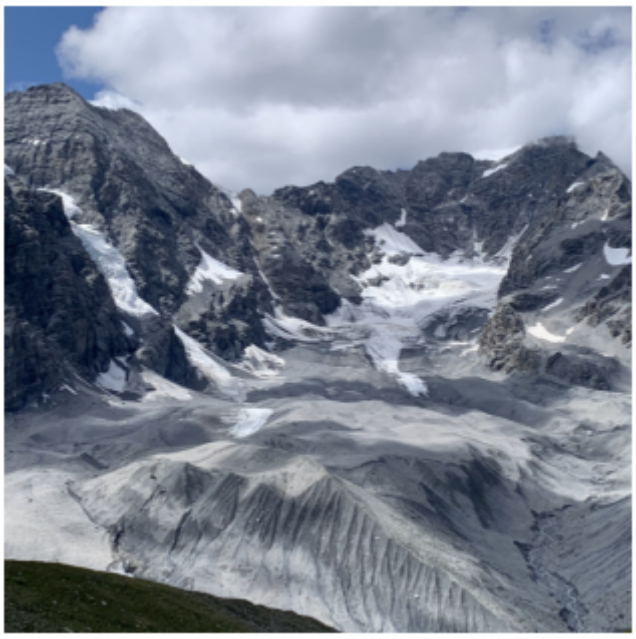
Project THESEUS

Innovative coastal technologies for safer European coasts in a changing climate

climate change | risk management

PROJECT DESCRIPTION

The ability to manage risk in coastal areas and the need to increase resilience to erosion and coastal flooding require a holistic, participatory and interdisciplinary approach. The solutions developed by specialists have to be contextualized in the local communities, considering the economic, social and cultural conditions, and take into account the average rise of the sea and the effects of climate change. In this perspective the THESEUS project aimed at making coastal areas safer, ensuring the development of human activities and preserving coastal ecosystems.



OBJECTIVES

The main objective of the project was the development of an **integrated methodology** for planning sustainable solutions for erosion and coastal flood management, considering technical, social, economic and environmental aspects. To this end the project Consortium included 31 participants of different nationalities (25 from 12 EU Member States and 6 international ones: China, Mexico, Russia, Taiwan, Ukraine, USA), and of different competences (civil and coastal engineering, marine ecology, sociology, economics, meteorology, information technology and geomatics).

PROJECT PHASES

The project was divided into three main phases: the development of a robust methodology for risk assessment, applied to case studies and exportable to other coastal areas; the analysis and improvement of innovative, technological and non-technological solutions for risk management; control of the efficiency and sustainability of the solutions proposed in the case studies.

The result of the main phases were as follows:

1. Methodology for assessing flood risk

The method is based on the *source-pathway-receptor-consequence model* and aims to clearly outline the system (infrastructures, environment and human activities) exposed to flooding, by providing a mapping of cause-effect relationships and their mutual dependencies. Unlike previous studies, THESEUS for first considered both the environmental and social consequences and highlighted that risk is a perception of the individual and of the community, rather than a characteristic inherent in the natural system.

2. Development and/ or improvement of technological and non-technological solutions for risk management

- Innovative techniques and best practices in coastal engineering:

THESEUS has examined the resistance of vegetated sea embankments, methods to maintain traditional breakwaters making them resilient to the rise of the middle sea, the use of artificial submerged structures to reduce wave action and the best practices for beach nourishment. THESEUS, for the first time, has also systematically analyzed the use of wave energy converters floating under the coast to protect it.

- Preservation and optimization of the coastal ecosystems' functionality:

THESEUS has shown how to adopt a systemic perspective that allows the integration of habitats into engineering solutions and social aspects. This increases the risk management options and helps make them compatible with the Habitats Directive.

- **Risk management:**

THESEUS has analyzed the perception of risk in terms of problems related to conflicts of pertinence and gaps between reimbursement requests based on evidence or on the legislation, leading to identifying in the regulations the main cause of the different perceptions of the coastal risk.

*3. **Support to decision in the field of coastal areas' sustainable development;***

THESEUS has applied the solutions proposed in the case studies, developing a multi-criteria methodology for selecting the best combination of solutions available in the specific context of the coastal area in question.

Based on the results achieved, THESEUS has developed a **GIS based software** to facilitate coastal managers in planning optimal strategies to minimize risk in the short, medium and long term. The calculation system reproduces, in a simplified way, the most important physical processes (erosion and flooding) induced by waves and sea level, taking into account physical and non-physical variables, such as climate change, subsidence, population variation and economic progress.

PROJECT RESULTS

Main results of the project were:

• *GIS-based decision support system*. This tool allows to estimate the hydraulic, environmental, social and economic vulnerability, and therefore to assess the risk; it also allows the selection of different technological and non-technological solutions and assesses the consequent effects on risk with reference to different climatic scenarios, and different social and economic development. The tool, addressed to technicians and managers of the coast, is accessible from the project website, along with some dedicated webinars and presentations. The possibility of creating new study sites is limited to the project partners who were involved in the development.

• *"Coasts@Risk: THESEUS, a new wave in coastal protection"*, an edition of *Coastal Engineering* dedicated to the scientific results of the project, composed of 18 articles published in 2014; the magazine addresses scientific diffusion with the aim of promoting interdisciplinary approaches to risk management.

• *"Coastal risk management in a changing climate",* a book published by Elsevier in 2014, addressed to coastal managers and professionals, aimed at presenting the innovative results of the project and proposing a combination of efficient risk mitigation solutions.

• *Summary brochures of the project's best practices*, linked to specific European Directives, in order to strengthen the synergy between scientists and managers, administrators, and people in charge of Directive- and legislation development in this field.

• *Information brochures on the risks in coastal areas*, distributed and presented in schools, to enhance population's and in

particular young people's awareness about the risk.

Case studies in Italy

The case studies examined in the THESEUS project included also **two sites** along the coasts of the Emilia Romagna Region, **Cesenatico** (the stretch between the mouth of the Tagliata chanel and Gatteo a Mare village) and **Bellocchio** (the stretch between the mouth of the Reno river and Porto Garibaldi village). Like all the coastal area of the Region, both areas are characterized by a slight elevation of the land compared to the current sea level and are affected by subsidence and erosion. They are therefore particularly vulnerable to coastal flooding.

For both sites, short, medium and long term weather and sea scenarios have been developed, taking into account the expected increase in the average sea level. The coastal systems at risk have been described using the *source-pathway-receptor-consequence model* and risk mitigation solutions have been proposed, through maintenance or modifications of the existing defenses (river embankments, port piers quotas, rock-barriers), introduction of new multifunctional defense systems such as floating wave energy converters under the coast, land use plans with retreat from the shore line and/ or changes in use, improvement of the management of sedimentary stocks, enhancement of the community's risk perception and evaluation of the response to existing alert systems. The case of Cesenatico has also been implemented in the GIS-based decision support system, allowing to assess the hydraulic, social and environmental vulnerability and therefore the present and future risks (2020, 2050, 2080) to which the area is subjected, and proposing combinations of mitigation measures, selectable by the user, taking into account the possible scenarios of social (population change) and economic (variation of GDP) development.

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