**Title:** Predictive Modelling and Simulation of Marine Debris Dispersion in Maltese Territorial Waters

**Abstract:**

The accumulation of marine debris in the territorial waters of Malta presents a severe ecological and environmental challenge, adversely impacting marine life and human activities. This project embarks on addressing this issue by developing an AI-enhanced predictive model integrated with a physics-based Lagrangian dispersion model. Utilizing the Ocean Parcels framework, the initiative simulates the movement and accumulation of marine debris, providing both real-time tracking and future forecast scenarios. By leveraging historical ocean current and weather data, a regression model augments the predictive accuracy of the system, ensuring data-driven, actionable insights. Hosted on a web platform, this model avails a novel, proactive approach towards marine debris management in the Maltese region, aiming to significantly aid cleanup operations and marine conservation efforts. Through real-time data visualization and predictive analytics, the project endeavours to provide a sustainable, long-term solution to the marine debris issue in Malta, moving a step closer towards restoring the pristine condition of its territorial waters.

1. Introduction:

1.1 Problem Definition and Motivation:

Marine debris accumulation poses severe threats to marine ecosystems and human activities in the Maltese Islands. Traditional cleanup approaches are reactive and resource-intensive. The project is motivated by the necessity for a sustainable, data-driven solution to predict and monitor marine debris dispersion for proactive management.

1.2 Aim and Objectives:

The primary aim is to develop a predictive model and real-time monitoring system for marine debris dispersion in Maltese territorial waters. The objectives are:

Collect and preprocess ocean and weather data.

Develop a Lagrangian dispersion model using the Ocean Parcels framework.

Create a regression model to forecast ocean currents and wind data.

Design a website for real-time visualization of marine debris dispersion.

Evaluate the accuracy and effectiveness of the predictive model and monitoring system.

1.3 Document Structure:

The document unfolds with a literature review, followed by the proposed solution and methodology, testing and evaluation of the system, and finally, a conclusion summarizing the progress and future steps.

2. Literature Review:

A comprehensive review of existing literature was conducted to understand the principles of Lagrangian dispersion modeling and its applications in marine debris tracking (e.g., Ocean Cleanup, OpenDrift, OceanParcels). The review also extends to studies on predictive analytics for ocean currents and wind data, and real-time monitoring systems for environmental conservation.

3. Proposed Solution/Methodology:

The project adopts a two-pronged approach; predictive analytics and Lagrangian particle tracking. Ocean and weather data are collected and preprocessed using NetCDF for ocean data and CSV files for weather data. The predictive analytics model is developed based on historical data, while the Lagrangian model simulates the movement of marine debris. The system's architecture facilitates real-time monitoring and visualization through a web platform, providing actionable insights for marine conservation initiatives.

4. Testing and Evaluation:

The testing phase aims to validate the accuracy and reliability of the predictive and Lagrangian models in simulating real-world marine debris dispersion scenarios. Evaluation criteria include the comparison of simulated results with actual marine debris accumulation data, and the usability and responsiveness of the web platform.

5. Conclusion:

The project presents a promising approach towards addressing marine debris accumulation in Maltese territorial waters through data-driven predictive modeling and real-time monitoring. The progress made lays a solid foundation for continued development and evaluation, driving towards a sustainable solution for marine conservation.

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