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Systemic vulnerability model for coastal erosion processes

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Many coastal areas constitute an extraordinary environmental worth and economic value resource continuously exposed to an unceasing transformation due to climatic and anthropic factors. The pressure factor overloads carry out an amplification of environmental degradation and economic rent decrease of these territories producing a disruption of normal and anticipated community growth. This paper copes with coastal erosion problem by a systemic vulnerability model application and environmental indicators approach. Through the definition of an original indicator depending on the observed annual rate of coastal erosion and wave climate parameters, such an approach allow scenario generation and it is useful and powerful planning and management tool. The model has been applied on the test case of Ionian Coast of Basilicata Region located in the southern part of Italy, in the middle of Mediterranean basin. The littoral area is constituted of sandy shores of about 50 km length and 5 river deltas take place. Looking at the shoreline in terms of displacements, a shift of a coastal part is a function of grain size characteristics of the shore sands and of the wave climate.

Therefore the selected index taking into account the energy stress affecting the shore area, characterizing the territorial system state and finalized to vulnerability estimation, is defined through the maximum annual erosion,t_E, and the surface-wave parameters (H, T) corresponding to the wave-generated bottom orbital velocities higher than critical velocity matches with the bottom incipient transport condition. The resulting coefficient ϑ ($\vartheta = t_E \Big/ \sqrt[3]{gH^2/T}$) is obviously dimensionless and represents the part of the available power in the seas, dissipated by erosion processes. If ϑ increases, the system integrity decreases and the system vulnerability increases.

Available data, in terms of topographic/bathymetric information referred to the period 1873-2008, were utilized to derive t_E by the use of a GIS-CAD "comb model" developed at the University of Basilicata, in which the full shoreline length was divided in 92 segments corresponding to 500 m for each one. Wave climate data were estimated from wind data by use of a hindcasting method for the observation period 1987-2010. Grain size characteristic of the shore sands were acquired by a in situ measurement campaigns.

The ϑ index gives a synthetic representation of the coastal erosion and progress processes exclusively due to climatic actions and the information derived in terms of vulnerability is distributed on the coastal territory.

Results show heterogeneous trends, with relevant difference in vulnerability response among the morphological elements. In particular, the river deltas represent a critical location with significant exposition.

By the analyses performed, the southern part of the coast, located near the delta of Sinni river, seems to be more sensible to the vulnerability respect to the other part of the test area.