Ecosystem Nutrition:
Forest Strategies for limited Phosphorus Resources
An introduction to the DFG/SNF Priority Programme 1685

www.ecosystem-nutrition.uni-freiburg.de

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Rational

The broken P cycle in agriculture and uncertainties regarding the consequences of human impact on the P nutrition of forest ecosystems highlight insufficient knowledge in the field of (eco)systemic P-related interactions. **Priority Programme 1685** addresses **the ecological dimension of phosphorus nutrition**, with ca. 70 researchers exploring the mechanisms underlying the ecological paradigm of the 'whole being more than the sum of its parts' for P nutrition of forest ecosystems.

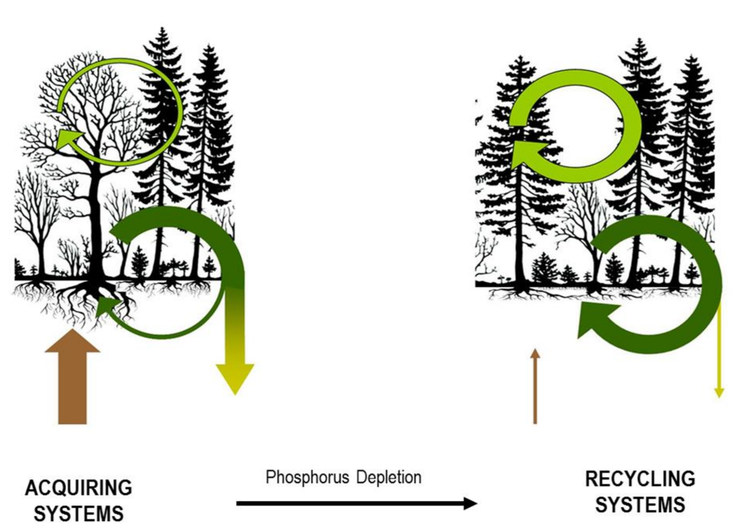
Definition of Ecosystem Nutrition

Ecosystem nutrition considers the mechanisms and feedbacks that regulate nutrient distribution and transfer between organisms, populations and ecosystem compartments. It addresses these mechanisms in relation to the spatial and temporal hierarchy and robustness of ecosystem processes and emergent properties of ecosystems.

Hypothesis

Our general **hypotheses** are:

1. Phosphorus depletion of soils drives forest ecosystems from **P acquiring systems** (efficient mobilisation of P from the mineral phase) to **P recycling systems** (highly efficient cycling of P).
2. Recycling systems are more sensitive to human impact than acquiring systems.



Research approach & Study sites

Phosphorus mobilization, **uptake**, **usage** and **transfer** will be studied at **5 long-term monitoring sites** of the Forest State Research Institutes in Baden-Württemberg, Bavaria, Lower Saxony, and Thuringia, which represent a **gradient in ecosystem P availability**. This offers the unique possibility combining the results of specific analyses with long-term data sets. The collaboration of scientists from soil, plant, and forest science, as well as from geosciences and environmental sciences is essential to address the research question.

	Bad Brückenau (Rhoen)	**Conventwald** (Black Forest)	**Vessertal** (Thuringian Forest)	**Mitterfels** (Bavarian Forest)	**Lüss** (North German Plain)
	Decreasing supply of easily available mineral P				
					
Elevation [m]	809	884	810	1033	115
Annual precipitation [mm]	1031	1749	1200	1229	779
Thickness of humus layer[cm]	8	11	11	12	13
Humus form	mull	moder	moder	moder	mor
C/P forest floor [g/g]	353	228	362	393	790
P_{tot} mineral topsoil [mg/kg]	2879	698	490	440	75

Prietzel 2013, personal communication

Research structure, projects & members

Mobilization

- **Frossard (ETH Zürich):** The phosphorus cycle in forest ecosystems as revealed by analysis of the isotopic composition of oxygen associated to phosphate
- **Luster (WSL, Birmensdorf):** Factors controlling phosphorus availability and their relevance for phosphorous nutrition of forest stands
- **Oelmann (Uni Tübingen):** The phosphorus cycle in forest ecosystems as revealed by analysis of the isotopic composition of oxygen associated to phosphate
- **Spohn (Uni Bayreuth):** Microbial P mobilization and immobilization in rhizosphere and in root free soil

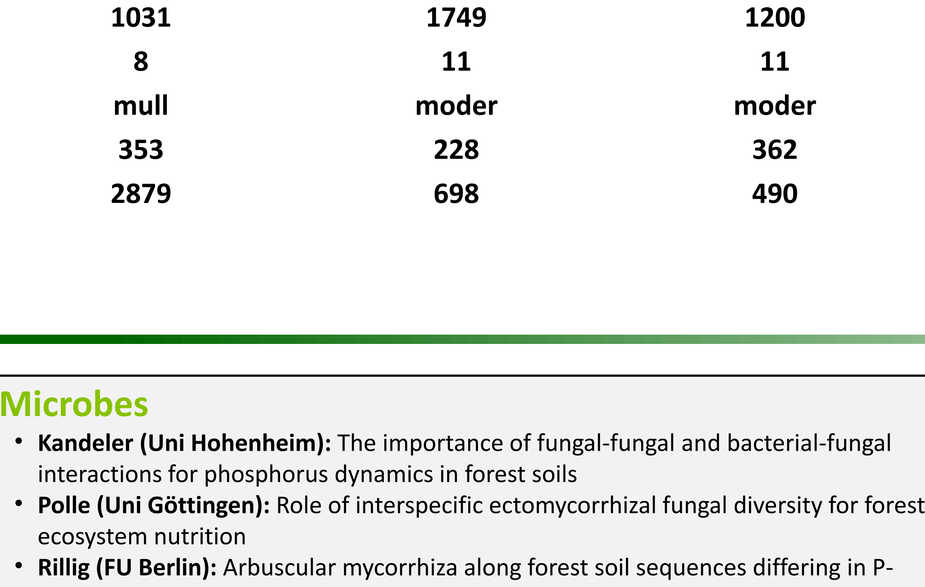
Soil

- **Amelung (Uni Bonn):** Bioaccessibility and residence time of phosphorous in forest subsoils
- **Hagedorn (WSL Birmensdorf):** Production, reactivity, and bioavailability of dissolved organic phosphorus species in soil - indicators of the recycling efficiency of forests
- **Kaiser (Uni Halle):** Production, reactivity, and bioavailability of dissolved organic phosphorus species in soil - indicators of the recycling efficiency of forests
- **Lang (Uni Freiburg):** Linking aggregate formation to small-scale P distribution and P-availability in soils
- **Mikutta (Uni Hannover):** When nano-scale meets biodiversity: retention and recycling mechanisms of organic phosphorus in soil
- **Prietzel (TU München):** Spatial heterogeneity of phosphorus concentration and P speciation in German forest soils: Dependence on soil P status and effect on P nutrition and growth of Picea abies and Fagus sylvatica
- **Talkner (NW-FVA Göttingen):** Phosphorus mobilization from forest soils as related to P nutrition of beech (Fagus sylvatica L.) stands*
- **von Wilpert (FVA-BW Freiburg):** Factors controlling phosphorous availability and their relevance for phosphorous nutrition of forest stands

* associated project

Microbes

- **Kandeler (Uni Hohenheim):** The importance of fungal-fungal and bacterial-fungal interactions for phosphorus dynamics in forest soils
- **Polle (Uni Göttingen):** Role of interspecific ectomycorrhizal fungal diversity for forest ecosystem nutrition
- **Rillig (FU Berlin):** Arbuscular mycorrhiza along forest soil sequences differing in P-availability
- **Schloter (Helmholtz Zentrum München):** Reconstruction of the microbial phosphorus turnover and uptake in response to the availability of nutrients in different soil compartments



Vegetation

- **Bauhus (Uni Freiburg):** Short-term and long-term variation in P-concentrations in growth rings of trees as indicators of P availability in forest ecosystems
- **Cierjaks (Uni Hamburg):** PhosForDiv - Phosphate availability as driver of plant biodiversity in forest ecosystems
- **Ludewig (Uni Hohenheim):** Epigenetic adaptation and memory in tree ecosystems
- **Nehls (Uni Bremen):** Linkage between plant sugar and fungal phosphate export in ectomycorrhizal symbiosis
- **Rennenberg (Uni Freiburg):** Environmental and intrinsic regulation of phosphorus acquisition, partitioning, storage, and mobilization in beech and poplar trees

Flux

- **Julich (TU Dresden):** Phosphorus transport along soil pathways in forested catchments
- **Klumpp (FZ Jülich):** Nanoparticles and colloids as vectors of P-losses and -redistribution during forest ecosystem development
- **von Blanckenburg (GFZ Potsdam):** Isotope geochemical determination of phosphorus weathering sources and fluxes in forest ecosystems
- **Weiler (Uni Freiburg):** Lateral transport of phosphorus along hillslopes and its relation with water age
- **Winkelmann (Uni Koblenz-Landau):** Soil type and land use as potential control mechanisms of river eutrophication*

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