Grain Size Retrieval Model for Spatiotemporal Monitoring of Tidal Flats Using Remote Sensing and Machine Learning

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Tidal flats play a crucial role in ecosystems by providing habitats for a variety of organisms, including microbenthos, clams, and fish. Additionally, tidal flats are recognized as one of the largest blue carbon reservoirs. The sedimentary facies of tidal flats are particularly significant as they influence carbon sequestration rates and marine biodiversity. Sediment distributions in tidal flats are affected by various factors, such as seasonal variations, climate changes, and anthropogenic impacts. Consequently, these dynamic areas require high temporal resolution monitoring to estimate and mitigate the effects of climate change. However, obtaining sediment information from tidal flats is challenging due to their low accessibility. To address this issue, many researchers advocate for satellite-based approaches.

Unfortunately, satellite-based approaches currently face limitations in generating robust time series of sediment variations in tidal flats due to several factors: (1) reflectance signals of tidal flats are influenced not only by sediment grain size but also by factors such as soil moisture, surface remnant water, benthic algae, and soil mineral types; and (2) reflectance signals from multiple satellite images cannot be easily compared on an absolute scale due to incomplete atmospheric corrections, especially in low reflectance areas like tidal flats.

In this study, we normalized multitemporal satellite images and applied a machine-learning method to generate multitemporal sediment grain size maps of tidal flats. Several fieldwork activities were also conducted to obtain ground truth data on sediment grain sizes in the Ganghwa tidal flat in South Korea. The trained model showed reliable testing results for multitemporal images. The results indicate that generating multitemporal satellite image-based sediment grain size distribution maps, which are comparable on an absolute scale, is feasible.