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Accuracy of remote sensing techniques in beach geomorphological surveys: a case study of Hvar island, Croatia

Marin Mićunović[1], Sanja Faivre[1], and Mateo Gašparović[2]
[1]University of Zagreb, Faculty of Science, Department of Geography, Zagreb, Croatia (mmicunov@geog.pmf.hr)
[2]University of Zagreb, Faculty of Geodesy; Kačićeva 26, Zagreb, Croatia

Beaches, as a shore accumulation of loose, unconsolidated sediment, are under constant change. Natural processes intertwined with increasing anthropogenic pressure cause changes in their morphology. Monitoring of beaches can provide quality data and information, which could be used for coastal management as beaches are an important resource in Hvar island touristic offer. Nowadays, there are many easily available remote sensing sources (satellite and aerial imagery) suitable for beach surveys. In this work, the accuracy and quality of remote sensing data, based on three different sources have been assessed, covering a 10-year period. The area and length were measured and compared on 20 different gravel pocket beaches on the island of Hvar.

Fundamental beach morphology measurements were done using historical satellite imagery from the Google Earth Pro desktop application, from which 5 different years (2013,2016,2018,2019 and 2020) have been selected, based on their spatial and temporal resolution quality. Furthermore, orthophotos provided by Croatian State Geodetic Administration – Geoportal, including four different orthophoto generations (2011,2014,2017 and 2019), were used. The recent period was collected with UAV – DJI Phantom 4 Pro v2.0. and Trimble GNSS GeoXH (<0,1 m). The fieldwork took place in November 2020 and May 2021. Collected images were processed in Drone2Map software, which is based on structure from motion algorithm (SfM). Photogrammetric data processing resulted in high-resolution models (DEM, DSM and orthophoto). Measurements were done using a digital measurement tool and by connecting WMS to ESRI ArcGIS Pro software.

The accuracy of measured values was calculated using Root Mean Square Error (RMSE) and percentage error. As UAV have much better spatial resolution than satellite or aerial imagery, it was chosen for a reference value. A measured beach area and length values from all sources revealed strong correlation (r2=>0,98). An average RMSE for beach area was 7,2% and length 2,5%, while deviation was calculated -2,3% to 5,6% for beach area, and -1% to 2,7% for beach length. Thus, linear feature measurement (e.g., shoreline) is more accurate than the polygon-based (e.g., beach area). Considering the 10-year period, as expected, recent imagery proved to have more accurate data than those from the beginning of the past decade. However, this work showed that different remote sensing sources (including the older ones) could be used in relatively accurate geomorphological beach investigations taking into account the errors. Defining the quality and errors of initial data sources represent a good base for further monitoring and analyses of beach

morphological changes and vulnerability assessment, but also for coastal management in the future.

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