Abiotic and biotic drivers of ecosystem development – results from Chicken Creek Catchment

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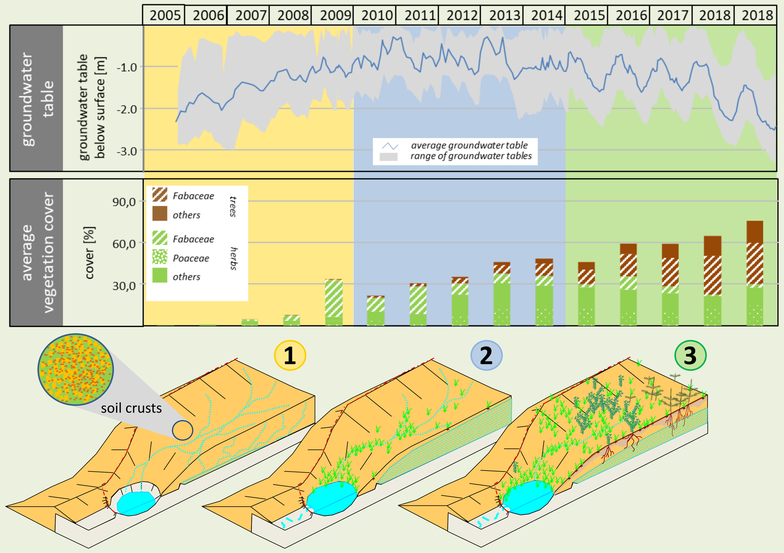
Chicken Creek Hühnerwasser

Initial Ecosystem Evolution
Initiale Ökosystemgenese

About: Constructed catchment and phases of ecosystem development

15 years of initial ecosystem development and unmanaged primary succession have been observed in the artificial 6 ha Chicken Creek Catchment in Eastern Germany. Three major phases of development can be distinguished based on hydrology and vegetation:



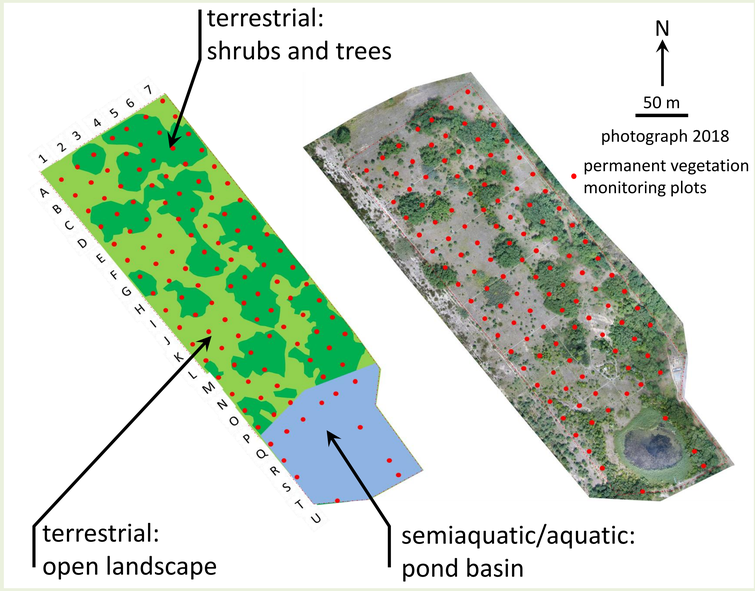
1. ▪ Formation of soil crusts (both physical and biological)
   ▪ Massive sediment relocation and formation of erosion rills
2. ▪ Reduced surface runoff and increasing infiltration
   ▪ Decreasing erosion and highest groundwater tables
3. ▪ Growing importance of woody vegetation
   ▪ Water uptake by trees and decreasing groundwater table

Abiotic and biotic drivers of ecosystem development

Initially, abiotic site conditions (soil, hydrology) in combination with external abiotic drivers (weather) shaped the development of the ecosystem. With the occurrence of plant species with specific functionality (e.g., high water consumption and N-fixation) biotic drivers increasingly contribute to differentiating habitats. Effects are reflected by changes of the vegetation's functional composition.

Ecosystem development: Overview of main types of habitats

Based on aerial photographs three major types of habitats were differentiated. In the terrestrial part the pioneer tree species *Robinia pseudoacacia* L. dominates all tree stands. Large surface areas, however, remained open land without tree or shrub vegetation.



Effects of biotic drivers reflected by plant functional traits

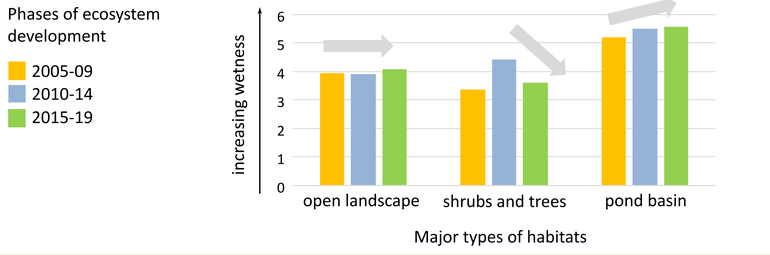
With growing influence of biota, particularly of tree species, new biotic drivers occur within the system. The massive development of *Robinia* together with other tree species leads to increased water consumption and groundwater lowering in the last phase of development. Furthermore, *Robinia* as a N-fixing tree species accumulates nitrogen in its litter layer and the topsoil.

The related effects can be made visible by means of plant specific indicator values for the different habitats. Mean weighted Ellenberg indicator values (for well-established herbaceous plants with cover > 5 %) were calculated based on time series of annual vegetation surveys. Temporal changes of these mean indicator values can be found during the observed phases of ecosystem development.

Interactions of plants and hydrology

During the third phase of development trees in combination with extreme weather conditions (dry summer seasons 2018/2019) can be seen most probably as main responsible drivers for decreasing groundwater tables. As a result, the overall vegetation composition in the terrestrial part changed slightly. Mean indicator values for soil moisture are decreasing in shrub/tree habitats in contrast to the open landscapes and the pond basin. This indicates dryer conditions particularly for herbaceous plants due to water uptake by trees.

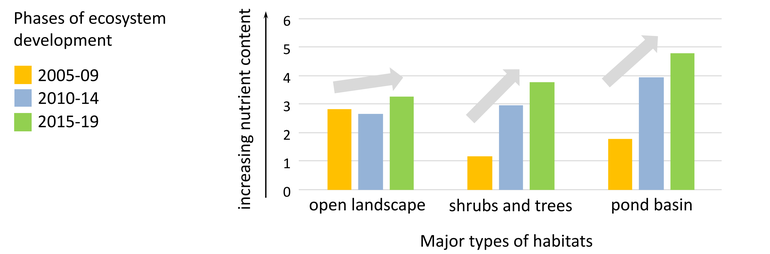
Mean weighted Ellenberg indicator values for soil moisture



Interactions of plants and soil conditions

As a general trend for all types of habitats mean indicator values show increasing nutrient availability during the three phases of development. However, this trend seems to be most pronounced for the pond basin and shrub/tree habitats. The increase in the pond basin can be interpreted as the result of nutrient fluxes within the catchment. The higher values for the *Robinia* dominated tree habitats reflect the influence of N-fixing abilities of this pioneer tree which alters the composition of the herbaceous vegetation.

Mean weighted Ellenberg indicator values for nutrients (N) availability



Selected publications:

- Gerwin, Badorreck, Schaaf, Hinz & Hüttl (2018): The Hühnerwasser catchment in SE Brandenburg in transition from an abiotic to biotic controlled water balance. Hydrology and Water Resources Management, 62, 134-144. *(in German)*
- Hüttl, Gerwin, Kögel-Knabner, Schulin, Hinz & Subke (2014): Ecosystems in transition: interactions and feedbacks with an emphasis on the initial development. Biogeosciences, 11, 195-200.
- Schaaf, Pohle, Maurer, Gerwin, Hinz & Badorreck (2017): Water Balance Dynamics during Ten Years of Ecological Development at Chicken Creek Catchment. Vadoze Zone Journal, 16. doi:10.2136/vzj2017.04.0074
- Spröte, Fischer, Veste, Raab, Wiehe, Lange, Bens & Hüttl (2010): Biological topsoil crusts at early successional stages on Quaternary substrates dumped by mining in Brandenburg, NE Germany. Géomorphologie, 2010/4, 359-370.

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