Sediment Profile Imagery (SPI) applicability for environmental impact assessment in shallow coastal environments

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The Marine Strategy Framework Directive (MSFD), descriptor 6 (Seafloor integrity) requires an assessment of the areal extent in physical loss and disturbance, and adverse effects caused by the ongoing anthropogenic activities within an area (EU guidance article 8). This requires monitoring the benthic environment on a large spatial scale and for many anthropogenic activity types. To accomplish this, a search is done for more cost-efficient tools. The sediment profile imaging (SPI) allows a quick examination of the benthic habitat quality and consists of a wedge-shaped prism with an inverted periscope that penetrates the seafloor to reflect the sediment-water interface (SWI). Therefore, the SPI camera provides an undisturbed 20 cm (maximum), high resolution, cross-sectional profile image which can be analyzed for biological, physical and chemical parameters. Each picture provides several parameters, such as sediment type (e.g. muddy, very fine, fine, medium, coarser sand); prism penetration (proxy for sediment compaction); surface reliefs & bedforms; surface and sub-surface fauna; sediment apparent redox potential discontinuity depth (aRPD) (estimates the oxidized sediment depth); and the % of anoxic surface area. Those parameters form the basis for the benthic indicators: the organism sediment index (OSI) [1] and benthic habitat quality (BHQ) [2]. Several studies test SPI applicability in deep-sea and estuarine environments, although very few studies were taken in shallow coastal areas. In this study, we tested the performance and applicability of the SPI derived parameters for environmental impact assessment (EIA in the dynamic coastal environment of the Southern North Sea. Therefore, a total of 600 SPI images were collected based on a control-impact design across 4 EIA cases (dredge disposal, sand extraction, offshore wind farms and fishery (beam trawl & pulse fishery)). The images were analyzed using the SpiArcBase software [3], which allows us to create and manage a database with the original SPI pictures and derived parameters. The SWI, penetration depth and aRPD (depth, surface area) were directly calculated within the software. The remaining features were catalogued in a pre-defined Excel table. The sediment classes were relevant information for each case and sediment changes (e.g. mud clasts) were most obvious for the dredge disposal case. The prism penetration depth revealed slight changes in sediment compaction due to fishery, dredge disposal and sand extraction activity. The surface fauna and % of anoxic sediment surface indicated to be relevant to assess the redox sediment stage and fauna quality for all the cases. However, the evaluation of sub-surface fauna, based on SPI, could only be done in areas where infauna was very abundant. This was true for the fishery case, where we observed a decline in Lanice conchilega after the fishery disturbance. The BHQ (adapted version from Nilsson & Rosenberg [2]) indicator allowed to detect changes due to the impacts, whereas the OSI indicator was not sensitive at all. Our study indicates the importance of the SPI derived parameters for EIA purpose in shallow coastal environments by combining information from multiple anthropogenic stressors. This comprehensive approach showcases the adaptability and ease of use of the SPI for benthic impact assessments. The SPI provides important information regarding specific features in-situ that other methods struggle to achieve, and its applicability must be seen as a complementary tool to improve the traditional sediment sampling programs.

References

[1] Rhoads D.C., Germano J.D. (1987) Interpreting long-term changes in benthic community structure: a new protocol. In: Heip C., Keegan B.F., Lewis J.R. (eds) Long-Term Changes in Coastal Benthic Communities. Developments in Hydrobiology, vol 38. Springer, Dordrecht. https://doi.org/10.1007/978-94-009-4049-9_25
[2] Nilsson H.C., Rosenberg R. (1997) Benthic habitat quality assessment of an oxygen stressed fjord by surface and sediment profile images. Journal of Marine Systems, Vol 11., Issues 3–4, Pages 249-264, ISSN 0924-7963. https://doi.org/10.1016/S0924-7963(96)00111-X
[3] Romero-Ramirez, A. *et al.* (2016) Development and validation of a video analysis software for marine benthic applications. J. Mar. Syst. 162, 4–17. https://doi.org/10.1016/j.jmarsys.2016.03.003

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