250828 - Hydrometeorological Processes and Their Interactions with the Ground

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2019
Degree: MASTER’S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: MARC BERENGUER FERRER
Others: MARC BERENGUER FERRER

Opening hours
Timetable: Wednesday, 12:00 to 13:30.

Degree competences to which the subject contributes

Specific:
13315. To calculate, evaluate, plan and regulate surface and groundwater resources. (Specific competence of the specialization in Groundwater Hydrology).
13323. To model, assess and manage geological resources, including mineral and thermal groundwater. (Specific competence of the specialization in Groundwater Hydrology).

General:
13300. To apply advanced knowledge in sciences and technology to the professional or research practice.
13301. To lead, coordinate and develop integrated projects in Geo-Engineering.
13302. To identify and design solutions for geo-engineering problems within ethical, social and legislative frameworks.
13303. To evaluate the impact of Geo-engineering on environment, sustainable social development and the significance of working within reliable and conscientious professional environment.
13304. To incorporate new technologies and advanced tools in Geo-engineering into professional and research activities.
13305. To conceive Geo-engineering as a multi-disciplinary field that includes relevant aspects from geology, sismology, hydrogeology, geotechnical and earthquake engineering, geomechanics, physics of porous media, geophysics, geomatics, natural hazard, energy and climate interactions.
13306. To promote innovation for the development of methodology, analyses and solutions in Geo-engineering
13307. To tackle and solve advanced mathematical problems in engineering from the drafting of the problem to the development of formulation and further implementation in computer programs. Particularly, to formulate, code and apply analytical and numerical advanced computational tools to project calculations in order to plan and manage them as well as to interpret results in the context of Geo-engineering and Mining engineering.

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.
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.
- The effects of precipitation on soil stability: drag erosion flows and landslides.
- Estimation of danger and vulnerability against floods and drag erosion occurrence.
- 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

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 19h 30m 15.60%</th>
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<tbody>
<tr>
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<td>Hours medium group: 9h 45m 7.80%</td>
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<tr>
<td></td>
<td>Hours small group: 9h 45m 7.80%</td>
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<td>Guided activities: 6h 4.80%</td>
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<td>Self study: 80h 64.00%</td>
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## Content

| **Meteorological processes** | **Learning time:** 8h 24m  
Theory classes: 3h 30m  
Self study: 4h 54m |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>The session will provide an intuitive introduction to the concepts of atmospheric physics relevant in the context of the course.</td>
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<td>Brief introduction to the different types of precipitation, and to the factors that affect its spatial and temporal distribution.</td>
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<td><strong>Specific objectives:</strong></td>
<td>Present different factors with impact on the spatial and temporal distribution of precipitation.</td>
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| **Observation of precipitation** | **Learning time:** 26h 24m  
Theory classes: 7h  
Practical classes: 1h  
Laboratory classes: 3h  
Self study: 15h 24m |
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<tr>
<td><strong>Description:</strong></td>
<td>Presentation of the different systems of observation of precipitation and its measuring principles and sources of uncertainty.</td>
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<td>The session will cover the principles of the precipitation measurement by weather radars, the most common error sources and the most popular radar products.</td>
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<td>Presentation of the systems of satellite observation of precipitation. Measurement principles. Most common products and available datasets.</td>
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<td>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.</td>
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<td><strong>Specific objectives:</strong></td>
<td>Present the different systems for precipitation observation, focusing on their advantages and disadvantages.</td>
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<td>Understanding the operation and the precipitation observations of weather radars.</td>
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<td>Understanding the satellite observation of precipitation.</td>
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<td>Access the most common data sources.</td>
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<td>Understand the observation of precipitation with the various existing systems and their complementarity.</td>
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<td>Manage and monitor weather radar observations, and understand the main sources of error.</td>
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### Weather forecasting

| 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. |

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

| 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. |
## Impact of hydrometeorological processes

**Learning time:** 18h
- Theory classes: 6h 30m
- Practical classes: 1h
- Self study: 10h 30m

**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.

## Effects of Global Change

**Learning time:** 14h 23m
- Theory classes: 3h
- Laboratory classes: 3h
- Self study: 8h 23m

**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.

## Qualification system

The mark of the course will consider the final exam, the final work and the student's participation during the course.

## Regulations for carrying out activities

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Bibliography

Basic:


Complementary:


