Catena 147 (2016) 545–555

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Anthropogenic influence on recent evolution of shorelines between the Conero Mt. and the Tronto R. mouth (southern Marche, Central Italy)

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ARTICLE INFO

Article history:
Received 25 January 2016
Received in revised form 22 July 2016
Accepted 9 August 2016
Available online 12 August 2016

Keywords:
Historical evolution
Adriatic shorelines
River mouths
Anthropogenic intervention
DSAS

ABSTRACT

A study of the shoreline evolution during the last two centuries along the southern portion of the Marche region (between the promontory of the Conero Mountain and the Tronto River mouth) has been carried out on the basis of historical data and taking into account the effects of both natural events and anthropogenic interventions.
The research started with searching, acquiring, georeferencing and digitizing all the available maps surveyed from 1835 to the present. The above data set has been used to implement a vector geodatabase containing the successive position and shape of shorelines, with particular attention to the neighboring river mouths. Since transitional and beach deposits have been almost completely eroded during the last decades, the adoption of traditional techniques of geomorphologic and sedimentological analyses has not been possible.
The results of the above analyses have been correlated with the main natural events and human interventions occurring during the considered time span. The results of this comparison highlights that the evolution of river mouths and neighboring beaches mostly depends on deforestation carried out in their hydrographic basins.
In the study area, the progradation of river mouths continued after the end of the Little Ice Age (ended around 1850). Namely, it has been observed that the retreat coincided with the start of reforestation and agricultural development (in the 20's of the last century). During the following decades, further interventions, such as construction of dams and check dams, extraction of sediments from thalwegs, fillings, modifications of stream paths, abandonment of agricultural practices etc., contributed to a severe reduction of river solid load with subsequent retreat of both river mouths and beaches, thus making it necessary to protect them with artifacts.

1. Introduction

It has been almost universally recognized that the general retreat suffered by the Italian shorelines mostly derives from scarcity of solid load (pebbles and sand) brought to the sea by rivers (Pranzini, 1994; Coltorti et al., 1995; Coltorti, 1997; Giraudi, 2005; Pranzini et al., 2015). Some authors gave more relevance to climatic variations (Vita-Finzi, 1969; Borrego et al., 1999; Grove, 2001; Materazzi et al., 2010), while others considered anthropogenic interventions to be predominant (Innocenti and Pranzini, 1993; Billi and Rinaldi, 1997; Guillén and Palanques, 1997; Bellotti et al., 2004; Pranzini et al., 2015). Surely, the mobilization of loose sediments is connected with the intensity and frequency of rainfalls (whose influence is primary on slope dynamics and floods); however, anthropogenic interventions, on short timescales, may dramatically increase or decrease both the production and the transport of sediments.

Changes in the shape of river mouths during a given period, standing the absence of significant tectonic or eustatic vertical movements, mostly depends on the precarious balance between fluvial and coastal dynamics. These changes represent the successive records of the many and complex environmental and anthropogenic transformations occurred in their river basins. Therefore, by studying the evolution of river mouths and shorelines and by acquiring a better knowledge of local littoral processes, it is possible to extrapolate data regarding the variation of sedimentary input during the past.

In this paper, the historical evolution of the mouths of the most important rivers flowing in the southern portion of the Marche region during the last two centuries has been compared with the interventions carried out in their drainage basins considered to be the most relevant for their influence, direct and/or indirect, on river solid load (such as deforestation/reforestation, construction of dams, check dams and other river barrages, modifications of shape and/or path of channels, reclamation works, changes in agricultural practices etc.). The aim is to check

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http://dx.doi.org/10.1016/j.catena.2016.08.018
0341-8162/

whether, at least for the investigated period, anthropogenic factors locally prevailed over natural ones in determining the variations of river solid load and, therefore, of the evolution of shores and river mouths.

2. The study area

Along the coast of the Marche region, three morphodynamic units are present, each having its own specific morphologic, sedimentological and evolutionary features. To the north, from the boundary with the Emilia-Romagna Region to Ancona, the shoreline is nearly rectilinear and has a NW-SE orientation. In the central portion, lies the Mount Conero promontory, with high cliffs and pocket beaches acting as a main morphological discontinuity. Moving southward, the shoreline is oriented NNW-SSE down to the Tronto R. mouth (marking the boundary with the Abruzzi Region). The study area includes the latter two sectors for an overall length of approximately 75 km (about 43% of the 172 km of regional shores); 99% of which are low coasts. Wide pebbly-sandy beaches characterize the front of the main alluvial plains, while more narrow ones border the inactive cliffs running parallel to the shoreline (AA.VV., 1990; Buli, 1994; Regione Marche, 2005; Dramis et al., 2011). The only minor exceptions are the short active wave-cut cliffs of Pedaso.

In the study area, the wave regime is mostly characterized by storms coming from NNE and ESE, the former being generally more intense and the latter more frequent (APAT, 2004). Tides are very weak, with average amplitudes around 20 cm to the north and 40 cm to the south; maximum amplitudes are around 70 cm.

Five major rivers flow along this sector (Potenza, Chienti, Tenna, Aso and Tronto, from north to south), providing nearly the total sedimentary load entering the sea; minor seasonally dry streams are also present.

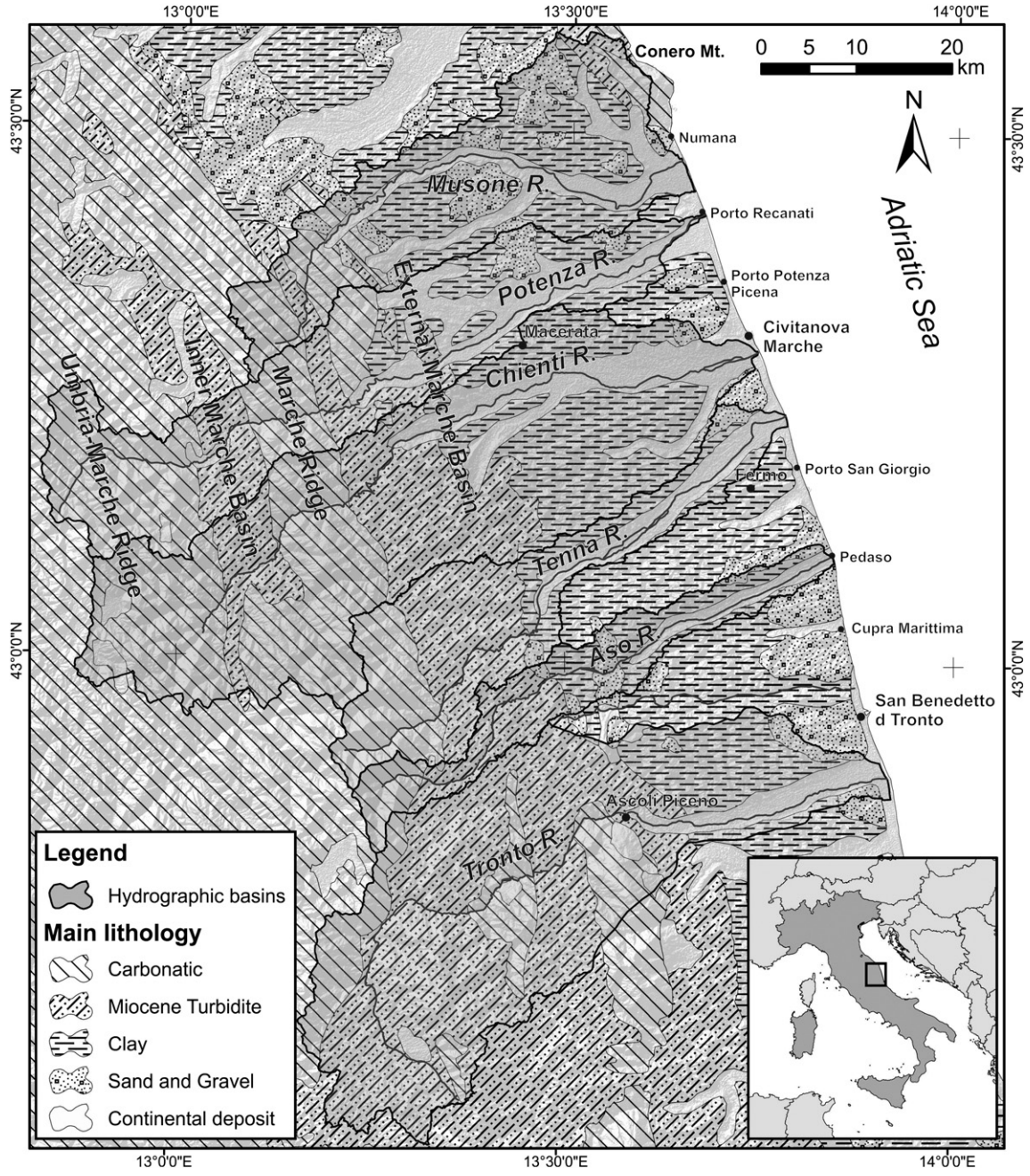

Fig. 1. Simplified sketch of the study area.