UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Groundwater Contamination and Remediation

2627-2-F7503Q027

Aims

The aim of the course is to enable students to acquire the:

- **knowledge and understanding** of
 * main contaminants of groundwater and their possible sources;
 * main processes governing the fate and transport of contaminants in groundwater;
 * main remediation techniques of contaminated groundwater and their operational characteristics;

- **applying knowledge and understanding** to
 * use the proper tools for assessing main processes, either natural or anthropogenic, that determine the quality of groundwater;
 * build the conceptual model of a contaminated site.

- **making judgements** with regard to:
 * the ability to assess the impact of humans on the groundwater environment and identify remediation measures;
 * solving problems relating to groundwater contamination, from designing a hydrogeochemical characterisation to selecting the most appropriate remediation techniques;

- **communication skills**, relating to the ability to:
 * appropriately describe the topics studied using the correct specific vocabulary;
 * present the results of case study analyses reported in scientific articles;

- **learning skills**, relating to the ability to:
 * consulting the literature on the topics covered and independently integrating the acquired knowledge with knowledge from other environmental science disciplines.

Contents

Main hydrogeochemical processes in groundwater.
Contaminants' characteristics and transport processes in groundwater.
Investigation techniques supporting the implementation of hydrogeological conceptual models, including stable isotopes analysis.
Groundwater remediation and monitoring techniques.
Case study analysis.

Detailed program

Basic concepts of hydrochemistry - concentrations and uncertainties, thermodynamics of aqueous systems, physico-chemical parameters
Basic concepts of hydrogeology - hydrogeological parameters, Darcy's law, flow equation, flow networks.
Hydrogeochemical processes in groundwater - dissociation reactions, weathering, gas dissolution, redox reactions.
Transport of contaminants in groundwater - advection, diffusion, dispersion, adsorption, multiphase transport.
Inorganic and organic contaminants in groundwater - origin, characteristics, frequency and distribution of the main contaminants in groundwater.
Stable isotopes - general principles, contamination tracing and aquifer recharge tracing.
Groundwater remediation techniques – operating principles, influencing factors, operating times, monitoring.
Analysis of case studies for the construction of a conceptual model of the contaminated site.
Practical exercises to consolidate the knowledge acquired also using numerical hydrogeochemical modelling.

Prerequisites

Basic knowledge of hydrogeology and hydrochemistry.

Teaching form

- 20 two-hour lectures of in-presence delivered didactics.
- 5 two-hour practical classes, in-presence interactive teaching, divided into:
  * 3 two-hour exercises using virtual computer labs
  * 2 two-hour exercises with analysis of real case studies

Textbook and teaching resource

Slides and texts provided by the teacher.

Recommended textbooks:
* Ingegneria degli acquiferi - Di Molfetta A. e Sethi R. (2012). Springer.
* Groundwater Geochemistry and Isotopes - Clark I. (2015). CRC Press.

Semester

First Semester.

Assessment method

The final examination will take the form of an oral interview, structured in:
* a first part in which the student will expose, by means of presentation with slides, the results of an assignment involving the critical analysis of a scientific paper on the topics covered by the course (duration of the presentation 10-15 min); in this part, the ability to critically understand, expose and communicate a scientific text will be evaluated;
* a second part of discussion, with 2-3 main questions, on the topics covered by the course (duration of 20-30 min); in this part the degree of knowledge acquired and the ability to apply the interpretative tools acquired will be evaluated.

The evaluation will award a maximum total score of 30/30 (maximum of 10/30 for the first part of presentation and 20/30 for the second part of program questions).

Office hours

By appointment by contacting the teacher by email: marco.rotiroti@unimib.it

Sustainable Development Goals

CLEAN WATER AND SANITATION | RESPONSIBLE CONSUMPTION AND PRODUCTION | LIFE BELOW WATER