The Ebergoetzen Measurement Site: Linking Biogeochemical Cycles and Soil Development in a Central European Beech Forest

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1 Background

- Climate change affects soil formation and biogeochemical processes on various spatial and temporal scales. This alters the interaction and feedback mechanism between long-term soil development and present biogeochemical cycles.
- To identify these mechanistic transformations and thus implications on soil function and ecosystem services, continuous and highly resolved observations are fundamental.
- In 2017, we established the Ebergoetzen measurement site in order to investigate biogeochemical processes and related soil formation under two distinct microclimatic conditions.

Hypotheses:

1. Higher insolation at the south-exposed slope increases evapotranspiration, reducing vertical water flow and element leaching (Figure 1).
2. Stronger leaching at the north-exposed slope will reduce pH and accelerate soil development (i.e. podsolization)
3. Biota will respond to these changes and consequently alter nutrient inputs and decomposition of soil organic matter

- Differences in annual balances may be used as indicators for follow-up treatment studies

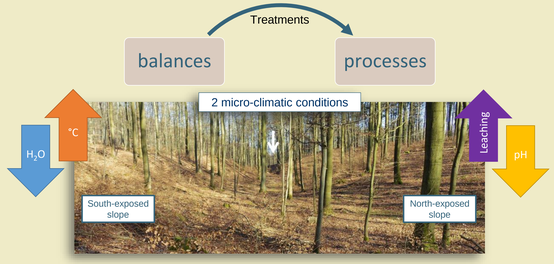

Figure 2. *Conceptual framework of the project objectives*

2 Study Area

- Small valley near the village of Ebergötzen, ~15 km east of Göttingen University (51°33'60.0"N 10°04'48.7"E) at 280 m a.s.l.
- Beech forest (*Fagus sylvatica*), about 50 year old stand
- Mean annual precipitation ~650 mm, mean annual temperature: 8.3 °C, Koeppen climate: Cfb
- Triassic sandstone with periglacial loess admixture on lower slopes (Figure 2)
- Soils: Cambisols with active clay migration, acidification and early-stage podsolization
- Two measurement sites: North-exposed and south-exposed slopes (Figure 3) with long-term measurement instrumentation (Figure 4)

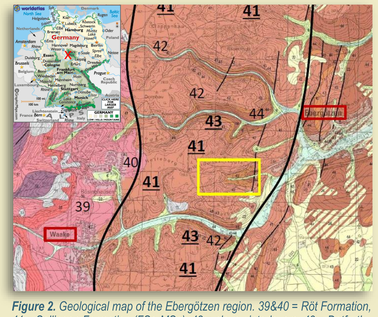

Figure 2. *Geological map of the Ebergötzen region. 39&40 = Röt Formation, 41 = Solligen Formation (FSa-MSa), 42 = clayey interlayers, 43 = Detfurth Formation (MSa-Csa)*

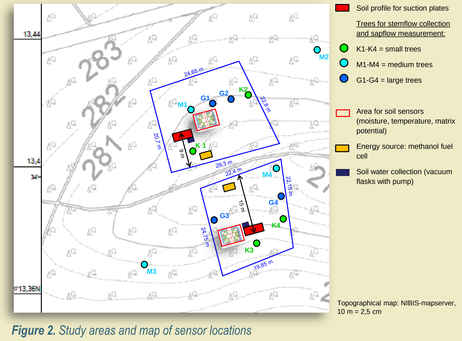

Figure 2. *Study areas and map of sensor locations*

Figure 2. *North-exposed slope (a) and soil profile (b), as well as south-exposed slope (c) and soil profile (d)*

3 Instrumentation

- Automated measurement system (enviLog, ecoTech Umwelt-Meßsysteme, Germany) with cable and near field communication, collecting data in 15 min intervalls. Central data transmission via mobile connection (Figure 5a)
- 15 tipping buckets for throughfall measurements (V2A, 0.1 l, UGT Germany), 4 of these with water sampling for laboratory analyses (Figure 5b)
- 12 tipping buckets for stemflow measurements (V2A, 0.5 l, UGT, Germany) with water sampling for laboratory analyses (Figure 5c)
- Each slope equipped with a weather station: Air temperature and relative humidity (HygroClip2 ADVANCED, rotronic, Switzerland) and a snow height sensor (Ultrasonic H8, Sommer, Austria) (Figure 5d)
- Additional weather station in an adjacent grassland for measuring bulk precipitation, snow height, relative air humidity, air temperature, wind speed and direction, as well as insolation

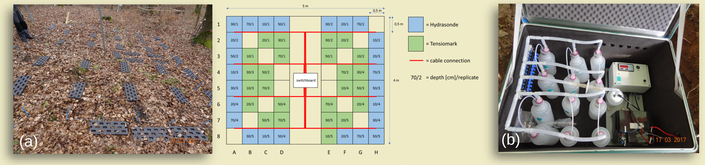

Figure 6. *Soil data collection: PE-bottles for soil solution (a) and sensor network for soil temperature, moisture and water potential measurements (b)*

Figure 5. *Logger switchboard (a), throughfall measurement and collection (b), sapflow and stemflow measurements (c) and climate station in the adjacent grassland (d)*

- Each slope equipped with 12 suction plates to collect soil water (-150 hPa) at four different soil depths (15, 30, 50 and 70 cm, n=3)
- Sensor network (Figure 6a): Soil moisture, temperature (Hydraprobe) and matrix potential (Tensiomark) at 5 depths – 5 replicates each
- Litter traps (0.5 m^2) sampled regularly to quantify seasonal element inputs from solid matter
- Soil solution is collected on a biweekly basis (Figure 6b) and analyzed for carbon and nutrient concentrations
- Laboratory Measurements:
  - Particular and dissolved organic & inorganic C, total & dissolved N, pH (TOC-analyzer, DIMATEC; TOC-analyzer, Shimadzu; pH-meter)
  - F-, Cl-, NO3-, SO42-, Na+, NH4+, Ca2+, Mg2+ (IC, Metrohm)
  - Al, Ca, Fe, K, Mg, Mn, Na, P, S, Si, Zn (ICP-OES)

4 Ebergoetzen Database

- Automatic quality control and data integration into a SQL-database
- Automated linkage between high resolution logger measurements and biweekly laboratory measurements
- Currently includes more than 16 600 000 data entries and 400 000 laboratory measurements
- Open access to online visualization (Figure 6): http://134.76.18.19/

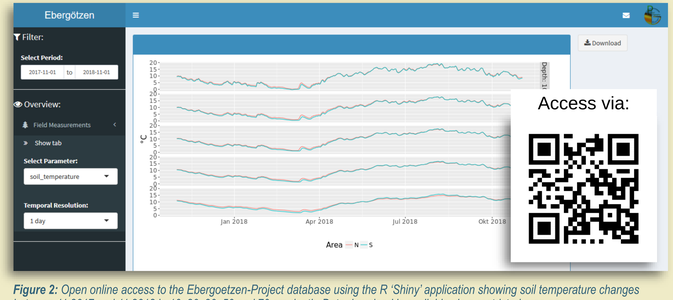

Figure 2: *Open online access to the Ebergoetzen-Project database using the R 'Shiny' application showing soil temperature changes between 11.2017 and 11.2018 in 10, 20, 30, 50 and 70 cm depth. Data download is available via a restricted area access.*