Seabed sediment grain size prediction using multibeam backscatter data and spatial regression models

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INFOMAR have been exploring the possibilities offered by the emergent field of spatial statistics to geo-acoustic modelling in marine environments. We will report on a trial study in which we tested the premise that the known complexities of the backscatter data response to the seabed can, within certain confines, be greatly simplified for the purposes of predicting seabed properties. A shallow-water embayment, Dunmanus Bay in southwest Ireland, was chosen as the study area on the basis that a large number of groundtruthing samples were available (n=175). Following exploratory data analysis, a strong linear correlation between percentage sand and mean backscatter data was identified for fine-grained sediments. In total, four linear regression models were fitted to the data: Ordinary Least Squares, where spatial dependence was not factored and three variations on Generalised Least Squares where spatial dependence was modelled using spherical, exponential and Gaussian variogram models respectively. Based on Akaike's Information Criterion, GLS using an exponential variogram model was identified as the most parsimonious. Predictions using both this model and OLS regression were subject to validation testing for prediction accuracy and uncertainty by calculating various model diagnostics from the results of a leave-one-out cross-validation. The key diagnostics indicated that the spatial model should be preferred to the non-spatial. Predictions produced for the study area had average error bands of $^{+}/_{-}10\%$ Sand at the 90% confidence level. The implications are that acoustic data could, potentially, be used to predict percentage sand for fine-grained sediments. While the empirical model devised is specific to the datasets employed, this study outlines a successful approach to prediction and mapping of seabed characteristics.