Course guide
250822 - 250822 - Stochastic Methods in Hydrology

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:** Spanish

LECTURER

Coordinating lecturer: DANIEL SEMPERE TORRES

Others: MARC BERENGUER FERRER, DANIEL SEMPERE TORRES

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).

Generical:
13300. To apply advanced knowledge in sciences and technology to the profesional 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 consciensous profesional environment.
13304. To incorporate new techncologies and advanced tools in Geo-engineering into profesional 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 subject consists of 3 hours of class per week. The proportion Theory and problems is variable for each session with a final percentage of 55% of Theory and 45% of problems. In addition there is a 3 hour session of follow-up and resolution of doubts, and a session of 3h of evaluation.

As a fundamental activity for the evaluation, a personal work of understanding, application and discussion of an analysis of data from a real case is requested. This work will be the subject of an oral presentation that will be evaluated by the teachers.

Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: contents, programming of assessment activities and directed learning and bibliography.d'aprenentatge dirigit i bibliography.

LEARNING OBJECTIVES OF THE SUBJECT

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
To characterize the geological environment and its interaction with civil works.
To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose testing programmes.
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 model, assess and manage geological resources, including mineral and thermal groundwater. (Specific competence of the specialization in Groundwater Hydrology).

* To manipulate the theoretical concepts of multiphase flow, heat flow and reactive transportation.
* To manipulate the theoretical concepts in geo-statistics.
* To analyze the stochastic data in hydrology and hydrogeology.
* To analyze the flow and reactive transportation processes in aquifers.
* To calculate the groundwater balance.
* To carry out practical aquifer reloading calculations.
* To apply hydrogeochemical and isotopic techniques to the study of aquifer reloading.
* To suggest general studies in groundwater hydrology.

- Geostatistics fundamentals
- Theory of regionalized variable.
- Variogram.
- Structural analysis.
- Theory of local Kriging estimation.
- Montecarlo method.
- Simulation of regionalized variables.
- Introduction to stochastic hydrogeology. Multiple regression. Analysis of the principal components.

Introductory course to the basic techniques of statistical analysis that are used Hydrology. Given that our experience shows that students have the basic concepts acquired mainly at the theoretical level, the course reviews the most important data analysis techniques and focuses on the realization of exercises and application practices to real data. The purpose being to acquire the ability to apply these techniques of spatial and temporal data analysis to real cases.
Generic objectives: Learn to handle basic statistical analysis techniques commonly used in applying them to real data in exercises on real problems Hydrology.

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

1. Introducción a la asignatura/Introducción a los métodos estadísticos utilizados en hidrología:

Description:
* Sistema de evaluación.
* Características del trabajo personal a realizar.
* Que aporta la estadística a la hidrología.
* Técnicas de análisis de datos en hidrología. La importancia de las técnicas estadísticas.
* Caracterización estadística de las variables hidrológicas.
* Ajustes de leyes de distribución de probabilidad.
* Bondad de un ajuste. Criterios estadísticos objetivos.
* Ejemplos con la distribución normal y lognormal

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

2. Calculation of return periods of variable hydrological

Description:
* The concept of return period. Use in hydrology. * Laws of probability distribution of expremos. Gumbel law. GEV. * Graphic setting: need and methodology. * Construction of graphics settings Gaussian, lognormal and Gumbel. * Examples and exercises. * Problem setting extreme values of flow rates. * Probability distributions Log Pearson III, TCEV and SQRT-MAX * Examples and exercises. * The method of GRADEX * Troubleshooting and exercises
* flow duration curve. * Applications to detection of drought, farms and hydrological characterization of the impact of climate change. * Uniformity of series. * Curves double cluster. * Comparison with other variables. * Examples and exercises.

Full-or-part-time: 24h
Theory classes: 4h
Practical classes: 6h
Self study : 14h

5. multivariate statistical analysis:

Description:
5. multivariate statistical analysis:
* Troubleshooting and exercises fit multiple regression

Full-or-part-time: 9h 36m
Theory classes: 2h
Practical classes: 2h
Self study : 5h 36m

7. Principal Component Analysis:

Description:
* Basic concepts. And eigenvalues. * Statistical significance. Choosing the number of variables. * Cluster analysis * Application to improve the reconstruction of series. * Application to improve the reconstruction of 2D fields. * Examples and exercises. * Study of the interpolation of the historical rainfall distribution patterns.
* Troubleshooting and exercises Principal Components Analysis

Full-or-part-time: 9h 36m
Theory classes: 2h
Practical classes: 2h
Self study : 5h 36m

9. Introduction of regionalized variables and Kriging:

Description:
* Basic concepts. Regionalized variables. * Random Functions. stationary and second order stationary random functions. * variogram. Relationship between semi-variogram and covariance stationary random functions. * Ordinary Kriging. * Examples
* Inference variogram. Semi-variogram sample. * semi-variogram models: exponential, spherical, Gaussian and pure nugget. * Exercises * Analysis of advanced structure: scales of variability, anisotropy causes of nugget effect semivariograms stationary and non-stationary. * Introduction to problem solving using IDL * Exercises
* Universal Kriging and residual * Cokriging * Kriging with external co-kriging and co-located derived. * Introduction to geostatistical simulation. * Monte Carlo method. sequential simulation. * Tracks to learn more. * Examples
* Troubleshooting and exercises and kriging geostatistical analysis

Full-or-part-time: 21h 36m
Theory classes: 6h
Practical classes: 3h
Self study : 12h 36m

13. Validation:

Description:
* Basic principle for validation * Simple techniques. * Advanced techniques. * Examples of models and validation on real data * Exercises. * Tracks to learn more.

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

14. Probabilistic models of hydrological forecasting:

Description:
* Concept of uncertainty. Characterization methods of uncertainty. * Impact of uncertainty in forecasting models. * probabilistic forecast. hydrological forecasting ensemble * Probabilistic models of rain forecast * Probabilistic models of rain forecast * Tracks to learn more.

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

15. Follow-up session:

Description:
* Resolution of doubts. * Presentation of results of exercises

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

16. Control of personal gain:

Description:
exercises

Full-or-part-time: 21h 36m
Practical classes: 6h
Laboratory classes: 3h
Self study : 12h 36m

GRADING SYSTEM

he qualification of the subject is distributed in 10% of follow-up activities throughout the course 60% of the personal work presented orally and 30% of the written exam.

EXAMINATION RULES.

If one of the activities of continuous evaluation is not carried out in the programmed period, it will be considered not evaluated.

BIBLIOGRAPHY

Basic:
- Sánchez San Román, F. J. Hidrología superficial y subterránea. Leipzig: F. Javier Sánchez San Román, 2017. ISBN 9781975606602.
- Hidrología probabilística. Ed. Universidad Católica de Chile, 1998. ISBN 956-140513X.
- Clarke, R. Statistical modelling in Hydrology. Wiley, 1994. ISBN 9780471950165.
- Chow, V.T.; Maidment,D.R.; Mays, L. Hidrología aplicada. Santa Fé de Bogotá, Colombia: McGraw-Hill Interamericana, 1994. ISBN 9586001717.
- Helsel, D.R; Hirsch, R.M. Statistical methods in water resources. Amsterdam: Elsevier, 1992. ISBN 0444814639.