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Empirical water depth predictions in Dublin Bay based on satellite EO multispectral imagery and multibeam data using spatially weighted geographical analysis

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The coastal shallow water zone can be a challenging and expensive environment within which to acquire bathymetry and other oceanographic data using traditional survey methods. Dangers and limited swath coverage make some of these areas unfeasible to survey using ship borne systems, and turbidity can preclude marine LIDAR. As a result, an extensive part of the coastline worldwide remains completely unmapped. Satellite EO multispectral data, after processing, allows timely, cost efficient and quality controlled information to be used for planning, monitoring, and regulating coastal environments. It has the potential to deliver repetitive derivation of medium resolution bathymetry, coastal water properties and seafloor characteristics in shallow waters. Over the last 30 years satellite passive imaging methods for bathymetry extraction, implementing analytical or empirical methods, have had a limited success predicting water depths. Different wavelengths of the solar light penetrate the water column to varying depths. They can provide acceptable results up to 20 m but become less accurate in deeper waters.

The study area is located in the inner part of Dublin Bay, on the East coast of Ireland. The region investigated is a C-shaped inlet covering an area of 10 km long and 5 km wide with water depths ranging from 0 to 10 m. The methodology employed on this research uses a ratio of reflectance from SPOT 5 satellite bands, differing to standard linear transform algorithms. High accuracy water depths were derived using multibeam data. The final empirical model uses spatially weighted geographical tools to retrieve predicted depths.

The results of this paper confirm that SPOT satellite scenes are suitable to predict depths using empirical models in very shallow embayments. Spatial regression models show better adjustments in the predictions over non-spatial models. The spatial regression equation used provides realistic results down to 6 m below the water surface, with reliable and error controlled depths. Bathymetric extraction approaches involving satellite imagery data are regarded as a fast, successful and economically advantageous solution to automatic water depth calculation in shallow and complex environments.