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Quantification of Benthic Phytoplankton using Remote Sensing and Machine Learning in the Wadden Sea*

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One of the main indicators of ecosystem stability in coastal regions is the occurrence and distribution of primary producers. In the intertidal flats of the Wadden Sea, benthic phytoplankton such as microphytobenthos are significant primary providers of energy. However, the Wadden Sea monitoring data inventory states that there is low availability of microphytobenthos data despite its high demand. To address this gap, a remote sensing approach coupled with data fusion through machine learning using the Random Forest algorithm was adopted and developed. This study also maximized existing datasets to demonstrate other possible applications of such data and subsequently, the added practical value these datasets offer.

Microphytobenthos thrive in areas where the sediments have high mud and nutrient content. These organisms are also known to aid in sediment stability due to excreted extracellular polymeric substances. Following this rationale, it was assumed that sediment grain size, Total Suspended Matter (TSM), Chlorophyll-a (Chl-a) and Photosynthetically Active Radiation (PAR) can be combined in determining microphytobenthos occurrence. The microphytobenthos model derived using Random Forest algorithm has the following input parameters: sediment grain size map derived from Landsat images, MERIS Products TSM, Chl-a and PAR. The benthic diatom model from Het Koninklijk Nederlands Instituut voor Onderzoek der Zee (NIOZ) was used as baseline data for the training model. Another scenario was considered using TSM and Chl-a modelling output from the Generic Ecological Model-Algal Bloom (GEM/BLOOM) model. Two main training models were derived from the microphytobenthos prediction algorithm. These models were distinct from each other; in that the first model had a higher and wider microphytobenthos concentration range (0 – 7000 mg C m^{-2}) and the second model had a lower and narrower range (0 —- 1000 mg C m^{-2}) suitable for warmer and colder time periods, respectively.

Although more extensive data is required to further validate this procedure, this alternative method has proven to be a feasible non-invasive technique to quantify microphytobenthos while utilizing existing datasets.

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