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SCIENCE AND EDUCATION FOR SUSTAINABLE LIFE

Modelling regenerative agriculture and soil physical health: feedbacks between carbon cycling, hydrological processes and crop production

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Background

- The majority of the soil resources of the world are in ”*poor, very poor, or only fair condition*”[1]
  - Globally, ca. 12 million hectares of agricultural land are lost to soil degradation each year[2]
- Degradation of soil physical health may be exacerbated by future land use and climate change
  - Projected decreases in crop yields of ca. 10 per cent globally by 2050 (without mitigation)[2]
- The potential benefits of *regenerative* agricultural practices are therefore in focus
  - Reductions in tillage intensity, ”continuous living cover”, cover crops, crop rotations/diversification

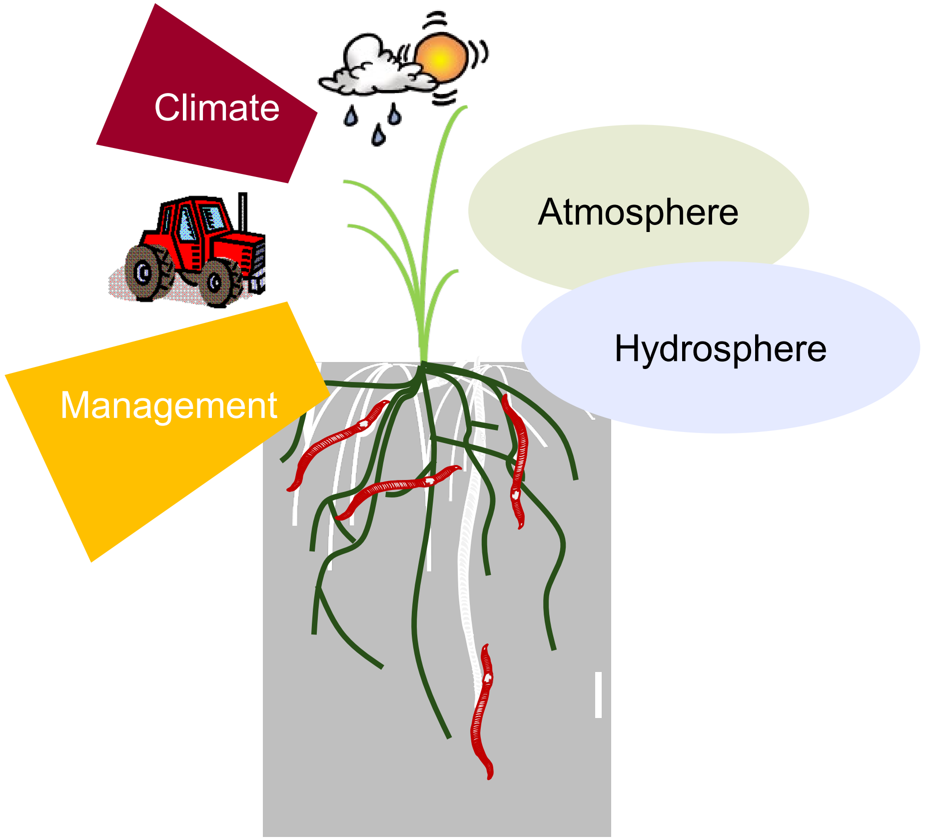
[1]FAO/ITPS. 2015. FAO/ITPS, Rome, Italy.

[2]IPBES. 2018. R. Scholes et al. (eds.) IPBES secretariat, Bonn, Germany, 44 pp.

Images: Jennie Barron, Ararso Etana

Regenerative agriculture: methodologies

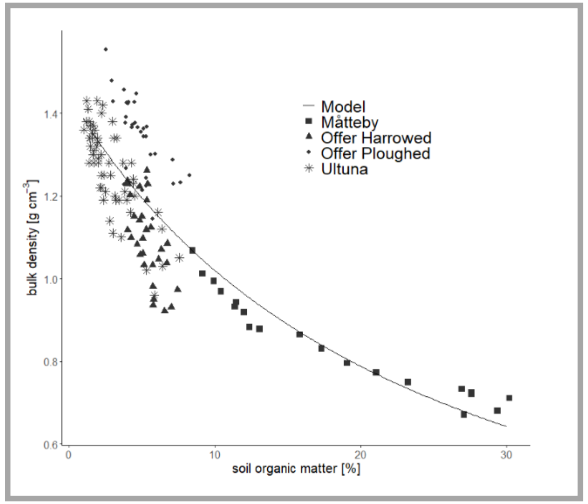
- Long-term field experiments (LTFE’s)
- Soil-crop simulation models are *potentially* useful tools to complement LTFE’s
  - Help in understanding the complexities of the soil-crop system, especially the myriad interactions and feedbacks
  - Useful for extrapolation in time and space: ”what if?” simulations
    - Land use and climate change
    - Contrasting soil types

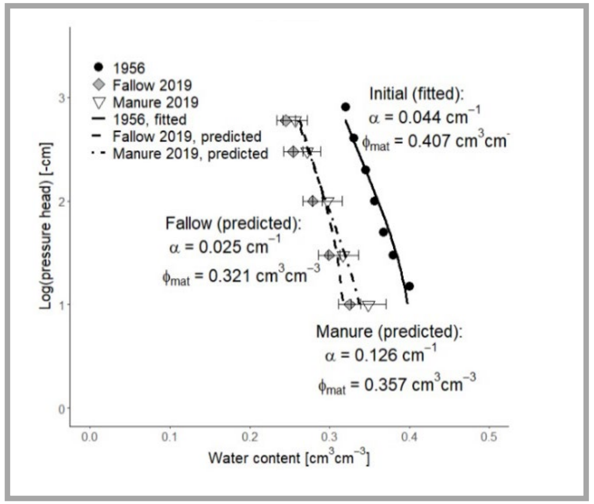


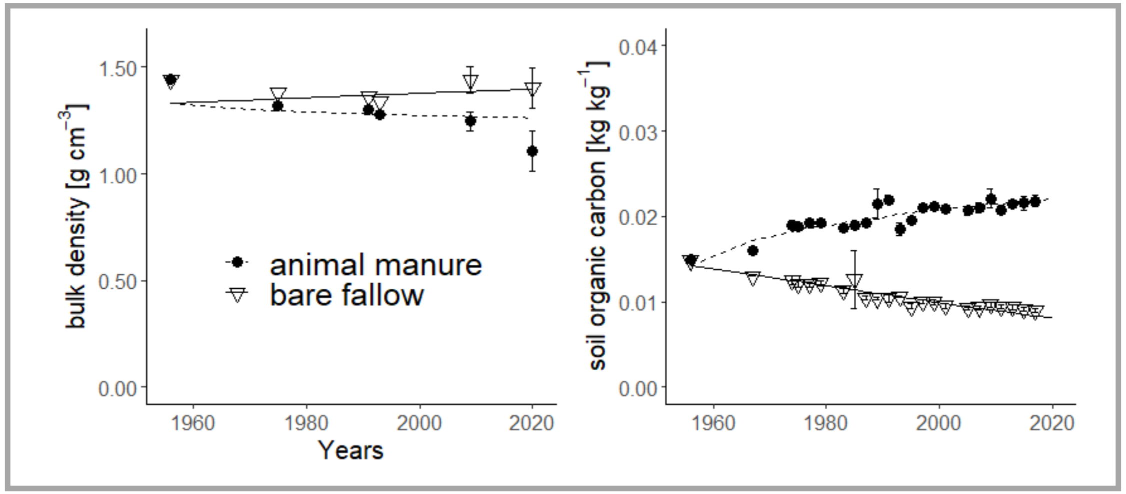
Schematic: Thomas Keller, Elsa Coucheney

Example model (1): soil structure and soil organic matter

- USSF captures the two-way interactions between soil physical/hydraulic properties and organic matter content in the Ultuna Frame trial







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Modelling dynamic interactions between soil structure and the storage and turnover of soil organic matter

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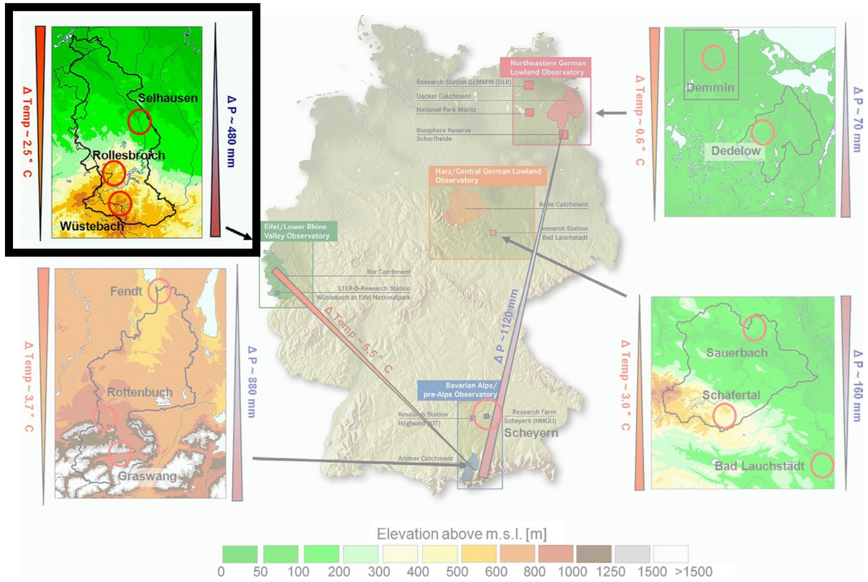
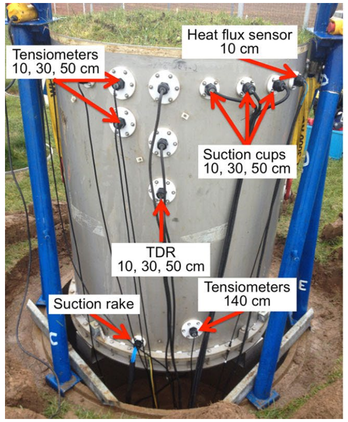
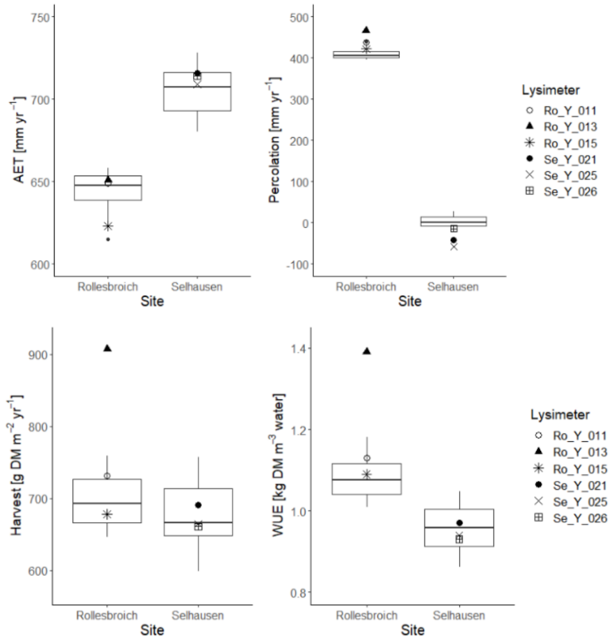
Example model (2): soil hydrology and grassland growth

TERENO-SoilCan lysimeter network: ”space-for-time” substitution to mimic climate change







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Coupled modelling of hydrological processes and grassland production in two contrasting climates

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- USSF captures the the impacts of drought on water balance and grassland growth
- Root depth increased following the move to a drier climate
- A greater proportion of assimilates is allocated to the roots in response to drought, which reduces above-ground grass growth and maintains transpiration at the potential rate (WUE decreases)
- Root water uptake in the dry grassland was extremely efficient
    - Shallow groundwater, compensatory uptake

Upcoming model applications

- Two new FORMAS projects on carbon sequestration in soil (Thomas Keller and Thomas Kätterer) and two projects in the EU EJP SOIL program:
  - *MaxRootC*: The potential for carbon sequestration in soils via crop varieties with enhanced root growth (without impacting yields)
  - *SoilX*: The potential of regenerative agricultural practices to support climate change adaptation through effects on soil hydrological processes

Thank you for your attention ….

… and many thanks to SLU colleagues:

Soil and Environment

Soil Nutrient Cycling: Katharina Meurer

Soil Mechanics and Soil Management: Thomas Keller

Soil and Environmental Physics: Elsa Coucheney, Mats Larsbo, Elisabet Lewan

Ecology

Thomas Kätterer