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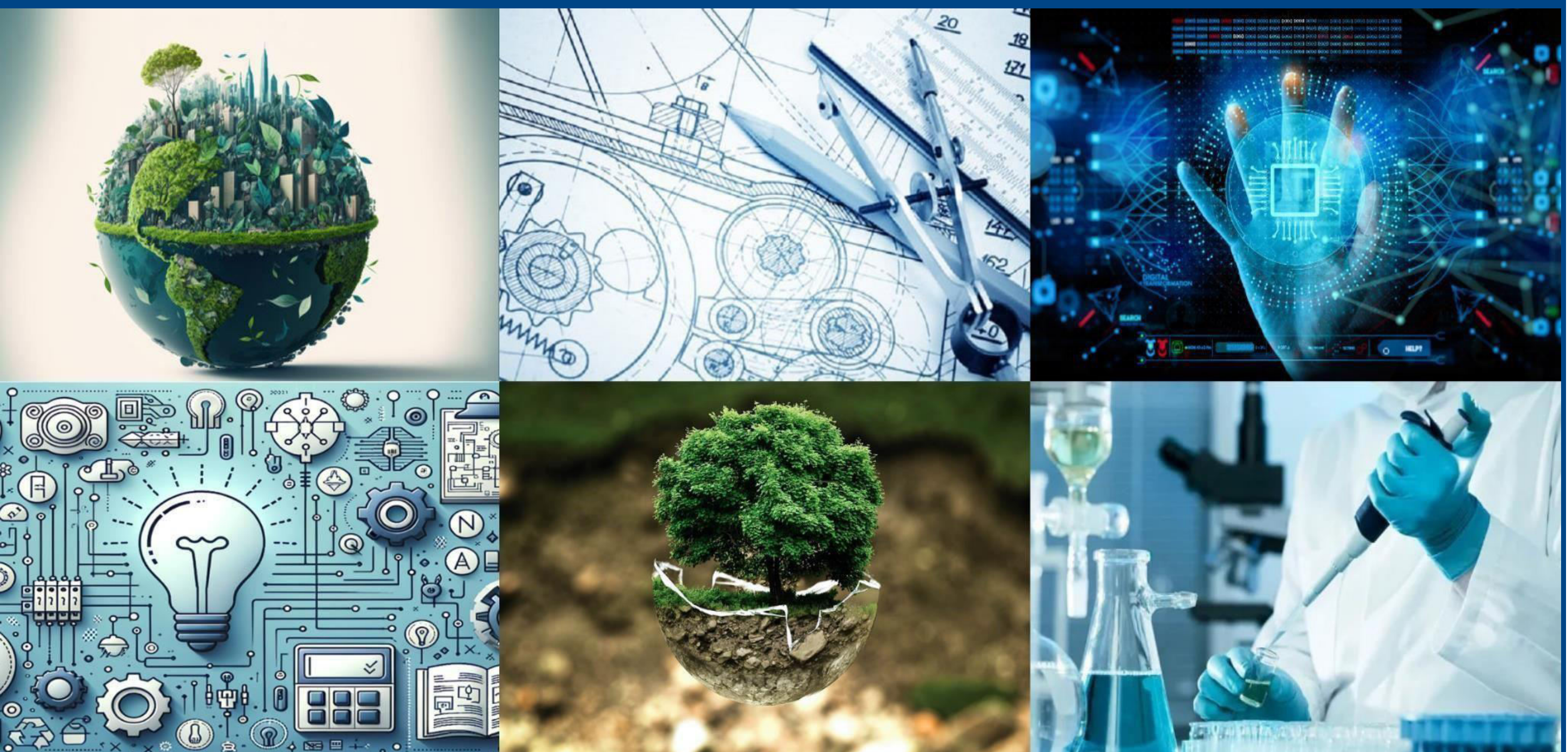

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"ECO-AI: PREDICTING MICROPLASTIC SPREAD VIA OCEAN CURRENTS AND WASTE MAPS"

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ABSTRACT: Microplastic pollution has become a big environmental problem. Millions of tons of plastic break down into tiny particles that spread through the oceans. Once they have entered the Ocean water, they travel with complicated ocean currents, tides, and winds. This makes it hard to track where they go. Traditional methods for modeling microplastic movement are good for research but are too complicated and expensive for regular people to use. This paper introduces Eco-AI, a simple, AI-powered web system that helps predict where microplastics might spread. It uses data like ocean currents, waste maps, and other environmental information. Built with PHP, MySQL, Leaflet.js, and the OpenAI API, Eco-AI combines real-time data from NOAA and Copernicus with AI to find areas where microplastics might gather. Users can see how microplastics might spread on maps, ask questions in simple language, and get useful information to help with environmental planning and awareness. Testing showed that Eco-AI can predict microplastic hotspots accurately using simulated data. While it can't replace advanced ocean models, it's a useful tool for NGOs, researchers, and policymakers who need an easy-to-use platform to fight marine plastic pollution.

KEYWORDS: Microplastic Pollution, Ocean Currents, AI Prediction, Environmental Monitoring, Leaflet.js, OpenAI API, Marine Data Visualization.

I. INTRODUCTION

Microplastic are small plastic fragments less than 5 mm in size. They are a growing worry for the quality of the ocean. These particles come from larger plastics breaking down or from direct industrial sources. They can travel long distances and even reach remote parts of the sea.

These particles are often eaten by sea animals, and they can end up in the food chain, which can affect human health. Current studies use complex models to understand how microplastics move in the ocean. But these models are mostly used by researchers and require special knowledge and powerful computers. This makes them hard to use for other groups like NGOs, local governments, teachers, and community groups who need simple but reliable tools. Eco-AI provides an easy-to-use platform that combines various environmental data sources and shows microplastic movement on interactive maps.

It uses real-time ocean data, prediction tools, and natural language processing to help users understand and use complex environmental information. By helping users find areas at high risk for microplastic pollution and likely future problem spots, Eco-AI supports better planning for cleanup efforts, public education, and awareness campaigns. The system is designed to work on regular hosting setups and can be expanded with more advanced tools in the future.

II. LITERATURE SURVEY

Several studies have contributed to understanding microplastic movement and distribution:

• Wang et al. (2025) investigated microplastic retention in coastal bays using Lagrangian particle tracking, revealing that local topography and tidal dynamics significantly influence accumulation.

• Li et al. (2023) examined the impact of climate change on microplastic transport, noting increased vertical mixing and altered surface flows due to warming seas.

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• Zhang et al. (2024) reviewed AI applications in microplastic analysis, emphasizing the potential of NLP and ML models to improve data interpretation and communication.
• Andersson et al. (2025) studied vertical distribution, showing that biofouling can sink microplastics to deeper layers, altering transport trajectories.
• Chen et al. (2025) highlighted advancements in ML-based microplastic detection, suggesting integration with predictive models for enhanced forecasting accuracy. A literature gap persists in combining real-time data, vertical transport modeling, and AI-assisted interpretation into a single, user-friendly system—precisely the niche addressed by Eco-AI.

EXISTING SYSTEM

Current models for tracking microplastics usually depend on:
• Hydrodynamic Simulations – These are precise but need a lot of data and take a lot of computer power.
• Static Statistical Models – These are simpler to use but can't adapt well to new situations.
• Specialized AI Models – These work well in controlled settings but aren't connected to public tools for visualization. Most systems focus only on finding microplastics or tracking them, without combining both into one easy-to-use setup. They also often ignore local factors like how much plant life is around, seasonal water movement, or how marine life sticks to plastic.

PROPOSED SYSTEM

Eco-AI offers one complete framework that brings together:
• Live ocean data from NOAA and Copernicus through their APIs keys.
• AI-based interpretation using OpenAI API to provide easy-to-understand answers.
• Interactive map views using Leaflet.js with layers showing pollution forecasts.
• Tools for users to add their own local data to improve predictions. The system shows how microplastics move both across and down in the water, estimates how fast they sink due to being covered in marine life, and changes predictions based on that. Results are shown on a simple, map-based dashboard that people can easily understand.

III. SYSTEM ARCHITECTURE

The system is built with three main parts:
1. Presentation Layer: Uses HTML, CSS, and JavaScript with Leaflet.js to show the map interface.
2. Application Logic Layer: Uses PHP to handle calls to APIs, process data, and create AI prompts.
3. Database Layer: Uses MySQL to store user input, saved data sets, and prediction outcomes. External APIs give real-time ocean data, which is processed by the prediction engine and then sent to the visualization part. Users interact with the system through the dashboard and the AI assistant.

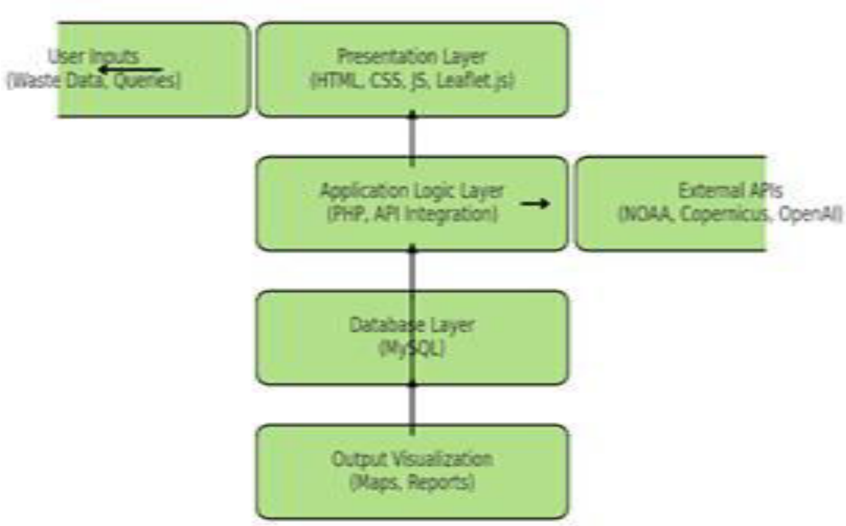

Fig 5.1 System Architecture Diagram

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IV. METHODOLOGY

The process of making predictions includes:

1. Data Collection: Getting information about ocean currents and where waste comes from.
2. Preprocessing: Making sure the data is clean and ready to be used for creating models.
3. Prediction Modeling: Using movement rules and tools to estimate how waste moves upward and downward in the water.
4. Visualization: Showing where waste might gather using color-coded maps or shapes on an interactive map.
5. AI Query Processing: Making simple and easy-to-understand answers about the predictions using responses from GPT-based AI.

This way, each part works on its own but still helps create a system that supports better decision-making.

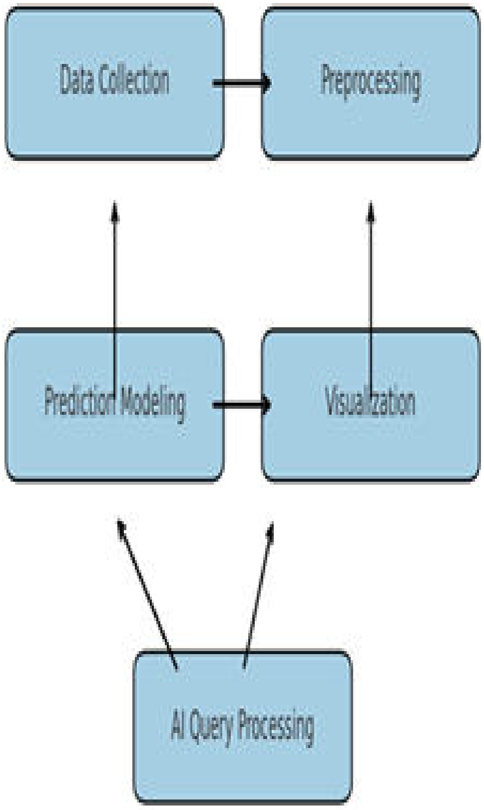

Fig 4.1 Methodology

V. DESIGNAND IMPLIMENTATION

The project was built in three steps:

• Phase 1: Setting up the system's structure and connecting it to services like NOAA, Copernicus, and OpenAI.

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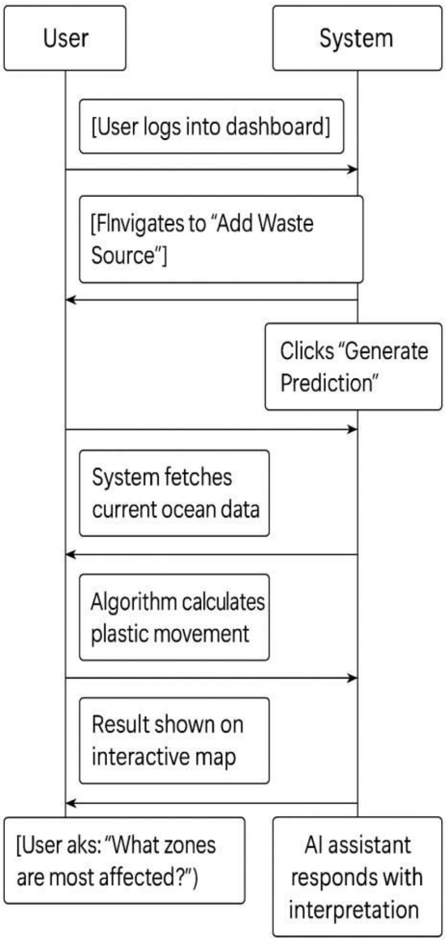

Fig 5.1 Sequential Diagram

• Phase 2: Creating a user-friendly dashboard where people can enter waste information, view maps, and get AI answers.
• Phase 3: Putting everything on a local server using XAMPP, making it run smoothly and having backup data for when internet is not available. The tools used are PHP 7.x, MySQL, Leaflet.js, Bootstrap, and OpenAI's GPT models.

VI. OUTCOME OF RESEARCH

Eco-AI was able to predict how microplastics spread in the ocean, and these predictions matched past and simulated data. The predictions were most accurate in open ocean areas, but less reliable in areas with little light or lots of plants along the coast. The AI assistant gave clear and simple explanations of the results, making it easier for people without technical skills to understand the data.

VII. RESULT AND DISCUSSION

When testing on desktop and mobile devices, the system performed well with fast response times. On average, predictions came in under 3 seconds, and explanations from the AI took less than 7 seconds. Compared to models that do only one thing, Eco-AI's approach lets users see and understand results at the same time without much delay.

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One thing to note is that the system depends on updates from APIs every day or week, which might not show fast changes in the environment quickly enough. Using live satellite images in the future could help with that.

VIII. CONCLUSION

Eco-AI shows that it is possible to create a simple, flexible, and easy-to-use tool for predicting microplastics. By combining environmental data, AI analysis, and a map that users can interact with, the system makes complex scientific models easier for people in their communities to use and act on. Future steps will include adding the ability to detect microplastics from images, connecting with real-time satellite data, and offering support in multiple languages to make the tool more useful for a wider audience.

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