Leibniz-Zentrum für Agrarlandschaftsforschung

Sustainability Assessment of Agricultural Soil Management

Conference on
Soil Biota driven Eocystem Services in European Agriculture

Braunschweig, 22. Oktober 2019

Helming et al., 2018. Sustainability

Katharina Helming
Leibniz-Zentrum für Agrarlandschaftsforschung

Soil functions and ecosystem services

Material

Food security
Energy security

Housing, industry infrastructure

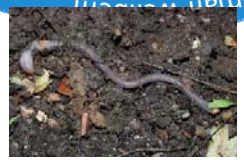
climate mitigation

heritage

Water storage & purification

temperature buffering

Nutrient supply



biodiversity

Adapted from Adhikari & Hartemink 2016

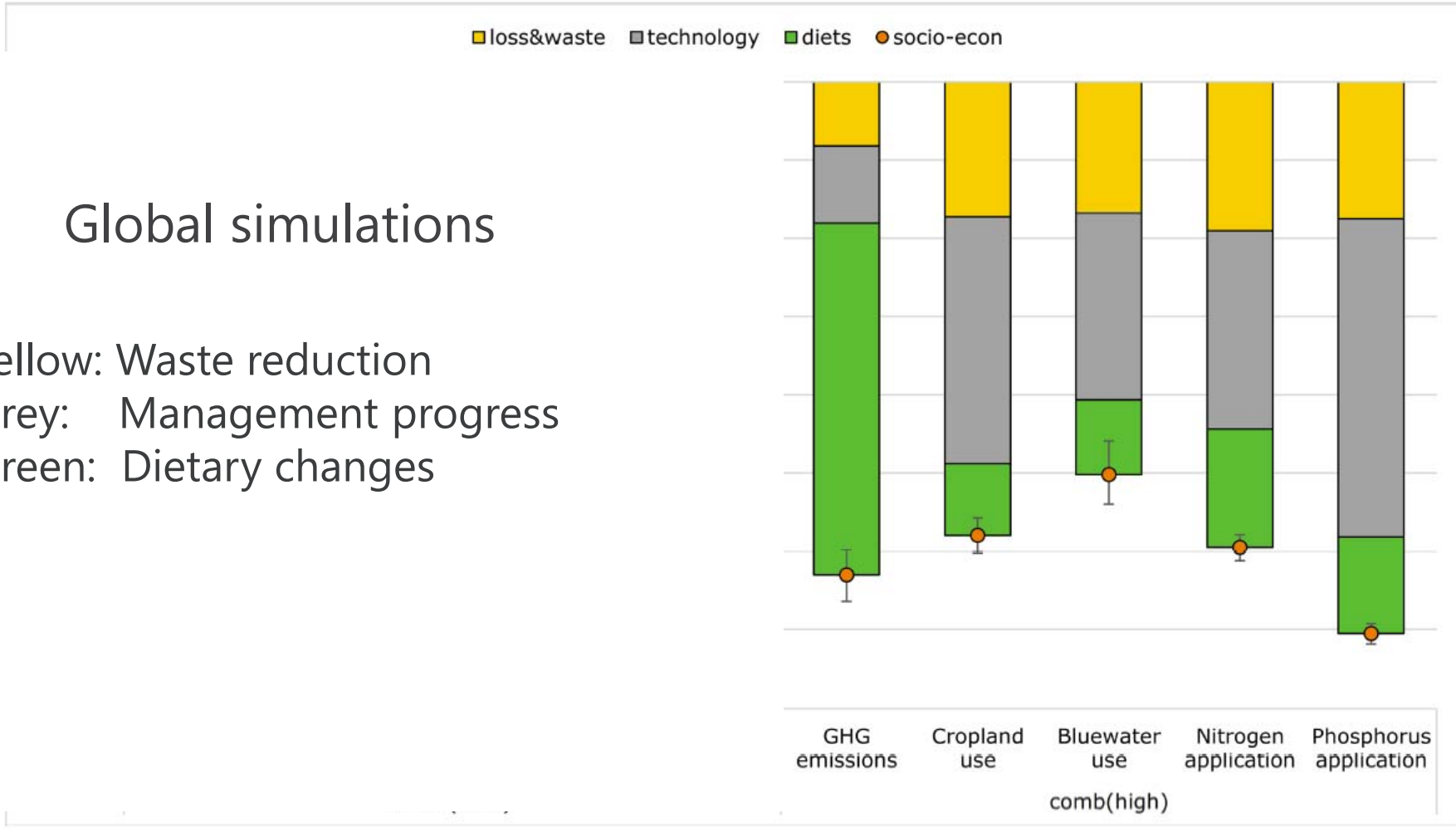
Soils and Sustainable Development

- Food Security (Goal 2)
  - population: > 9 billion in 2050
  - Increasing meat consumption
- Energy security (Goal 7)
  - Bioenergy
- Sustainable production (Goal 12)
  - Resource use efficiency
- Climate Change (Goal 13)
  - Adaptation
  - Mitigation
- Terrestrial ecosystems (Goal 15)
  - Biodiversity
  - Land degradation neutrality

How to reduce the environmental impact of the food system?

Global simulations

Yellow: Waste reduction
Grey: Management progress
Green: Dietary changes



Springmann et al., Nature 2018

Sustainability Assessment of Soil Management

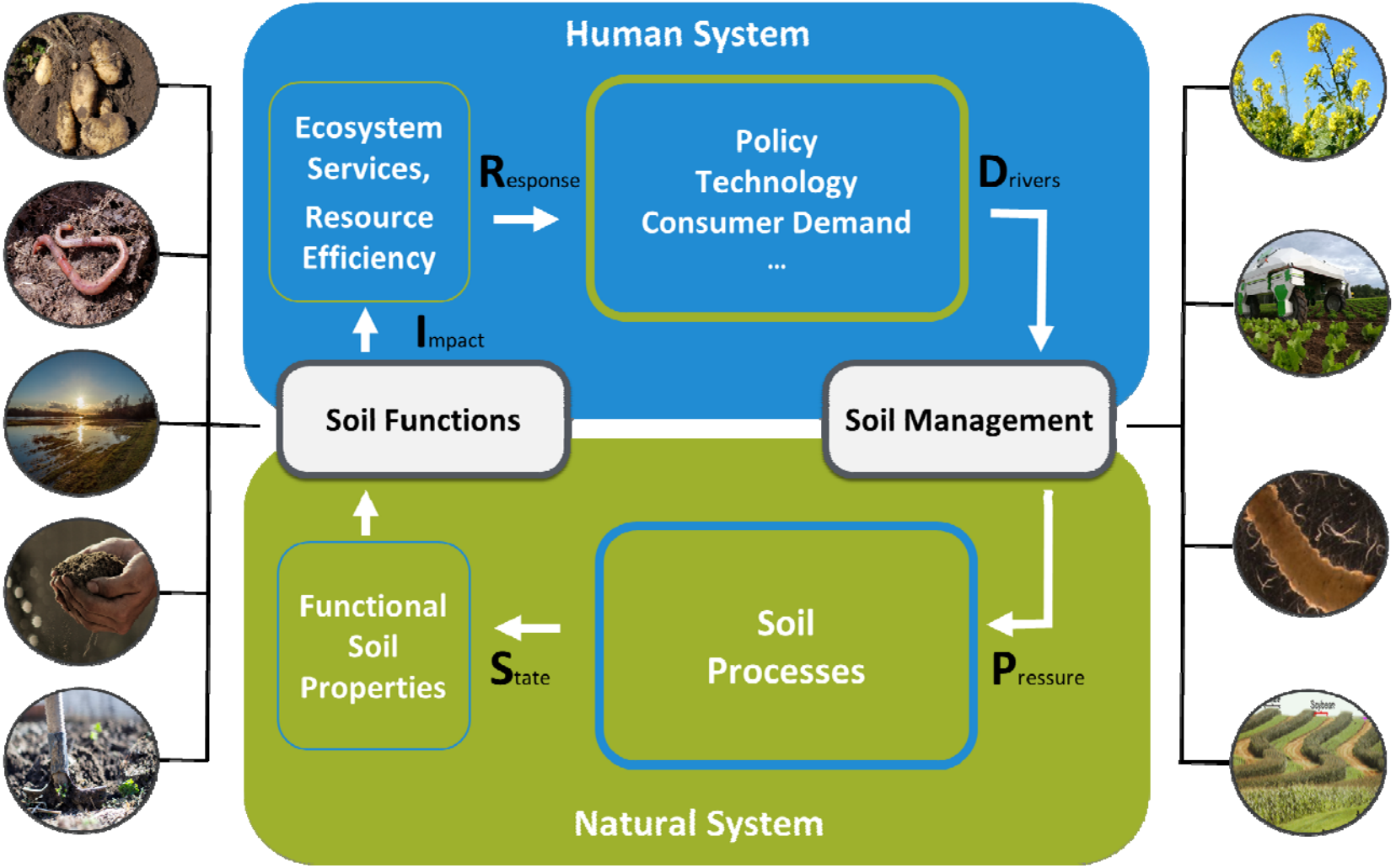
Concept

- Sustainable Intensification (Garnett et al., 2013)
- Ecological Intensification (Tittonell, 2014)
- Regenerative agriculture (who?)

Questions:

- What are future soil management options?
- How can they improve agricultural production and maintain the othr soil functions?
- What are the impacts on ecosystem services, resource use efficiency and sustainable development targets?
- What are the trade-offs?

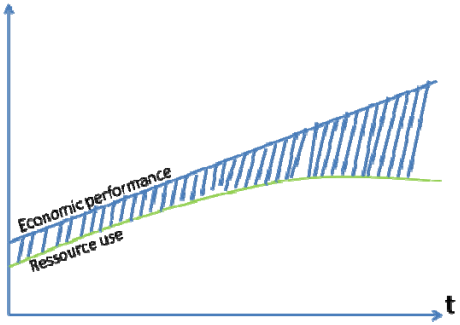
The BonaRes approach to systemic soil analysis



Vogel et al., 2018. Soil

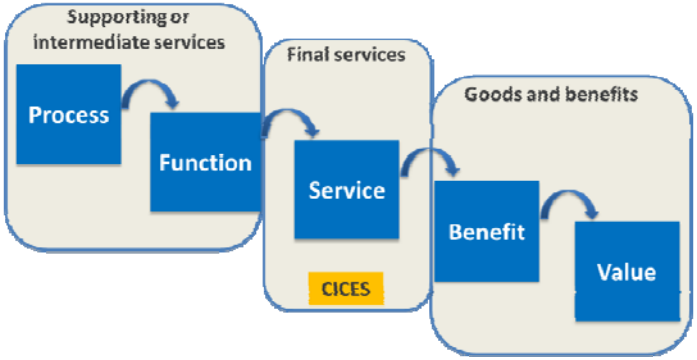
Sustainability Assessment of Soil Management

Resource use efficiency

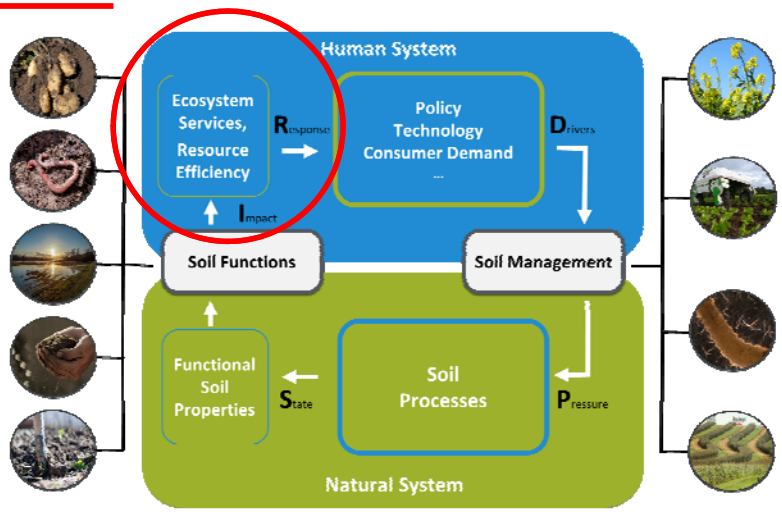


e.g. energy use efficiency, water use efficiency, land use efficiency, nitrogen use efficiency, cost efficiency….

Ecosystem services



simplified from Haynes-Young & Potschin, 2013



Helming et al., 2018. Land Degr. Dev,

External driving forces of future soil management

Ceteris paribus is not plausible

Multiple driving forces determine future developments

- Consumers' demand (→ prices)
- Factor costs
- Policies
- Farm(er)s' attributes
- Research & innovation

Socio-economic Drivers

- Available productive agricultural land
- Soil degradation
- Climate change
- Resource scarcity

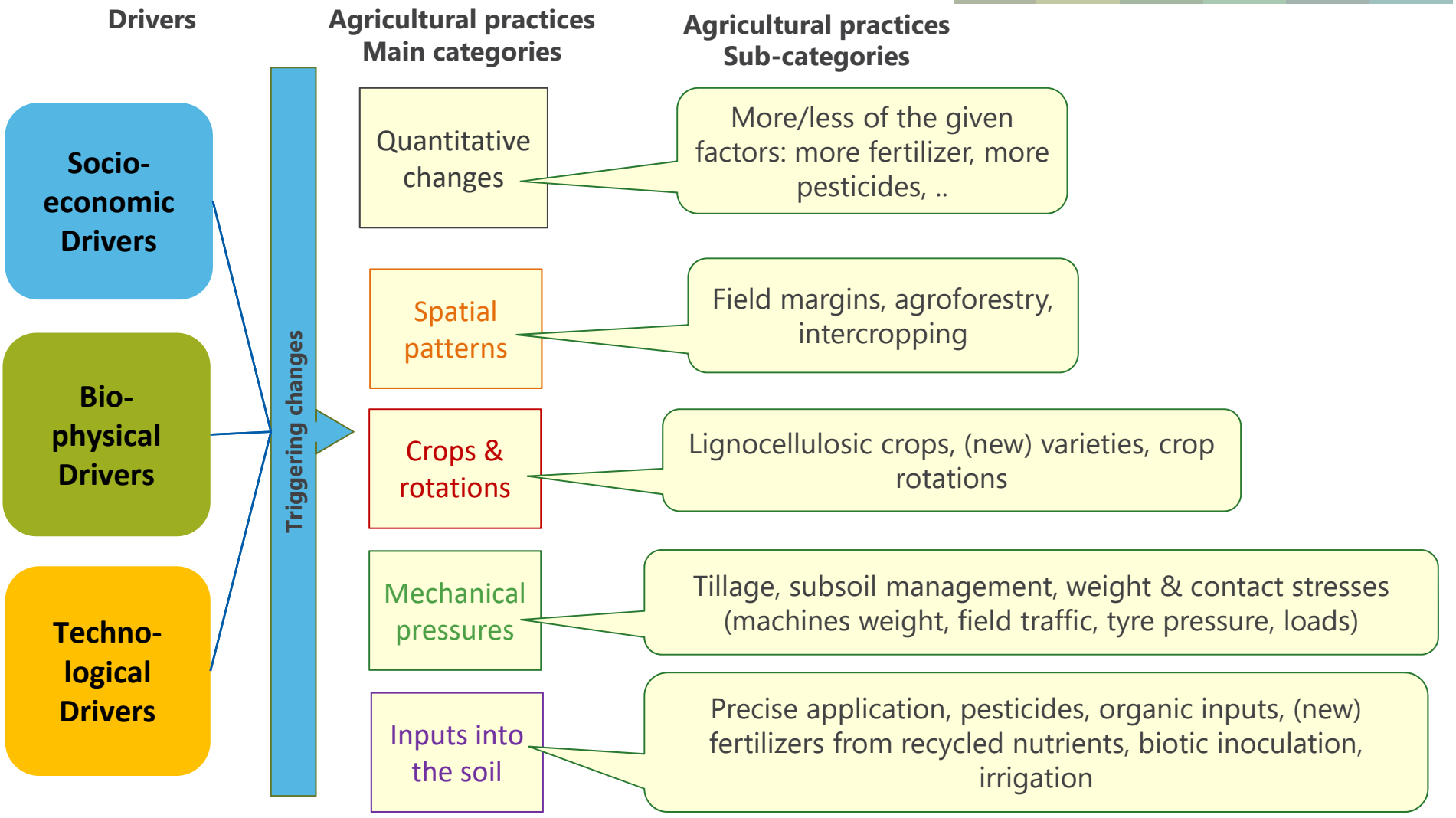
Bio-physical Drivers

- ICT & robotics („Agriculture 4.0")
- Biomass technology
- Technology (other)

Techno-logical Drivers

Techen & Helming 2017. Agron. Sust. Dev.

Foresight on emerging soil management practices and technologies

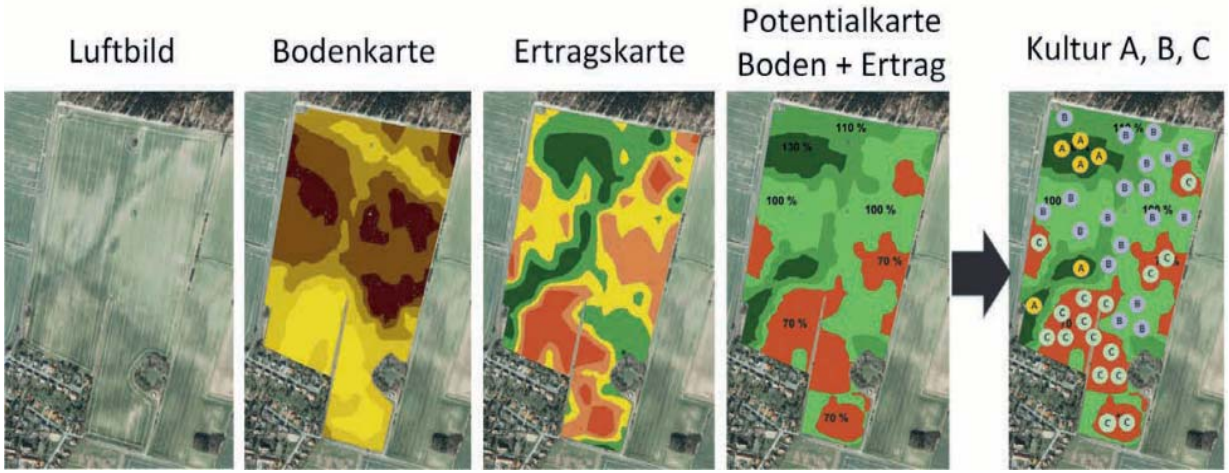


Techen & Helming 2017. Agron. Sust. Dev.

Digitization for precision farming

Quelle: 2)

Quelle: 3)



Quelle: 1)

1) WEGENER, J. K., MINßEN, T.-F. & GAUS, C.-C. 2017. Developing new cropping systems - Which innovative techniques are required? Landtechnik, 72
2);3) Gandofer (LfL 2018).

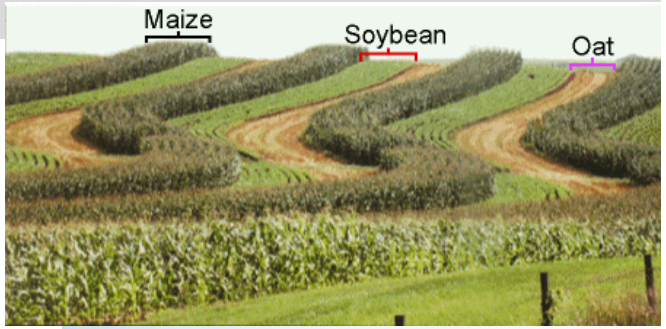
Small autonomous machines

Drivers: production costs, soil threats, technology, policy

Time frame for relevant spread: 15-20 years

Probability: very high for autonomous machines, high but uncertain for small autonomous machines

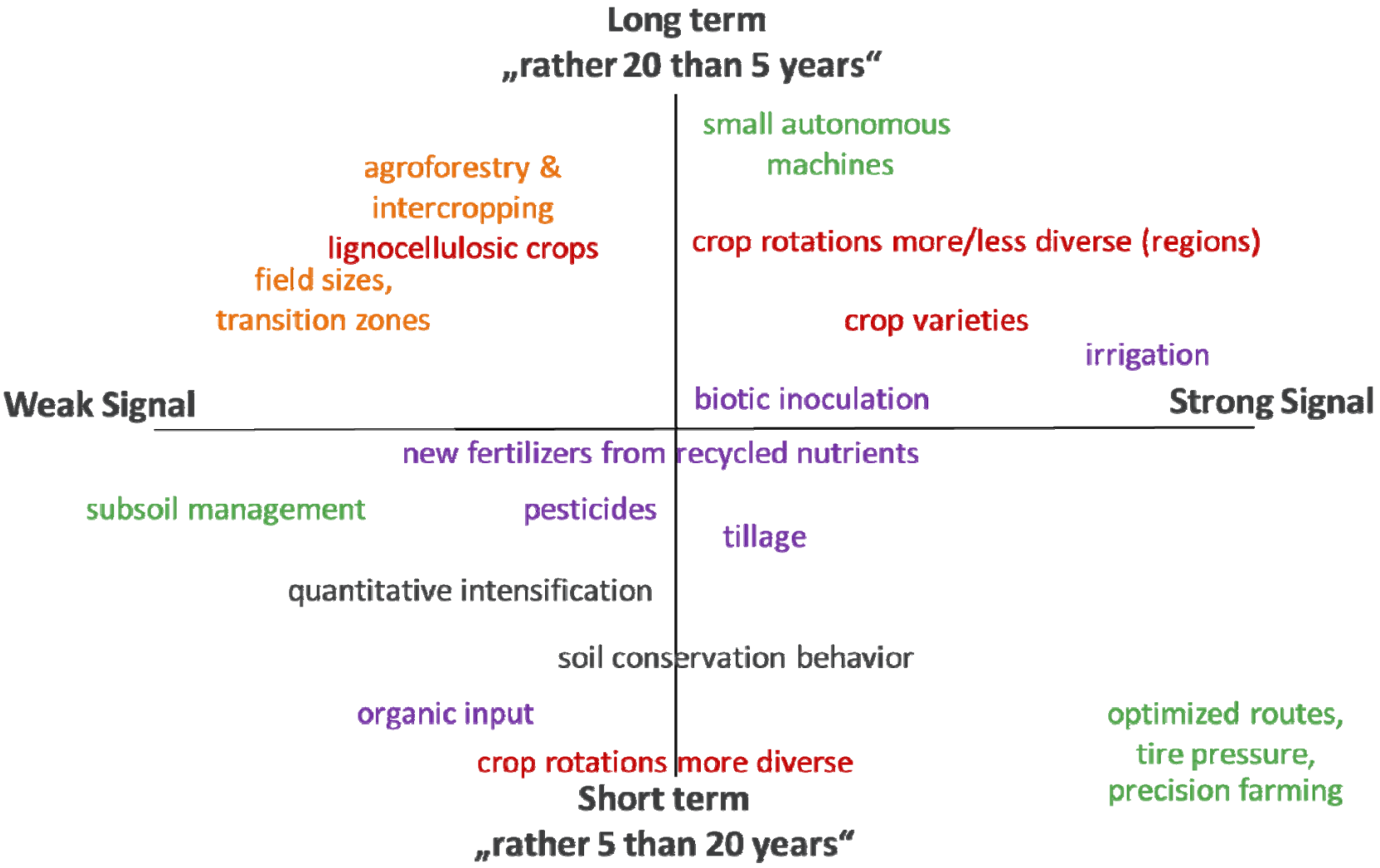
Impact: opportunities for smaller-scaled farming, intercropping, less weight stresses → positive impact on all soil functions possible, but details and other impacts unclear (e.g. resource efficiency)



Sources top to down:

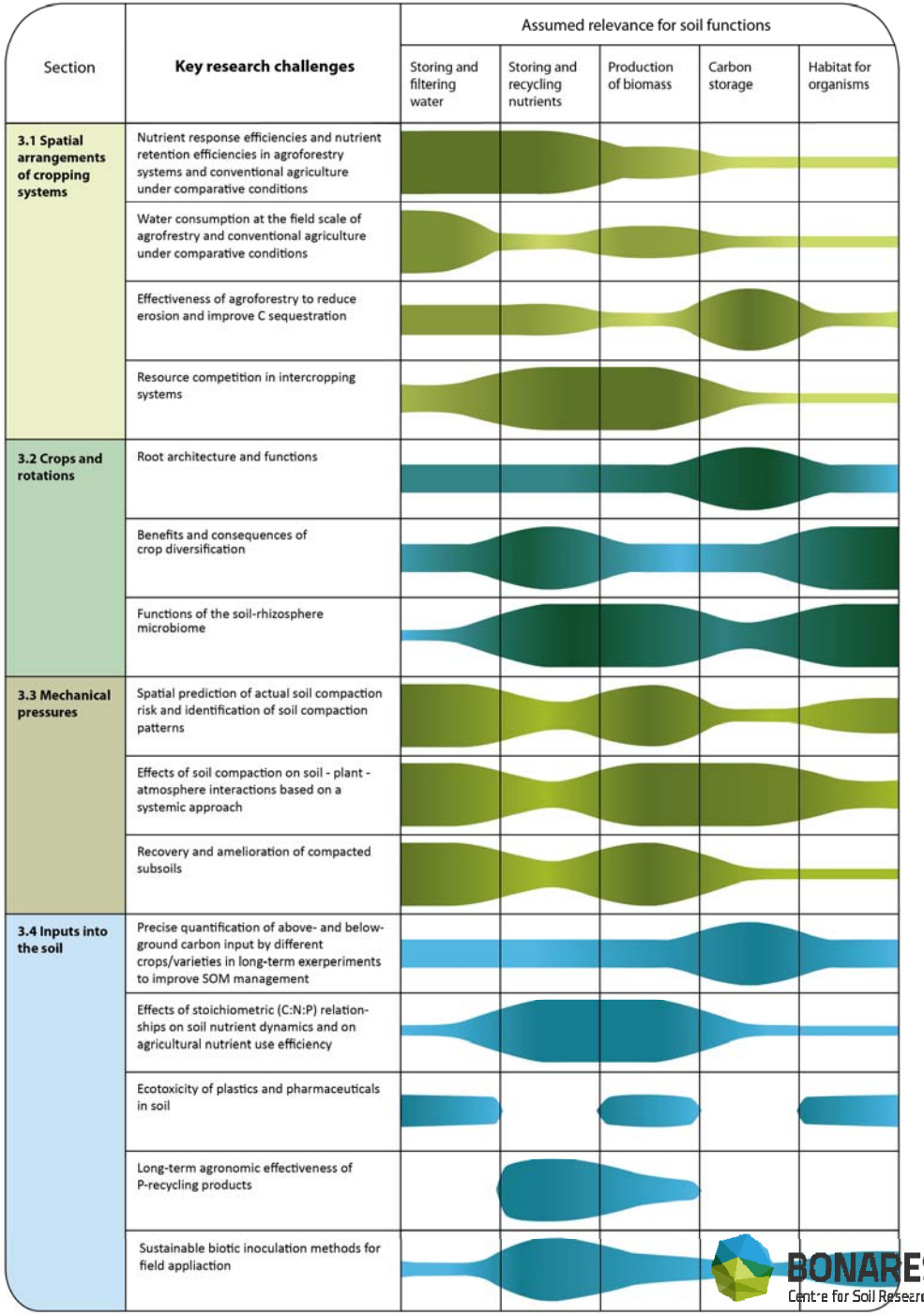
http://otizvora.com/forum/index.php?topic=1116.15; Farm Journal Media; Ecorobotix autonomous robot weeder 2016; Herlitzius, TU Dresden, https://tu-dresden.de/ing/maschinenwesen/int/ressourcen/dateien/agrarsystemtechnik/forschung/Poster_AST_Maehdrescherkonzepte.pdf?lang=de

Multifunctional land use



Techen 2019

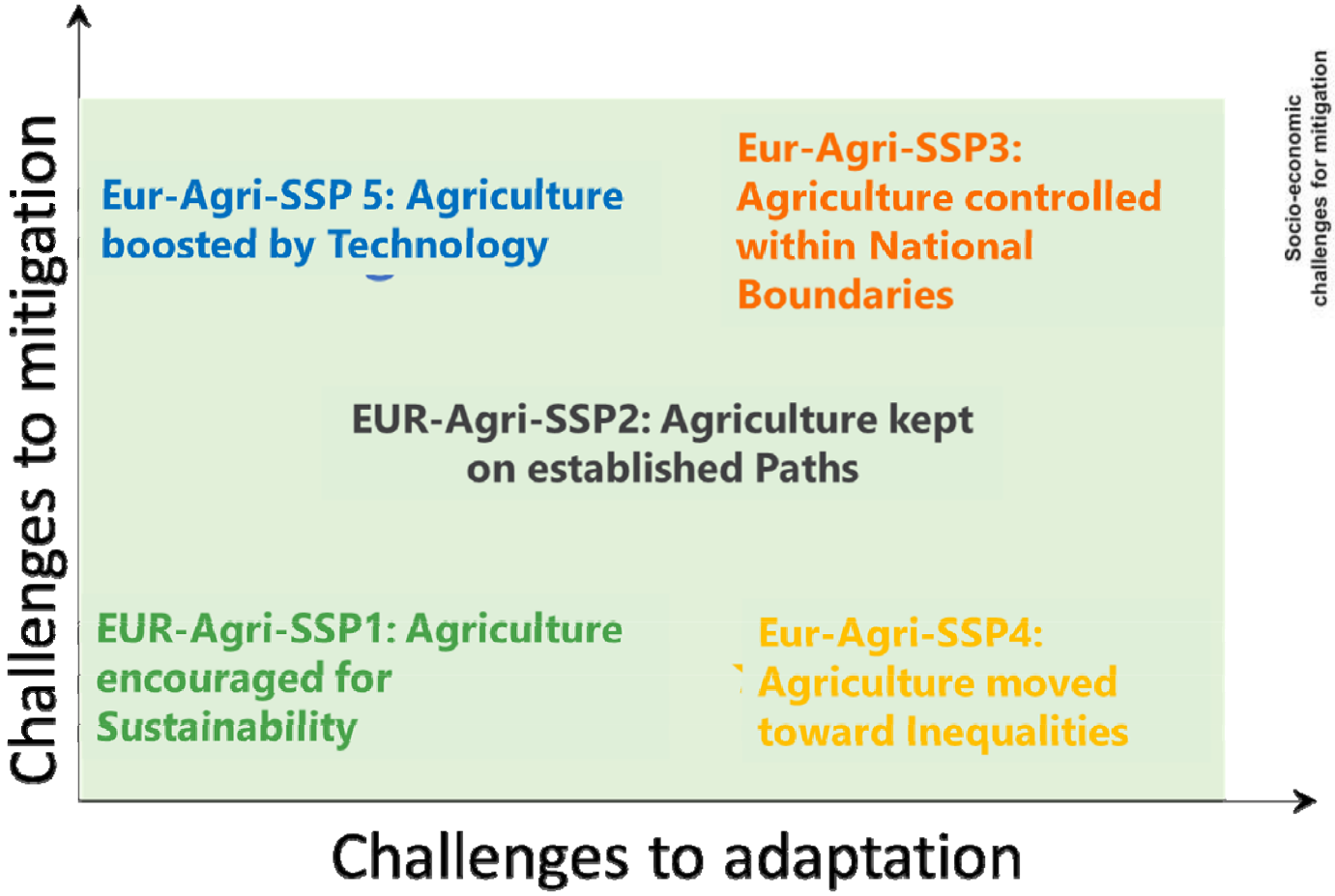
How relevant are new practices for soil functions?



Techen et al., Advances in Agronomy (in review)

European Agricultural Socio-Economic Pathways
EU-Agri-SSPs

IPCC shared socioeconomic pathways



Mitter et al., 2019 J. Env. Manag.

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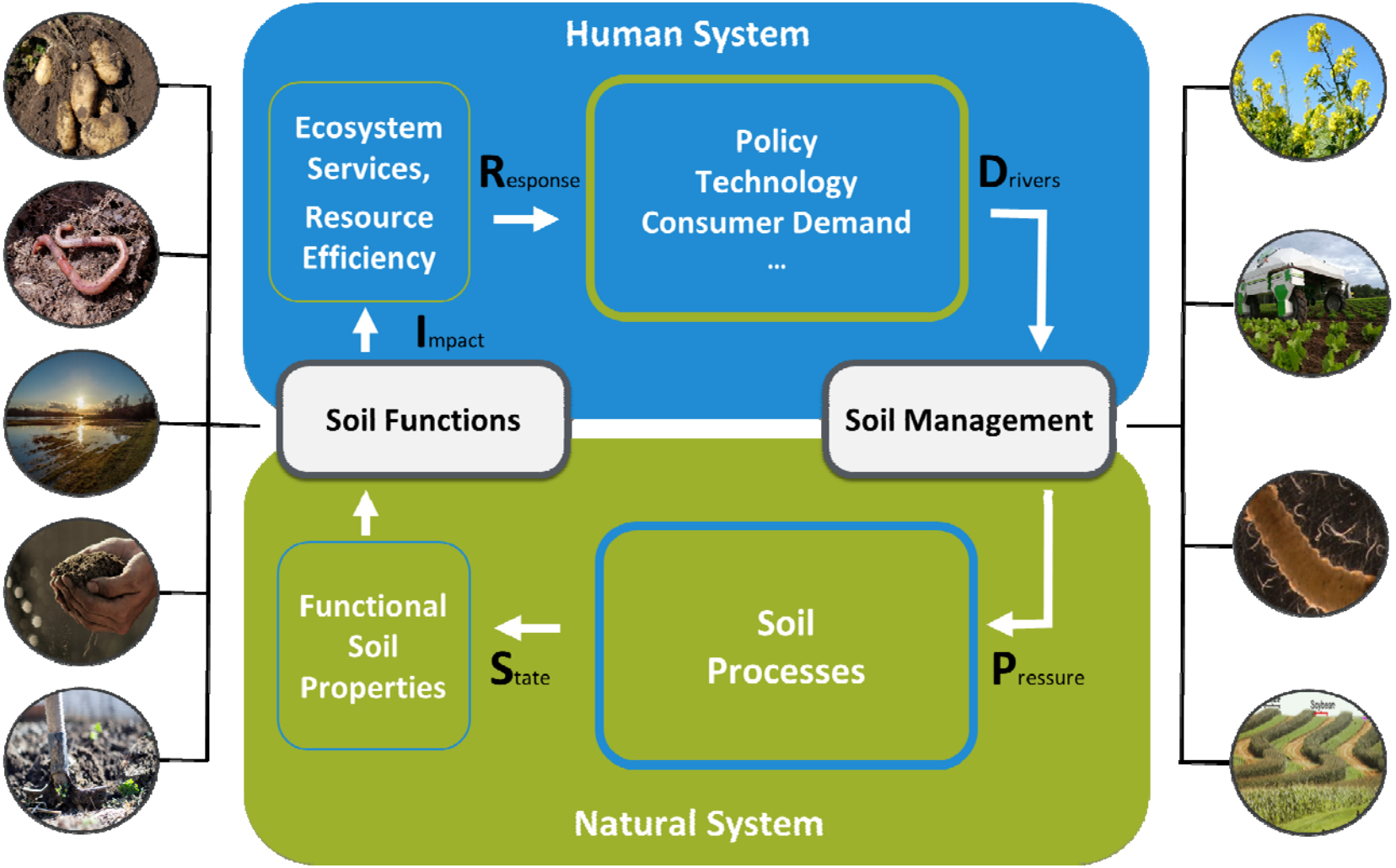
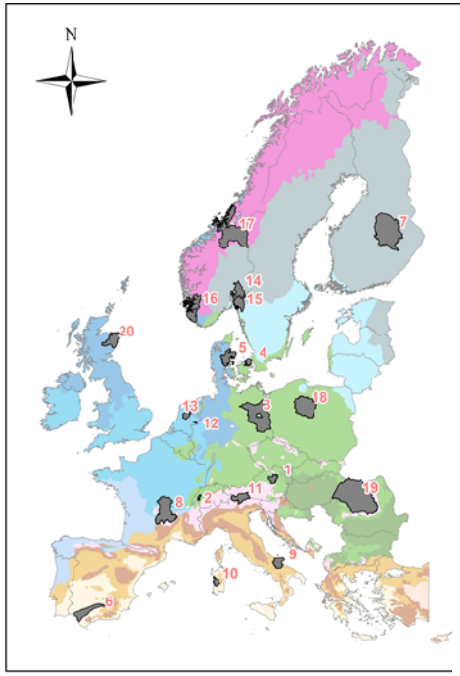
The BonaRes approach to systemic soil analysis



Vogel et al., 2018. Soil

A meta-study of European cases:
Impacts of climate change adaptation scenarios on soil functions

Location of 20 case study areas across environmental zones in Europe



Adaptation pathways

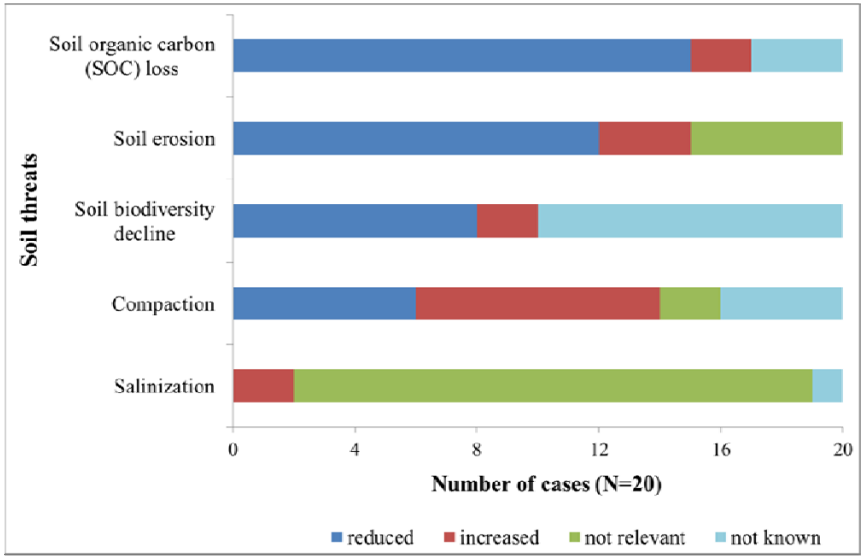
Case studies	Adaptation options				
	crops & crop rotation	tillage	irrigation / drainage	fertilization	share of arable land
Foggia (IT)	more winter wheat, tomato		increase irrigation efficiency	increase efficiency	
Oristanese (IT)	more grain, forage	increase conservation tillage	increase in irrigation areas and efficiency	increase efficiency	increase cropland
South Tyrol (IT)	same crop but adapted varieties		increase irrigation efficiency		
Baakse Beek (NL)	more maize, potato			reduce amount	increase cropland, reduce grassland
Flevoland (NL)	more winter wheat		increase irrigation efficiency		
Hobøl, Østfold (NO)	more forage	increase conservation tillage	improve drainage system		increase grassland, reduce cropland
Jæren, Rogaland (NO)			improve drainage system		increase grassland, reduce cropland
Lowland Trøndelag (NO)			improve drainage system		increase grassland, reduce cropland
Romerike Akershus (NO)	more forage	increase conservation tillage	improve irrigation system		
Kujawsko-Pomorskie (PL)	more cereals, maize, rape	increase conservation tillage	increase irrigation efficiency	increase amount	
Transylvanian Plain (RO)	more maize, soybean, wheat	increase conservation tillage	introduce irrigation for key crops	apply organic fertilizers	
NE Scotland (UK)					increase cropland, intensify grassland

Hamidov et al., 2018. LandDegr.Dev

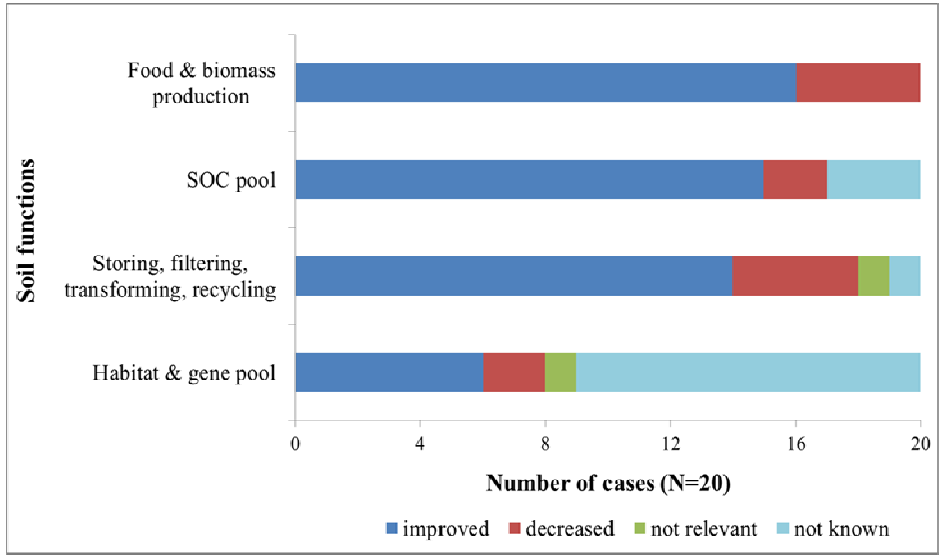
A meta-study of European cases:
Impacts of climate change adaptation scenarios on soil functions

Anticipated impacts of agricultural adaptation options

on soil threats



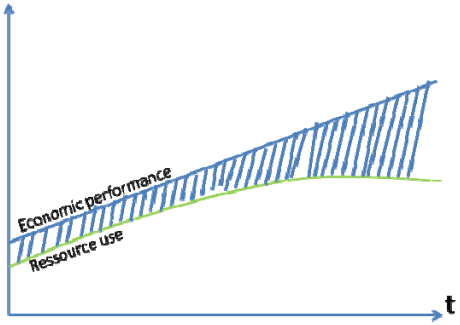
on soil functions



Hamidov et al., 2018. LandDegr.Dev

Sustainability Assessment of Soil Management

Resource use efficiency



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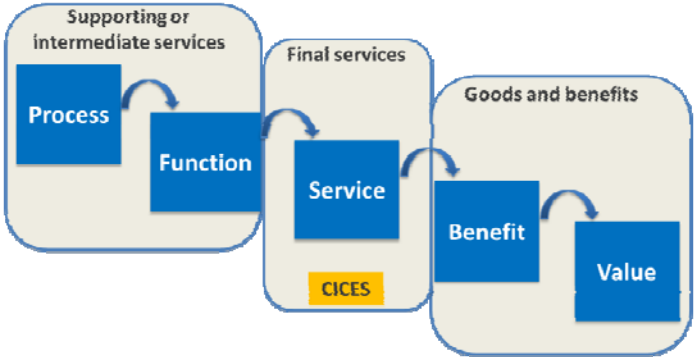
Ecosystem services



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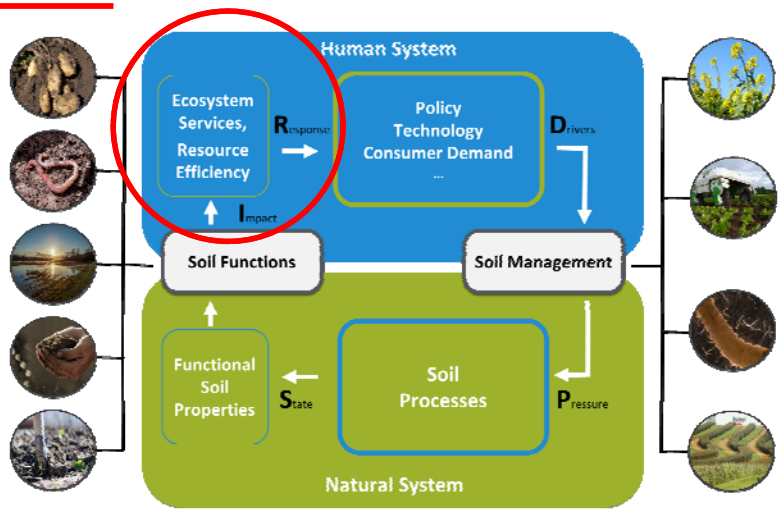

Helming et al., 2018. Land Degr. Dev,

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https://www.bonares.de/socioeconomics/sustainability-assessment

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Sustainability Assessment

You are here : Home > Soil functions > Socioeconomics > Sustainability Assessment > Welcome Page

Welcome to the BonaRes Assessment Platform

This platform is designed to support researchers in conducting state of the art assessments for evaluating impacts of agricultural soil management. It is also addressed to a wider audience who want to use and interpret findings of published impact assessments.

It is the first edition of a living document and further editions will be published at irregular intervals to allow for improvements, updates and the inclusion of new research.

platform is structured to follow the process of conducting impact assessments, starting

Impact Assessment

- Welcome Page
- Background Knowledge
- Designing Research
- Impact Areas & Indicator Fact Sheets
- Implementing Impact Assessment

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Multifunctional land use

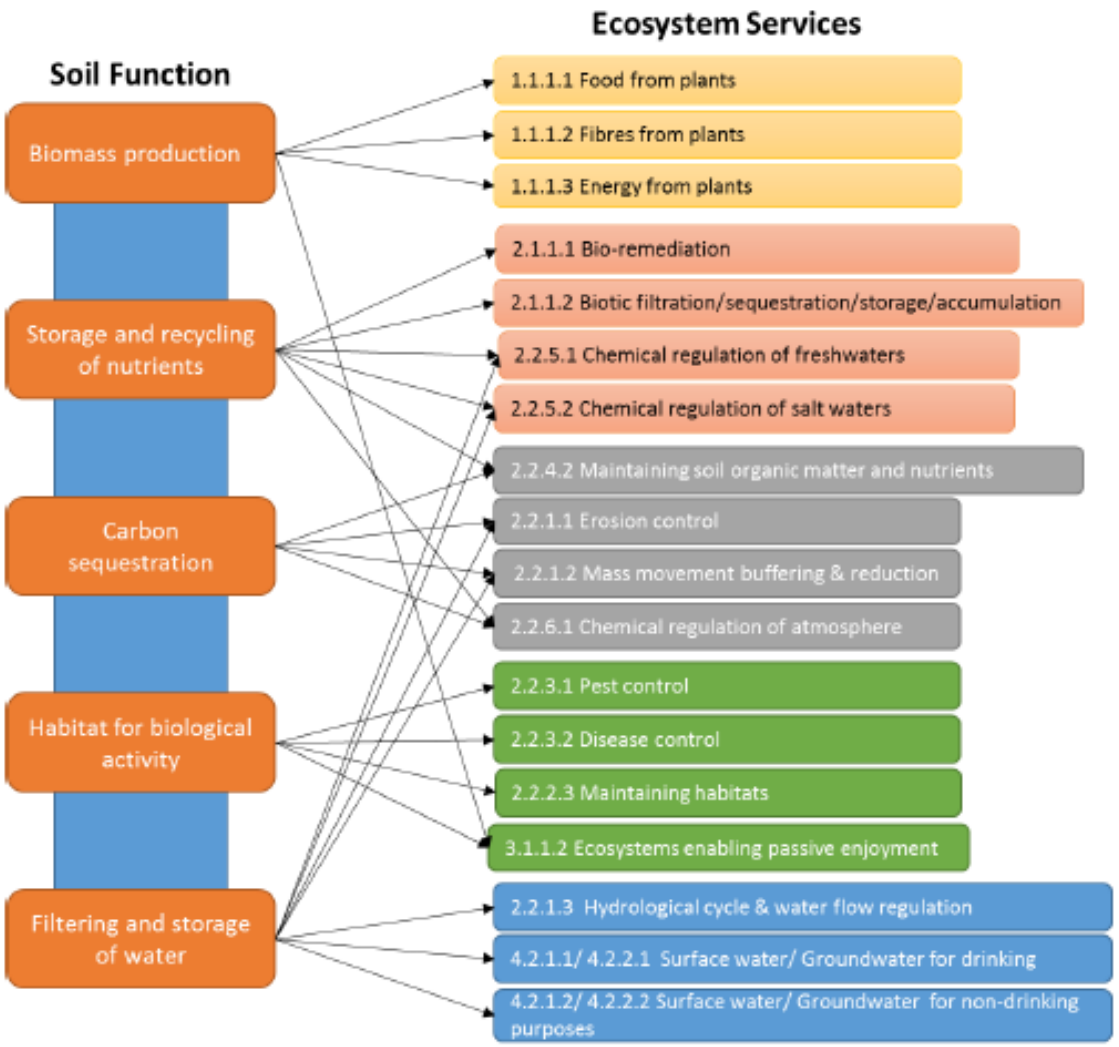

Figure 10: Connection between soil functions and selected soil related ecosystem services. Please note that all soil function are connected to and influencing each other.

Paul & Helming 2019. BonaRes Series

Multifunctional land use

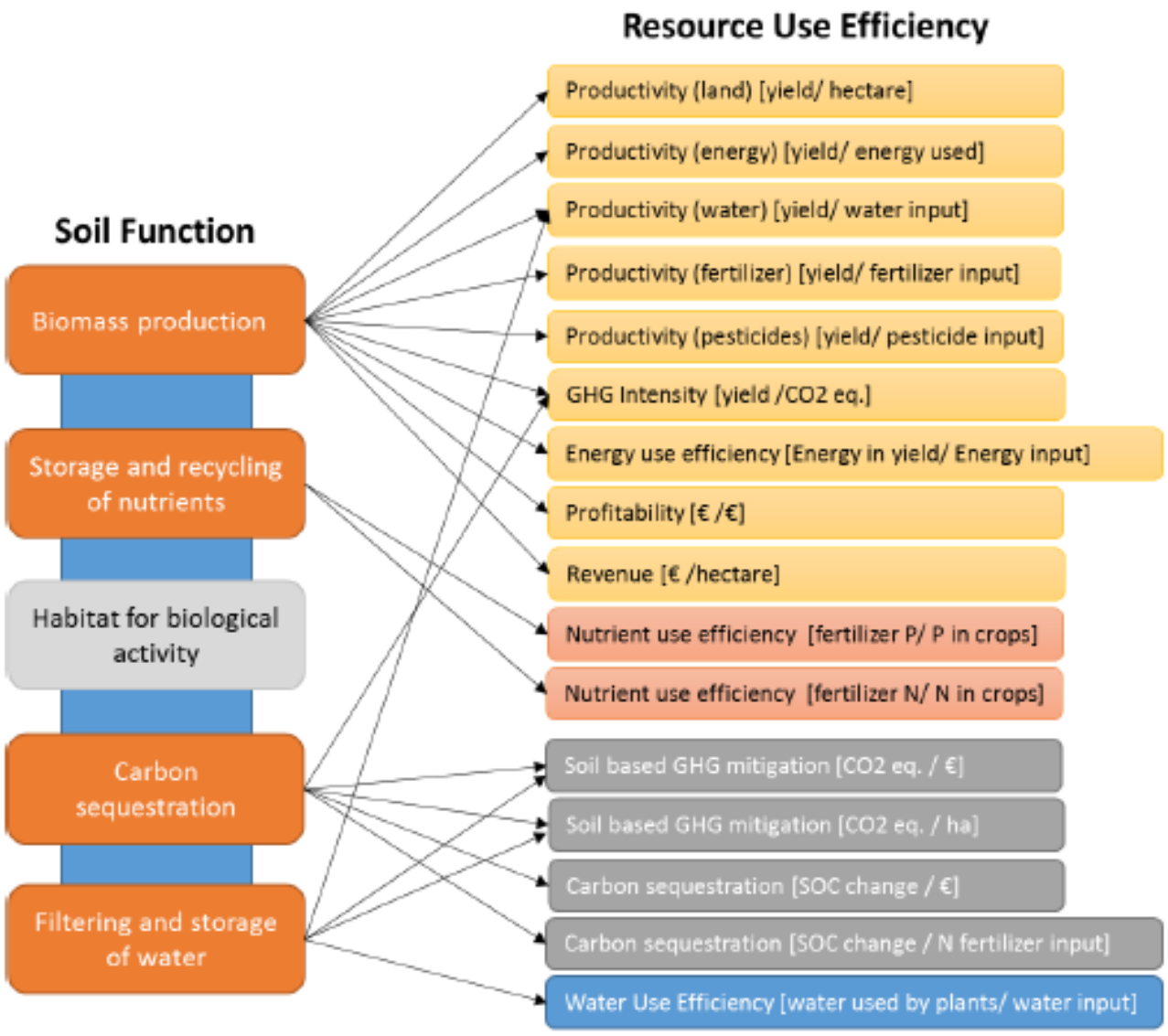

Figure 12: Connection between soil functions and selected resource use efficiency categories relevant for agricultural soil management. Please note that all soil function are connected to and influencing each other.

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How are soils addressed in European Policies?

5 Policy Sectors, 19 Policies, 2 Strategies

Agriculture (5)
- Gemeinsame Agrarpolitik
- Nitrates Directive
- Pesticide use directive
- GMO directive
- Plant protection products directive

Environment (4)
- Habitat directive
- Water framework directive
- Air quality directive
- Floods directive

Climate (3)
- Carbon Storage directive
- Renewable energy directive
- Kyoto protocol

Industry (5)
- Landfill directive
- Mining waste directive
- Waste directive
- Industrial emmissions directive
- Biocides directive

Urban settlements (2)
- Sewage Sludge directive
- Urban waste directive

Strategies (2)
- Resource efficiency roadmap
- 7th Environmental Action Plan

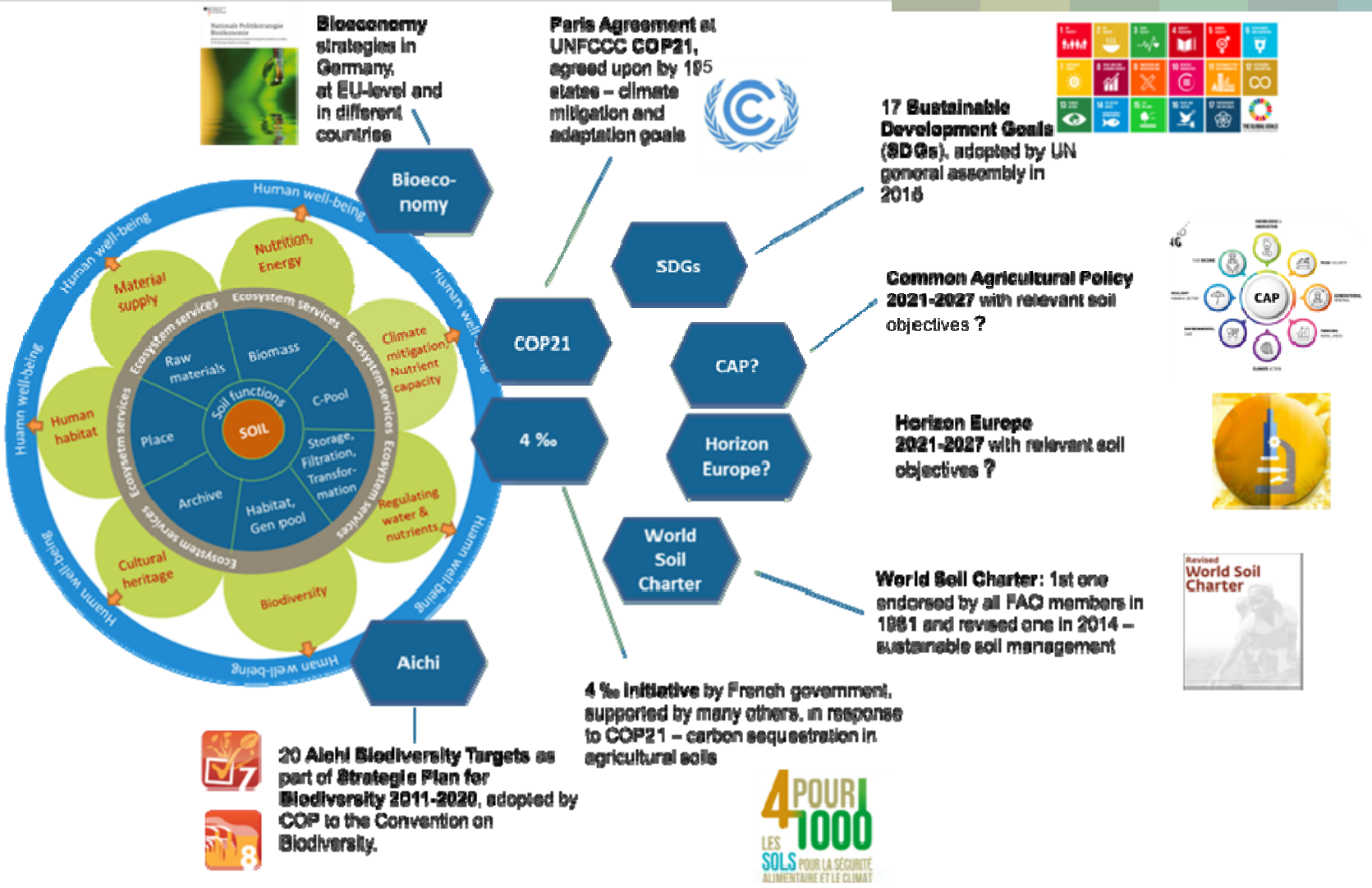
Glaesner, Helming, De Vries. 2014. Sustainability

Soil policy analysis – key points

- Many policies address single aspects of soil conservation
- Among soil threats, Soil compaction and soil salinization are not addressed at all
- Policy targets are mainly on soil conservation, not on improving soil health and soil functions
- A paradigm shift is emerging in environmental policies: from conservation to support of functions and services
- Multifunctionality of soils is not considered in policies, policy coherency is lacking
- The contribution of soils to societal services needs to be better emphasized, measured, monitored and demonstrated!

Glaesner, Helming, De Vries. 2014. Sustainability

Policy goals related to soil functions



Techen & Helming, 2019, BonaRes Series

„healthy soils are farmers insurance against climate change“

Farmer in Brandenburg, 2018

Thank you for your attention!

Prof. Dr. Katharina Helming, Leibniz Centre for Agricultural Landscape Research | ZALF, helming@zalf.de