Course guide
480USE004 - 480USE004 - Elements of Statistics and Spatial Analysis

Last modified: 17/06/2026

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 749 - MAT - Department of Mathematics.
751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN SUSTAINABILITY AND STRATEGIES FOR A JUST GLOBAL TRANSITION (Syllabus 2026). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: Buenestado Caballero, Pablo

Others: Ferrer Ramos, Núria

PRIOR SKILLS

For optimal progress in the course, it is recommended that students have:
- Digital Competence: Independent user in the use of spreadsheets and file management. Previous experience with GIS tools will be positively valued, although it is not a mandatory requirement.
- Understanding of the Environment: Basic notions of geographic coordinate systems and general concepts of sustainability and the environment.

REQUIREMENTS

- Foundations of Statistics: Knowledge of probability and univariate statistics at an undergraduate level.

TEACHING METHODOLOGY

MD.1.- Active expository teaching (participatory lecture).
MD.3.- Problem-based learning (PBL).
MD.4.- Case studies.
MD.7.- Project-based learning.

LEARNING OBJECTIVES OF THE SUBJECT

Statistics is a fundamental discipline for deriving insights from data, and in this course, it is placed at the service of sustainability and geosciences. The objective is for students to internalize statistical methodology as a framework for analyzing complex phenomena—from data collection to spatial prediction and data visualization—while understanding its implications for urban and territorial development.

The course is eminently applied in nature and is structured around four core pillars aligned with the technical syllabus and key competencies:

- Data Management and Geographic Information Systems: Students will learn to efficiently acquire and process geospatial data and sustainability indicators. They will become familiar with the use of Geographic Information Systems (GIS) software (QGIS) to manage digital data, evaluating data management within the context of open science and the accessibility of information sources.

- Modeling and Probability: The foundations of descriptive statistics and probability models will be covered as a prerequisite for spatial regression. This tool will enable the modeling of geographic trends and the formulation of methodological strategies to analyze socio-ecological systems and support decision-making in sustainability.

- Inference and Hypothesis Testing: Through the use of statistical tests (z, t, chi-square, and ANOVA), students will be able to validate their hypotheses using objective criteria, identifying significant relationships to assess environmental and social impacts.

- Geostatistics and Prediction: Advanced techniques such as variograms and kriging will be introduced. These data science and geospatial analysis tools are key to implementing sustainable management methodologies for natural resources and assessing the challenges of climate change on the geosphere.

Finally, the course places a strong emphasis on data exploration and visualization, enabling students to communicate technical results in a critical and contextualized manner. This foundation prepares students to tackle the more complex models encountered in the discipline of socio-environmental data processing.

STUDY LOAD

Type	Hours	Percentage
Hours large group	22,7	18.15
Hours small group	11,0	8.79
Hours medium group	11,4	9.11
Self study	80,0	63.95

Total learning time: 125.1 h

CONTENTS

Integration and management of geospatial data

Description:
Indicators of sustainability, development, and socio-ecological transition
Databases. Types and accessibility
Geospatial data and GIS

Full-or-part-time: 16h 40m
Theory classes: 6h
Self study : 10h 40m

Statistical modeling

Description:
Data processing and descriptive statistics
Probability
Probability models
Spatial regression (modeling of geographic trends)

Full-or-part-time: 33h 20m
Theory classes: 12h
Self study : 21h 20m

Statistical inference

Description:
z and t hypothesis tests
Chi-square test
ANOVA

Full-or-part-time: 25h
Theory classes: 9h
Self study : 16h

Geostatistics

Description:
Techniques (variograms and kriging)
Spatial prediction and interpolation
Indicators

Full-or-part-time: 16h 40m
Theory classes: 6h
Self study : 10h 40m

Data processing and tools

Description:
Georeferenced data processing
GIS software and tools (QGIS)

Full-or-part-time: 16h 40m
Theory classes: 6h
Self study : 10h 40m

Data visualization and presentation

Description:
Data exploration and visualization (e.g., Tableau)

Full-or-part-time: 16h 40m
Theory classes: 6h
Self study : 10h 40m

GRADING SYSTEM

The continuous assessment system is based on three core elements: active participation in face-to-face sessions, a two-part lab report, and a final project. The final grade (NF) is calculated using the following formula:

NF = 0.45*P + 0.45*T + 0.10*PA

Where the components are distributed as follows:
- Practical Course Grade (P = P1 + P2 —> 45%): Corresponds to the assessment of the lab report carried out in pairs. It is divided into two submissions throughout the course with equal weight (P1 during the first half and P2 during the second half).
- Project Grade (T —> 45%): Final project aimed at globally assessing the learning objectives achieved by the students. This will also be done in pairs.
- Active Participation (PA —> 10%): Assessment of engagement and involvement in face-to-face sessions throughout the entire course.

EXAMINATION RULES.

- To pass the course, it is compulsory to submit all assessment activities (P1, P2, and T) within the established deadlines.

- Continuous assessment tests are strictly individual, with the exception of the lab reports (P1 and P2) and the final project (T), which will be done in pairs.

- The use of generative AI tools shall be adjusted to the specific instructions of each assessment activity.

- Any sign of plagiarism, copying, or unauthorized use of external tools will result in the immediate application of the UPC academic regulations (failing the activity).

BIBLIOGRAPHY

Basic:
- Navidi, William. Estadística para ingenieros y científicos [on line]. 5a ed. Ciudad de México: McGraw Hill, 2022 [Consultation: 29/07/2026]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=13722. ISBN 9781456293147.
- Dodge, Yadolah. The concise encyclopedia of statistics. New York: Springer, 2010. ISBN 9781441913906.
- Devore, Jay L. Probabilidad y estadística para ingeniería y ciencias. 9a ed. México: Cengage Learning, 2016. ISBN 9786075228280.
- Pérez López, César. Estadística aplicada : conceptos y ejercicios a través de Excel. Madrid: Garceta, 2012. ISBN 9788415452058.
- Bolstad, Paul. GIS Fundamentals: A First Text on Geographic Information Systems. 7th Edition. White Bear Lake: Eider Press, 2022. ISBN 9780971764750.

Complementary:
- Peña, Daniel. Análisis de datos multivariantes [on line]. Madrid [etc.]: McGraw-Hill, cop. 2002 [Consultation: 29/07/2026]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4203. ISBN 8448136101.

RESOURCES

Hyperlink:
- The concise encyclopedia of statistics. https://doi-org.recursos.biblioteca.upc.edu/10.1007/978-0-387-32833-1- QGIS Documentation Team. (2023). QGIS Training Manual (Versión 3.x). https://docs.qgis.org/latest/en/docs/training_manual/

Other resources:
Course materials available on ATENEA