

Master thesis topic measuring soil health – linking physical and biological process description to quantify enzymatic activity



Context:

According to FAO (Food and Agriculture Organization of the United Nations), a quarter of the global surface of agricultural land is already highly degraded, therefore maintaining long-term **soil health** gains importance. Nevertheless, there are currently no easy, fast, and reliable ways to assess the effects of soil management on soil health and in particular on soil biology.

The planned thesis-project seeks to support development of an easy-to-use, portable sensor (Digit Soil), measuring the activity of soil enzymes.

Project:

Soil enzymes are a key factor for sustaining soil functions and soil health due to their essential role in carbon decomposition and the mineralization of nitrogen and phosphorus. The scientists of DigitSoil found an innovative and easy way to measure this enzyme activity in soil samples. However, for the quantitative interpretation of the measured activity, the soil volume that can be assigned to the activity must be known. This soil volume depends on the physical properties of the soil (particle and pore sizes and initial water content). More specifically, the transport of water and substrate from chemical plates to the soil with enzymes must be measured and modeled for a wide range of soil textures and water contents.

The outcome of the master theses allows the exact quantification of soil enzyme activity that is needed to extrapolate these measurements to field and landscape scales for predicting nutrient fluxes accurately.

Research question:

- What is interaction volume of soil represented by the surface based measurements of enzymatic activity (diffusion depth, detectability, accuracy), dependent on soil texture, soil temperature and soil moisture?
- Can measurements per area with this method be used for enzymatic activity stock estimations (e.g. 30 cm depth of a field)?

Tasks:

- Experiment planning and execution (enzymatic activity measurements with reactive plate system) with various soils and conditions (dataset building), potentially using dyes or other tracers
- Data analysis and processing
- Model building capturing the movement of substrates and products in the soil matrix
- Model evaluation and assessment of stock enzymatic activity and parameters controlling interaction volumes.
- (optional) publication of the results

Experience and skills:

- Knowledge in soil physics/vadose zone hydrology or practical courses
- Independent worker, coordinate several stakeholders,
- lab experience
- systematic thinking
- R/Python/Matlab/Mathematica skills or interest to learn
- Self-organized, diligent, and detail oriented
- Self-motivated and problem-solving oriented (proactively look for solutions)
- Good level in English (written and oral)

Supervision:

The project is a collaboration between the groups of Physics of Soil and Terrestrial Ecosystems at ETHZ and the ETH Spin-off startup Digit Soil.

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We offer:

- possibility to co-design and plan experiments with support at every step of work
- working in a diverse team consisting of soil physicists, soil chemists, environmental scientists, modelers, ..
- application oriented topic aiming to develop a real product under umbrella of Innovation & Entrepreneurship Lab;

Start of the thesis: from now on

About Digit Soil:

Digit Soil AG is an ETH spin-off, located at the ieLab in Schlieren. We develop solutions to farmers to limit their losses of soil nutrients and optimize their fertilizer use by measuring soil enzyme activity. Our company's main activities reside in the development of IoT devices and chemical membranes measuring soil quality and providing services to researchers and farmers.

For more information, visit our website: <https://www.digit-soil.com>