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Management and Protection of Coastal Area, the Importance of Coastal Processes During the Planning Phase

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ABSTRACT: Coastal processes should be one of the main issues in coastal zone management; ignoring it could lead to wrong decisions which, in turn, could lead to environmental disaster. This letter shows some examples of coastal structures that are built without taking into account coastal processes, and discusses their impact on the environment, with the hopes that the examples provided can serve as a warning for any future decisions. The analyzed zone is the coast of the Calabria Region in southern Italy. The coast is being studied as part of an agreement between the Mediterranea University of Reggio Calabria and the Calabria Basin Authority, concerning the redaction of the Coastal Erosion Risk Mitigation Plan. All data and results are obtained from a preliminary study of the coastal processes in Calabria. Calabria, with more than 700 km of coasts, is affected by coastal erosion, so the proper management and protection of the coastal zone represents an important issue that cannot be avoided.

KEYWORDS: coastal processes, coastal erosion, coastal area management

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The protection and management of coastal areas should be supported by a deep knowledge of the coastal processes and of the interaction between water motion, seabed topography, and coastal structures, which affect the natural response of coastal systems. In some cases, these processes cause damage to the environment by permanently changing the coast's morphology.

Coastal morphology refers to the study of the adaptation of the coastline, which is driven by waves, currents, wind, and induced sediment transport. Coastal morphological models are indispensable and powerful tools that allow us to set up reliable protection and management plan for coastal areas.

Morphological models are based on various sub-models that are related to each of the phenomena involved in the dynamics of the coast, such as storms, waves, erosion, run-up, set-up, shoreline evolution, and wave structure interaction.

A sea storm is defined as a sequence of sea states in which the significant wave height (H_s) exceeds a given threshold. The force of a storm that is acting on a coast can rapidly change its morphology, causing damage to urban areas. The definition and prediction of storms[1] is also an important issue in wave modeling and in structure design, since a reliable model for storm approximation provides an easy way to predict extreme waves.[2]

Erosion control is one of the main issues of coastal zone management; it is a natural process, but it can be accelerated by human activities that often interfere with the natural movement of sand along the coast through the construction of coastal structures. The long shore sediment transport (LST) is connected to the wave-induced current and to the energy dissipation caused by breaking waves in the surf zone. However, a part of this energy is partially converted into potential energy as run-up on the foreshore of the beach.

Figure 1. Aerial view of the Saline Joniche Port in 1984 and in 2013.

LST, set-up and wave run-up are the principal causes of coastal erosion and coastal flooding. The physical description and quantification of these phenomena are frequently carried out by means of simplified models.[3–8] Many times, all natural processes are influenced by urbanization which, through the construction of coastal structures, affects the natural evolution of the shoreline.[9] In these cases, it is important that a deep knowledge and investigation of the interaction between wave and structure is established in order to avoid the failure of an intervention.[10–14]

Unfortunately, the coastal dynamic does not appear to play an important role in the planning phase, and many environmental disasters happen due to wrong decisions made during the planning or the design phases. In particular, the evaluation of the LST rate is necessary to prevent the occurrence of coastal erosion after the construction of a coastal structure. To support this hypothesis, many examples should be explored.

First of all is the case of Saline Joniche in southern Italy, where a port stops the natural movement of sand along the coast. The amount of LST is so big, and in 20 years, the entrance of the port has been subjected to a total obstruction; now, it is completely unserviceable (Fig. 1).[9] The port also influences the coastal equilibrium of the northeast side, causing the disappearing of more than 20 hectares of beach in 5 km of coast (Fig. 2).[9]

A similar situation occurred in the near zone of the Cetraro Port, located in southern Italy. Here, a periodic dredging of the entrance is necessary to make the port serviceable. In fact, in 1988, the entrance was completely closed by sand (Fig. 3), and now, after 20 years, the silting process, which has never been stopped, is nullifying the interventions of dredging (Fig. 4). The movement of the sand goes from the northwest direction to the southwest direction, which is confirmed by the presence of a large and stable beach on the northwest side (it has an average width of 80 m), and by a strong erosion on the southwest side (Fig. 4).

The last two examples clearly demonstrate that the placement of a port should be subordinated to the evaluation of the LST rate which, in the first approximation, is more than 100,000 m^3/year. In these cases, it is impossible to avoid the interference between the port and the coastal processes without the realization of a permanent bypass system that should restore the continuity of the natural movement of the sand along the coast.

Another example could be represented by the operation of coastal defense made in Lazzaro, in southern Italy. Here, in an attempt to restore the original beach, a groin was built. Unfortunately, it is too long (70 m) for the location, which is characterized by a limited surf zone due to the bottom slope, which is up to 10%. In this particular situation, a groin should be avoided; otherwise, a deep study and evaluation of different solutions should be done (Fig. 5).

Figure 2. Aerial view of the eroded area near the Saline Joniche Port, and a view of the eroded beach.

Figure 3. Aerial view of the Cetraro Port in 1988 before the dredging, and in 2000 after the dredging.

Figure 4. Aerial view of the actual situation of Cetraro Port, of the northwest side and of the southeast side.

Figure 5. Aerial view of the groin in Lazzaro.

These three cases are not the only examples that support the importance of the coastal dynamic in a coastal zone management and protection plan. I hope that such situations will never happen again.

Author Contributions

Conceived the concept: GB. Analyzed the data: GB. Wrote the first draft of the manuscript: GB. Made critical revisions: GB. The author reviewed and approved of the final manuscript.

DISCLOSURES AND ETHICS

As a requirement of publication the author has provided signed confirmation of compliance with ethical and legal obligations including but not limited to compliance with ICMJE authorship and competing interests guidelines, that the article is neither under consideration for publication nor published elsewhere, of their compliance with legal and ethical guidelines concerning human and animal research participants (if applicable), and that permission has been obtained for reproduction of any copyrighted material. This article was subject to blind, independent, expert peer review. The reviewers reported no competing interests.

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