DETECT PLASTIC LITTER IN CYPRUS REGION USING SENTINEL-2.

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ABSTRACT

Marine litter is permanent, manufactured or processed solid matter that is disposed of in oceans, rivers, or beaches. Indirectly brought into the sea by rivers, sewage, rainwater and wind, or discarded or lost at sea. Marine litter poses environmental, economic, health, aesthetic and cultural threats. This includes the degradation of marine and coastal habitats and ecosystems, causing socioeconomic losses in the marine sector. Marine litter is characterized by unsustainable production and consumption patterns, poor waste management and infrastructure, and lack of adequate legal and policy frameworks and enforcement (including cross-border trade of plastic waste between regions), and a transnational challenge rooted in a lack of financial resources. This paper aims to detect plastic waste and fish farms. The study was conducted in Limassol, Cyprus, south of the Limassol Old Port. The Sentinel Application Platform (SNAP) was used to conduct the study, using the Sentinel-2 imagery data. We used several well-established indices for water feature extraction to detect plastic litter. The Normalized Difference Water Index (NDWI), Water Ratio Index (WRI), Normalized Difference Vegetation Index (NDVI), Automated Water Extraction Index (AWEI), Modified Normalization Deference Water Index (MNDWI) and Normalization Deference Moisture Index (NDMI), the Simple Ratio (SR). Also, the Plastic Index (PI) and Reversed Normalized Difference Vegetation Index (RNDVI). The results when applying the above indicators are satisfactory and can separate the plastic waste in the sea.

Keywords: Plastic Litter, Sentinel-2, Indices, Cyprus

1. INTRODUCTION

Marine litter refers to waste originating from human activities that has been discharged into coastal or marine environments. Such litter may result from activities on either land or at sea. Currently, 60 to 80% of such marine litter consists of plastic, reaching 95% in some areas and has become a serious environmental hazard. Marine litter can be classified as floating and sinking litter based on its weight and shape. It has been estimated that marine litter is split into 15% floating on the sea surface, another 15% remaining in the water column and 70% subsides on the sea floor. Plastics are one of the most pervasive pollutants in the world's oceans, and they pose a significant threat to marine ecosystems, wildlife, and human health. Plastic waste can harm marine life by entangling animals or being ingested, leading to injury or death. It can also disrupt the food chain by accumulating in the bodies of marine organisms and eventually entering the human food chain. Additionally, plastic waste can degrade marine habitats, altering the balance of ecosystems and leading to the loss of biodiversity. Also, the economic impact, marine plastic pollution can have significant economic impacts, including losses in fishing and tourism revenue, cleanup costs, and damage to infrastructure. Furthermore, for the human health impact, the chemicals found in plastics can leach into the marine environment, potentially impacting human health through the consumption of contaminated seafood or water.

For the detection of plastic litter, we used several well-established indices for water feature extraction. The Normalized Difference Water Index (NDWI), Water Ratio Index (WRI), Normalized Difference Vegetation Index (NDVI), Automated Water Extraction Index (AWEI), Modified Normalization Deference Water Index (MNDWI) and Normalization Deference Moisture Index (NDMI), the Simple Ratio (SR). Also, the Plastic Index (PI) and Reversed Normalized Difference Vegetation Index (RNDVI).

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2. METHODOLOGY

2.1 Study Area

An area of interest (AoI) Sentinel-2 image was processed throughout this research. AoI-1 is located South of the Limassol Old Port in Cyprus. Sentinel-2 data from the Copernicus Open Access Hub is available via the web interface.

The satellite images used are:

- S2A_MSIL1C_20181215T083341_N0207_R021_T36SVD_20181215T085809

Figure 1. Area of interest – South of the Limassol Old Port in Cyprus.

2.2 Methods

Using the Copernicus Open Access Hub service, it is now feasible to access satellite data in fully automated and near real-time mode and deliver plastic litter information through a web portal interface, using freely available Sentinel-2 imagery data. The Sentinel Application Platform (SNAP) was used to conduct the study. For the detection of plastic litter, were used several well-established indices for water feature extraction. The Normalized Difference Water Index (NDWI) [1], Water Ratio Index (WRI) [2], Normalized Difference Vegetation Index (NDVI) [3], Automated Water Extraction Index (AWEI) [4], Modified Normalization Deference Water Index (MNDWI) [5] and Normalization Deference Moisture Index (NDMI) [6], the Simple Ratio (SR) [7]. Also, the Plastic Index (PI) [8] and Reversed Normalized Difference Vegetation Index (RNDVI) [9].

Table 1. Indices for detection of plastic litter for water feature extraction.

	INDICES FOR WATER FEATURE EXTRACTION
[1]	NDWI = (B03 - B08)/(B03 + B08)
[2]	WRI = (B03 + B04)/(B08 + B012)
[3]	NDVI = (B08 - B04)/(B08 + B04)
[4]	AWEI = 4 x (B03 - B012) - (0.25 x B08 + 2.75 x B011)
[5]	MNDWI = (B03 - B012)/(B04 + B012)

[6]	NDMI = (B03 - B08)/(B03 + B08)
[7]	SR = B08/B04
[8]	PI = B08/(B08 + B04)
[9]	RNDVI = (B04 - B08)/(B04 + B08)

2.3 Logic Diagrams

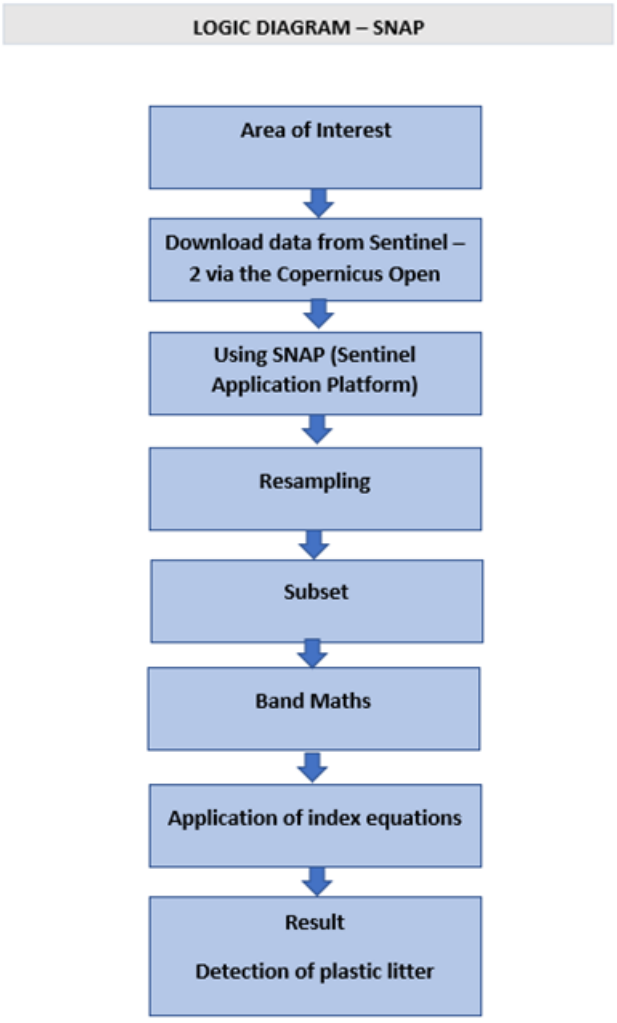

Figure 2. Methodology illustration via logic diagram for the software SNAP (Sentinel Application Platform).

3. RESULTS

The results when applying the above indicators are satisfactory and can separate the plastic waste in the sea. All of the above indicators detected plastic waste, except AWEI. It was found that indices with B04 performed better since the spatial

resolution was 10 m. The sensitivity analysis performed on the indices showed that the best indices for detecting plastic waste were PI (Plastic Index) and RNDVI (Normal Difference Vegetation Index).

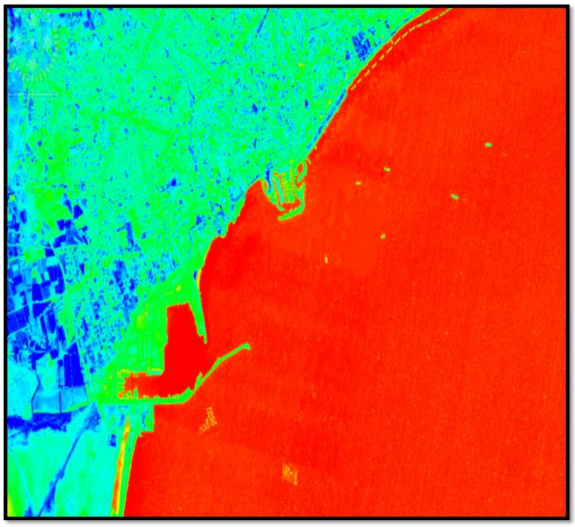

Figure 3. Normalized Difference Water Index (NDWI)

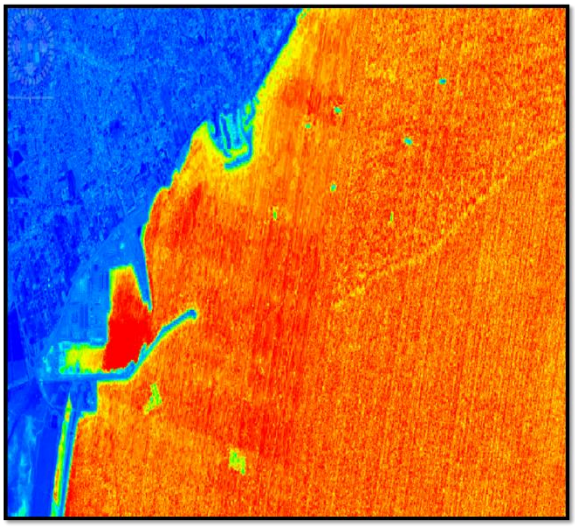

Figure 4. Water Ratio Index (WRI)

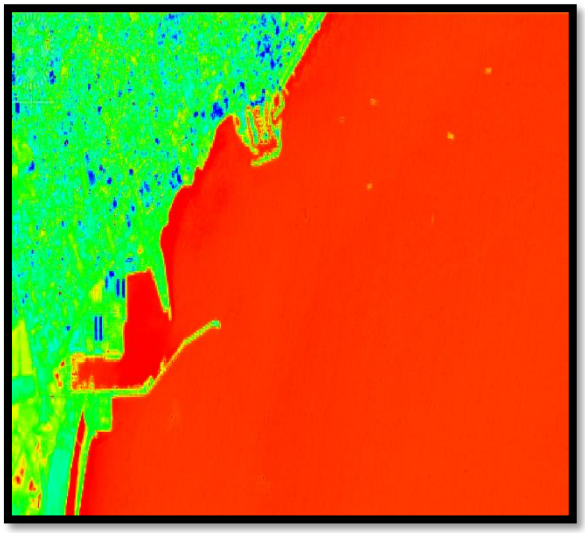

Figure 5. Automated Water Extraction Index (AWEI)

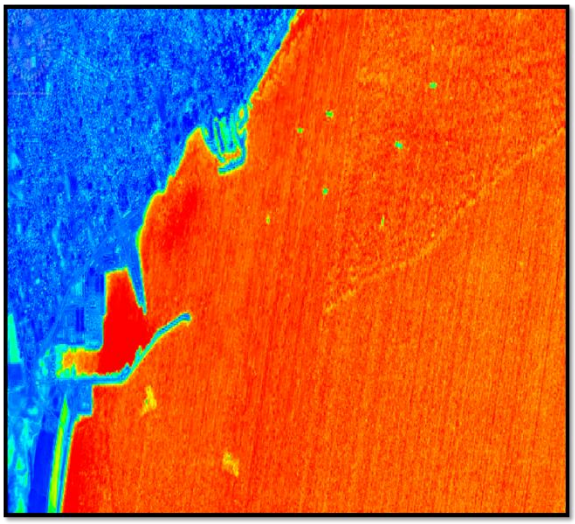

Figure 6. Modified Normalization Deference Water Index (MNDWI)

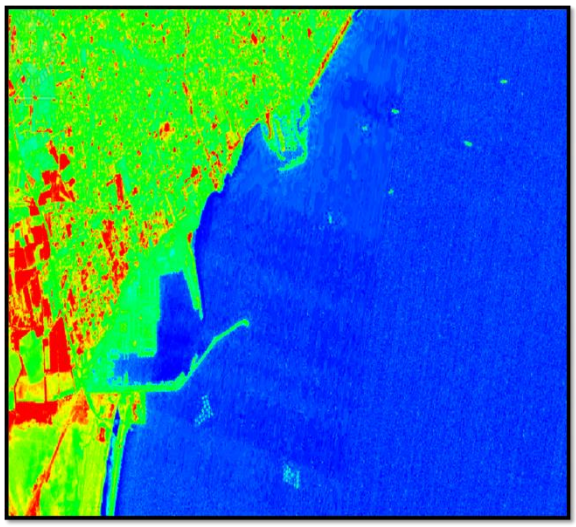

Figure 7. Normalized Difference Vegetation Index (NDVI)

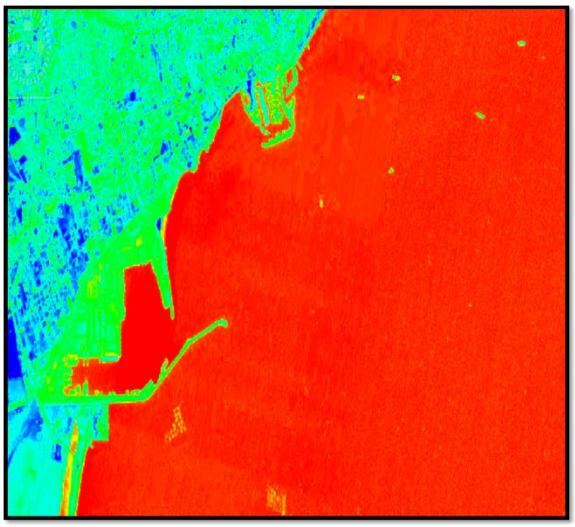

Figure 8. Normalization Deference Moisture Index (NDMI)

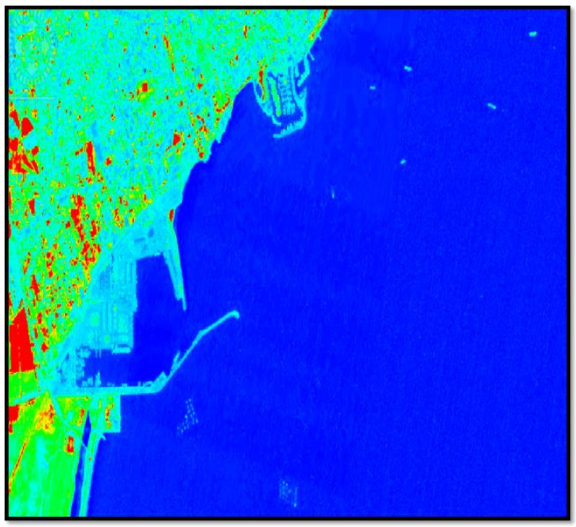

Figure 9. Simple Ratio (SR)

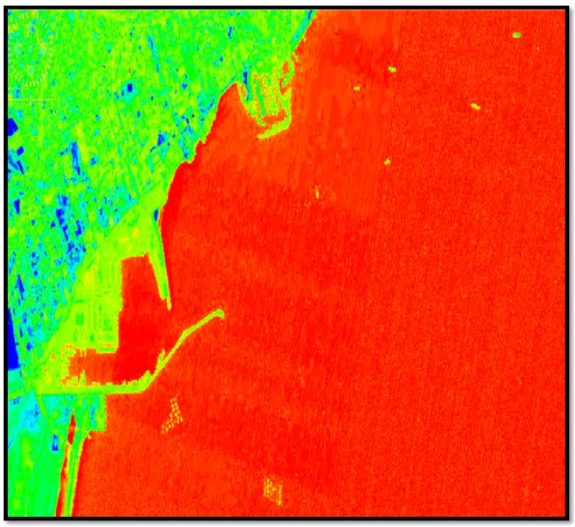

Figure 10. Reversed Normalized Difference Vegetation Index (RNDVI)

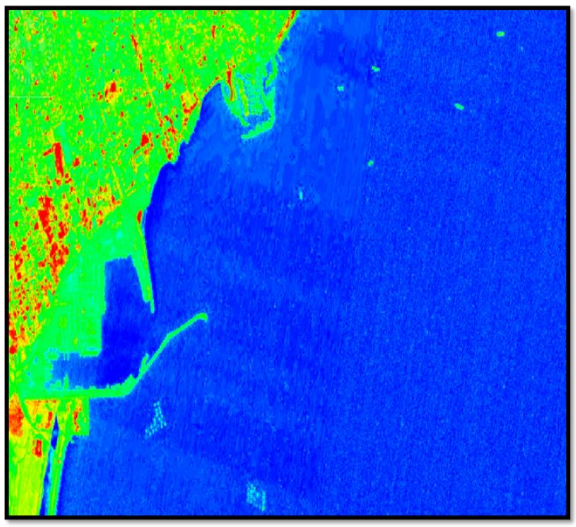

Figure 11. Plastic Index (PI)

4. CONCLUSIONS

The results are significantly enhanced and show that the use of different indicators provide a thorough detection analysis so that they can be used for maritime safety. Plastics are one of the most pervasive pollutants in the world's oceans and pose a significant threat to marine ecosystems, wildlife and human health, so through oversight, inspection and preventative procedures, threats to marine safety will be minimized.

5. FUTURE WORKS

Improving the resolution of satellite images could allow smaller plastic debris to be detected. Also, such observations provide a "snapshot" of local conditions at a given time and are difficult to use to infer the origin of waste. Combining methods and data will enable more accurate and timely information on the location and movement of plastic debris in oceans and waterways.

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