UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Groundwater Pollution and Remediation

2223-2-F7501Q086

Aims

To know the main categories of groundwater contaminants and their possible sources;
To know the chemical and physical characteristics of contaminants that influence their behavior in groundwater;
To know the main chemical processes that contaminants create in groundwater;
Distinguish between anthropogenic pollution and natural contamination;
Understand the concept of low solubility and separated fluid phase in relation to groundwater contamination:
Be able to solve simple problems related to transport of contaminants subject to advection, dispersion, retardation and degradation phenomena;
Know the main investigations to be carried out to acquire hydrogeological and hydrochemical knowledge aimed at a contamination case;
Be able to develop a conceptual model of the problem based on the available data;
Know the main techniques of groundwater remediation.

Contents

Study of contaminants and their propagation in groundwater;
Methods of investigation for polluted area definition and site characterization;
Methods for groundwater remediation;
Guidelines for remediation monitoring.

Detailed program

Anthropogenic pollution and natural contamination;
Types of anthropogenic pollutants and pollution sources: characteristics, frequency, and distribution;

Chemical and physical characteristics of contaminants;
oxidation-reduction reactions in groundwater
Transport mechanisms: advection, dispersion, adsorption and retardation, degradation;
Principle of mass conservation and transport equation;
Application of an analytical transport solution in the case of continuous source;
Basic concepts of capillarity and wettability, permeability and relative permeability;
Movement of non-soluble fluids NAPL, light and heavy (LNAPL and DNAPL);
Hydrogeological and hydrochemical investigations and site characterization for a conceptual model building;
Legislation on remediation with mention of risk analysis;
Remediation modality (insitu, onsite, offsite) and criteria for selecting a remediation method;
Main remediation techniques, with respect to: the principle of operation, physicochemical factors of influence, system feasibility, time of operation prediction, monitoring mode and timing, data interpretation, and achievement of remediation objectives;
Technologies covered: Hydraulic Barrier, Soil Vapour Extractiong, Air Sparging, Permeable Reactive Barrier, techniques for removal of separated phases (LNAPL, DNAPL) nods to other remediation techniques.

Prerequisites

Basic knowledge of hydrogeology.

Teaching form

Lectures, 4 cfu.
Tutorials, 2 cfu.

Textbook and teaching resource

Materials used during lectures (slides, exercises, diagrams, material and spreadsheets of exercises) posted at https://elearning.unimib.it/course/view.php?id=44628

Recommended texts (viewable from the lecturer):
Francani V., 2014. Hydrogeology. C.E.A. Ambrosian Publishing House;
Di Moffetta, Sethi, 2012. Aquifer engineering. Springler;
Fetter C.W., 1993. Contaminant hydrogeology, New York, Macmillan.

Semester

First Semester.

Assessment method

A final examination is scheduled in written mode with mandatory oral.
The written examination is aimed at assessing the acquisition of basic knowledge related to contaminants and to their transport in groundwater. The examination, lasting 3.5 hours, consists of:

- no.2 open-ended questions (demonstrate the ability to analyze, understand and describe the picture of a contamination phenomenon);
- no.3 closed-ended tests (demonstrate knowledge of basic concepts);
- no.1 problem (demonstrate the ability to solve questions related to a single case of contamination in a rational way).

The oral examination is aimed at assessing the acquired knowledge related to investigation and remediation methods and their application. The examination, lasting 30-45 minutes, consists of:

- discussion of the written paper;
- interview on topics covered in class related to the remediation of contaminated sites (characterization, legislation, remediation techniques);
  The evaluation of the written paper will award a maximum total score of 30/30 (8/30 questions, 3/30 tests, 19/30 problem).
  The evaluation of the oral test will be averaged with that of the written test to award the final grade

Office hours

By appointment with the lecturer

Sustainable Development Goals

CLEAN WATER AND SANITATION | RESPONSIBLE CONSUMPTION AND PRODUCTION