The evolution of the Adriatic Coastal zone (Italy) between the Gabicce promontory and the Tronto River mouth

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Abstract

Since the beginning of the 20th century, the world’s coastal areas have been affected by a widespread shoreline regression that has reached the critical stage since 1950. The Italian coastal zone along the Adriatic Sea is a good example of the mentioned state of environmental destabilisation. The continuous shoreline regression from 1950 up to the present time was faced by many kinds of defence works put into operation. All these protective works, impelled by necessity at different times, were built in the course of the erosive process at enormous cost. Considering the evolutional trend of the Adriatic coastal stretch between the Gabicce promontory and the Tronto river mouth, it is possible, utilizing some geomorphological and sedimentological parameters derived from precedent studies, to show how it was possible to predict the negative evolution before it became irreversible. If this prediction was possible, even prevention would have been possible with low cost defence works and with a better chance of success at facing the shoreline regression. The considered parameters are: the granulometric characters of the sea bottom between the shoreline and the offshore, the maps showing the dimension of landslides on the cliffs, the seasonal variations of the backshore over the last 20 years, the shoreline regression or advancement over the last 50 years expressed in m/year, the increased bottom slope between the shoreline and the wave breaker zone over the last 50 years expressed as a percentage. The examination and comparison of these parameters permit the possibility of preventive action, following the evolutive prediction, to face the erosive phenomena at its beginning.

Keywords: coastal evolution, coastal landslides, Adriatic Sea.
1 The Adriatic coastal zone

In the northern Adriatic coastal zone (Italy), from Gabicce to the Ancona promontory and from here to the mouth of the Tronto River, the Marche region coastal zone is given by a narrow, sandy and gravelly strip, which, in some places, lies at the toe of a cliff belonging to the Apennines Mountains, very often close to the Adriatic Sea.

The Ancona promontory divides the Marche coast into two differently oriented sections.

The shorelines of the first section, from Pesaro to Ancona, and that of the second one, from Ancona to the Tronto River, are interrupted by the mouths of many minor rivers coming from the Apennines close to the hinterland. About the 42% of this coast is covered with defence works against erosion from winter storm waves.

The coastline from Pesaro to Ancona and from south Ancona to the Tronto river is mainly sandy and gravelly.

From the Gabicce promontory to Pesaro and where the Ancona promontory is found, the narrow backshore, at the foot of the high cliff, is composed of boulders and gravel with sand. Samples, collected from the shoreline to the isobaths 10m, indicate gravel with sand from the shoreline to 2-3m depth in correspondence of the Gabicce-Pesaro cliff and the Ancona promontory.

In the stretches from Pesaro to Ancona and from here to the Tronto river, sand and pelitic sand are present from the shoreline to 3-5m depth; from here to 10m isobath, very sandy pelite (quantity of sand between 30 – 70 %) and sandy pelite (quantity of sand between 5 – 30 %) follow.

The grain size indicates a high environmental energetic level in the zone between shoreline and isobath 5m, corresponding to the breaker zone of the storm waves.

Fig. 1 shows the map of the landslides and their characters. The cliff is formed by Plio-Pleistocene sediments, namely by coarse variably cemented, clastic materials, in turn overlying grey-blue over consolidated clays.

The heavy precipitations (rain and snow) of the cold/wet periods are the main cause of the landslide occurrence.

The general advancing, of the shoreline for the whole area, in spite of same local regressions of the cliff at south, was continuous from the 1600 up to the beginning of the XXth century. All the cartographic data confirm it. After the first decade of 1900, only some sectors continued to increase, but at a speed decidedly inferior with respect to the past.

The greater part of the littoral presents, first of all, an arrest of the increase followed by a regression of the shoreline which is accentuated mainly during the fifties, with and ever increasing speed and intensity up to the end of the ’70s.

The explosion of the erosive phenomena coincide with the increase of storm waves action connected with the cold/wet weather in the 1950-70 period and the reduced sediment yield to the sea due to the protection by seawalls of the cliff, to avoid landslides dangerous for the Adriatic railway line, and to the rash removal of riverbed material.
The final result was the general regression of the shoreline and the increasing of the bottom slope up to the breaker zone: consequently the storms are, to day, much more effective and destructive.

The comparison of the shoreline variation from 1944 up to day shows the explosion of the erosion with regression of the shoreline in the time interval 1954-1980. Very significant is the localization of the major regression in [1, 2, 3, 4].
The correspondence of the mouths of the rivers to test their insufficient sediment yield.

The comparison of the situation 1980 – 1999 shows a diminished regression and modest increasing of the advancing of the shoreline. This situation is due to the action of the intense employ of defence works along the entire Marche coast after 1980.

The comparison among the 1954, 1968 (from Gabicce to Ancona only) and 1981 bottom slopes shows an increase in slope (fig. 2) which, upsetting the coastal equilibrium, allows the winter storm waves to become more destructive. The variations of the bottom slope from the shoreline to the 5m isobaths confirm a correlation between the reduction of the backshore in the period 1954 – 1981 and, in the same period, an increase in steepness of the corresponding bottom slope [5].

Figure 2: Variations of bottom slope between the shoreline and the isobath 5m in the years 1954, 1968, 1981 [5, 6].
2 Conclusion

The shoreline variations are very similar in the North and South Ancona zones even in presence of differences in the coastal direction and in the construction of defence works.

The natural nourishment of the beaches, in the past times, is due to fluvial yield and to the material derived from landslides of the cliffs that the longshore current from S to N distributes along the coast [2]. In the XIX century the coastline was progressing, thanks to the southern longshore current still rich in sediment yield. However, since the beginning of the XX century widespread regression began and took over, reaching a critical stage after the Second World War, sometimes with irreversible effects. A reversal in this trend was caused by several factors.

The urbanisation of large coastal zones due to tourism without regarding the natural environment.

The decrease in material from the cliffs caused by the construction of seawalls to protect the railway from storm waves [3].

The continued excavation of sand and gravel along the minor rivers has drastically lowered the supply of sediments to the shore. The longshore currents deprived of sandy material decrease their importance in the coastal regime. While the onshore – offshore transport carries the beach sands toward the open sea.

The bottom slope is then increasing near the shoreline and, consequently, storm waves are much more effective and destructive in spite of defence works.

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References


