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Validation of the coastal storm risk assessment framework along the Emilia-Romagna coast

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ABSTRACT

The Italian coasts are threatened by coastal flooding and erosion. The Emilia-Romagna region coastline is exposed to marine storms because of its low-lying nature and massive urbanization. Regional managers need comprehensive tools for coastal storm risk assessment. The RISC-KIT Coastal Risk Assessment Framework (CRAF) provides a conceptual framework, which includes hazard, exposure and vulnerability evaluation, to implement a screening process able to identify littoral zones that can be classified as hotspots (Phase 1) and to successively rank the identified hotspots to select the most critical ones (Phase 2). This study includes the results of the implementation of CRAF Phase 1 in the Emilia-Romagna coast. The method is based on a Coastal Index approach, calculated for 1 km length coastal sectors, applied taking into account both hazard and exposure indicators. The general methodology was partly modified thanks to the strong collaboration with the End-User (Servizio Geologico Sismico e dei Suoli, SGSS) which provided data, suggestions and comments at every step of the implementation. The SGSS also provided data to validate the outcomes of the CRAF methodology. Thus, the critical areas identified by the CRAF were compared with historical (1946–2010) storm impacts, resulting in a reasonable agreement between the identified hotspots.

1. Introduction

The Italian peninsula has almost 8 000 km of coastlines, of which more than 60% are low shores. The 34% of the Italian territory located in a corridor of 300 m from the shoreline is urbanised, with higher percentages in the regions facing the Adriatic sea (ISPRA, 2012). The effect of marine processes on the coastal area has therefore a great importance, as erosion and inundation hazards are increasingly threatening large portions of the coastline, human structures and the population. In fact, coastal inundation caused by storm events represents a major issue, especially in low-lying areas such as alluvial plains.

National and regional governments urge a comprehensive evaluation of coastal risk, to better manage coastal areas in terms of allocation of funds for coastal protection and definition of effective land-use plans (Viavattene et al., 2017, in this issue and references therein).

The Emilia-Romagna coastline (Fig. 1) is particularly exposed to erosion and inundation hazards (Armaroli et al., 2012; Perini et al., 2016) because of its low-lying nature and high coastal urbanization. Consequently, there is an increasing demand for effective methodologies to properly evaluate coastal risk, which in the RISC-KIT project was defined as the probability of a hazard and its impacts (consequences) (Viavattene et al., 2015).

The RISC-KIT project (Van Dongeren et al., 2017) provided a tool for coastal hotspot assessment and selection at the regional level: the Coastal Risk Assessment Framework (CRAF) (Viavattene et al., 2017, in this issue). The Phase 1 of the tool provides a conceptual framework to implement a screening process able to identify areas that can be classified as hotspots, through the integration of hazard and socio-economic components. Then, the Phase 2 of the CRAF is applied to rank the identified hotspots to select the most critical ones. The CRAF method is described in the paper by Viavattene et al. (2017, in this issue), together with a comprehensive review of different methodologies adopted to evaluate coastal risk and the main differences between the CRAF and previous methods.

In this paper the authors present the outcomes of the application of the CRAF Phase 1 along the Emilia-Romagna coast. The results were validated with historical data provided by the end-users involved in the project. Regional managers, land-use planners and decision-makers were indeed involved in all the phases of CRAF Phase 1 implementation, because of their awareness and knowledge of coastal characteristics and issues that are important and valuable. Furthermore, they made a lot of data available for the analysis and followed the key steps of the

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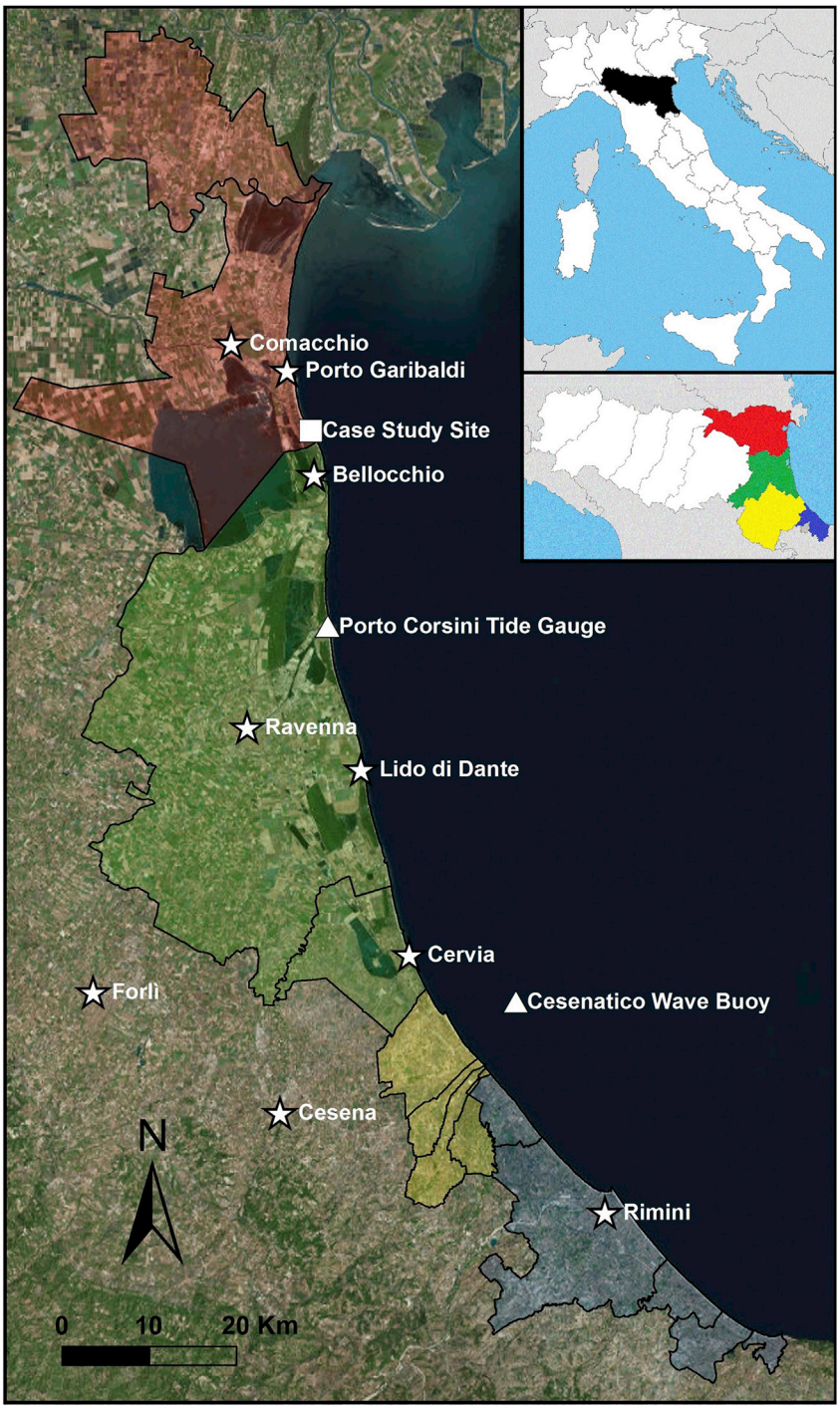

Fig. 1. The coast of the Emilia-Romagna Region: coastal municipalities belonging to the provinces of Ferrara (red), Ravenna (green), Forlì-Cesena (yellow) and Rimini (blue) and the location of localities presented in the text is highlighted. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

assessment, providing suggestions and comments. Finally it is important to point out that, although CRAF phase 1 was applied at the regional level, the application of CRAF phase 2 and other tools implemented in the RISC-KIT project was carried out in the area of Porto Garibaldi-Bellocchio (Ferrara province, Fig. 1), that was selected as the case study site (CSS hereafter) along the Emilia-Romagna coastline.

2. Study area

The coast of the Emilia-Romagna Region (RER hereafter) is located in northern Italy, facing the Adriatic Sea (Fig. 1). It is composed of almost 130 km-long sandy beaches characterized by mild slopes and a dissipative nature (Perini et al., 2010a). The northern part of the coastline comprises the Ferrara and Ravenna provinces. The coastal corridor, defined as a strip of ~2 km cross-shore width, is composed of wide and low-lying coastal plains, generally below MSL (minimum values of -2/-3 m; Perini et al., 2010b; Fig. 1). Furthermore it includes the last dune fields of the region that occupy almost 40% of this sector. The southern part includes the Forlì-Cesena and Rimini provinces (Fig. 1). The coastal corridor is characterized by 2–3 m elevations above MSL and the dunes have disappeared because of tourist pressure in the last 50 years (Sytnik and Stecchi, 2014). Over 60% of the coastline is protected by hard

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