



Can Sentinel-2 Images Predict the Seasonal Behavior of Floating Marine Plastic Debris? A Case Study of the Western Coast of Sri Lanka

H.H.M.H.K.B. Herath^{1*}, Ranmalee Bandara², Thisal Jayathilaka³

¹Department of Remote Sensing and GIS, Faculty of Geomatics, Sabaragamuwa University of Sri Lanka, Sri Lanka.

²Department of Surveying and Geodesy, Faculty of Geomatics, Sabaragamuwa University of Sri Lanka, Sri Lanka.

³IFS R&D International (Pvt) Ltd, Orion Towers 1, Level 18, 736, Dr. Danister De Silva Mawatha, Colombo 09, Sri Lanka.

*hashanbandara01@gmail.com

Marine Plastic pollution has emerged as a critical global environmental issue, causing significant threats to marine ecosystems, human health, and coastal economies. Despite recent advancements in satellite-based detection, long-term assessments of the seasonal behaviors of Floating Marine Plastic Debris (FMPD) remain limited in Sri Lanka. This study investigates the seasonal behavior of FMPD along the western coast of Sri Lanka, extending approximately 98 km from Negombo to Kalutara and 50 km towards the Indian Ocean. Sentinel 2 multispectral images from 2019 to 2025 were utilized, and a previously developed spectral index was applied to detect the FMPD. A threshold-based classification, validated using the ground truth data from the X-Press Pearl incident, achieved an overall accuracy of 73.07%. Initial mapping of FMPD identified hotspots in off Kalutara, Beruwala, and Moratuwa, likely influenced by the river discharge and oceanic processes. Seasonal variation analysis using the Chi-square test revealed non-significant variation of FMPD during the period before 2021, but statistically significant variation was found from 2022 to 2025, with high plastic accumulation during the Northeast monsoon and lower levels during the other seasons ($p < 0.05$). This transition may be associated with the excess use of plastics during the COVID-19 pandemic period. A seasonal autoregressive integrated moving average (SARIMA) model was applied to monthly data from 2022 to 2025, identifying a 14-month seasonal cycle and demonstrating satisfactory predictive performances with a 2.46 Root Mean Square Error and a Mean Absolute Error of 1.58. Forecast results indicate the continuous presence of seasonal fluctuations. Overall, the findings confirm the applicability of satellite-based remote sensing techniques for large-scale monitoring of FMPD and highlight the strong influence of seasonal climatic factors on accumulation and distribution, supporting effective coastal management and pollution mitigation strategies. However, an extended period of observation would improve predictive performance.

Keywords: *Marine plastic pollution, Sentinel-2, Seasonal variability, SARIMA, Remote sensing*