Coastal Hydromorphodynamics (250581)

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 10ES1 Spanish (Q1)

Faculty

Responsible Faculty: Octavio Cesar Mösso Aranda
Faculty: Ivan Caceres Rabionet, Octavio Cesar Mösso Aranda

Objectives of Education

This subject will show the most important hydro-morphodynamic aspects related to coastal physical processes induced by various forcing mechanisms, such as the astronomical tides, meteorological tide, the wind, and in particular, the breaking of waves. Emphasis will be placed on sea level changes, on circulation and on the resulting transport. Subsequently, the most relevant aspects related to coastal protection and the integral management thereof will be shown.

1. Familiarization with basic concepts of coastal waves and hydrodynamics, their characteristics and their differences with hydrodynamics in the open sea.
2. Understand fluid-sediment interaction, sediment transport processes and their relation to morphodynamic processes and coastal and estuarine evolution
3. Relate hydrodynamics and coastal processes at different spatial and temporal scales
4. Application of analytical and numerical models of morphodynamic evolution

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.

To provide students with the necessary knowledge to understand hydromorphodynamic processes and the importance they have on coastal actions, both from an environmental and functional point of view, particularly those that have an impact on the morphology and configuration of the coast. The organization of the course has a well-defined hierarchical structure, starting with waves, their generation, characterization, study in the short, medium and long term, propagation, breakage and hydromorphodynamic processes induced by breakage. Coastal current generation, sediment transport mechanics, sea levels (study techniques and trend analysis), longitudinal and transverse transport to the beach, and analytical models of coastal evolution will be addressed. The strictly functional design of coastal protection works will be addressed, analyzing their environmental impact.

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.
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 environmental impact, management and protection studies of the marine environment and adjacent coastal areas, including the corresponding infrastructures and their related impacts.
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.
Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.

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

Introduction

Introduction to the course

Specific Objectives

Basic objectives of the course and approach. Definition of the problem concept (processes vs. problems). Definition of the coastal zone as a multicomponent system (physical, ecological and socio-economic). Concept of temporal and spatial scales for the definition of processes, problems and solutions. Basic typology of coastal problems and conceptual solutions.

Hydrodynamic Processes

Regular wave basics
Regular Swell
Basic Aspects of Irregular Waves

Irregular swell
Fundamental aspects of wave propagation and breaking
Wave Propagation and Breaking
Radiation Stress.
Radiation Tensor Concept
Coastal currents
Coastal currents
Sea level variations
Sea Level Variations

Specific Objectives

Assumptions made and field of validity. Small amplitude waves. Movement of particles. Group speed. Energy and energy flow.
Wave Generation. Statistical description of the waves. Spectral description. Average wave regime. Temporary regime. Return periods.
Shoaling. Refraction. Diffraction. Reflection. Break. Edge wave generation.
Processes associated with wave asymmetry and breakage. Radiation Tensor. Variation in sea level due to breakage of the waves.
Wave breaking as a driving agent. Current systems: longshore, in cells and cross-shore to the beach and the response of the beach.
Generation of Meteorological Tides. Components of the meteorological tide. Prediction. Sea level measurements with Tide Gauges. Analysis techniques (Time Series and Trend Analysis).

Evaluation

Sediment Transport

Fundamental aspects of the mechanics of sediment transport
Sediment transport mechanics
Sediment Transversal Transport
Cross-shore Sediment Transport
Longshore Sediment Transport
Longitudinal Sediment Transport
Aeolian Sediment Transport

Specific Objectives

Logarithmic Velocity Profile. Boundary layer concept. Prandtl Mixing Theory. Fluid-Sediment Interaction. Start of Transportation. Formulations for Swell, Currents and Combined Flow.
Driving Agents. Balance profile concept. The role of transverse transport in coastal changes. Parameters that determine transport. Transversal transport models.
Driving Agents. The role of longitudinal transport in coastal changes. Integrated longitudinal transport. Local transportation. Calculation of longitudinal transport. Integrated Formulations (CERC, Kamphuis).
Driving Agents. The role of aeolian sediment transport in the generation of Dunas. Parameters that determine transport.

Coastal Evolution

Coastal Evolution
Coastal Evolution Models
Coastal Evolution Models
Morphodynamic Impact of Structures

Specific Objectives

Balance concept. Active depth concept. Sedimentary balance. Changes in the shoreline and beach profile.
Analytical models in plan and profile. Model of a line for plant changes. Profile change models. 2DH models. Large-scale models. Calibration and validation of the models.
Typology of coastal protection structures. Walls, Breakwaters and Dikes exempted. Functional design and impact.

Activities

Irregular Waves

Wave generation. Statistical description of the waves. Spectral description. Average swell regime. Storm regime. Return periods.

Dedication

1h

Wave Propagation and Breaking

Shoaling. Refraction. Diffraction. Reflection. Rupture. Generation of edge waves.

Dedication

1h

Sea Level Variations

Meteorological tide generation. Components of the meteorological tide. Prediction. Sea level measurements with tide gauges. Analysis techniques (Time Series and Trend Analysis).

Dedication

1h

Sediment Transport Mechanics

Logarithmic Velocity Profile. Boundary layer concept. Prandtl Mixing Theory. Fluid-Sediment Interaction. Start of Transportation. Formulations for Swell, Currents and Combined Flow.

Dedication

1h

Cross-shore Sediment Transport

Driving agents. Concept of equilibrium profile. The role of transverse transport in coastal changes. Parameters that determine transport. Models of transverse transport.

Dedication

1h

Longshore Sediment Transport

Driving Agents. The role of longitudinal transport in coastal changes. Integrated longitudinal transport. Local transportation. Calculation of longitudinal transport. Integrated Formulations (CERC, Kamphuis).

Dedication

1h

Teaching Methodology

The course consists of 2.3 hours per week of classroom activity (large size group) and 1.2 hours weekly with half the students (medium size group).

The 2.3 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 1.2 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Note: The language in which the course is taught will depend on the teacher. Specifically, Professor César Mösso will give his classes in Spanish, and Professors Vicenç Gracia and Iván Cáceres will give them in Catalan.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

Grading Rules

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

Ordinary Evaluation (EO) The qualification of the continuous evaluation is the weighted arithmetic mean of the exercises/problems (Pr) carried out during the course, of the directed activities such as assignments or reports (Tr) and of the partial exams (Ex, which will have the same value). There will be two partial exams and they will count for 70% of the grade. Problems will count 15% and directed activities will count 15%. If the entire group agrees, the first partial exam can be replaced by the delivery of a numerical tool (made for example in Excel, Matlab, etc.), which calculates and solves all the processes explained in the first part of the exam. syllabus. The final mark will be EO=0.7*(average of Ex1 and Ex2)+0.15*(average of Pr) +0.15*(average of Tr). To pass, the EO grade must be greater than or equal to 5. Re-evaluation (RE) Qualification and admission criteria for re-evaluation (Re): Students who have failed the ordinary evaluation and who have regularly attended the assessment tests of the failed subject will have the option to take a reassessment test in the period set in the academic calendar. Students who have already passed or students who have not been submitted or who have not handed in all the exercises/problems (Pr) and the papers and reports (Tr) may not take the reassessment test of a subject. The reassessment (RE) will consist of a single exam that covers all the content of the course. The maximum grade for the reassessment will be five (5.0) and the final grade for the course will be the maximum grade between the continuous assessment and the reassessment exam, that is, MAX(EO/RE). The non-attendance of a student summoned to the re-evaluation test, held in the set period, may not lead to 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 carried out within the corresponding school period.

Test Rules

If one of the laboratory or continuous assessment activities is not carried out in the scheduled period, it will be considered as a zero score. The tests will be carried out individually, with test-type 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.

Bibliography

Basic

- Komar, P.D. Beach processes and sedimentation. 2nd ed. Upper Saddle River, N.J: Prentice Hall, 1998. ISBN 0137549385.
- Kamphuis, J.W. Introduction to coastal engineering and management. 2nd ed. Singapore: World Scientific, 2010. ISBN 9789812834843.
- Dean, R.G; Dalrymple, R.A. Coastal Processes with Engineering Applications. Cambridge: Cambridge University Press, 2002. ISBN 0521495350.

- Woodroffe, C.D. Coasts: form, process and evolution. Cambridge: Cambridge University Press, 2002. ISBN 0521011833.
- Kay, R.; Alder, J. Coastal planning and management. 2nd ed. Oxon: Taylor & Francis, 2005. ISBN 0415317738.