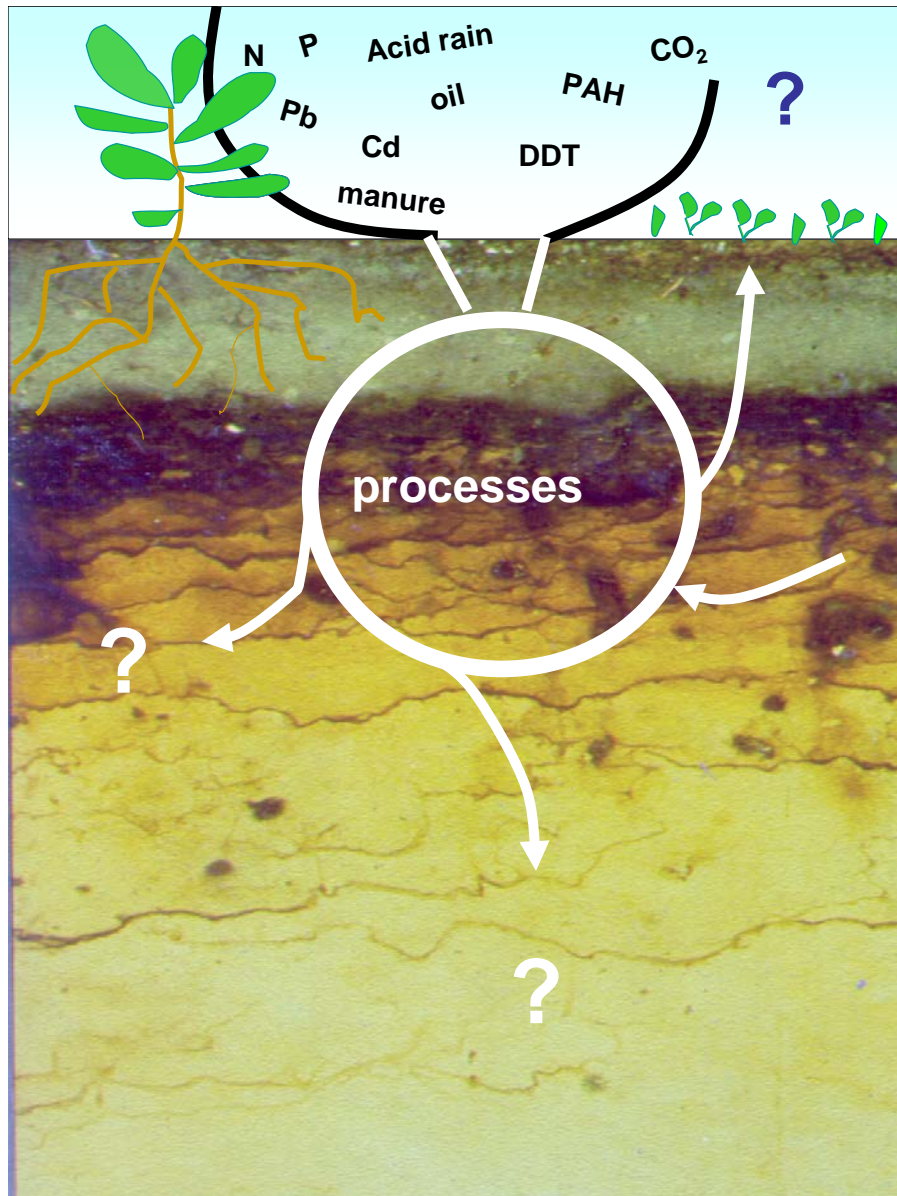


## Soil pollution and soil protection

SOQ-21306



Department of Soil Quality  
[www.wageningenur.nl/soq](http://www.wageningenur.nl/soq)



## **Soil pollution and soil protection (SOQ-21306)**

Acronym:	SP
Contributing science groups:	Soil chemistry and chemical soil quality (CSQ) Soil biology and biological soil quality (BSQ)
Language of instruction:	English
Study load / Credit points:	6 ects
Components:	Lectures 3 ects (24 lectures of 1 h) Tutorials 1.5 ects (12 tutorials of 1 h) Practical 1.5 ects (12 x 4 hours)
Period/time:	period 5 (March - April), afternoon (13:30 – 17:15 h)
Contact person & examiner:	Dr.ir. J.E. Groenenberg
Lecturers:	Dr.ir. J.E. Groenenberg Dr. R.G.M. de Goede Dr.ir. J.T.C. Grotenhuis
Examination	Written exam with open questions (75%). Practical report (25%).
Type of written exam:	Open book (you are allowed to bring with you all course material made available to you). Questions comparable to tutorial assignments.
Assumed knowledge:	Introductory course on soil science (e.g. Soil and Water 2 (AEW-21306), Soil – Plant relations (CSA-20306)
Continuation courses:	Applications in Soil and Water chemistry (SOQ-34806) Nutrient management (SOQ-31806) The Carbon Dilemma (SOQ-35306) MSc Thesis Soil Chemistry and Chemical Soil Quality (SOQ-813xx)
Study material:	Reader Soil pollution and soil protection Practical manual Soil pollution and soil protection
For whom?	The course is compulsory for BSc-Environmental Sciences (BMW-B); restricted optional for MSc-Environmental Sciences (MES).
Information:	J.E. Groenenberg, bertjan.groenenberg@wur.nl

## **Profile of the course:**

Knowledge of the behaviour of compounds in soil and their effects on organisms (human beings, plants, soil biota) is required in order to assess soil quality and to select proper soil remediation methods in case of severe pollution. The field of application is not limited to soil but includes sediments and solid wastes. The course focuses on soil risk assessment (soil quality evaluation) and the basic knowledge necessary to be able to apply a risk assessment procedure to polluted soil sites. Basic knowledge comprises compound behaviour in soils (speciation, transport, uptake) and effects on soil organisms (bioavailability, uptake, dose-response relationships, risk assessment). Speciation focuses on adsorption to soil particles and on complexation reactions: mechanism and modelling, especially the reaction of heavy metals with (dissolved) organic matter.

Important key words are: soil risk assessment, compound behaviour, speciation, adsorption, bioavailability, uptake, dose-response relationship.

## *Lectures*

The lectures cover the following subjects:

- The behaviour (especially speciation, transport and uptake) of contaminants in soil. Much attention will be paid to the various distribution processes (adsorption and desorption, dissolution and precipitation, volatilization and condensation) and transport in water and gas phase. This will be elaborated for compounds like heavy metals, volatile organic chemicals, nitrogen and phosphate.
- Effects of contaminants on organisms (plants and soil biota); particular attention will be paid to accumulation in the food chain (uptake and effects), the determination of dose-response relationships and the concept of bioavailability.
- Background concentrations of heavy metals in soils.
- Chemical analysis of contaminants in soil-water systems.
- Pollution phenomena like soil acidification, accumulation in soils, leaching of contaminants in soils, application of organic waste materials to soils, uptake of contaminants by plants and soil organisms, exposure to human beings, spreading of contaminants via groundwater.
- Policy aspects: choice and determination of soil quality criteria (soil standards) as part of a soil quality evaluation procedure; the Dutch approach as example.
- Risk assessment procedure for soil and groundwater; analysis of exposure pathways. Analysis of actual risks for human beings, eco systems and groundwater spreading.
- Applicability of various soil remediation techniques.

All lecture presentations (PowerPoint files) will be made available in BlackBoard on the course site.

### *Tutorials*

The tutorials are linked to the subjects dealt with in the lectures, and are intended to explain in another way theoretical aspects and to improve practical skills in the application of relevant theoretical knowledge. Assignments will be handed out and answers/solutions will be discussed.

Relevant exam questions will be discussed making participation to the tutorials also a good preparation for the examination.

### *Practical*

The laboratory practical aims at enhancing practical skills in carrying out experimental soil pollution research. The student will be familiarized especially with relevant research methods and measurement techniques essential for the determination of the dose – response relationship of heavy metals for plants grown in polluted soils. Basic data are derived from a pot experiment with grass, including two different soil types (sand and clay), and several treatments with different heavy metal doses (Cu, Zn) and different pH levels. Techniques applied: plant and soil sampling, chemical analysis of total metal amounts in plant and soil, determination of bioavailability (0.01 M CaCl<sub>2</sub>-extraction of the soil), determination of free metal concentrations (speciation calculation), pH measurement, AAS-analysis, regression analysis (parameter fitting).

The practical is not particularly aimed at teaching the student how to handle analysis equipment and how to execute standard chemical (soil) analyses. The subjects dealt with during the practical concern mainly the determination of adsorption behaviour of heavy metals in the soil depending on soil type and pH, and the evaluation of effects of heavy metals on plant growth and metal uptake as a function of total or bioavailable amount in the soil or as a function of free metal concentration in the soil solution. The objective is to find the parameters for relevant soil adsorption models (Freundlich and NICA-Donnan) and dose – response relationships (power type functions).

In principle, a group of two students will jointly carry out the experiments and write a report focused on experimental and modeling results. On the last practical day each group will present results and interpretation of a part of the pot experiment. Approximately half of the total time available for this practical will consist of experimental work (sampling, soil extractions, chemical analysis). The remainder consists of data processing (calculations, regression analysis) and report writing.

### **Learning outcomes:**

After successful completion of this course you should be able to:

- recognize and describe the impact of soil pollution on the environment
- analyse and describe compound behaviour in soils
- explain and describe essential elements of a soil quality evaluation procedure
- apply a soil risk assessment to a contaminated soil site
- carry out simple dose – response experiments including sampling, chemical analysis of soil and plant samples, data processing, simple statistical data handling (linear regression) and report writing

### Activities:

- attend lectures and tutorials
- read and study relevant chapters in the reader
- answer tutorial assignments
- read, study and use the practical manual
- take part in the practical: sampling, chemical analysis, statistical analysis, report writing and presentation
- written exam

### Assessment strategy

assessors: J.E. Groenenberg, R. de Goede

Assessment of learning outcomes

Learning outcome	Answers tutorials	Practical report*	Exam
recognize and describe the impact of soil pollution on the environment	x		x
analyse and describe compound behaviour in soils	x	x	x
explain and describe essential elements of a soil quality evaluation procedure	x		x
apply a soil risk assessment to a contaminated soil site	x		x
carry out simple dose – response experiments including sampling, chemical analysis of soil and plant samples, data processing, simple statistical data handling (linear regression) and report writing		x	
<b>Contribution to final mark (%)</b>	<b>0</b>	<b>25</b>	<b>75</b>

\* Deliver practical report before period 6 starts

Minimal score 5.5 for each part

Results of partial interim examinations stay valid for a time period of 5 years.

**Course schedule:** period 5 (March – April); afternoon (13:30 – 17:15 h)

During first 6 weeks:

Monday	2 lecture hours
Tuesday	2 lecture hours
Wednesday	practical (4 hours)
Thursday	practical (4 hours)
Friday	2 tutorial hours
week 7	preparation for exam; question hour
week 8	exam

**Lecture programme** (4 lecture hours per week):

week	Subjects
1	Introduction; soil quality evaluation and risk assessment
2	Soil processes: speciation and transport
3	Soil organisms: uptake and effects; bioavailability
4	Waste disposal and soil acidification
5	Behaviour and risks of volatile organic compounds
6	Monitoring bioavailability and ecological risk assessment

**Tutorial programme** (2 tutorial hours per week)

same programme as for lectures

**Practical programme** (2 practical half days per week):

week	Activity
1	Harvesting and sampling pot experiment
2	Chemical analysis of plant and soil samples; soil extractions
3	Chemical analysis of plant and soil samples; AAS measurements
4	Data processing; regression analysis for adsorption model
5	Data processing; regression analysis for dose-response relationships
6	Report writing; presentation of results