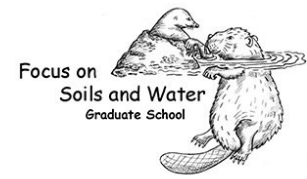


## **P000134 Course Syllabus**

### **Soil systems: integrating chemical and biophysical interfaces in soils, 3 credits**



#### **Objectives**

Soil is the most complex and heterogeneous system on earth in terms of its physical structure, chemical constitution and inherent biodiversity. In recent decades, methodological developments in the study of chemical and biophysical interfaces at the micro-scale have provided new opportunities to soil scientists to promote interdisciplinary research and integrate process understanding into a holistic soil system view. In this approach, soil is seen as a complex, adaptive and structured system in which macroscopic properties and processes depend on interactions at smaller spatial scales.

Indeed, our ability to describe small-scale soil interactions has been transformed by the use of modern technologies applied to intact soils, including the visualization, quantification and spatial analysis of soil components and functions (e.g. X-ray tomography, microscopy and microanalysis) together with integrated measurements of biological activity through enzyme activities or energy flows (e.g. thermodynamics). The exploration of these interactions in the minute soil universe has, in turn, profound implications for our understanding of soil functions at field, catchment and regional scales relevant to the sustainable use and protection of soils and water.

The aim of this course is to

- (i) provide an introduction to soils as complex, adaptive structured systems;
- (ii) give an overview of recent micro-analytical methods to explore interactions at soil chemical and biophysical interfaces, and their application to soil samples;
- (iii) present how the knowledge gained of microscale processes can inform soil management, policy and decision making at larger scales;
- (iv) discuss opportunities and challenges of these micro-analytical methods applied to soil as well as possible future innovative development and applications.

## **Learning outcomes**

After completion of the course, the student should be able to:

- define the soil as an adaptive, complex, and structured system
- describe modern techniques for the visualization and quantification of chemical and biophysical interfaces in soil as well as their application to the study of soil functions and processes
- discuss some opportunities and challenges in using the micro-analytical methods presented in the course

## **Target group**

This course is primarily intended for PhD students participating in the Focus on Soils & Water graduate school, but is also open to other PhD students working in related research areas. Researchers are also very welcome to participate in lectures and discussions, if places are available. There are no specific requirements concerning prior knowledge.

## **Content**

The course consists of two parts:

- 1) Literature group meetings: selected research and review papers will be discussed as well as student oral or poster presentations (three meetings prior to, and one meeting after, the workshop).
- 2) A workshop (see below) will be held at Ultuna with participation of international leading scientists in this research area.

## **Literature**

The course literature will consist of research and review papers selected by the invited lecturers

## **Number of ECTS-credits**

In total 3 ECTS

## **Examination**

- Read the literature provided and attend the literature group meetings
- Active participation in group meetings and workshop discussions
- Final group meeting: give an oral (10-15 minutes) or poster presentation on your own research assessing in what ways at least one micro-analytical method may be applied to your research and to answer what questions

## Workshop 24<sup>th</sup> – 28<sup>th</sup> of November 2025

### *Program's skeleton*

Monday 24/11	<b>DAY 1</b> <i>Soil as a complex, adaptive structured systems</i>
Tuesday 25/11	<b>DAY 2</b> <i>Soil interactions in the natural soil habitat: Technical advances (1) - <a href="#">biogeochemical interfaces</a></i>
Wednesday 26/11	<b>DAY 3</b> <i>Soil interactions in the natural soil habitat: Technical advances (2) and <a href="#">spatial analysis- biophysical interfaces</a></i>
Thursday 27/11	<b>DAY 4</b> <i>Relevance of the soil systems approach for soil management, policy and decision making</i>
Friday 28/11	<b>DAY 5</b> <i>Future Opportunities and challenges of micro-analytical methods of intact soils</i>

**International invited speakers:** Claire Chenu (INRAe, France), Naoise Nunan (CNRS, France), Steffen Schlüter (UFZ, Leipzig), Marco Keiluweit (University of Lausanne, Switzerland) and Seeta Sistla (CalPoly University, California, USA)

**SLU teachers:** Anke Herrmann, Nick Jarvis, Sara Hallin, Jon-Petter Gustafsson, Mats Larsbo, Grace Pold, Pascal Benard, Elsa Coucheney

## Literature meetings and student presentations (preliminary dates and themes)

Monday 3/11 (9-12)	Soils as complex, adaptive and structured systems & spatial analysis.
Monday 10/11 (9-11)	Visualization and quantification of the soil habitat and components (e.g. X-ray tomography, XANES spectroscopy, Microscopy)
Monday 17/11 (9-11)	Visualization and quantification of the soil microbial communities environment and functions (e.g. Planar optode imaging system; in situ microsenors, hydrogel beads and microfluidic chips)
Tuesday 2/12 (9-12)	Student presentations: use of the micro-analytical methods in my own research project?