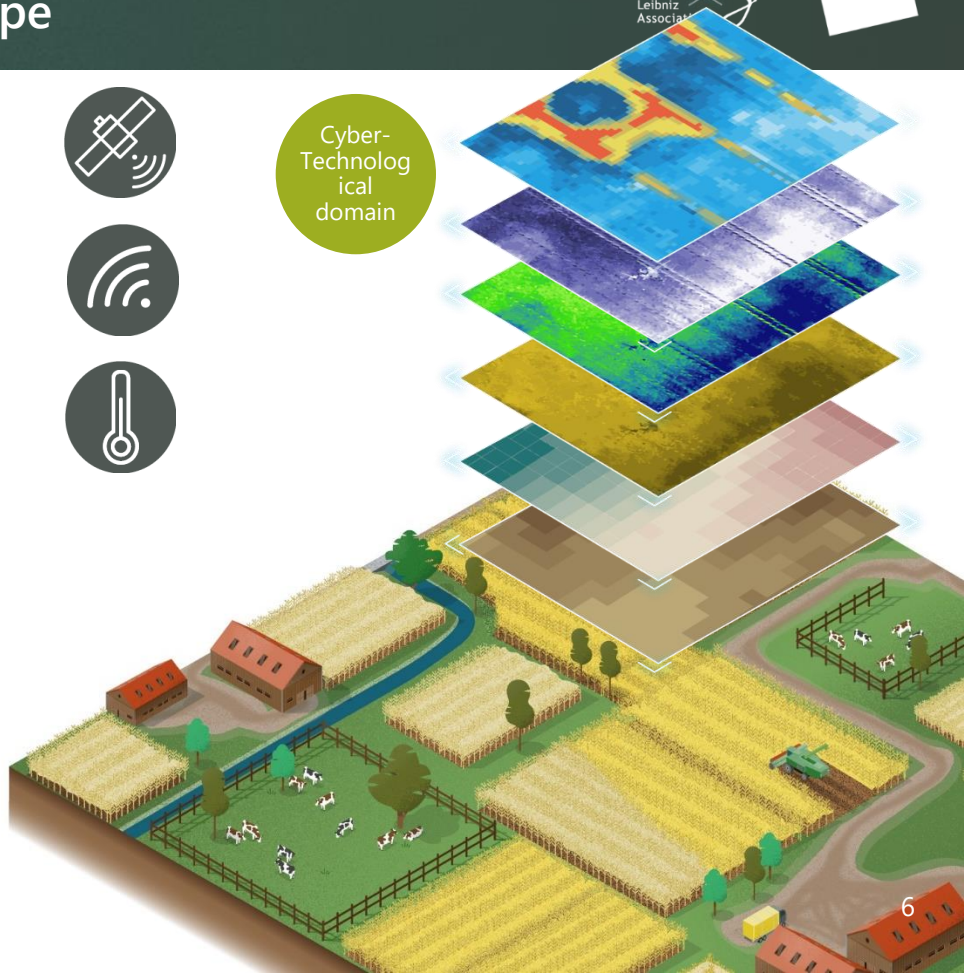
A social-cyber-physical system for planning and managing ecosystem services in agricultural landscape

Social-economic domain

Cyber-Technological domain

DAKIS

Physical-ecological domain



Digital agricultural knowledge and information system (DAKIS)

The collected data, together with market information, is being put into a digital system that supports decision making.

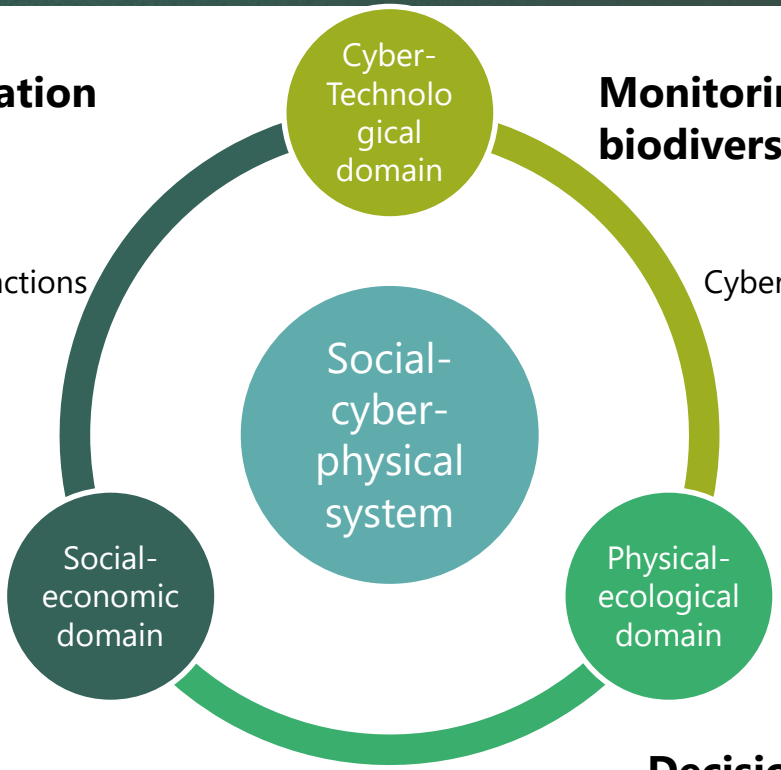
Agriculture and digitalization: Synergies through emerging technologies

The system connects data, information and actors with each other and provides recommendations on how to sustainably adapt our agriculture.

A social-cyber-physical system lens for functions of DAKIS

Support for communication and collaboration

Monitoring of production, biodiversity and ecosystem services



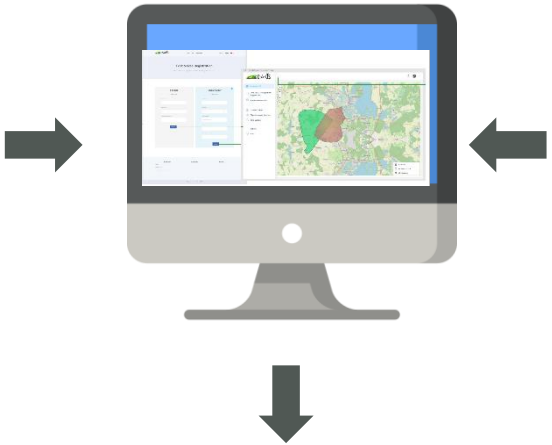
Decision support for farm operation and management

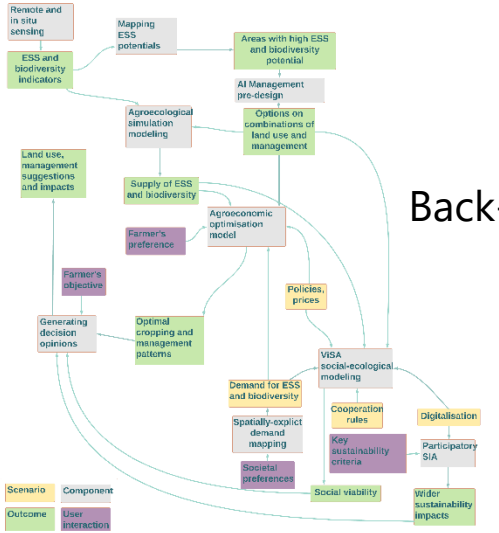
A social-cyber-physical system lens for components of DAKIS

	Farmer	Stakeholders
Cyber-physical interactions	- Spatio-temporal monitoring (satellite, UAV, sensors) - GIS into subfield and field level - Rule-based AI system - Agroecologocal model - Microclimate model - Biodiversity model	- Ecosystem services damand mapping
Social-physical interactions	- Agroeconomic model to support farm decision - Farm management and information system (FMIS)	- Agroeconomic model to support policy
Social-cyber interactions	- Graphical user interface (GUI) - Farmer‘s preferences and objectives - Scenarios to support decision	- Sustainable impact assessment

DAKIS prototype

Front-end design





Back-end design

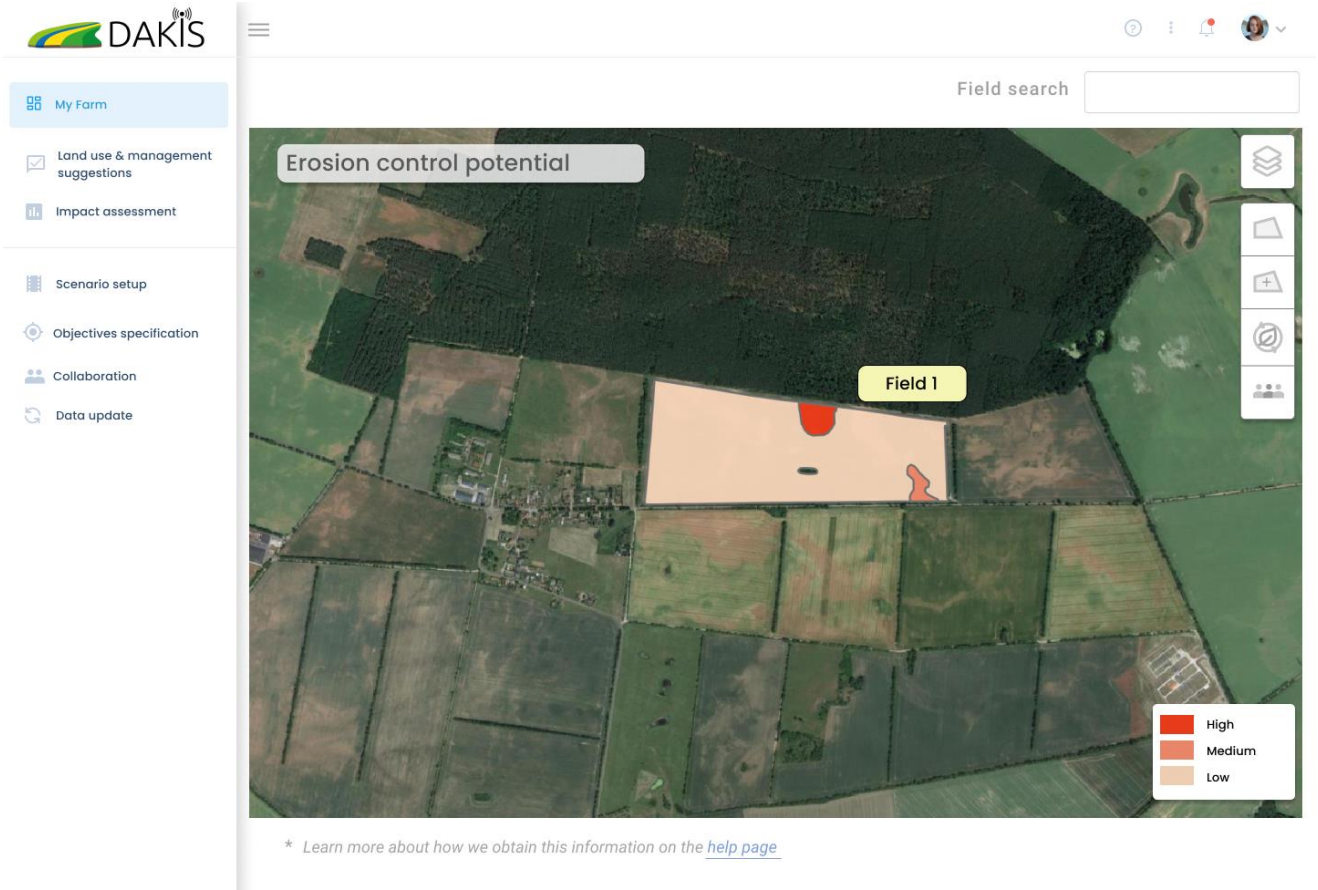
Provision of ESS and biodiversity with stable incomes for farmers.

Monitoring of production, biodiversity and ecosystem services

ca. 46 ha
in Brandenburg, Germany

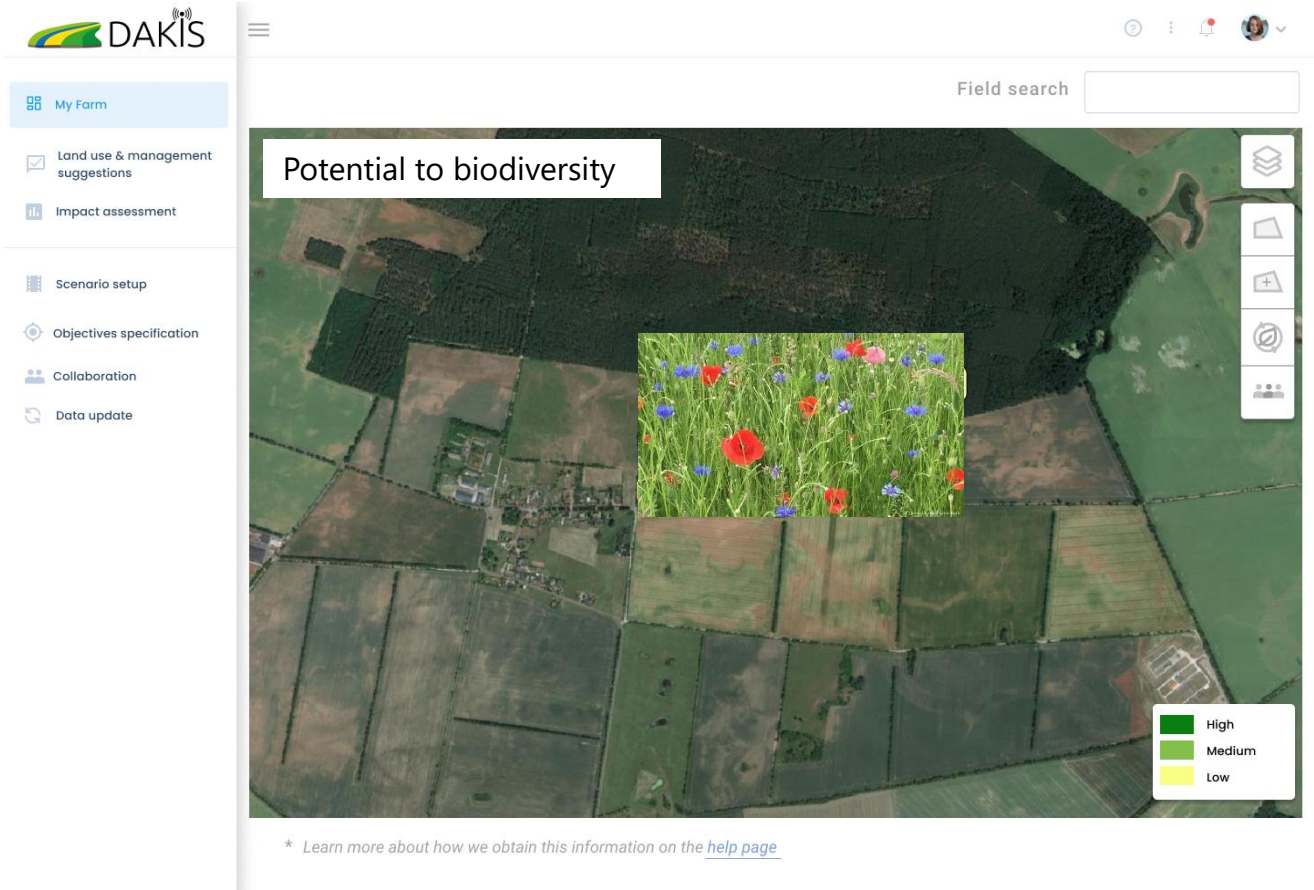
Spatio-temporal monitoring

Monitoring of production, biodiversity and ecosystem services



Spatio-temporal monitoring
GIS into subfield and field level

Monitoring of production, biodiversity and ecosystem services

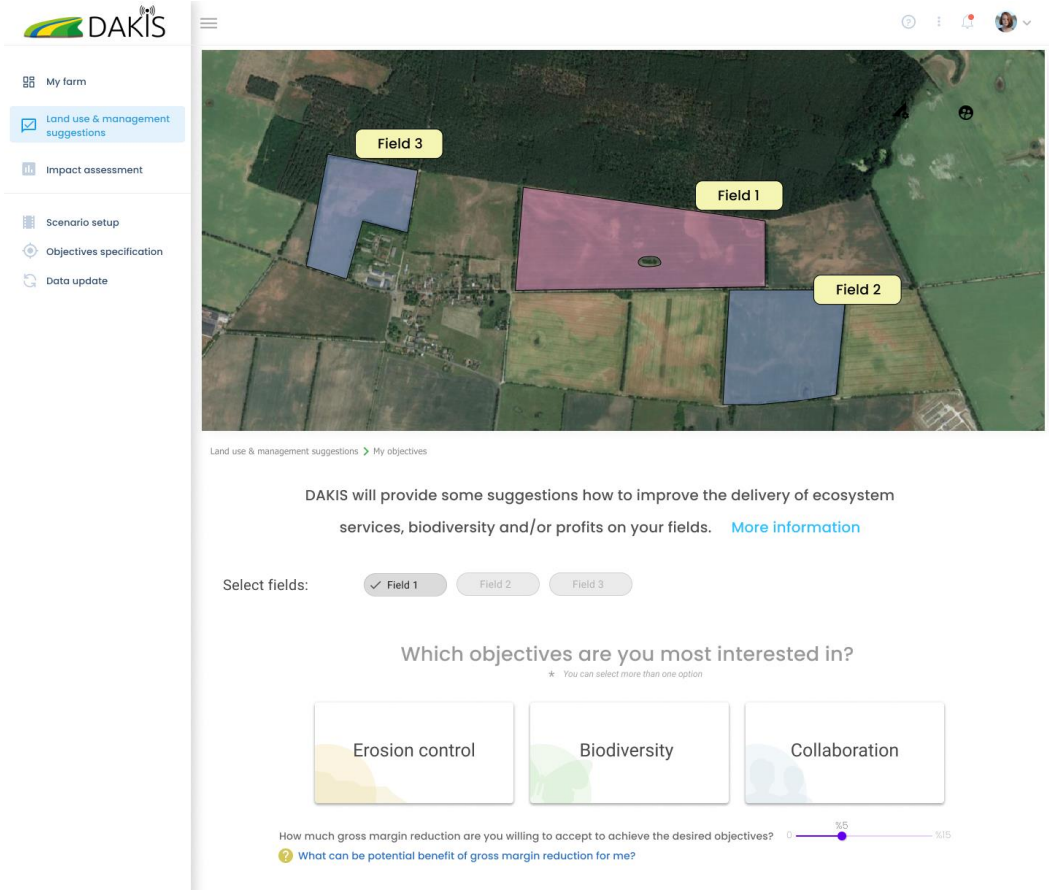


Sensors
Biodiversity model

Support for communication and collaboration

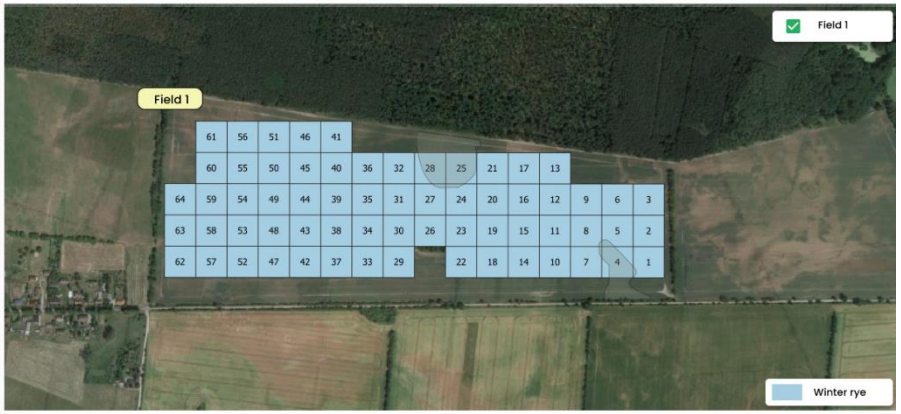
Ecosystem services damand mapping

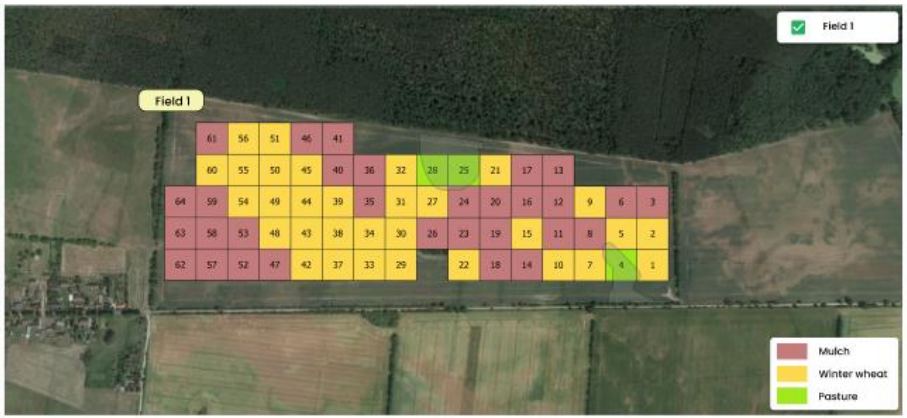
Decision support for farm operation and management

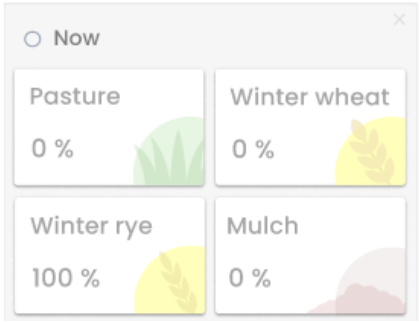


Farmer's preferences and objectives

Decision support for farm operation and management







Agroeconomic model to support farm decision

Conclusion

- Challenges to the real-world applicability of digital decision support system
- Digitalization should go beyond to just replace manual process with digital ones
- But rather transform the way farm-actors use and integrate multiple flow of information and lead to sustainably managed agricultural landscape
- A social-cyber-physical system lens can help systemic change
- DAKIS embeds the consideration of ecosystem services, biodiversity, and sustainability into farmers' decision-making toward multifunctional and diversified agriculture
- Future uptake is not only from individual farmer, but also industry and policy players

Thank you for your attention!

Contact: cheng.chen@zalf.de

DAKIS
Digital Agricultural Knowledge and Information System

https://adz-dakis.com

SCAN ME

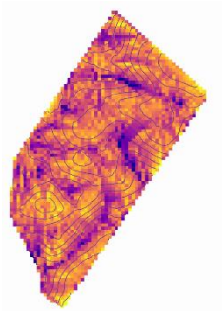



Back-end: Biomass potentials

Marco Donat (ZALF)

Soil points

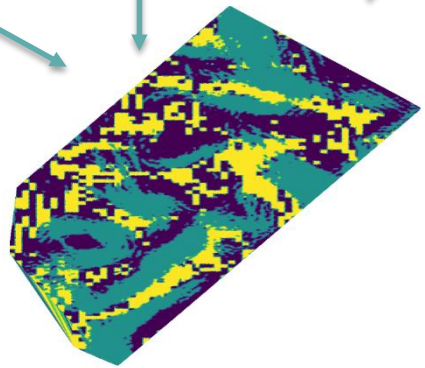
Slope angle



Soil humidity

Solar radiation

Identification of biomass potentials at subfield level at the Dahmsdorf site

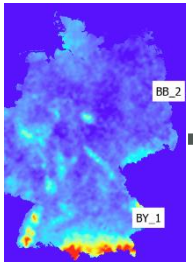


High soil quality

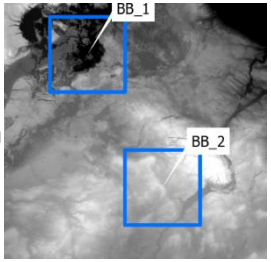
Moderate soil quality

Moderate soil quality at slope

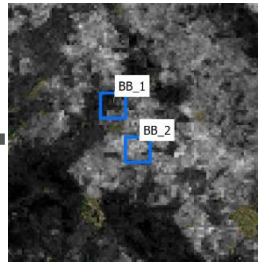
Back-end: Erosion control potentials



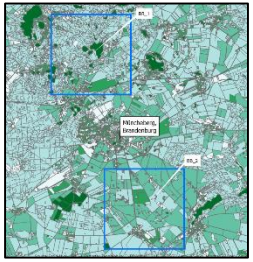
Climate



Relief



Soil



Land use

Waterbodies

Marvin Melzer (ZALF)

Identification of potential to reduce soil erosion and erosion hotspots at subfield level for four landscape windows (5x5 km) in Brandenburg and Bavaria

Back-end: Biodiversity potentials

Floristic biodiversity

- Neural Network Model

Selected Indicators

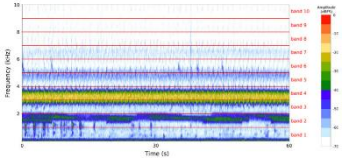
First results using neural network model

Faunistic biodiversity

- Bird, frog & land animal recorders

Bird community

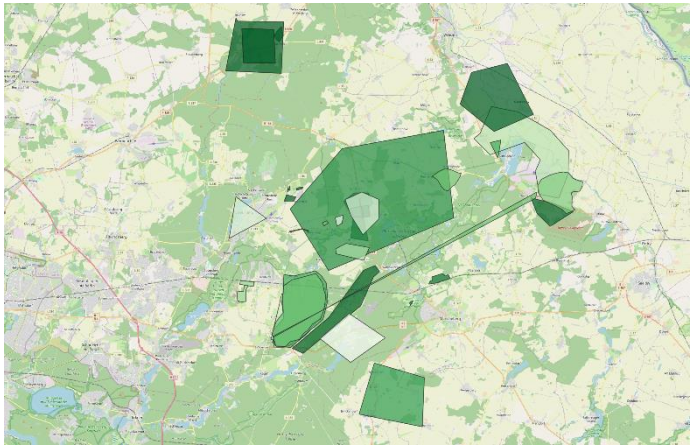
Soundscape ecology

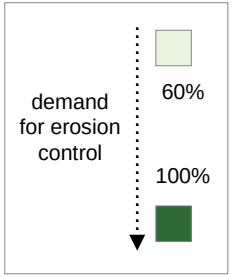


Back-end: Spatially explicit demand for ES

Carmen Schwartz (ZALF)

Opportunity to identify demand for ES and biodiversity by societal actors and inform farmers

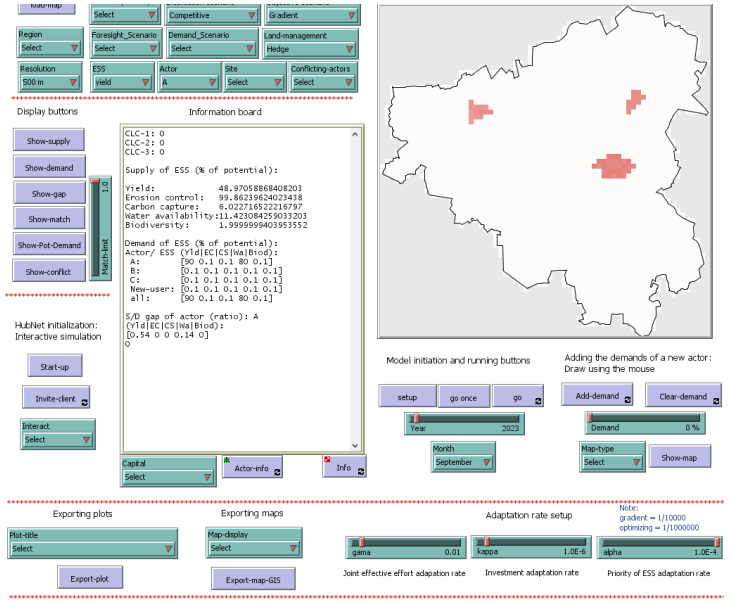




Back-end: Collaboration potential: Agent-based modeling

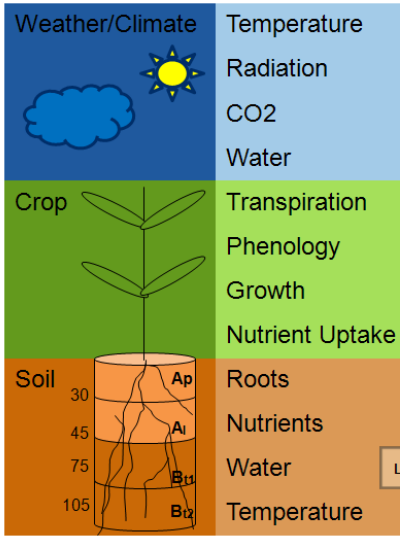
Mostafa Shaaban (ZALF)

Identify mismatch between demand and supply, and potential for cooperation/risk of conflict between land use actors at landscape scale



Back-end: Agroecosystem and bioeconomic modelling

SIMPLACE



Gaiser/Krauss/Enders (UBonn) www.simplace.net

- Crop yields and environmental indicators
- Historical price data
- Changing resource endowments
- ....

MODAM

Objectives
- Gross margin maximisation
- Risk minimization
- ESS implicit return maximization

Constraints
- Farm/sub-field specific physical and financial constraints
- Environmental and legal rules and constraints

Modules
- Livestock
- Cropping, Land and Land Use
- Labour
- Farm Machinery
- Investments, Financing and Cash Flow
- Manure, Synthetic Fertilizers, Plant Nutrition
- Environmental Accounting
- Biogas

Digital Agricultural Knowledge and Information System (DAKIS)

- April 2019 - March 2024
- 10 Partner
- ~ 50 scientists
- ~ 7 millions €

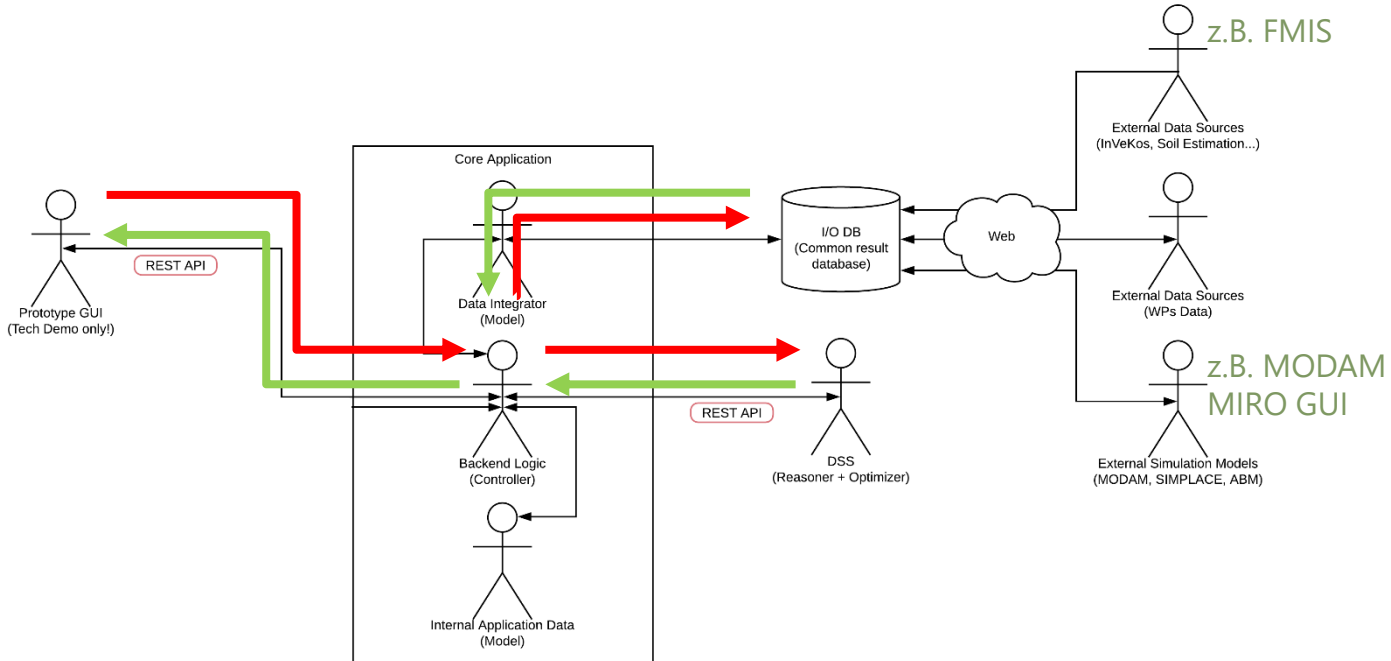
DAKIS
Digital Agricultural Knowledge and Information System

DAKIS data flow

Landwirt beauftragt die Generierung von Landnutzungs- und Handlungsempfehlungen

Core application holt sich die Daten von einem FMIS oder von INVEKOS und startet

Startet diverse tools (Reasoner, Simplace, … ➔ Ertrag/Erosion, Hecken etc.) und füttert die Datenbank mit Zugriff für FMIS und MODAM.

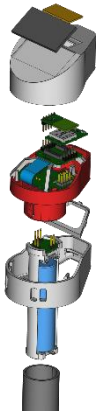


Request

Reply

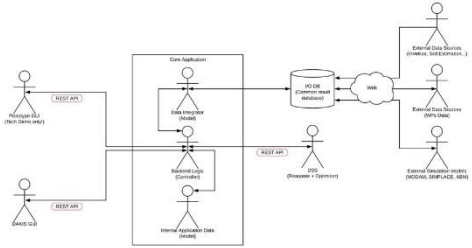
More in DAKIS

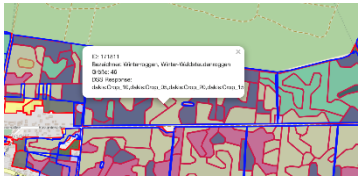
Sensor Platform



Max Frohberg (IHP)

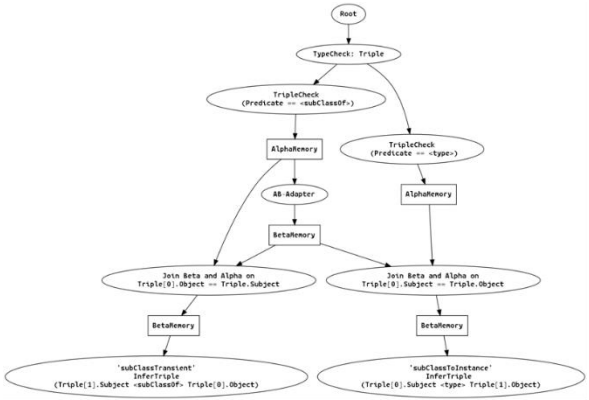
Database





Sebastian Möller
Hochschule Osnabrück

AI system



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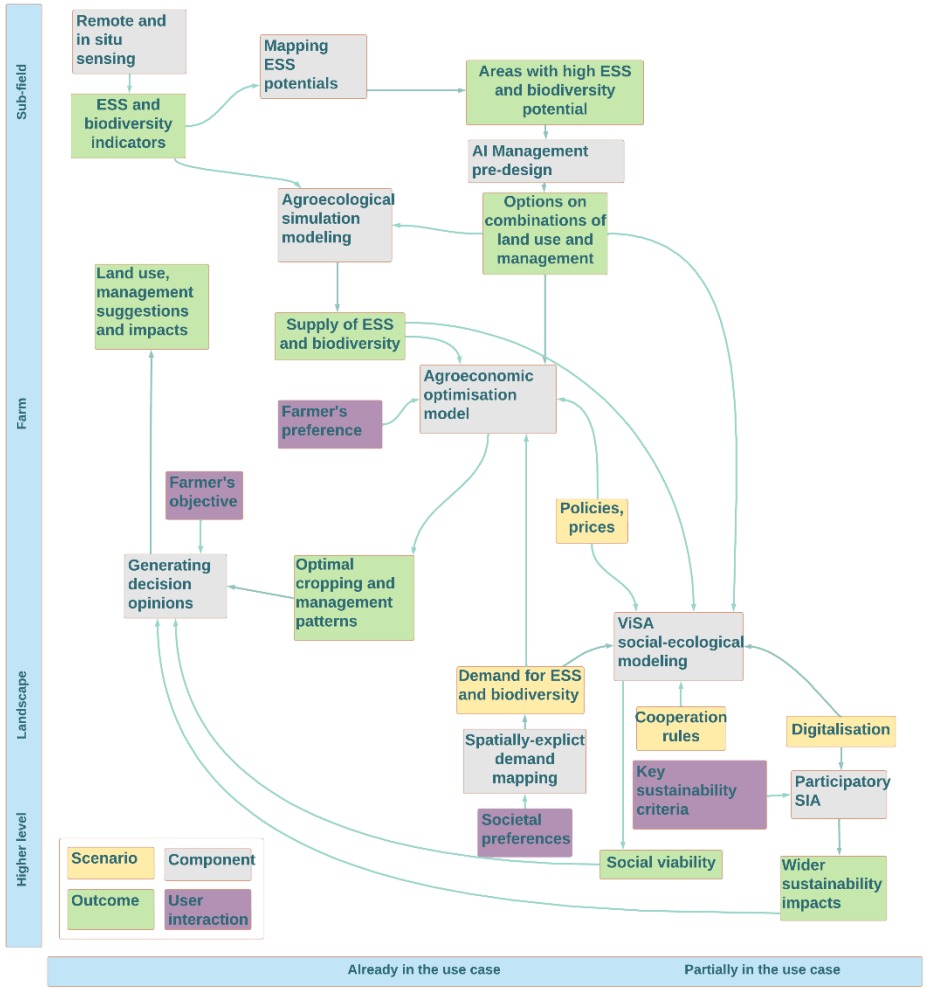
Sub-field
Farm
Landscape
Higher level
Remote and in situ sensing
Mapping ESS potentials
Areas with high ESS and biodiversity potential
ESS and biodiversity indicators
AI Management pre-design
Agroecological simulation modeling
Options on combinations of land use and management
Land use, management suggestions and impacts
Supply of ESS and biodiversity
Agroeconomic optimisation model
Farmer's preference
Farmer's objective
Policies, prices
Generating decision opinions
Optimal cropping and management patterns
ViSA social-ecological modeling
Demand for ESS and biodiversity
Cooperation rules
Digitalisation
Spatially-explict demand mapping
Key sustainability criteria
Participatory SIA
Societal preferences
Social viability
Wider sustainability impacts
Scenario
Component
Outcome
User interaction
Already in the use case
Partially in the use case