From satellite imagery to soil-plant interactions: Integrating disciplines and scales in process-based simulation models

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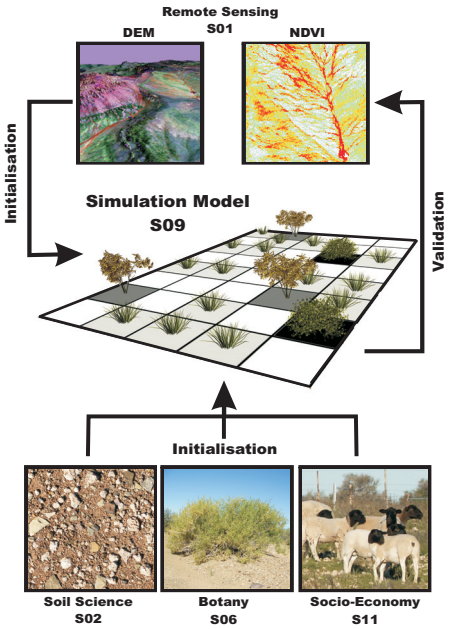
Introduction

Decisions for the conservation of biodiversity and sustainable management of natural resources are typically related to large scales, i.e. the landscape level. However, understanding and predicting the effects of land use and climate change on scales relevant for decision-making requires to include both, large scale vegetation dynamics and small scale processes, such as soil-plant interactions. Integrating the results of multiple BIOTA subprojects enabled us to include necessary data of soil science, botany, socio-economics and remote sensing into a high resolution, process-based and spatially-explicit model. **Using an example from a sustainably-used research farm and a communally used and degraded farming area in semi-arid southern Namibia we show the power of simulation models as a tool to integrate processes across disciplines and scales.**



Methods - integrative processes

The model simulates the spatio - temporal dynamics of the dominant plant guilds (perennial grass, annuals and key functional types of woody plants).

Surface run-off is included by initialising the topographical information for the simulation model with the help of digital elevation models (DEM).

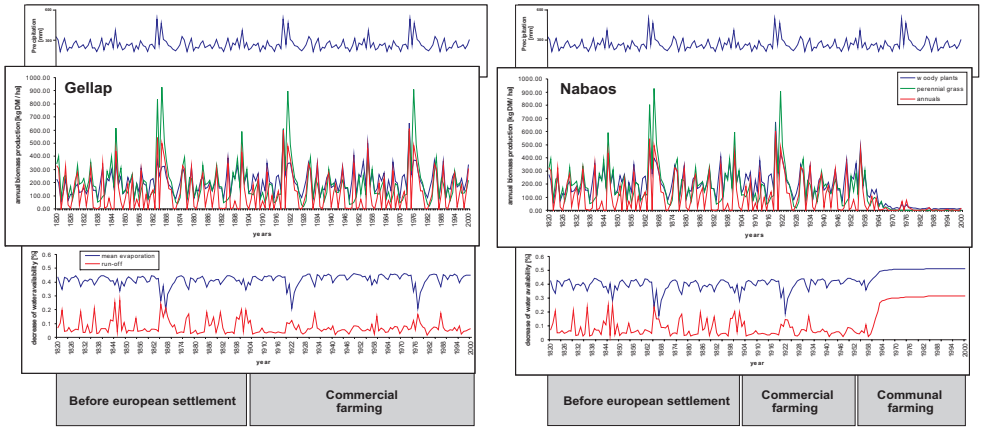
Landuse is considered by livestock type and density as well as palatability of the different vegetation types.

Soil texture and vegetation composition affect local infiltration and evaporation rates.

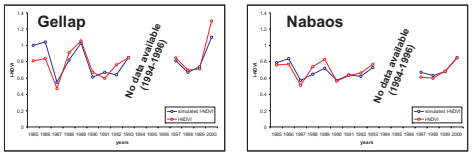
Simulated annual biomass production is compared with remotely-sensed estimates of annual total biomass production (NDVI) for the sustainably-used research farm Gellap and the more heavily stocked communal farming area at Nabaos.

Results

Data and information from different disciplines and scales could successfully be integrated to simulate landscape dynamics. A sample result (see figures right) for the two contrasting land use types demonstrates how productivity depends on rainfall, land use and vegetation composition. Communal farming at Nabaos led to rapid vegetation degradation (years 1956-2000). The resultant loss of perennial grasses and dwarf shrubs decreased water availability due to increased evaporation and run-off.



Validation



Simulated annual total biomass production is converted into NDVI. Resulting NDVI values correspond closely to remotely sensed NDVI values for the years 1985-2000 (data from NOAA satellites).

Discussion

The results clearly demonstrate that high resolution and spatial explicit simulation models serve as a valuable tool to integrate different disciplines and scales. Furthermore, we show the relevance of small scaled processes for predictions on the landscape level.

Outlook

Currently we are linking the vegetation model with an economic decision model. A soil moisture module with a greater degree of detail will be implemented. In phase 3, we aim to develop a generic version of the simulation model that can be used to analyse small scale and large scale processes at different savanna sites along the rainfall gradient of the BIOTA- transect.

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