Data integration of Scuba benthic communities' photography surveys with physico-chemical multiparameter sensor platform as a means for more efficient coastal ecosystems studies

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Classical benthic ecology surveys based on in-situ sampling and laboratory analyses serve as basis for modern coastal ecosystems monitoring programs and are the basis for the EU Water Framework Directive and Marine Strategy Framework Directive monitoring programs. Such studies require expertise in benthic ecosystems and the taxonomy and biology of the flora and fauna in the coastal zone, and are time-consuming and slow to obtain results. In these studies, environmental data on physical and chemical parameters of the marine environment is usually added post-factum in the data analysis and it usually comes from separate surveys, often from a different location and time.

Modern advances in digital underwater photography and photogrammetry allow a rapid and more efficient survey of benthic communities, especially in the case of macroalgal and zoobenthic communities on hard bottom. The usage of photography as a non-destructive method for sampling allows the surveyors to gather significant amount of data in the limited time available underwater (see Berov et al. 2016, 2018), which could then be quickly processed with image analysis software (CPCE, PhotoQuad etc.) and analyzed in statistical and geographical information software packages (e.g. Primer-E, R, SPSS, Arc GIS), thus significantly shortening the time needed for sampling, data analysis and results generation. Recently developed multiparameter sensor platforms are compact enough to be used in surveys conducted from small research vessels and by scuba divers, opening up the opportunities for measuring relevant environmental parameters (e.g. depth, temperature, light intensity, pH, salinity, oxygen contents, chlorophyll-a, and DOM concentration) in the exact locations of the benthic ecology surveys, thus putting the obtained biological results in the correct oceanographical context. The purpose of this work was to develop and test a system integrating data from photogrammetry benthic surveys, GPS navigation data and physico-chemical parameters measurements, with possibilities for results exports in statistical packages, GIS, and oceanographical data visualization programs (Ocean Data View).

The system is based on a high-resolution full-frame photo camera (Canon 5D Mark III in an Ikelite housing), equipped with strobes (Ikelite DS-161), a multiparameter probe (MpX NKE Instrumentation with sensors measuring depth, temperature, salinity, oxygen concentration, pH, chl-a fluoresence), a sensor module for PAR (NKE sPAR logger), and a surface-towed GPS buoy. The different components of the system can be used modularly, allowing several configurations of usage: for (1) georeferenced scuba divers photo surveys of benthic ecosystems combined with measurements of physico-chemical parameteres, and (2) autonomous deployment of the photo- and multiparameter sensor platform from a boat for surveys of the benthos covering larger areas and at depths higher than recommended for repetitive scuba dives.

The integration of the data is carried out in a MS Access SQL database. The georeferening of the photos is based on time-synchronization of the data logs from the GPS with the EXIFF time stamp of each photo, with different options for photo-GPS delay compensation. Depth readings for each

photo are extracted from the CSV-format logs of the multiparameter platform, or alternatively – from the logs of the diving computer used by the diver operating the camera. The georeferencing and integration of the data logs from the multiparameter platform is again based on time synchronization of the data logs. Various modules for metadata attributes for each survey are also included in the database. The system allows data exports in tabular format for import in ArcGIS (georeferenced photos, physico-chemical data, metadata), Ocean Data View (physico-chemical data), as well as statistical packages (e.g. MS Excel, R, Primer-E).

Initial tests of the system in specific case studies in the Black Sea coastal zone are currently underway. Our first results show significant improvement of the efficiency of coastal benthic mapping surveys, water quality monitoring and environmental impact assessment studies in comparison with previous surveys based on separate and non-integrated instruments and data sources. Data output is used in surveys of the good ecological state and modelling of the distribution of the hard bottom infralittoral habitats along the Bulgarian Black Sea coast (MSFD Descriptor 1.6), monitoring of the recovery of a coastal area after the completion of a waste water treatement plant, and possible environmental impacts from *Mytilus galloprovincialis* black mussel farms.

References

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