Climate Change. Impacts in the Marine Environment and Coastal Zone (250582)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	6.0 ECTS
Programs	GRAU EN CIÈNCIES I TECNOLOGIES DEL MAR (pla 2018)
Course	2024/25

Main teaching language at each group

- Group 10CA1 Catalan (Q1)

Faculty

Responsible Faculty: Octavio Cesar Mösso Aranda
Faculty: Manuel Espino Infantes, Albert Folch Sancho, Manuel Grifoll Colls, Maria Liste Muñoz, Juan Pedro Martín Vide, Octavio Cesar Mösso Aranda, Xavier Pascual Lorente, Xavier Sánchez Artús, Agustin Sanchez-arcilla Conejo, Juan Pablo Sierra Pedrico

Objectives of Education

In this subject, basic aspects of Climate Change at a global scale will be addressed (considering the future scenarios described by the IPCC), and its impact at a regional coastal scale. Emphasis will be placed on the main factors of change at the coast, such as the variation of the mean sea level, the distribution of extreme wave, wind and rain events, water temperature and its relation to acidification. Finally, the most relevant aspects of the impact on the coasts and ports and, in general, on the planning of the coastal zone will be addressed.

1. Understand the anthropogenic causes of climate change. Understand the different projections presented in the IPCC reports.
2. Understand the impact of climate change on marine and coastal systems from an ecological, physical and human point of view.
3. Become familiar with the most common methods to mitigate the effects of climate change on the coast, and potential adaptation techniques, both natural and assisted.

The topics addressed in this matter cover most of the physical, environmental and ecological problems and challenges identified by the scientific community and the social agents that the coastal zone will face in the near future under different development scenarios and climate change.

* Introduce vocabulary and concepts used in the analysis of climate change. * Analyze the basis and present dynamics of the marine and coastal environment to be able to evaluate the climatic impact. * Participate in multi-disciplinary work teams, made up of students with different curricular itineraries and led by teachers with different skills to respond to the challenges posed by climate change. * Evaluate the multiple dimensions of the impact on the marine and coastal environment with multi-disciplinary criteria. * Address the most relevant scales and processes that determine the physicochemical, biological-geological and socio-economic components of climate change over the coastal zone. * Pose and analyze possible interventions for an adaptation of the coastal zone together with the adjacent marine and terrestrial strip and thus achieve greater sustainability under climate change. * Use data and models to calculate the impacts of climate change on marine and coastal areas and possible adaptation measures. * Develop a conceptual framework to structure the actions of adaptation to time scales ranging from storms to decades and space scales ranging from a coastal ecosystem to a regional analysis of the marine environment (terrestrial,

coastal and platform) under different climatic scenarios. * Possess an integrated perspective of the different tools and technologies of calculation to determine impacts and paths of adaptation to the climatic change to marine and coastal zones. * Improve the ability to write reports and present analyzes on the impact of climate change on marine and coastal areas.

Competencies

Especific

To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.
Establish a good practice in the integration of common numerical, laboratory and field techniques in the analysis of any problem related to the marine environment.
Participate and eventually lead multidisciplinary work teams in the field of Marine Sciences and Technologies to respond to the social challenges related to this field.
Evaluate the bio- and geo-diversity of the marine environment, identifying habitats and ecosystems with multidisciplinary criteria.
Evaluate the dynamics of seas and oceans at different scales, identifying water masses and their properties. (Specific competence of Marine Science and Engineering Mention)
Address the most relevant processes and their interactions related to their physical / chemical / biological / geological components, applying technical and scientific knowledge and criteria.
To set, analyze and optimize the functionality of actions and infrastructures in the marine environment. (Specific competence of the Marine Science and Engineering Mention)
Carry out operational predictions in the open sea and coastal areas, including the corresponding risk maps. (Specific competence of the Marine Science and Engineering Mention)
Use state-of-the-arte mathematical models in the marine field to analyze impacts and interactions with socio-economic activities supported by this environment. (Specific competence of the Marine Science and Engineering Mention)
Develop a conceptual framework to address the sustainability of the marine environment and the related socio-economic activities at different scales, explaining the effects of climate change.
Set, plan and execute basic and applied research in the field of Marine Sciences and Technologies.
Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.
Write technical reports and disseminate knowledge about the different components of the marine system, considering the applicable legal framework.

Generic

Apply state-of-the-art methods and techniques in oceanography and marine climate, jointly covering the physical, chemical, geological and biological aspects.
Develop a conceptual framework that links the scientific-technological and management aspects for marine resources, explaining the interactions with marine infrastructures and management plans in coastal areas.
Encompass and teach studies in the different research lines that converge in Marine Sciences and Technologies.
Combining preservation with economic activity within the framework of current legislation promoting the development of a social and environmental awareness.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	30.0 h	50.00 %
	Medium group	15.0 h	25.00 %
	Laboratory classes	15.0 h	25.00 %
	Guided Activities	0.0 h	0.00 %
Self Study		90.0 h	

Contents

1. Introduction to climate change in environments coastal

Presentation of the structure
Hydrodynamic models for beaches. Morphodynamic response models. Calibration and limits under present conditions. Application under future scenarios. Implications for calculating impacts. Support for adaptation projects

Specific Objectives

Introduction to climate change in coastal environments
Present the models for the hydro-morphodynamic analysis of beaches and the possible calculation of the impacts of different actions. Familiarize students with models under present conditions and explore the effect of future scenarios.

2. Meteo-oceanographic factors. Sea level and swell

Average steric and local sea level. Scales of change. Regional and local waves. Scales of change. Affectation in low coastal areas. Affectation of port infrastructures. Affectation of promenades. Conclusions for adaptation.

Specific Objectives

Familiarize the student with the meteo-oceanographic factors under present and future conditions and their interactions, with emphasis on their impact on natural systems and coastal and port infrastructures.

3. Meteorographic factors. Analysis with real data

Analysis of storms and climatic trends. Calculation programs. Applications under present climate. Meteorological variables. Oceanographic variables. Applications under future climates.

Specific Objectives

Carry out a practical analysis of the variability of meteorological and oceanographic factors relevant to pacts in ports and beaches. Compare differences under present and future conditions.

4. Geological factors. Topography and bathymetry of the Catalan coast

Tectonic variations and average sea level. Subsistence in deltaic areas. Applications on the Catalan coast. Variation of bathymetry and topography and consequences for impacts. Coupling due to meteorological forcing associated with topo-bathymetry. Variations in the active profile of the beach and monitoring of a dynamic topography.

Specific Objectives

Familiarize the student with how geological factors condition the impact of climate change on natural systems and infrastructures in the coastal area, with special emphasis on the Catalan coast.

5. Continental contributions and river-delta-sea connection on the Catalan coast. The case of the river Ebro

Present the connection between the continent and the maritime area, especially the coast, in terms of water flows, sediments, nutrients and pollutants under present and future conditions, considering the interactions with the different existing infrastructures and / or plan

Specific Objectives

Present the connection between the continent and the maritime area, especially the coast, in terms of water flows, sediments, nutrients and pollutants under present and future conditions, considering the interactions with the different existing and / or planned infrastructures.

Continental contributions and river-delta-sea connection on the Catalan coast. The case of the Llobregat river

Continental contributions by surface runoff. Effects of packaging. Effects of river regulation. River-delta / estuary connection. River-sea connection due to the Mediterranean climate. The case of the Llobregat.

Specific Objectives

Present the connection between the continent and the maritime area, especially the coast, in terms of water flows, sediments, nutrients and pollutants under present and future conditions, considering the interactions with the different existing and / or planned infrastructures.

7.Coastal aquifers, with exchange and salinization flows under present and future climatic scenarios

Continental contributions by surface runoff. Effects of packaging. Effects of river regulation. River-delta / estuary connection. River-sea connection due to the Mediterranean climate. The case of the Llobregat.

Specific Objectives

Present the connection between the continent and the maritime area, especially the coast, in terms of water flows, sediments, nutrients and pollutants under present and future conditions, considering the interactions with the different existing and / or planned infrastructures.

9. Hydro-morphodynamic modeling of real beaches under present and future conditions

Hydrodynamic modeling of beaches. Domains and boundary conditions. Morphodynamic modeling of beaches. Domains and boundary conditions. Calibration and validation under present conditions. Applications under future climates. Limits of application.

Specific Objectives

Develop practical applications of hydrodynamic and morphodynamic models for beaches typical of the Catalan coast, considering the differences under present and future conditions.

10. Early warning systems and their technical evolution under present and fu climatic conditions

Coastal early warning systems available. Applications to port cases. Applications to beach cases. Thresholds for present conditions. Thresholds for future conditions. Extrapolation of the modeling under future conditions.

Specific Objectives

Introduce the available coastal early warning systems and plan their evolution based on technical advances and future climate scenarios, based on real examples of our coast.

11. Approach of the course work

Program for the elaboration of the course work. Elaboration of groups. Assignment of topics Evaluation criteria.

Specific Objectives

Elaboration of a group course work

12.Concepts of sustainable development for marine and coastal areas under present scenarios

Concepts of development and sustainability. Application to the coastal zone. Scales of analysis. Marine areas and ecosystems. Coastal areas and ecosystems. Coastal infrastructures. Interactions under present conditions and under future scenarios.

Specific Objectives

Present the concepts of sustainable development for coastal areas, analyzing their application for different types of coast and port infrastructures.

13. adaptation tools for low coasts (deltas / estuaries) and artificial ones. Concepts and models

Concept of adaptation. Limit point concept. Adaptation routes. Necessary models and calculations. Application to deltaic coasts. Application to artificial coasts. Application to other coastal typologies with high vulnerability.

Specific Objectives

Present the concept of adaptation route and its temporal evolution depending on the interventions that are carried out. Also present the concepts of limit points and their application to different coastal and port cases on our coast.

14. Adaptation routes for ports and dikes under present and future scenarios. Concepts and models

Port adaptation routes. Functional and resistant analysis. Differences and complementarities with natural systems. Limit point review. Applications for dikes. Applications for other port infrastructures. Applications for promenades.

Specific Objectives

To generalize the concept of adaptation routes for coastal infrastructures, mainly ports but also including promenades. Illustration with cases of the Catalan coast.

15.PRACTICE 3 Numerical modeling for the adaptation of dikes to climate change. Functional analysis and resis

Functional modeling of dikes and calibrations. Durable modeling of dikes and calibrations. Validation and limits under present conditions. Interactions under present conditions. Application under future conditions.

Specific Objectives

Develop a practical application of models for the functional and resilient analysis of dikes under present and future conditions, comparing the differences in impact and the limits of the models.

16. Presentation of the course work

Activities

1. Climate change in Catalonia. Temperature, precipitation and other relevant variables

Temperature, precipitation and other relevant variables

Dedication

2h

2. Climate action commitments and emblematic projects related to the sea and the coast

Dedication

2h

3. Environmental responsibility for the river-sea connection. The case of Flix

Dedication

2h

Teaching Methodology

This course has been structured in 42 hours of theory class per course, complemented with 16 hours of practice and 2 hours of laboratory.

Although most of the sessions will be taught in the language indicated in the guide, it is possible that the sessions with the support of other invited experts may be taught in another language.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

Ordinary Evaluation (EO)

The grade of the continuous evaluation is the weighted arithmetic average of the two exams of the subject, which will have the same value (50% and 50%). The continuous evaluation will have a maximum modification of 10%.

In order to pass, the final grade of the EO must be greater or equal to 5.

Re-evaluation (RE)

Criteria of qualification and admission to the re-evaluation (Re):

Students suspended to the ordinary evaluation who have regularly presented themselves to the evaluation tests of the suspended subject will have the option to take a re-evaluation test in the period fixed in the academic calendar. Students who have already passed the re-evaluation test of a subject and students who have been marked as "no-shows" will not be allowed to take the re-evaluation test.

The re-evaluation (RE) will consist of a single exam covering the entire course content. The maximum grade for the re-evaluation will be five (5.0) and the final grade for the course will be the maximum grade between the continuous evaluation and the re-evaluation exam.

The non-attendance of a student summoned to the re-evaluation test, held in the fixed period, will not give rise to the realization of another test at a later date. Extraordinary evaluations will be carried out for those students who, due to accredited force majeure, have not been able to take any of the continuous evaluation tests. These tests must be authorized by the corresponding head of studies, at the request of the professor responsible for the subject, and will be held within the corresponding academic period.

Test Rules

If any of the laboratory or continuous evaluation activities are not performed in the scheduled period, it will be considered as a zero score. The exams will be individually administered, with multiple-choice questions that can be theoretical or problem-type questions. The exams may include short questions to be developed by the students and exercises to be solved.

Office Hours

Appointments will be arranged by e-mail with students who request them.

Bibliography

Basic

- Masselink, Gerd ; Gehrels, Roland. Coastal Environments and Global Change. Chichester : Wiley: Wiley, 2014. ISBN 9780470656594.

- Basco, David. Design of Coastal Hazard Mitigation Alternatives for Rising Seas. Singapore: World Scientific 2020, 2020. ISBN 9789811206931.

Complementary

- Science of The Total Environment. Science of The Total Environment, 2016.
- Berry PM, Betts RA, Harrison PA, Sanchez-Arcilla A. High-end climate change in Europe, Impacts, Vulnerability and Adaptation. Sofia, Bulgaria: Pensoft Pu, 2017. ISBN 9789546428615.
- Intergovernmental Panel on Climate Change. Climate change 2022 : mitigation of climate change. IPCC, 2022. ISBN 978-92-9169-160-9.