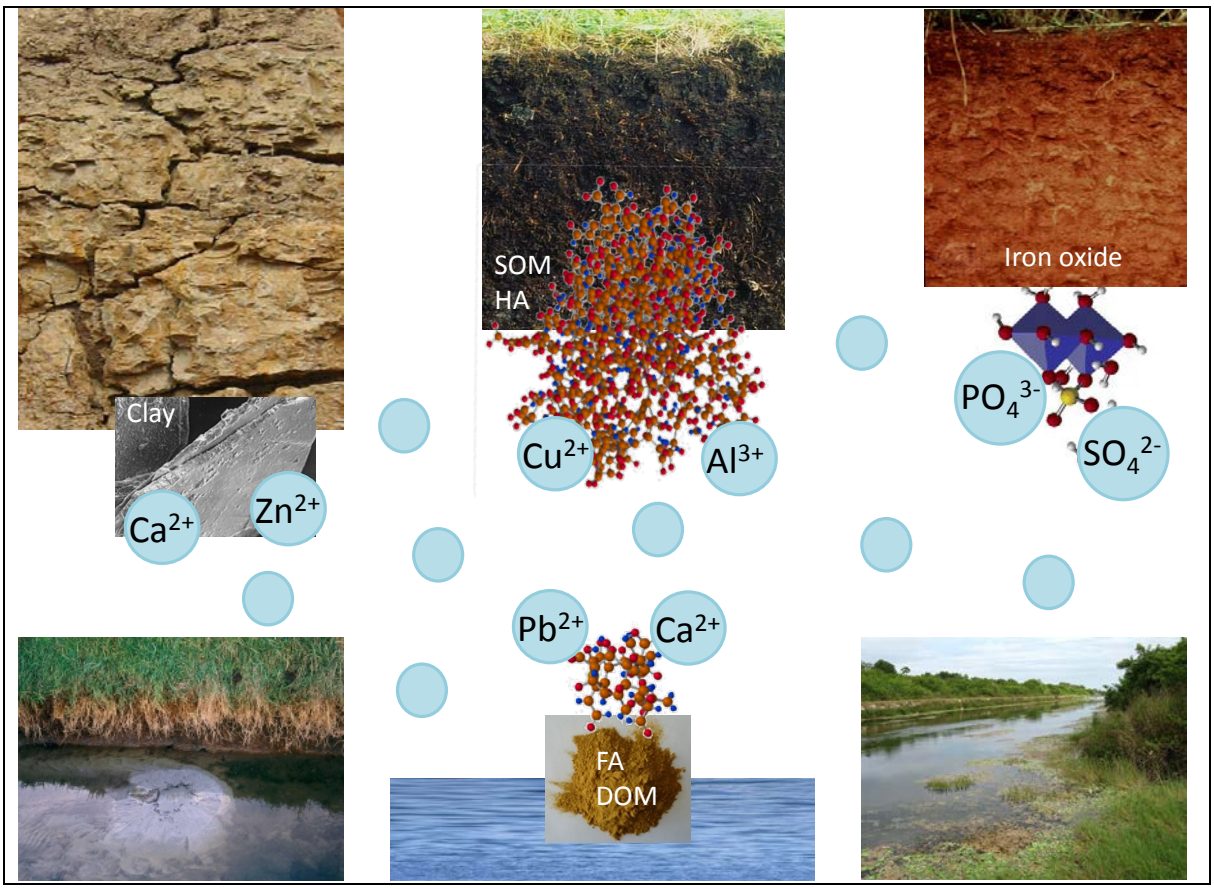
COURSE GUIDE

Applications in Soil and Water Chemistry

SOQ-34806



Department of Soil Quality
www.wageningenur.nl/soq

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Applications in soil and water chemistry (SOQ-34806)

acronym:	App-SWC
Contributing science groups:	**Soil quality and chemical soil quality (SOQ)** **Aquatic ecology and water quality management (AEW)**
Language of instruction:	English
Study load / Credit points:	6 ects
Components:	Lectures 25% (7 weeks 2 hrs) Tutorials 25% (7 weeks 2 hrs) Lab-practical 25% (6 days of 4 hrs) pc-practical 25%
Period/time:	period 4 (February-March), full days (8:30 – 17:15 h)
Contact person & examiner:	J.E. (Bert-Jan) Groenenberg
Lecturers:	J.E. Groenenberg, G.F. Koopmans (SOQ), M. Lurling (AEW)
Examination	Tutorial assignments (50%) Lab-practical report (25%) pc-practical (25%)
Assumed knowledge:	Soil Quality (SOQ-30306) or Soil Pollution and soil protection (SOQ-21306) or Aquatic Chemistry AEW-31306) or comparable courses.
Continuation courses:	The Carbon Dilemma (SOQ-35306) MSc Thesis Soil Chemistry and Chemical Soil Quality (SOQ-813xx). MSc thesis Aquatic Ecology and Water Quality Management (AEW-804xx).
Study material:	Reader App-SWC. Practical manual App-SWC. Textbook pc-practical speciation calculations.
For whom?	The course is essential for MSc thesis Soil Chemistry and Chemical Soil Quality. It is optional for MSc thesis Aquatic Ecology and Water Quality Management.
Information:	J.E. Groenenberg: bertjan.groenenberg@wur.nl

Profile of the course:

New developments in soil and water chemistry make it possible to apply sophisticated knowledge regarding speciation and multi component transport in describing and predicting compound (nutrients, contaminants) behaviour in soil and water systems. Especially modelling approaches for adsorption onto (dissolved) organic matter (NICA-Donnan), clay (Donnan ion exchange) and metal oxides (CD-Music) offer interesting opportunities. Combination of these three approaches leads to the recently developed successful *multi surface complexation* modelling.
In this course students learn to use this modelling approach for practical applications for instance related to soil remediation, soil risk assessment, soil and (ground)water pollution, soil fertility or (ground)water quality control. Basic aspects of adsorption modelling are explained. The course focuses on – partly experimental - determination of essential soil, water and compound parameters and on computer simulation of the distribution (mainly adsorption and complexation) of chemical compounds, especially of heavy metals. Phosphate behaviour is studied in relation to P-removal from polluted surface water.
The course starts with introduction lectures related to basic aspects of speciation (especially adsorption) and multi component mass transport. Then in several case studies the application of advanced adsorption modelling (especially NICA-Donnan for heavy metals) will be discussed regarding basic processes (speciation, transport), usefulness and perspectives for practical situations. The chemical behaviour of phosphorus (processes, mechanisms, modelling) gets attention in the case study on P-removal from polluted surface water.
Most tutorials are linked to the subjects dealt with in the lectures, and are intended to explain theoretical aspects and to improve practical skills in the application of relevant theoretical knowledge to more realistic practical situations. Assignments will be handed out and answers/solutions will be discussed. Some tutorials are linked to the lab-practical (e.g. simulation of adsorption behaviour with a speciation computer model) and to the pc-practical (introductions and support related to different topics, e.g. complexation, adsorption, mineral equilibria, and how to work with the speciation program ECOSAT).
In the lab-practical students determine the adsorption behaviour of heavy metals (Cu, Zn) in different soil types (sand, clay) as function of organic matter content, clay content and pH. Multiple linear regression will be used to estimate parameters for relevant adsorption models (e.g. Freundlich and NICA-Donnan).
Heavy metal distribution in soil and water systems can be described and predicted by modelling speciation (multi surface complexation) based on characteristics of the system. Speciation simulation will be done with the computer model ECOSAT using most relevant adsorption models. Some tutorials are used to explain several basic aspects of data processing and computer modelling and its application to the data gathered in the lab-practical.

In the pc-practical students learn the basic concepts of speciation calculations and learn to apply it to simple chemical systems using the computer model ECOSAT. It starts with formulating chemical equilibria and mass balances using chemical reactions (expressed in terms of components and species present in the system considered). Basic aspects of the numerical iteration process used in speciation programs are treated. The general approach in solving chemical equilibria is applied to simple basic adsorption modelling and to equilibria with minerals. The same approach is used in the more advanced adsorption modelling as implemented in the speciation program ECOSAT.

Learning outcomes:

After successful completion of this course, the student is expected to be able to:

- Conduct laboratory experiments to determine adsorption isotherms, analyse important chemical soil and water characteristics and interpret experimental results.
- Analyse speciation problems in soil-water systems and perform speciation calculations with a computer speciation model.
- Describe and predict compound behaviour in soil and surface water.
- Describe applicability of speciation and mass transport in soil and water chemistry.

Activities:

- Attend lectures and tutorials; answer tutorial assignments
- Carry out laboratory experiments and computer simulation; write report.
- Do pc-practical (answer practical assignments on speciation calculations).

Assessment strategy:

assessors: J.E. Groenenberg, M. Lurling

Assessment of learning outcomes

	Practical report*	pc-practical	Tutorial assignments
Conduct laboratory experiments to determine adsorption isotherms, analyse important chemical soil and water characteristics and interpret experimental results.	x		
Analyse speciation problems in soil-water systems and perform speciation calculations with a computer speciation model.		x	x
Describe and predict compound behaviour in soil and surface water.	x	x	x
Describe applicability of speciation and mass transport in soil and water chemistry.		x	x
Contribution to final mark (%)	25	25	50

* Deliver practical report before period 5 starts

Examination: Answers tutorial assignments (50%); practical report (25%); pc-practical (25%).

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

Course schedule: A detailed schedule will be handed out.

Lectures on Monday and Tuesday in the morning during 3.5 weeks. Related tutorials (support and evaluation) on several days during 4 weeks in the morning. Lab and pc-practical in the afternoon. Lab-practical mainly in the first week. pc-practical mainly in week 2 and 3. Lab-practical report writing in week 4.

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

1.1 Introduction: course setup and examples of applications of soil and water chemistry
1.2 Modelling adsorption: basic concepts
1.3 Principles and applications of chemical speciation calculations
1.4 Basic concepts of mass transport in soils

2.1 & 2.2 Eutrophication: problems and mitigation
2.3 & 2.4 Chemical P-inactivation

3.1 & 3.2 Modelling adsorption: advanced concepts
3.3 Copper mobility in soil affected by pH and DOC
3.4 Transport of humic and fulvic acids in relation to Cu mobility

4.1 Contribution of individual sorbents to the control of heavy metal activity in soil: multi surface complexation modelling in soils
4.2 heavy metal leaching: modelling a long term field experiment