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Image analysis methods, geo-statistics and GIS techniques to derive spatial budgets for benthic communities at mud volcanoes

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Currently, the multitude of information about marine geophysical, biological data and spatial patterns increases tremendously. Compared to the increasing amount of information only a few concepts and techniques are applied for efficient visualisation and optimal analysis of present and upcoming data sets. There is a considerable need for a generalised analysis of acoustic data, still photographs, video flows and video mosaics of the sea floor. For example, more than 4200 geo-referenced video mosaics have been derived during the RV Polarstern equipped with the remotely operated vehicle (ROV) Victor6000 cruise to the Håkon Mosby Mud Volcano (HMMV) in 2003. Therefore the automatic or semiautomatic image analysis gains more and more in importance concerning greyscale, colour, texture and contour detection.

An automatic extraction of the areas of interest could be realized by edge detection and geometrical shape recognition of the Freeman Chaincode algorithm. The transmission of the shapes into polygons allows a further spatial analysis within GIS and with geo-statistical methods. This includes spatial budgets of geological and biogeochemical cycles and characterisation of habitats at the seafloor based on the combination of several information layers.

The geo-statistical methodology is used to be practiced to analyse structures and to describe spatial patterns. The classical tool, the interpolation, takes place in describing the variography of spatial dependence of data (semi-variance) as a function of their distance. This spatial variability is examined in order to derive a model which describes the spatial characteristics of the variables. This model is the crucial input for the actual interpolation, the Kriging. The Indicator Kriging used in this study op-

erates with data from a bivariate data type to predict the probability of thresholds (e.g. occurrence yes (1) or no (0)) of the same data type at unsampled locations. Thus the kriged surfaces reveal whether the probability of occurrence of a certain habitat indicator e.g. bacteria mats $< 50\%$ is particularly high or particularly low. This can be accomplished successively for all interesting regions. Finally a potential habitat map of the benthic communities at HMMV results from the interpolation. Some surfaces can remain undefined, since the Kriging permits an interpolation only up to the distance determined by the semivariogram. Beyond that no statements about surfaces are made. For validation of the computed results, Kriging allows calculation of standard errors of prediction. Furthermore, we applied a cross-validation analysis which gives information about the accuracy of the computed maps.

The combination of semiautomatic video mosaic analysis and geo-statistical methods enables us to estimate the percentage of coverage by diverse parameters. The different information layers were overlaid by GIS technique for the consideration of different geochemical habitats, mud flows and calculation of spatial budgets.