Tietjen Group
- Biodiversity/Theoretical Ecology -

Theoretical Ecology

Freie Universität Berlin

How Models Help to Understand Ecosystem Processes

Theoretical ecology and the use of models

"**Theoretical ecology** is the scientific discipline devoted to the study of **ecological systems** using **theoretical methods** such as simple conceptual models, mathematical models, computational simulations, and advanced data analysis."[1]

Models can help to understand the underlying processes in ecosystems. We can, for example, understand why spatial patterns in drylands emerge (Fig.1).

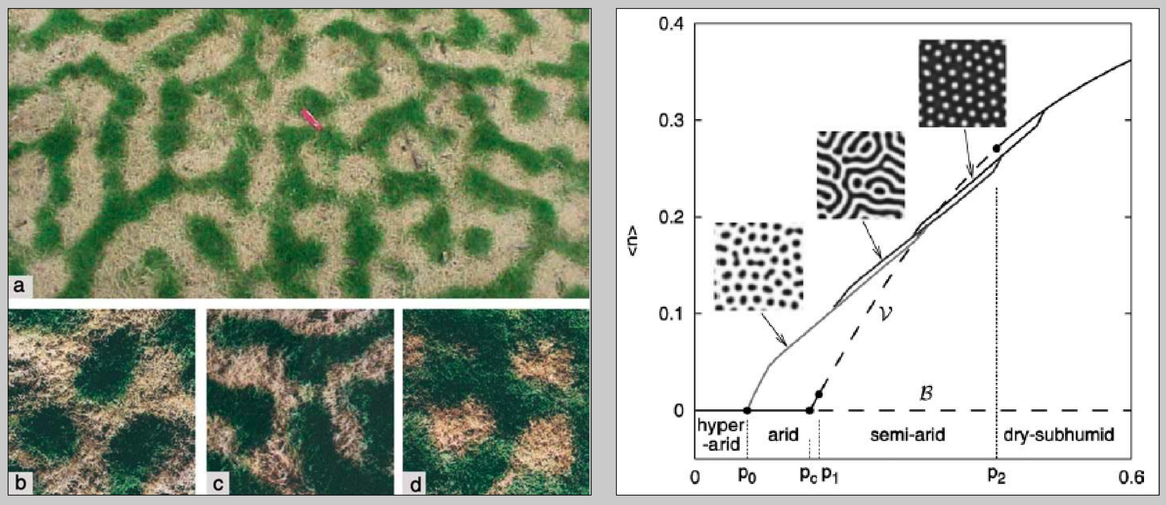


Fig. 1 Observed (left) and simulated (right) spatial patterns.[2]

Our research focus areas

Current research topics

- Above and belowground interactions in grasslands
- Effects of stress priming on mircobiobal communities
- Climate change impacts on biocrusts and water losses
- Land use in savanna ecosystems
- Restauration of Mediterranean-type eecosystems
- Biodiversity and the nitrogen cycle on the Tibetian Plateu

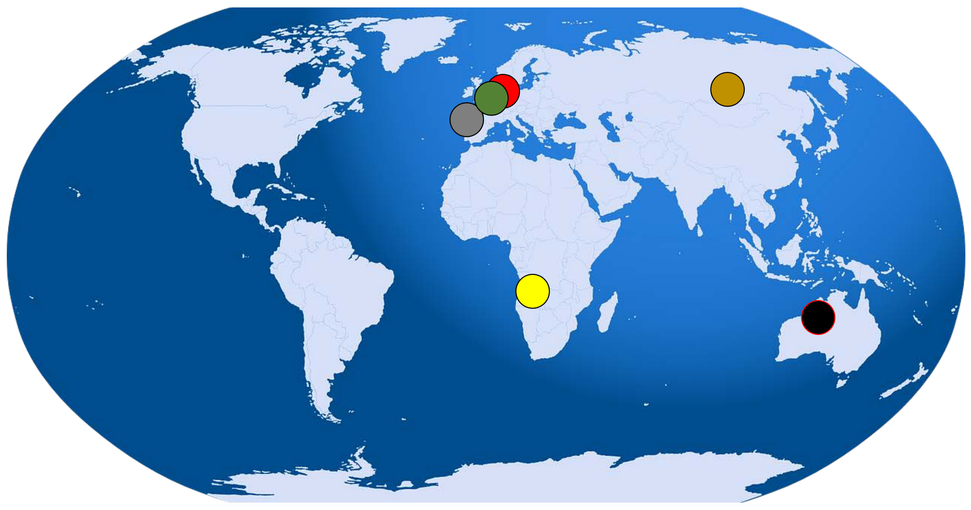


Fig. 2 Research areas of our group.

We assess **present and future ecosystem functioning** and the supply of **ecosystem services**. For this, it is essential to understand the **underlying processes** of ecosystems and how these are affected by **biodiversity** and **environmental conditions**.
In our research, we use different **modelling approaches** to quantify the dynamics of populations and ecosystems. To develop these models, we use different programming languages, such as R, C++ or NetLogo.

Example: Understanding impacts of global change on savannas

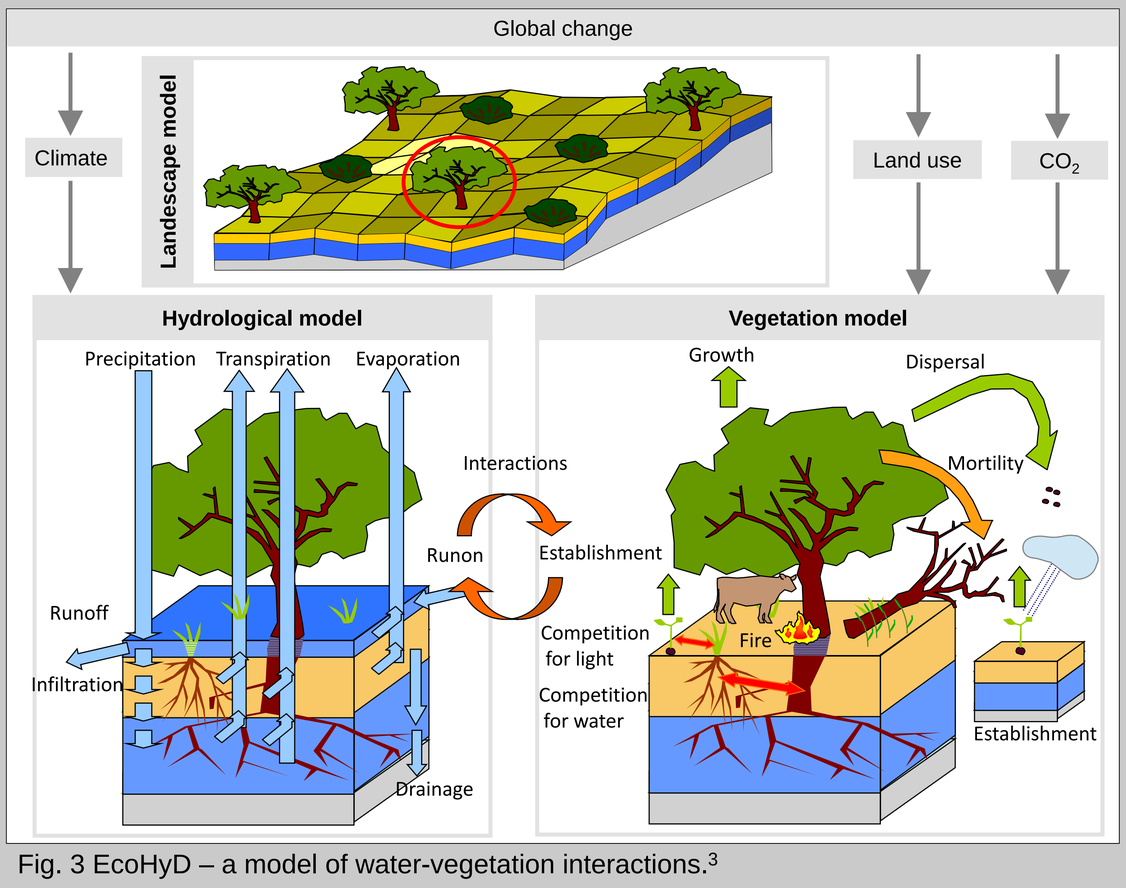
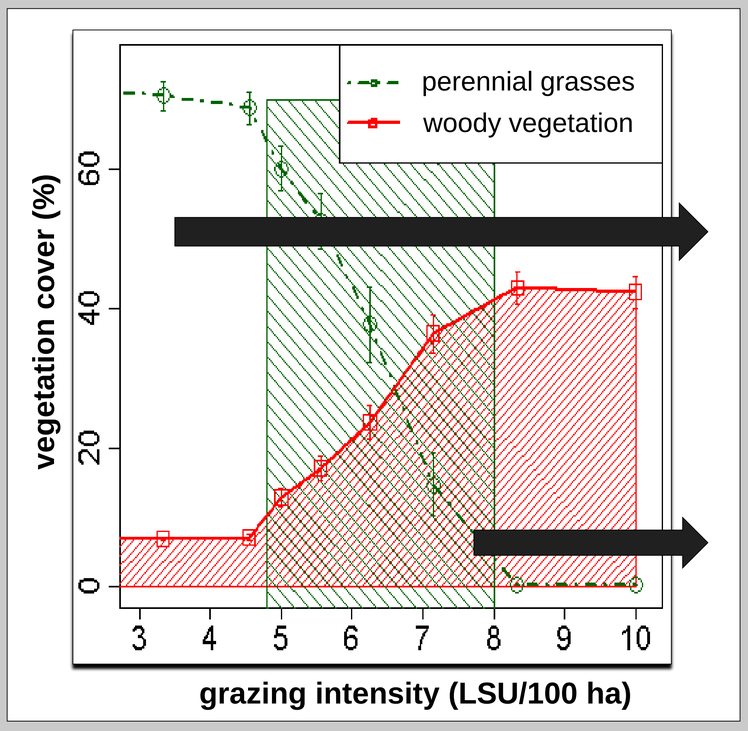


Fig. 3 EcoHyD – a model of water-vegetation interactions.[3]

The model EcoHyd (Fig. 3) describes the complex interactions between water and vegetation in drylands. The landscape is divided into grid cells, and in each cell, a hydrological module is coupled with a vegetation module simulating the fate of different plant functional types.



Today

Highland savanna, MAP 250-300 mm, grazing by cattle

Fig. 4 Influence of livestock grazing on the vegetation cover.[4]

The model is used to assess impacts of land use by livestock for example on vegetation composition or on erosion risk. By evaluating scenarios, we can systematically assess how ecosystem services (e.g. fodder production, carbon storage, erosion control) will be impacted by climate change.

Reference
1 Wikipedia: The Free Encyclopedia. Wikimedia Foundation Inc. Updated 17 September 2018, 19:28 (UTC). Encyclopedia on-line. Available from. https://en.wikipedia.org/wiki/Theoretical_ecology. Internet. Retrieved 19 November 2018.
2 Meron, E., Gilad, E., von Hardenberg, J., Shachak, M., & Zarmi, Y. (2004). Vegetation patterns along a rainfall gradient. Chaos, Solitons & Fractals, 19(2), 367-376.
3 Tietjen, B. , Jeltsch, F. , Zehe, E. , Classen, N. , Groengroeft, A. , Schiffers, K. and Oldeland, J. (2010), Effects of climate change on the coupled dynamics of water and vegetation in drylands. Ecohydrol., 3: 226-237.
4 Lohmann, D. , Tietjen, B. , Blaum, N. , Joubert, D. F. and Jeltsch, F. (2012), Shifting thresholds and changing degradation patterns: climate change effects on the simulated long-term response of a semi-arid savanna to grazing. J. Appl. Ecol., 49: 814-823.