Quantum-AI Enhanced Ocean Clean-up System

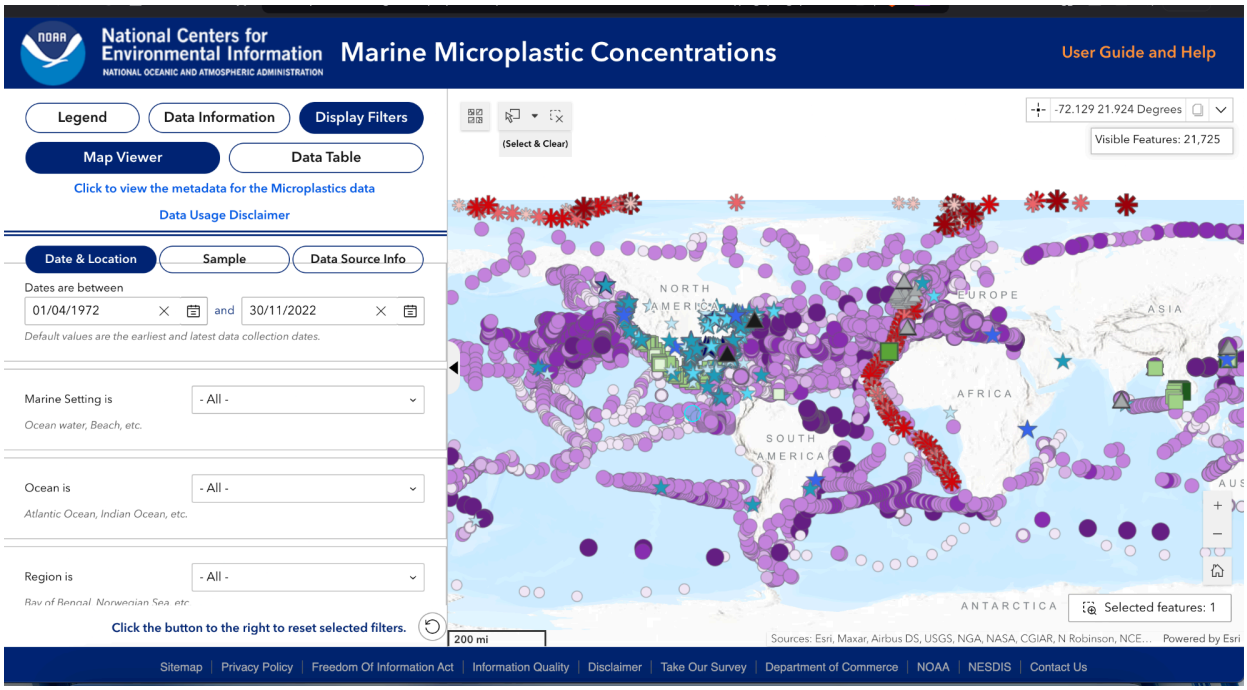
The project tackles ocean Micro plastic pollution by optimising routes for clean-up systems.

NCEI Marine Microplastics product provides access to aggregated global data on microplastics in marine settings.

https://www.ncei.noaa.gov/products/microplastics

MAP
:https://experience.arcgis.com/experience/b296879cc1984fda833a8acc93e31476/page/Page/?views=Display-Filters%2CMap-Viewer#data_s=id%3AdataSource_1-18cf9a85fdd-layer-4%3A10466

Here the image of a map
points => the location of microplastic in the ocean.



Sample data extracted from above map

OBJECTID	Latitude	Longitude	Microplastics Measurement (density)	Density Class Range	Concentration Class
8854	43.1094	3.1144	0.002	0.0005-0.005	Low
11091	43.0966	5.9917	0.78917	0.005-1	Medium
11092	43.1132	5.9279	1.95013	1-10	High
11093	43.077	5.9792	0.97608	0.005-1	Medium
11123	43.0951	5.9821	0.638818	0.005-1	Medium
11124	43.0779	6.1997	0.171411	0.005-1	Medium
11210	43.2842	5.2766	0.676127	0.005-1	Medium
11211	43.0879	5.7908	0.352637	0.005-1	Medium
11212	43.0941	5.98	0.525459	0.005-1	Medium
11213	43.0726	6.2372	4.75602	1-10	High

Below are few haversine distances measured between points

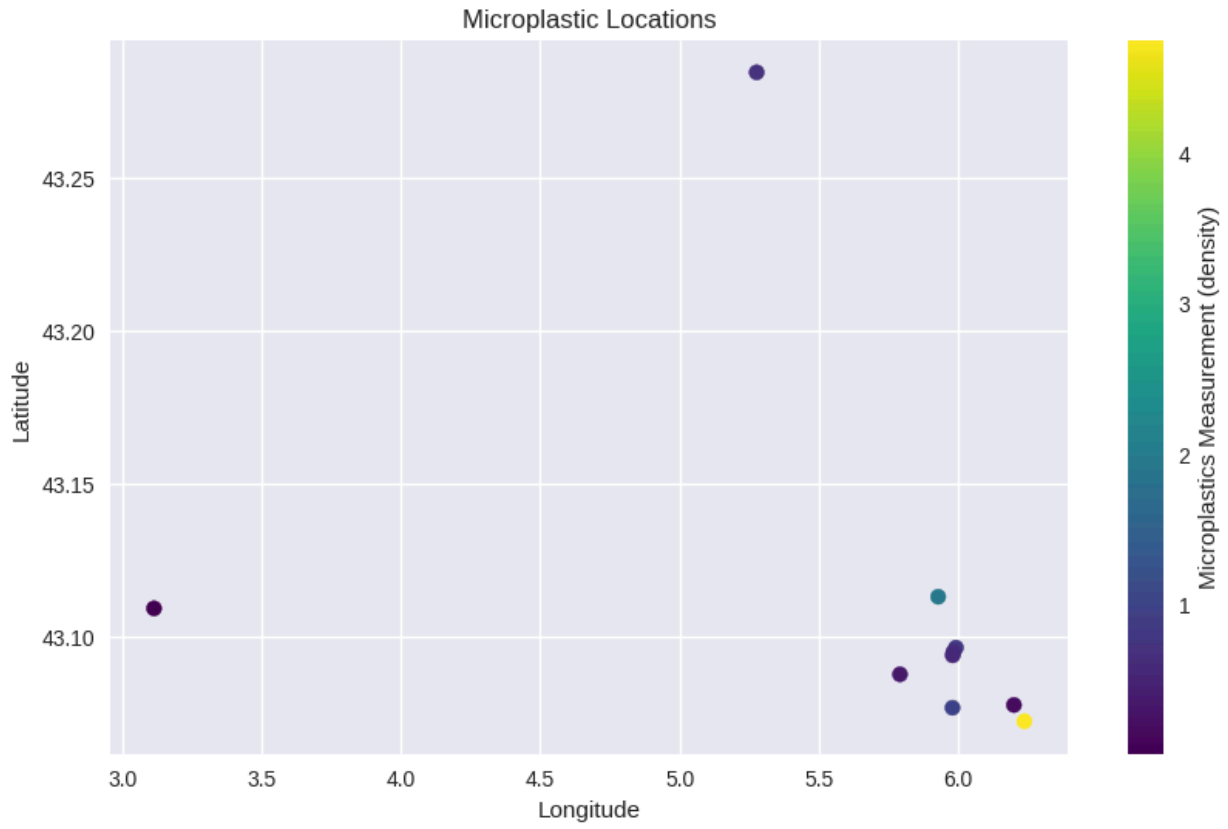
Distance between location 1 and 2: 233.59 km
Distance between location 1 and 3: 228.38 km

Note:

Haversine Distance:

- **Geolocation services**: Calculating distances between GPS coordinates.
- **Navigation**: Finding the shortest distance between two points on Earth's surface.
- **Logistics**: Optimizing delivery routes or calculating travel costs.

Microplastic location in ocean based on Latitude and Longitude



1. Based on the Cleaning system initial location (can be decided by the cleaning organization)
   We will optimize the cleaning system route with help of Quantum computer , using QAOA

2. Using AI model we can predict and pri-inform the cleaning system about weather, ocean current

Related information.

Q&A

What is QAOA ?

The **Quantum Approximate Optimization Algorithm (QAOA)** is a **hybrid quantum-classical algorithm** designed to solve **combinatorial optimization problems**. It works by:

1. **Mapping the problem** to a cost function (Hamiltonian), where the optimal solution corresponds to the lowest energy state (ground state).
2. Alternating between two quantum operations:
    - **Cost Hamiltonian evolution** (captures the problem constraints).
    - **Mixing Hamiltonian evolution** (explores the solution space).
3. Using a **classical optimizer** to fine-tune the parameters (γ,β\gamma, \beta) of the quantum circuit to minimize the cost function.

QAOA is particularly well-suited for problems like routing, scheduling, and resource allocation, and it is designed for near-term quantum devices due to its shallow circuit depth and robustness to noise.

Why are we using QAOA ?

Problem Type: Routing is a combinatorial optimization problem, perfectly suited for QAOA.
Efficiency: Finds the shortest, most energy-efficient routes while handling constraints.
Scalability: Adapts to both small and large-scale clean-up operations.