

**COURSE DATA****Data Subject**

<b>Code</b>	33108
<b>Name</b>	Indicators and environmental monitoring
<b>Cycle</b>	Grade
<b>ECTS Credits</b>	4.5
<b>Academic year</b>	2022 - 2023

**Study (s)**

<b>Degree</b>	<b>Center</b>	<b>Acad. year</b>	<b>Period</b>
1104 - Degree in Environmental Sciences	Faculty of Biological Sciences	4	First term

**Subject-matter**

<b>Degree</b>	<b>Subject-matter</b>	<b>Character</b>
1104 - Degree in Environmental Sciences	176 - Environmental indicators and monitoring	Optional

**Coordination**

<b>Name</b>	<b>Department</b>
GARCIA ROGER, EDUARDO MOISES	275 - Microbiology and Ecology
ROCA PEREZ, LUIS	25 - Plant Biology
SACRISTAN MORAGA, DANIEL	25 - Plant Biology

**SUMMARY**

This course will provide theoretical and practical introduction to the use of indicators of environmental and ecological status, as well as planning and conducting follow-up (monitoring) environment. Indicators are measures of a component or material environmental phenomenon, used to estimate or evaluate conditions or environmental changes or to establish environmental goals. Therefore, knowledge of the indicators is essential in ecological research and environmental management, for its versatility and synthetic capacity in the evaluation of the state of the habitat and ecosystem. Here we will therefore both descriptive indicators (ecological) and standards (indicators for environmental management), either abiotic or biological indicators. Be detailed use, selection and applications, and interpretation. Environmental monitoring involves obtaining environmental data over time to observe or detect changes in key variables. This monitoring is usually focused on environmental management objectives, or to evaluate possible harmful effects of human impacts on biodiversity or investigate ecological processes over time. This course aims to clarify the needs and planning strategies for environmental monitoring, and practical aspects to carry out quality monitoring. regular monitoring networks will be introduced, but



also what methods and techniques can be implemented in the field for data and indexes in a standardized and quality for proper environmental monitoring and further analysis to draw conclusions with statistical soundness.

## PREVIOUS KNOWLEDGE

### Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

### Other requirements

Consolidated knowledge of Ecology and Soil Science.

Working knowledge of spreadsheet programs and internet search tools.

## COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

### 1104 - Degree in Environmental Sciences

- Capacidad para seleccionar y aplicar sistemas de indicadores ambientales en el medio natural.
- Capacidad para diseñar sistemas de monitorización ambiental y realizar planes de vigilancia en distintos sistemas naturales.

## LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

Practical work involving problem solving, data analysis and critical interpretation.

Using bibliographic databases in electronic form, access to magazines and other printed and electronic format, and use of at least one presentation software.

Solving problems involving making qualitative and quantitative data in the laboratory or field, the analysis of these data and their interpretation in a theoretical context.

Knowledge and application of environmental indicator systems in the natural environment.

Knowledge of the main types of indicators and their particular use.

Practice and use of ecological indicators in the field and interpreting their meaning in the assessment of ecological status.

Development of environmental monitoring systems and implementation of environmental monitoring plans.

Implementation issues and case owners of different sampling techniques in environmental and ecological data.

Planning and analysis of data resulting from the environmental monitoring.



## DESCRIPTION OF CONTENTS

### 1. Basic characteristics of the environmental indicators

- 1.1 Introduction to environmental indicators.
- 1.2 Characteristics to meet the indicators.
- 1.3 Main types of indicators.
- 1.4 Indicators and temporal and spatial variability of the natural environment.

### 2. Design and selection of indicators

- 2.1 Selection of indicators.
- 2.2. Models of indicators.

### 3. Abiotic indicators of the environmental and land use

- Indicators of the soil environment.
- Indicators of the aquatic environment.
- Indicators of land use.

### 4. Data processing, development of indicators and ad-hoc indexes. Spatial variability.

- 4.1. Sampling methods and design.
- 4.2. Exploratory data analysis.
- 4.3. Geostatistics.
- 4.4. Elaboration of principal component indices.

### 5. Biological indicators of ecological status and biodiversity

- 5.1. Criteria for the selection of ecological status indicators.
- 5.2. Classification of ecological status indicators.
- 5.3. Indices based on indicator species.
  - 5.3.1. Concept of ecological niche.
  - 5.3.2. Stenoic indicator species.
  - 5.3.3. Endemic and protected species.
  - 5.3.4. Alien and invasive species.
- 5.4. Indices based on ecological strategies.
- 5.5. Indices based on diversity measures.
- 5.6. Indices based on measures of biomass and abundance.
- 5.7. Integral and holistic indices.
- 5.8. Indicators in paleoecology, environmental reconstruction and ecological restoration.



## **6. Use of indices of ecological status in rivers in the context of the Water Framework Directive.**

- 6.1. The Water Framework Directive
- 6.2. Typological classification of rivers
- 6.3. Criteria for selection of reference sites and definition of reference conditions
- 6.4. Indices for river ecological status studies.
  - 6.4.1. Organisms used.
  - 6.4.2. Unimetric indices.
  - 6.4.3. Multimetric indices.
- 6.5. EQR values and intercalibration exercises.
- 6.6. Establishment of quality classes.

## **7. Indicators for the study of the ecological status of marine ecosystems**

- 7.1. Introduction.
- 7.2. Types of indicators.
  - 7.2.1. Environmental and habitat indicators.
  - 7.2.2. Indicators based on key species.
  - 7.2.3. Indicators based on size.
  - 7.2.4. Trophodynamic indicators.
- 7.3. Network analysis.
- 7.4. Application cases including fisheries maintenance.

## **8. Use of ecological state indices in terrestrial ecosystems. Application of thermodynamic indices in agroecosystems**

- 8.1. Energy and entropy balance in a terrestrial ecosystem: agroecosystem.
- 8.2. Entropy surplus as an index of ecosystem degradation.
- 8.3. Criteria and reference conditions.
- 8.4. Examples

## **9. Introduction to environmental monitoring**

- 9.1. Introduction to environmental monitoring. Necessities, periodicity, regulations and dissemination.
- 9.2. Types of environmental monitoring. Data analysis.
  - 9.2.1. Inventory design.
  - 9.2.2. Status and trend studies.
  - 9.2.3. Cause and effect studies.
- 9.3. Design of environmental monitoring plans.
  - 9.3.1. Randomized design.
  - 9.3.2. Systematic design.
  - 9.3.3. Stratified design.
  - 9.3.4. Multilevel design.
- 9.4. Data collection methods.
- 9.6. Networks for monitoring abiotic environment and environmental processes.

**10. Informatics practices**

- 10.1. Exploratory analysis of survey data on As, Cd and Pb contamination (statistics and geostatistics).  
10.2. Evaluation of soil contamination by heavy metals with indices generated by principal component analysis (PCA) and geoaccumulation indices (Igeo).

**11. Laboratory Practice**

- 11.1. Analysis and evaluation of water quality indicator parameters.  
11.2. Analysis and evaluation of indicator parameters of soil properties.

**12. Field Practice**

Obtaining biological indices and taking samples to calculate environmental indicators. Sampling techniques will be used to monitor organisms and habitat. The field trip will be carried out jointly with other subjects to a site with areas with little impact and others more disturbed by man.

**WORKLOAD**

ACTIVITY	Hours	% To be attended
Theory classes	27,00	100
Laboratory practices	12,00	100
Computer classroom practice	4,00	100
Tutorials	2,00	100
Attendance at events and external activities	4,00	0
Development of group work	10,00	0
Development of individual work	10,00	0
Readings supplementary material	3,50	0
Preparation of evaluation activities	15,00	0
Preparing lectures	5,00	0
Preparation of practical classes and problem	10,00	0
Resolution of case studies	10,00	0
<b>TOTAL</b>	<b>112,50</b>	

**TEACHING METHODOLOGY**





The hours of classroom theory will be taught primarily through lecture methodology, with the support of board and presentations, which will first be made available to the students in the virtual classroom. Also, you can also use participatory methods of problem solving or case studies, and discussion of scientific texts, guided by the teacher.

The hours of computing be taught in groups of approximately 32 students working in pairs. In these sessions students, supervised by a teacher, do exercises using data processing software such as spreadsheets or statistical.

Hands-on activities will include field sessions (7h) and laboratory (5h). In field and laboratory sessions are groups of approximately 16 students and work in pairs or in groups of 4. Under the supervision of a teacher, do practical work related to the themes developed in the theory sessions. In the field work to obtain biological indices and sampling for calculation of environmental indicators and sampling techniques used for monitoring organisms and habitat. The field trip will take place with other subjects in a place with little impacted areas and more disturbed by man.

The tutorials are performed in subgroups of 16 students or so. In them, the teacher monitors the work and progress of students and addresses the concerns raised.

## EVALUATION

The evaluation of knowledge is done through a written test (examination) consists of multiple choice and open questions. The issues may include any aspect that has been presented, discussed and worked in lectures, tutorials, seminars and practices that have been independently in computer classroom, lab or field. In order to get approved will be necessary to overcome a 5 on the exam. This examination will consist of two parts according to the syllabus. The review counted 80% of the final grade.

In the part of the subject taught by the Educational Unit of Ecology, students attend one or more workshops with oral presentations in the classroom for guest researchers. The attendance at the seminar counted 15% of the final grade.

In the part of the course taught by the Educational Unit of Soil Science, Reports and / or practical activities counted 10%.

To pass the course will have to overcome each of the parties with at least 5 points 10 on each.

## REFERENCES

### Basic

- Heink, U. & I. Kowarik, 2010. What are indicators? On the definition of indicators in ecology and environmental planning. *Ecological Indicators* 10(3): 447-459
- McComb, B., et al., 2010. *Monitoring animal populations and their habitats: a practitioners guide*. CRC Press.



- Cassatella, C., Peano, A., 2011. Landscape Indicators. Assessing and Monitoring Landscape Quality
- Jorgensen et al. (Eds) 2005. Ecological Indicators for Assessment of Ecosystem Health. CRC press.
- Spellerberg, I. 2005. Monitoring ecological change. Cambridge Univ. Press.
- Berger, A.R. & W.J. Iams 1996. Geoindicators: Assessing Rapid Environmental Changes in Earth Systems. Rotterdam: A.A.Balkema.
- Aguirre Royuela, M.A., 2002. Los sistemas de indicadores ambientales y su papel en la información e integración del medio ambiente. I Congreso de Ingeniería Civil, Territorio y Medio Ambiente, febrero 2002, Madrid. Vol. II, pp. 12311256.
- Banco Público de Indicadores Ambientales (BPIA) - Calidad y evaluación ambiental - magrama.es [WWW Document], n.d. URL <http://www.magrama.gob.es/es/calidad-y-evaluacion-ambiental/temas/informacion-ambiental-indicadores-ambientales/banco-publico-de-indicadores-ambientales-bpia/#> (accessed 5.14.15).
- Artiola, J., I. L. Pepper, M. L. Brusseau 2004. Environmental Monitoring and Characterization. Elsevier Science & Technology Books.
- Berger, A.R. & W.J. Iams 1996. Geoindicators: Assessing Rapid Environmental Changes in Earth Systems. Rotterdam: A.A.Balkema.
- Environmental indicator report 2013 European Environment Agency (EEA) [WWW Document], n.d. URL <http://www.eea.europa.eu/publications/environmental-indicator-report-2013> (accessed 5.14.15).
- Fidalgo, M.L., Ferreira, C., Sampaio, A., 2013. Assessment of the preferences of red swamp crayfish (*Procambarus clarkii*) fed with Riparian tree leaves: A microcosm study. International Review of Hydrobiology 98, 183190. doi:10.1002/iroh.201301536
- Liu, Y., Zheng, B.H., Fu, Q., Wang, L.J., Wang, M., 2012. The Selection of Monitoring Indicators for River Water Quality Assessment. Procedia Environmental Sciences 13, 129139. doi:10.1016/j.proenv.2012.01.013
- Lobato, T.C., Hauser-Davis, R.A., Oliveira, T.F., Silveira, A.M., Silva, H.A.N., Tavares, M.R.M., Saraiva, A.C.F., 2015. Construction of a novel water quality index and quality indicator for reservoir water quality evaluation: A case study in the Amazon region. Journal of Hydrology 522, 674683. doi:10.1016/j.jhydrol.2015.01.021
- Mason B.J., 1992. EPA. Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies. ENVIRONMENTAL MONITORING SYSTEMS LABORATORY OFFICE OF RESEARCH AND DEVELOPMENT U.S. ENVIRONMENTAL PROTECTION AGENCY LAS VEGAS, NEVADA 89193.
- Schuschny, A. & Soto H., 2009. Guía metodológica Diseño de indicadores compuestos de desarrollo sostenible, Colección Documentos de proyectos. Comisión Económica para América Latina y el Caribe (CEPAL) Naciones Unidas.
- Sotelo, J.A. et al., 2011. Indicadores por y para el desarrollo sostenible, un estudio de caso. Estudios Geográficos Vol. LXXII, 611654. doi:10.3989/estgeogr.201124
- Tugel, A.J. et al., 2008. Soil Change Guide: Procedures for Soil Survey and Resource Inventory, Version 1.1. USDA, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.



- USDA-NCRS, 2008. Installing Monitoring Wells in Soils. USDA Natural Resources Conservation Service National Soil Survey Center Lincoln, Nebraska.
- USDA-NCRS, n.d. Soil Quality as an Indicator of Sustainability [WWW Document]. URL [http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs142p2\\_053174.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053174.pdf) (accessed 5.14.15).
- USDA-NRCS, n.d. Soil Quality Indicator Sheets [WWW Document]. URL <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/health/assessment/?cid=stelprdb1237387> (accessed 5.14.15).