UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Applied Hydrogeology

2324-1-F7401Q075-F7401Q079M

Aims

To provide skills about: the characteristics of soils and rocks that control subsurface water storage and circulation; estimation of groundwater reserves and renewable water resource; surface and deep water relationships; hydrochemistry of groundwater and principles of the evolution of water chemistry; classification of springs and their hydraulic regime; construction of intake and catchment works; characterization of aquifers with flow tests to determine hydraulic parameters of aquifers. The use of analytical and numerical solutions for problem solving and interpretation of tests. Notes on methods and regulations for resource and catchment point defense.

The second part of the course "Contaminant Hydrogeology" is aimed at the hydrogeology of contaminants, the types of substances involved, the physics of transport in groundwater, tracer tests, transport equations with terms for reaction and adsorption, solutions for the determination of hydrodispersive parameters, active and passive water and contaminant measurement and sampling techniques, and techniques for securing, remediation and de-pollution for both saturated and unsaturated conditions. Mention will be made for the heat transport part, which will be integrated in detail in the GEOENERGY course

Contents

Students will learn basic knowledge on hydrogeology, applied and contaminant hydrogeology, treatment of contaminated sites
Contaminant Transport Processes:

Advection, dispersion, and diffusion
Contaminant sorption and retardation
Source characterization and release mechanisms
Contaminant fate and transport modeling
Reactive transport and biodegradation processes
Contaminant Site Investigation:

Site characterization techniques
Sampling methods and analysis
Contaminant plume delineation
Groundwater monitoring networks
Risk assessment and management strategies
Groundwater Remediation:

Pump-and-treat systems
In-situ remediation techniques (e.g., bioremediation, chemical oxidation)
Permeable reactive barriers
Enhanced natural attenuation
Remediation performance assessment
Groundwater Modeling:

Numerical modeling principles
Development and calibration of groundwater models
Modeling of flow and contaminant transport
Uncertainty analysis in groundwater modeling
Model validation and sensitivity analysis
Emerging Topics:

Managed aquifer recharge and groundwater banking
Groundwater and climate change
Groundwater governance and policy
Impacts of urbanization and land-use change on groundwater
Groundwater sustainability and resource management

Detailed program

Fundamentals of hydrogeology

Hydrologic cycle and water circulation in different geological systems. Hydrogeological balance: rainfall, temperature, real and potential evapotraspiration. Porosity definitions and use. Fluid flow in saturated and unsaturated soil, porous rocks or jointed rocks. Reconstruction and interpretation of piezometric surfaces and flow nets. Classification and analysis of springs, spring discharge regime, evaluation of spring discharge dynamics using recession curves, Hydrochemistry: physical chemical properties of groundwaters, TDS, dissolved elements their origin and their effects, data representation, plotting and analysis. . Well design and installation, drilling and construction techniques, purging, maintenance, materials. Monitoring and interpretation of well hydraulic testing and pumping tests under steady state and transient conditions. Well sampling techniques and problmes, methods and materials, sampling campaigns. Applying site characterization to model development.

Applied hydrogeology

Solute transport and contaminant migration in saturated and unsaturated soils. Tracer tests and characterization of dipersivity. Multi-fluid processes. NAPLs, physical chemical characteristics and transport in the vadose and saturated zones. Primary or direct and secondary contamination processes. Interaction between soil matrix and solutes. Transformation, attenuation and decay processes of solutes. Biodegradation: theory, in situ estimation, and modelling. Organic and inorganic compounds in subsurface water. Treatments at contaminated sites and groundwater remediation methods and techniques.

Risk analysis for soil and water contamination. Reference legislation: regional, national and european laws for superficial and subsurface water.

Lab exercises: Flow net construction, simple solution of water flow in porous media, interpretation of well tests.

Design of a reclamation scheme for different contaminated sites.

Prerequisites

A base-level knowledge in engineering geology, site investigation, physics and mathematics is required. IT is mandatory the acquisition of the credits in the course of Hydrogeology

Teaching form

- Lessons

- Laboratory experiences and problem solving

Textbook and teaching resource

All the lectures are downloadable form the elearning website

Semester

1st and second semenster

Assessment method

Oral

Office hours

Sustainable Development Goals

CLEAN WATER AND SANITATION