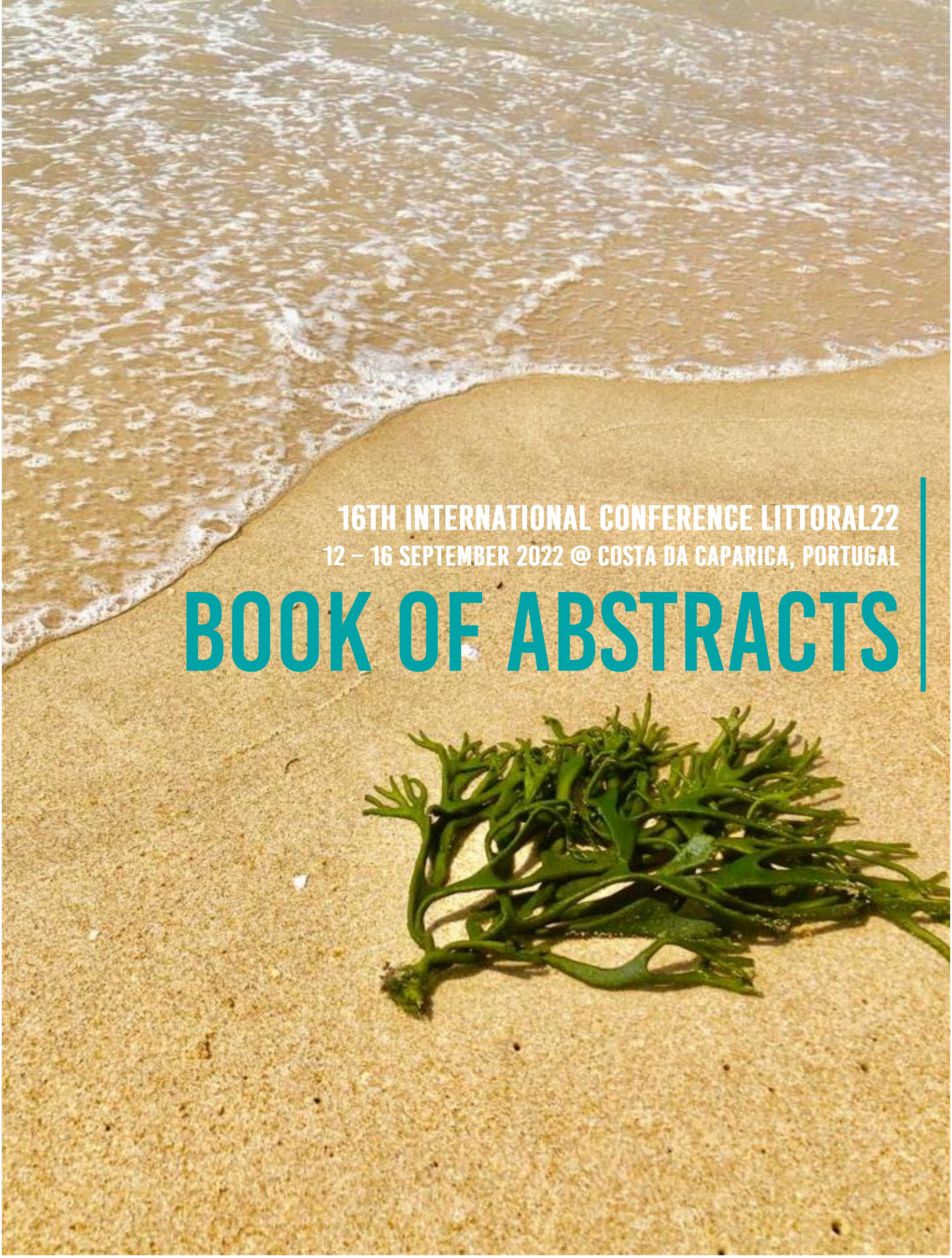

16TH INTERNATIONAL CONFERENCE LITTORAL22

12 – 16 SEPTEMBER 2022 @ COSTA DA CAPARICA, PORTUGAL

BOOK OF ABSTRACTS

16TH INTERNATIONAL CONFERENCE LITTORAL 22 12 - 16 SEPTEMBER| COSTA DA CAPARICA, PORTUGAL ADAPT OUR COAST FOR A SUSTAINABLE FUTURE

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Abstracts are organized by chronological order of presentation.

December 2022

Coastal slope instability and susceptibility mapping

Thursday, 15th September - 10:30: (Costa Azul Room) - Accept for Poster

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1. INTRODUCTION

The rocky coasts represent 52% of the world's coastline, being a source of resources for human activities and a support for diverse ecosystems. Landslides are one of the most recognizable geomorphological processes in rocky coastlines, particularly in coastal cliff systems. The most common landslide types in these areas are: rockfalls, topples, and rotational and translational slides. As dynamic systems, coastal cliffs have a wide variety of drivers involved in different types of erosional processes, which can reach high magnitude and consequently, a high potential for destruction. Depending on the cliff sub-system type (plunging cliff, shore platform-cliff, beach-cliff) and local settings, these drivers may include: i) marine forcing as direct wave action (depending on changes in sea level, tides, storm surge or runup); ii) cliff toe morphology, be they related with shore platforms, beaches, or deposits, with their associated dynamics; iii) cliff geology; and iv) rainfall regimes and groundwater distribution.

The aim of this research is to assess landslide susceptibility in coastal cliff systems and to identify the set of predisposing variables that contribute for the spatial distribution of the different landslide types at Safi coast, Morocco. Safi is in the west coast of Morocco and has a particular geological setting that includes sedimentary successions of clay and limestone layers which makes it highly prone to slope instability.

2. METHODS

Coastal cliff landslide susceptibility model was build using the Information Value (IV) statistical method (e.g., Yin and Yan 1988, Zêzere, 2002). The model includes 14 predisposing factors and a detailed landslide inventory with 298 landslides along a 32km cliff coastal stretch and 5.5km^2 research area.

Coastal cliff landslide inventory aimed to identify location, size, type, and rupture depth of landslides (van Westen et al. 2006, Petley 2008), based on topographical and interpretation/photointerpretation of geological maps, aerial photographs, satellite imagery, hydrological data, and extensive detailed fieldwork. The landslides were classified according to the landslide type (Cruden and Varnes, 1996) and include shallow and deep-seated rotational and translational slides. Debris fall, debris flow, rock falls, rock slides and rock topples are also included in the landslide inventory to account for rupture surfaces. Each landslide type data set was divided into a training group, set containing 70% of the observed landslides, and a validation group, including the remaining 30 % of observations, aiming for a independent cross validation of the models prediction capacity.

The dataset mapping of coastal landslide predisposing factors is in a 12.5m x 12.5m resolution grid including: elevation, aspect, slope, slope profile curvature, slope plan profile, cliff height, topographic position index (TPI), slope over area ratio (SOAR), lithology, lithology at the toe, beach protection at toe, slope deposit protection at toe, permanent drainage, and spring presence.

The Landslide susceptibility model is first based in the bivariate statistical relationship between each independent variable and each coastal cliff landslide inventory partition defined according to the different landslide types, allowing to rank susceptibility for each coastal cliff terrain unit in a form of an IV score. IV score classification for final susceptibility mapping grouped IV scores into 4 classes of susceptibility: very low susceptibility ($< -1_{IV}$), low susceptibility (-1_{IV} to 0_{IV}), moderate susceptibility (0_{IV} to 1_{IV}), and high susceptibility ($>1_{IV}$).

3. RESULTS

Coastal slope instabilities are present in 3.4km^2 (61.8% of the study area), of which 2.7km^2 are deep-seated landslides. The most frequent type of landslides counting on the inventory records are the rotational slides (37.9%, predominantly deep movements), rock topples (21.1%), translational slides (17.5% predominantly shallow movements) and rock falls (15.8%).

Coastal landslide drivers were assessed considering for the total landslide inventory and for each type of landslide. Results from the total landslide inventory model highlight the importance of cliff height class 120-134m (4.957$_{IV}$), elevation class 20-30m (4.712$_{IV}$), TPI class -11 – 3 (4.414$_{IV}$) and the lithology marls and sandy marls (4.242$_{IV}$). Elevation class 130-160m, TPI class 34 – 42 and aspect class flat surface have the lowest IV scores. Results also point out the high dependence of the different landslide types regarding to their position in the cliff slope and to the different lithologies. As predominant landslide type, rotational slides occupy 2.6km^2 of the study area and almost 80 % of the landslide area, are highly dependent on the same instability drivers obtained for total landslide inventory susceptibility model.

Translational slides represent the 3rd more frequent landslide type and the 2nd most extensive area with landslides (0.4km^2). Elevation class 15 - 20m (0.690$_{IV}$), slope class 30 – 35º (0.499$_{IV}$) and aspect class Southwest (0.475$_{IV}$) are the main drivers for this particular type of landslide. Rockfalls (4th more representative and extensive landslide type) are most attributed to the presence slope deposit at the cliff toe (0.760$_{IV}$), to slope class 25 – 30º (0745$_{IV}$), limestones as the main lithologies at the toe (0.656$_{IV}$) and aspect class North (0.623$_{IV}$).

Rock topples main drivers are the lithology limestones and sandstones at the toe (2.594$_{IV}$) and cliff height class 20 – 40m (1.861$_{IV}$). Rock topple IV model underlines how sensitive this type of landslide is to the more competent lithologies and to the lower sections of the slope where marine processes are predominant.

Classified IV scores for slope instability susceptibility mapping reveal that most of the research area have high susceptibility when considering the total landslide inventory IV model. Similar results were achieved for the deep-seated rotational slides model.

Individual model validation using prediction and success rate curves and area under the curve (AUC) values showed good results with minimum AUC values for prediction and success rate curves over 0.70.

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