Development of a grassland simulation model to support decision making on grassland use

Felix Nößler

YoMos meeting

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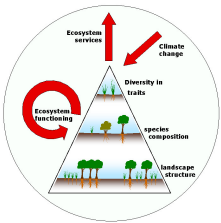
Freie Universität Berlin



About me

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- studied Landscape Ecology and Conservation (Greifswald) and Ecology, Evolution and Conservation (Potsdam)
- have knowledge in plant ecology (plants & bryophytes), simulation modelling and in (Bayesian) statistics
- am a doctoral student at the FU Berlin
- teach statistics with R, individual-based modelling, and a botany & ecology module

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Overview

Research questions

- How can the taxonomic and functional diversity of plants in grasslands be promoted and, at the same time, the loss of yield (forage production) be minimised?
  $\rightarrow$ Model can be used as an evaluation tool for different measures

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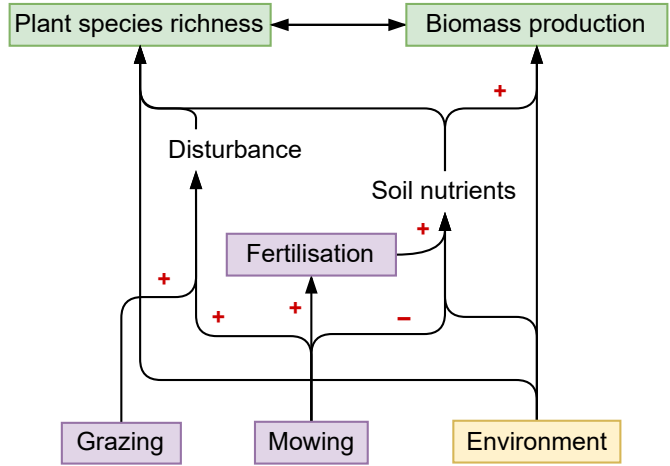
  $\rightarrow$ Model can be used as an evaluation tool for different measures
- Does a higher taxonomic and functional plant diversity lead to a higher temporal stability of the forage production?

Plant species richness and biomass production



Model overview

- spatially explicit (meta-) community model of grassland plant species
- implementation with difference equations
- each species is characterized by ecophysiological traits

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- biomass of species i in patch x
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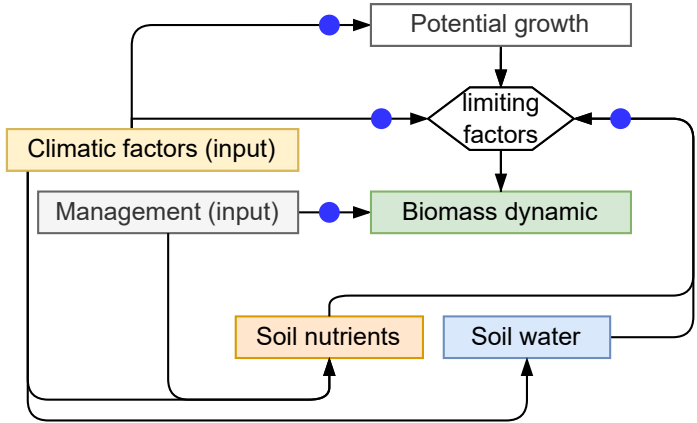
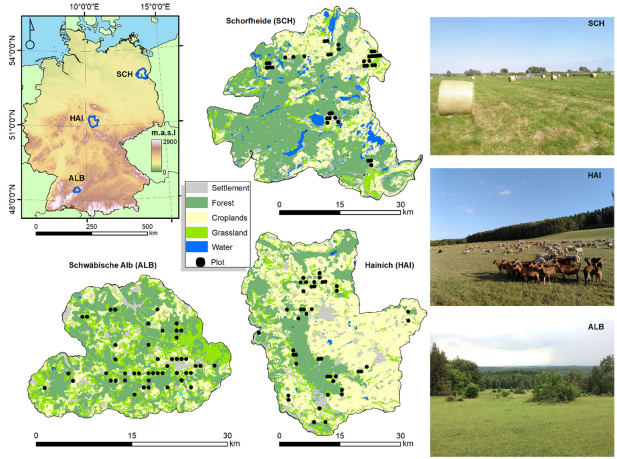
Assumptions

- the vegetation is homogeneous within a patch
- no intraspecific trait variability and trait evolution/phenotypic plasticity

Model overview



Study site - Biodiversity exploratories



Muro et al. (2022)

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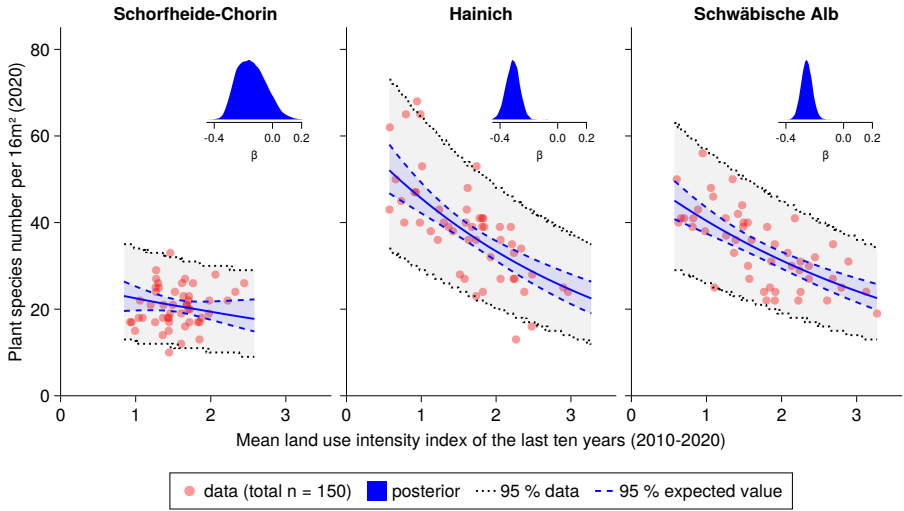

Species-specific response - Plant traits

Radiation use efficiency

- Specific leaf area ↑
- Plant height ↑

Water and nutrient use efficiency

- Specific leaf area ↓
- Root surface area / aboveground biomass ↑
- Mycorrhizal colonisation ↑

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Senescence rate

- Specific leaf area ↓

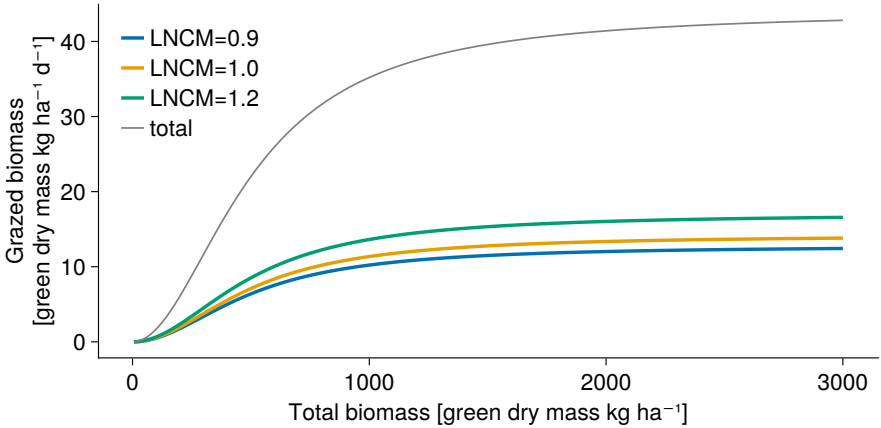
Grazing and trampling

- Leaf nitrogen content ↓
- Plant height ↓
- Leaf area ↓

Mowing

- Plant height ↓

Species-specific response - Example



Model parametrisation

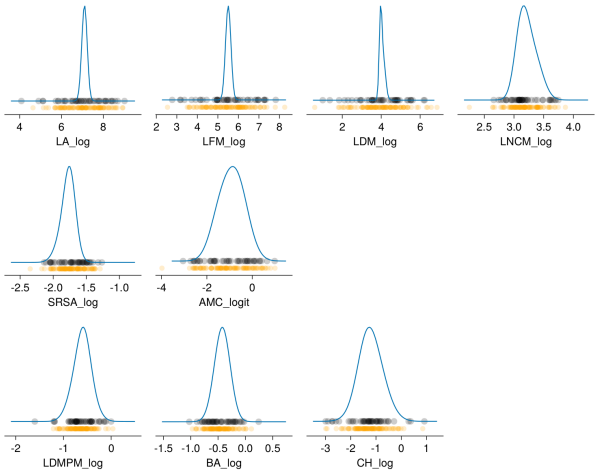
for fitting internal parameters:

- observed time series of climatic and management variables are used

for running scenarios:

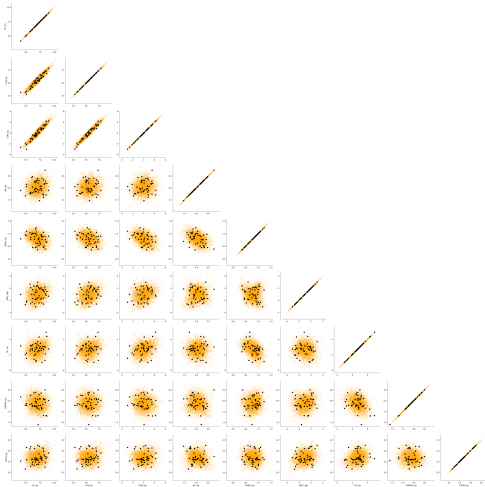
- random samples from fitted time series models of the climate data are used
- management options can be varied
- plant species number can be varied

Plant traits - Gaussian mixture model



- 46 species with values for all traits (out of 138 of the three exploratories)
- Gaussian mixture model with full covariance matrix and transformed data
  - black: data
  - orange: generated samples
  - blue line: marginal likelihood

Plant traits - Gaussian mixture model



- correlation structure between the traits
  - black: data
  - orange: generated samples

Model

- Model is developed as a *Julia* package:
  `https://github.com/FelixNoessler/RegionalGrasslandSim.jl`
- documentation (WIP):
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  - basic local model is working
  - nutrient sub-model has to be adjusted

Questions?

Thanks for listening! Do you have questions or remarks?

References

Muro, J., A. Linstädter, P. Magdon, S. Wöllauer, F. A. Männer, L.-M. Schwarz, G. Ghazaryan, J. Schultz, Z. Malenovský, and O. Dubovyk (2022). "Predicting plant biomass and species richness in temperate grasslands across regions, time, and land management with remote sensing and deep learning". In: *Remote Sensing of Environment* 282, p. 113262. DOI: 10.1016/j.rse.2022.113262.