The Nutrient Network Experiment in Bayreuth

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The Nutrient Network research cooperative

Human activities have strongly increased nutrient inputs into terrestrial ecosystems during the last decades. The effects of these changes in nutrient availability in grassland ecosystems are studied in the Nutrient Network (NutNet). For this purpose, the same full-factorial fertilization experiment is conducted in grasslands around the world (Figure 1). The first experiment started in 2006, and every year more experimental sites join in (Borer et al., 2014).

Figure 1*: Participating NutNet sites around the world in 2017.*

Experimental design

On each NutNet site, the same full factorial experiment is conducted, comprising addition of three nutrients (N, P, and K) and two grazing exclusion treatments (Exclosure + Ctrl and Exclosure + NPK). The 10 treatments are organized in a randomized-block design with at least 3 blocks per site. Each nutrient is applied at a rate of 10 g m^{-2} y^{-1} before every growing season in the form of slow release urea (N), triple superphosphate (P) and potassium sulfate (K).

Research at the NutNet site in Bayreuth

At the NutNet site in Bayreuth, we study the effects of changes in nutrient inputs on plant community and on element cycling.

Plant community (Anke Jentsch, Disturbance Ecology): Standing biomass, species cover, species composition, and light attenuation are studied bi-annually according to the NutNet protocol.

Soil element cycling (Marie Spohn, Soil Biogeochemistry): Total and plant available nutrients, microbial biomass C, N and P, net C, N and P mineralization, N_2 fixation by symbiotic and free-living microorganisms, enzyme activity and microbial community composition are measured on a regular basis. The aim of this research is to develop a conceptual framework (Figure 2) of element cycling as driven by stoichiometric homeostasis of soil microorganisms (Spohn, 2016).

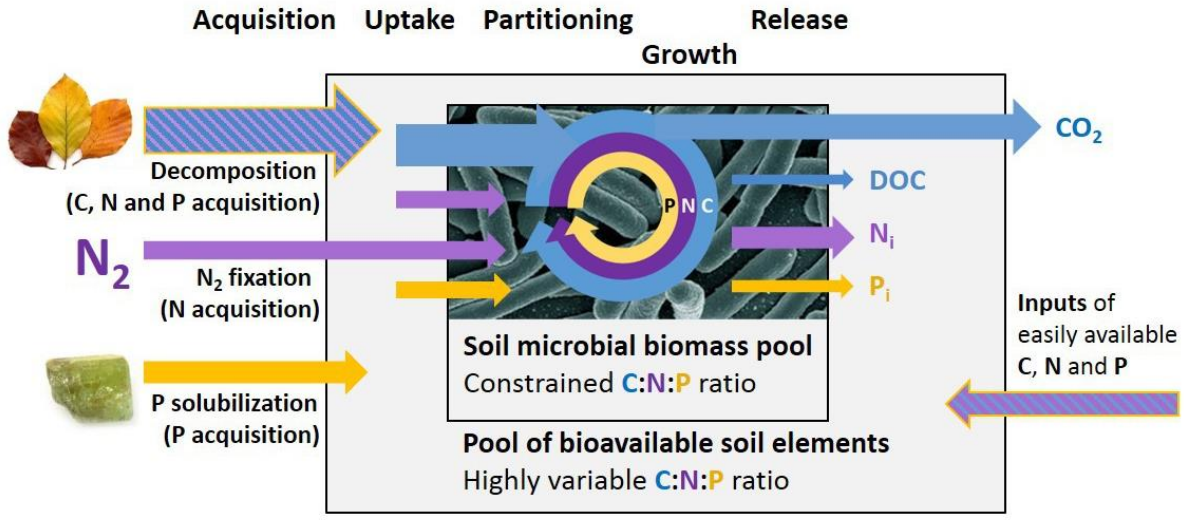

***Figure 2**: Element cycling in soil driven by the soil microbial biomass that keeps its biomass element ratio constant despite changes in element inputs.*

Description of the NutNet site Bayreuth

Location and land-use history: The NutNet experiment in Bayreuth is located in the Ecological Botanical Garden of the University of Bayreuth at 365 m a.s.l. (49°55´19´´N, 11°34´55´´E). The soil has not been ploughed for the last 35 years. For the last 25 years, the grassland has been mown twice a year and has not received any fertilizer prior to the installation of the Nutnet experiment in 2016.

Climate: The climate is temperate and moderately continental, with a mean annual temperature of 8.0 °C and a mean precipitation of 756 mm (1981–2010). The precipitation has a bimodal distribution with a major peak in June/July and a second peak in December/January (Figure 3).

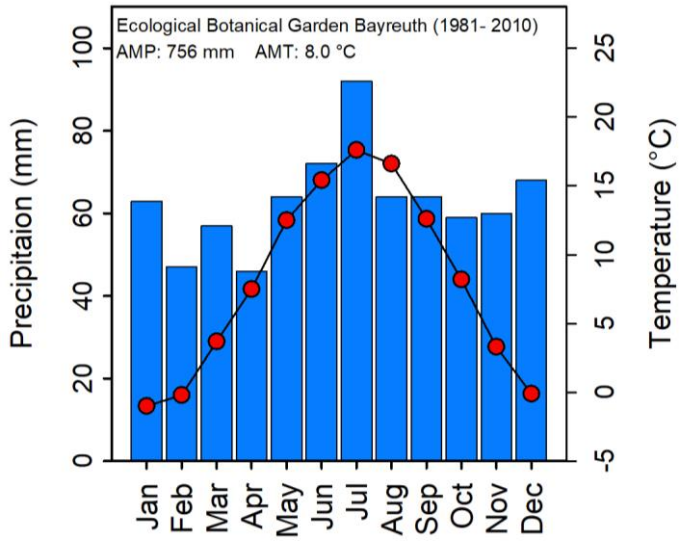

***Figure 3**: Means of monthly precipitation and temperature (1981 to 2010) at the Ecological Botanical Garden in Bayreuth. Data source: Department of Micrometeorology, University Bayreuth*

Soil: The soil is a Stagnic Cambisol (Figure 4). The A horizon (Ah: 0-30 cm) is characterized by a homogenous anthric horizon as consequence of the former agricultural history. It overlays the cambic B horizons (> 54 cm) with stagnic properties. In the main rooting zone (0-15 cm), the soil texture is a sandy loam (sand: 65%, silt: 22%, clay: 13%), the soil has a high bulk density (BD: 1.3 g cm^{-3}), and has moderate pH (pH: 4.7). In total, 2.9 kg C m^{-2} and 0.23 kg N m^{-2} are stored in the upper 15 cm.

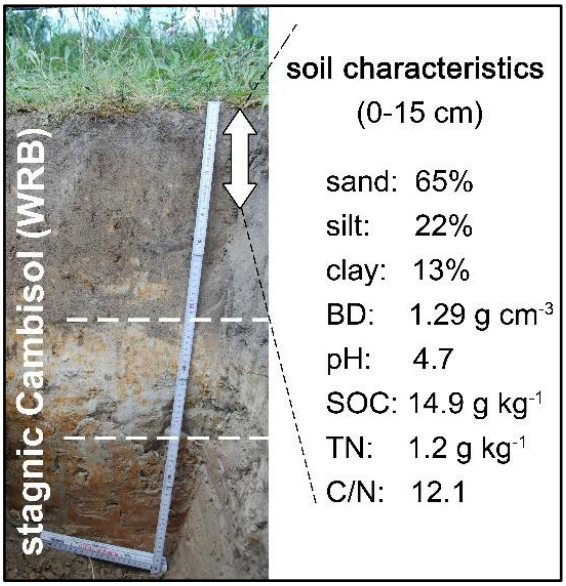

***Figure 4**: Soil profile and basic soil characteristics of the upper 15 cm at the Bayreuth NutNet site.*

Vegetation: The Bayreuth NutNet site hosts a semi-natural grassland community. It is dominated by tall grasses such as *Alopecurus pratensis* and *Arrhenatherum elatius* and belongs to the Galio molluginis-Alopecuretum pratensis plant community. Overall up to 13 different plant species can be found per square meter (Kreyling et al., 2017).

Experimental design: The 30 plots of the experiment are each 5×5 m large and are organized in three blocks (Figure 5). The whole site is mown twice a year (in May and in September) and

the cuttings are removed. The fertilization started in 2017 after soil properties and vegetation in each plot were characterized in 2016.

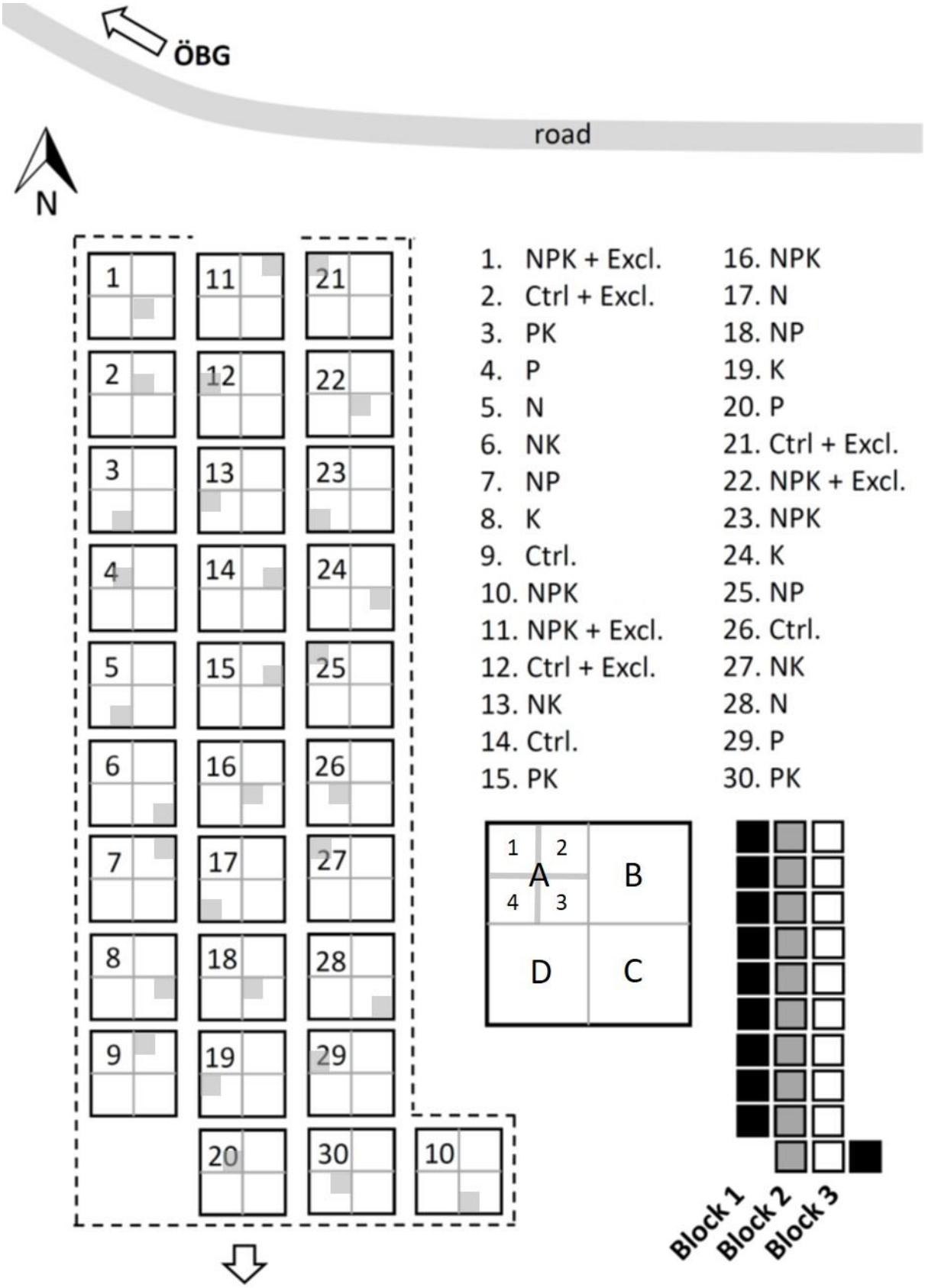

***Figure 5**: Experimental design of the Nutnet site in Bayreuth*.

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