# Course guide
# 250828 - 250828 - Hydrometeorological Processes and Their Interactions with the Ground

**Last modified:** 25/01/2024

**Unit in charge:** Barcelona School of Civil Engineering
**Teaching unit:** 751 - DECA - Department of Civil and Environmental Engineering.

**Degree:** MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Optional subject).

**Academic year:** 2023 **ECTS Credits:** 5.0 **Languages:** English

## LECTURER

**Coordinating lecturer:** MARC BERENGUER FERRER

**Others:** MARC BERENGUER FERRER, DANIEL SEMPERE TORRES

## TEACHING METHODOLOGY

The course consists of three hours of classes a week in the classroom of theory and practice sessions.
Support material in the form of a detailed teaching plan is provided in the virtual campus ATENEA: content, evaluation activities and literature.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

## LEARNING OBJECTIVES OF THE SUBJECT

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.
To analyze, discriminate and integrate geological and geotechnical information in studies and projects.
To calculate, evaluate, plan and regulate surface and groundwater resources.(Specific competence of the specialization in Groundwater Hydrology).
To assess and manage environmental impacts from waste disposal, soil contamination and groundwater pollution. (Specific competence of the specialization in Groundwater Hydrology).
To model, assess and manage geological resources, including mineral and thermal groundwater. (Specific competence of the specialization in Groundwater Hydrology).

* To recognize the relationship between soil mechanics and hydrogeology.
* To evaluate the impacts caused by civil works (excavations, walls, tunnels) in aquifers and vice versa.
* To acquire concepts on exceptional contamination of aquifers and remediation techniques.
* To gather knowledge on the mathematical models to evaluate the impact of works on aquifers.
* To recognize the main technologic options available to grant economical and efficient services with regards to the basin.
* To suggest solutions to benefit from the local natural resources taking into account the economical, social and environmental sustainability.
* To understand the chemical balance and kinetic processes from a rigorous mathematical point of view.
* To suggest and solve the reactive transport equations in simple cases .
* To recognize the most frequent processes and sources of contamination in soils, aquifers, rivers, dykes, coasts and wetlands.
To suggest solutions to remediate the contamination of water masses using numerical modelling.
* To acquire advanced knowledge on the problems regarding urban and especial solid waste management.
* To understand the extent of the studies on environmental impact.
* To understand the atmosphere-soil hydrological processes.
* To model the hydrological processes at a local, basin and regional scale.
* To know the differences among different types of hydrological modelling.
* To understand the effects of precipitation on soil stability.
* To admit the possibility of natural disasters occurring due to water and to be able to estimate the vulnerability and risk of a ground when facing flooding or debris flow.

- Precipitation : Processes of precipitation formation. Measurement and forecast methods.
- Hydrological processes. Slope and river runoff. Evaporation and evapotranspiration. Soil moisture.
- Hydrological modeling. Basin and regional scale models. Components of a hydrological model. Use of observations in hydrological modeling.
- The effects of precipitation on soil stability : drag erosion flows and landslides.
- Estimation of danger and vulnerability against floods and drag erosion occurence.
- Warning systems for natural disasters related to water.

Introduce briefly the meteorological processes with impact on the terrain (mainly related to precipitation) and present the observation and weather forecasting systems.
Present the hydrological processes and runoff generation and its modeling, and provide an overview of the operational systems for hydrological forecasting.
Give an overview of the problems triggered by the hydrometeorological processes (floods, landslides, debris flows, erosion) and their management.

## STUDY LOAD

| Type | Hours | Percentage |
|---|---|---|
| Hours large group | 25,5 | 20.38 |
| Hours medium group | 9,8 | 7.83 |
| Hours small group | 9,8 | 7.83 |
| Self study | 80,0 | 63.95 |

**Total learning time:** 125.1 h

## CONTENTS

### Meteorological processes

**Description:**
The session will provide an intuitive introduction to the concepts of atmospheric physics relevant in the context of the course.
Brief introduction to the different types of precipitation, and to the factors that affect its spatial and temporal distribution.

**Specific objectives:**
Provide a brief introduction to the physics of the atmosphere and the processes of generation preciptiació.
Explain the different mechanisms of precipitation generation.
Present different factors with impact on the spatial and temporal distribution of precipitation.

**Full-or-part-time:** 8h 24m
Theory classes: 3h 30m
Self study : 4h 54m

### Observation of precipitation

**Description:**
Presentation of the different systems of observation of precipitation and its measuring principles and sources of uncertainty.
The session will cover the principles of the precipitation measurement by weather radars, the most common error sources and the most popular radar products.

Presentation of the systems of satellite observation of precipitation. Measurement principles. Most common products and available datasets.
Computer practices on the precipitation observation systems. There is the possibility of installing the software that will be used (multi-platform) to the students' personal computers.
Exercises: Observation of precipitation

**Specific objectives:**
Present the different systems for preciptitation observation, focusing on their advantages and disadvantages.
Understanding the operation and the precipitation observations of weather radars.
Understanding the satellite observation of precipitation.
Access the most common data sources.
Understand the observation of precipitation with the various existing systems and their complementarity.
Manage and monitor weather radar observations, and understand the main sources of error.

**Full-or-part-time:** 28h 47m
Theory classes: 7h
Practical classes: 5h
Self study : 16h 47m

### Weather forecasting

**Description:**
Weather forecast. Horizons scales and different prediction systems meteorlògica. Numerical weather prediction models. Presentation of conceptual elements. Common products. Evaluation and accurate numerical estimates of precipitation. Predicting precipitation in the very short term. Advantages and disadvantages. Complementarity with numerical weather prediction models.

**Specific objectives:**
Present the different weather forecasting systems, with special attention to factors such as resolution, forecast horizon, and expected quality of the precipitation forecasts.

**Full-or-part-time:** 4h 48m
Theory classes: 2h
Self study : 2h 48m

## Hydrological processes, rainfall-runoff modelling and hydrological forecasting

**Description:**
Introduction to hydrological processes. The water cycle. The concept of catchment. Water balance.
Evapotranspiration, soil moisture and infiltration.
Runoff. Surface and underground runoff.
Hydrological observations. Gauging stations. Other variables (recharge, evapotranspiration, soil moisture, snow cover...).
Rainfall-runoff modelling. Types of models and main components. Calibration and validation of a hydrological model. Hydrological forecasting.
Rainfall-runoff modelling. Types of models and main components. Calibration and validation of a hydrological model.
Exercises: Hydrological processes

**Specific objectives:**
Introduce the main components of the water cycle and their interactions, and observation systems.
Present the interest of hydrological simulation and the different types of hydrological models.
Introduce the use of rain-runoff models for hydrological forecasting at catchment scale.
Present several case studies in basins of different sizes and different environments.
Understanding the components of the hydrological models based on different case studies.

**Full-or-part-time:** 24h
Theory classes: 5h
Practical classes: 5h
Self study : 14h

## Impact of hydrometeorological processes

**Description:**
Flooding. Effects on ground stability. Detachments, landslides and debris flows.
Elements of risk management. Components of early warning systems. Timescales.
Management of emergency situations. Decision making and responsibilities.
Exercises: Impact of hydrometeorological processes

**Specific objectives:**
Present the main effects of precipitation on the ground.
Analyse early warning systems for hazards triggered by hydrometeorological processes and illustrate the different elements with real cases.
Introduce the management of hydrometeorological emergencies.

**Full-or-part-time:** 20h 24m
Theory classes: 6h 30m
Practical classes: 2h
Self study : 11h 54m

## Effects of Global Change

**Description:**
Climate change and global change. Projections of the effects of global change on hydrometeorological system.
Main elements of the studies of the effects of global change. Case studies.

**Specific objectives:**
Give a brief introduction of the methods used to study the effects of climate change with practical cases.

**Full-or-part-time:** 7h 11m
Theory classes: 3h
Self study : 4h 11m

**Evaluation**

**Full-or-part-time:** 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

## GRADING SYSTEM

The mark of the course will be calculated from the class exercises and the course work (50%) and the final exam (50%).

## EXAMINATION RULES.

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## BIBLIOGRAPHY


**Basic:**
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- González de Vallejo, L.I. Ingeniería geológica [on line]. Madrid [etc.]: Prentice Hall, cop. 2002 [Consultation: 30/04/2020]. Available on: http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1237. ISBN 8420531049.
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**Complementary:**
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- Strangeways, I. Precipitation: theory, measurement and distribution. Camdridge: Cambridge University Press, 2007. ISBN 9780521172929.