candidate for publication in "Aquatic Ecosystem – Health & Management"

ASSESSMENT OF COASTAL VULNERABILITY BASED ON THE USE OF INTEGRATED MONITORING APPROACH AND OPEN-SOURCE MODELLING: THE CASE OF RICCIONE

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Paper topic: Coastal Engineering, Oceanography, Geology and Ecology

1. Introduction

In recent years, the use of video-monitoring techniques for the evaluation of coastal erosion in maritime areas is significantly increased due to the diffusion of high-resolution cameras at relatively-low costs (Archetti et al., 2016). The capability of performing several analyses makes video monitoring suitable for applications in coastal research fields and for practical purposes, such as the identification and quantification of the shoreline dynamics, the assessment of the coastal vulnerability and the basic input to engineering design in the coastal zone (Davidson et al., 2007; Archetti and Romagnoli, 2011). Beach evolution and wave run-up are important coastal state indicators to be monitored and predicted for the coastal vulnerability assessment. The results of image analysis offer significant data for the shoreline modeling calibration.

In this work, we present a study about the coastal vulnerability of a coastal stretch at Riccione (RN), Italy, by means of an integrated approach of low-cost video-monitoring system and coupled wave-hydrodynamics modeling system. Some unconventional prototypes for the coastal protection of this site have been recently installed in the submerged beach and are presently under monitoring to verify their stability and efficacy.

2. Methods

In this study, we make use of a low-cost monitoring technique and numerical simulations in order to quantify the coastal erosion through image processing of the shoreline evolution and calibrate a numerical evolution model. The camera system consists of a Raspberry Pi integrated with a camera capturing images at 8 MP and was firstly implemented for coastal monitoring issues. Raspberry Pi is a small and affordable computer, which allows controlling the camera acquisition through a simple programming language.

At the first stage of our monitoring campaign, we acquired data with one Raspberry Pi in a fixed position. The images were taken with a data rate of 2 s for 10 minutes each hour, in order to extrapolate a time exposure image i.e. *timex* representative of the shore studied. From the timex, we detect the shoreline position by means of an algorithm developed in MATLAB. Image processing includes the rectification of the acquired images, which has been obtained through a projective transformation from an image reference system (in pixels) to a local reference system (in m). The bathymetric data was acquired by the use of a Multibeam Klein Hydrochart 3500 installed on an Unmanned Surface Vehicle (USV). The pre-planned routes were followed by the USV with high precision. The position errors between the planned and actual route were always

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below 0.3 m, this allows (eventually) the acquisition of 4D bathymetric data, to precisely show bottom morphology changes over time. Numerical codes will be set up to predict the shoreline evolution. Good candidate tools are MIKE21 SM and XBeach, forced by coupled wave-hydrodynamics models.

3. Results and discussions

Some preliminary results were obtained from a training field campaign in March 2019. Fig. 1(b) shows a *timex* of this training field campaign with the shoreline extrapolated through the MATLAB elaboration. It can be noted that the software can correctly separate the limit between water and sand (in red). Fig. 1(a) shows the points used for the homographic transformation and the shoreline extracted in real coordinates, while Fig. 1(c) reports the rectified *timex* image.

(a) (b) (c)

Figure 1. (a) Transformation from the pixel coordinate system to a local reference system in m. (b) *Timex* with the shoreline (in red) automatically detected. (c) Rectified timex image.

Preliminary numerical results of wave field during an extreme sea state condition at the site is presented in Fig. 2(b).

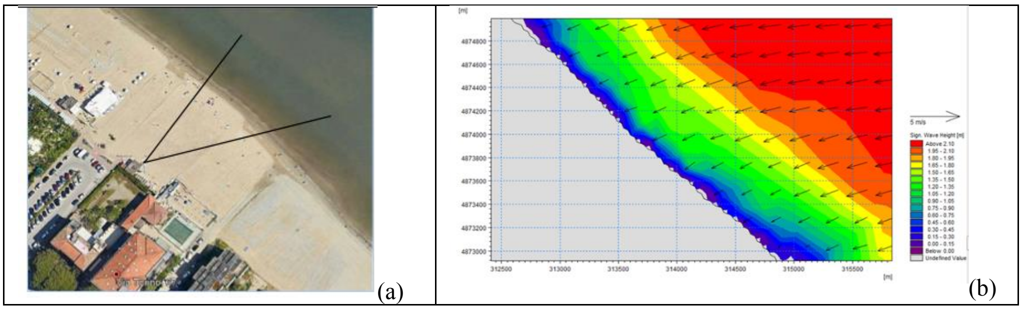

Figure 2. (a) Aerial view of the study site with the angular view of the camera. (b) Preliminary numerical results of extreme wave propagation obtained by means of MIKE21 application.

Acknowledgements

The study is part of the STIMARE project, funded by the Italian Ministry for the Environment and Protection of the Territory and the Sea (MATTM).

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