Seasonal Pulses of Microplastic Emissions to the Mediterranean Sea: the Na'aman Stream (Israel) Case Study

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INTRODUCTION

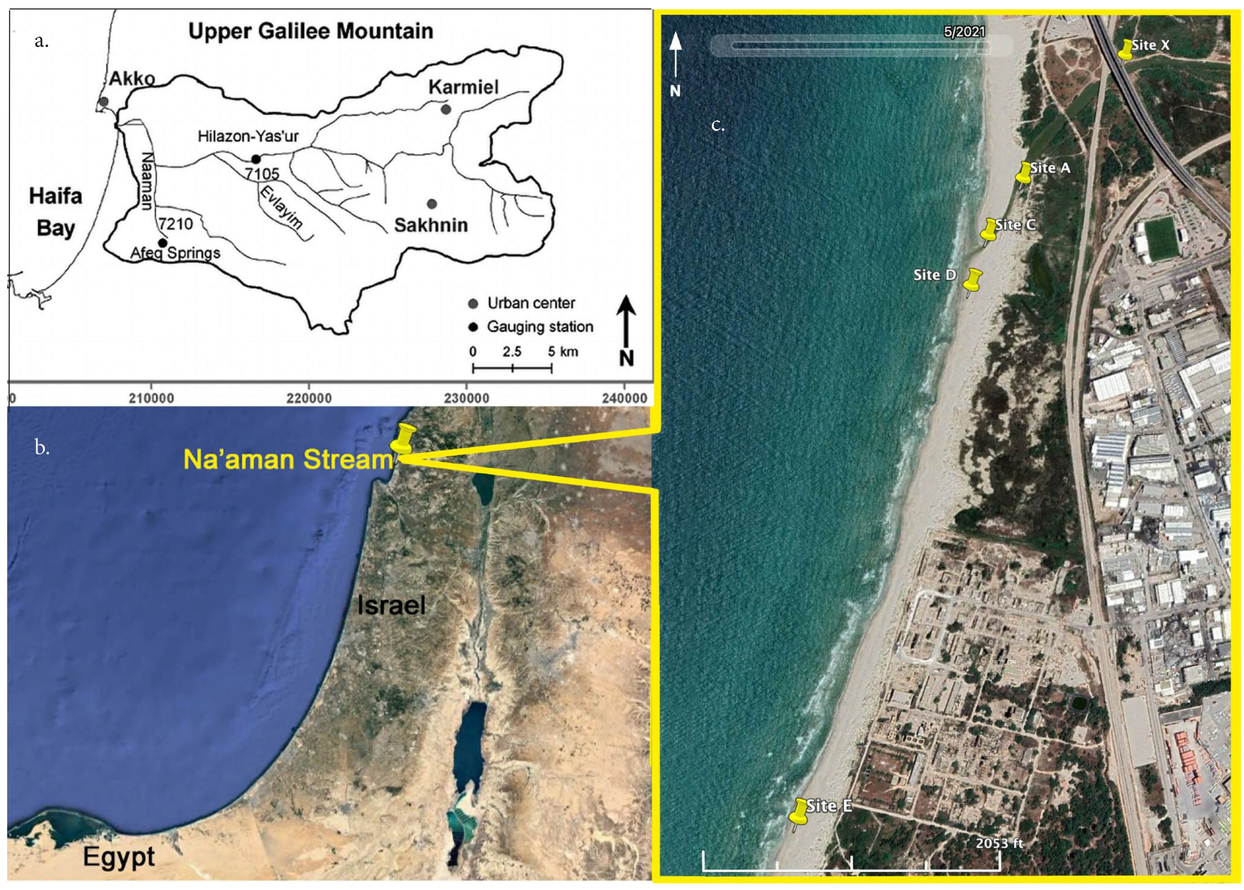
Microplastics (<5mm) are omnipresent pollutants that are persistent in aquatic environments throughout the world.

Recent studies have shown that the Mediterranean Sea acts as a vast accumulation zone for plastic debris, and particularly high levels of microplastic (MPs) have been reported in the eastern Mediterranean (Llorca et al., 2020).

Despite the largely terrestrial origin of marine microplastics (80%), there are relatively few studies of Mediterranean streams and rivers and their microplastic emissions to the Sea.

This study aimed to:

- Quantify and categorize the microplastics in and near the outlet of the Na'aman Stream south of Akko, Israel.
- Document the Na'aman's currently unknown seasonal variations in MP abundances in relation to hydrological and meteorological conditions.



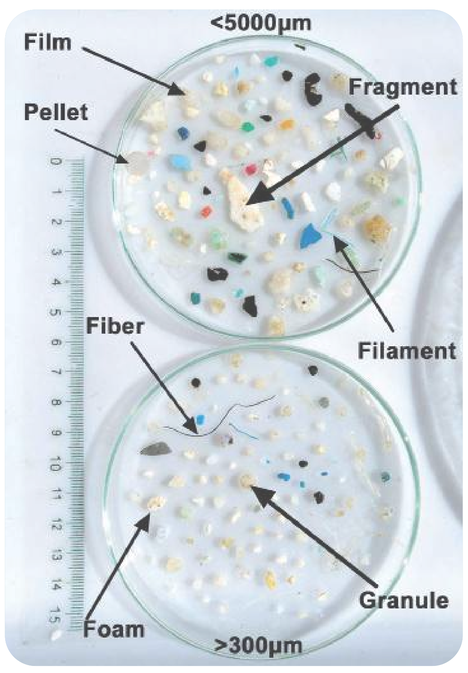
The study area: a) The Na'aman drainage basin. Image courtesy of Lichter et al., 2009; b) The southeastern Mediterranean; c) The five sites chosen for sampling along the river course and outlet (Site X, A, C, D and E).

1. Sample Collection

- Sampling took place in both the dry and rainy seasons in April, October, and December 2021.
- Four sites were chosen along the stream, outlet, and nearby beach, as well as a reference site.
- Three sediment replicates of 25cm x 25cm x 5 cm were taken every 10m along a transect at each site.

2. Sample Processing

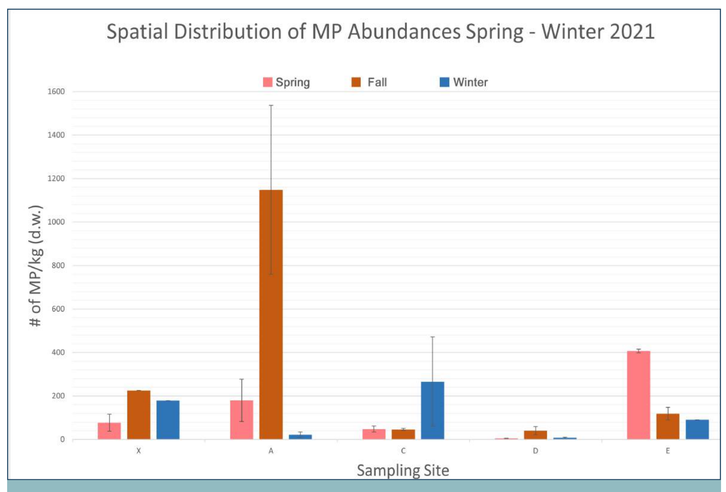
- Wet sediment was dried at 40 °C for 2-4 days, subsequently weighed, and sieved using sieves with mesh sizes of 5000, 1000, and 300 microns and placed in glass petri dishes for analysis.
- If necessary, samples underwent NaCl density separation from the sediment matrix.



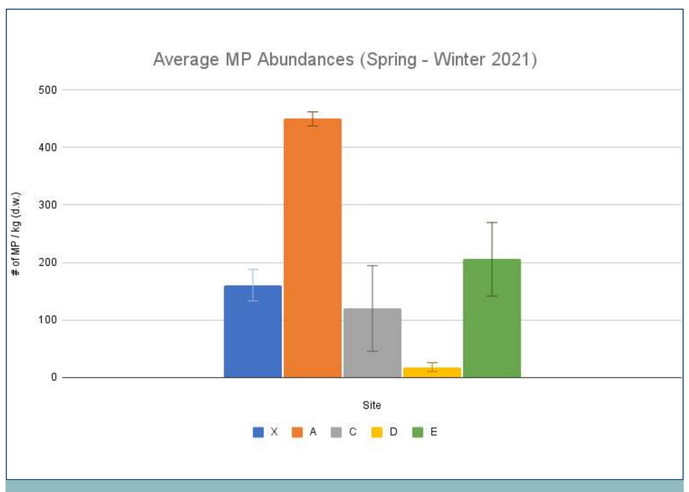
3. Sample Quantification

- Samples were examined by dissecting microscope and classified by type, color, and transparency.
- MP concentrations were expressed in number of MP/kg of sediment dry weight.
- Selected MPs underwent FTIR Spectroscopy for polymer analysis.

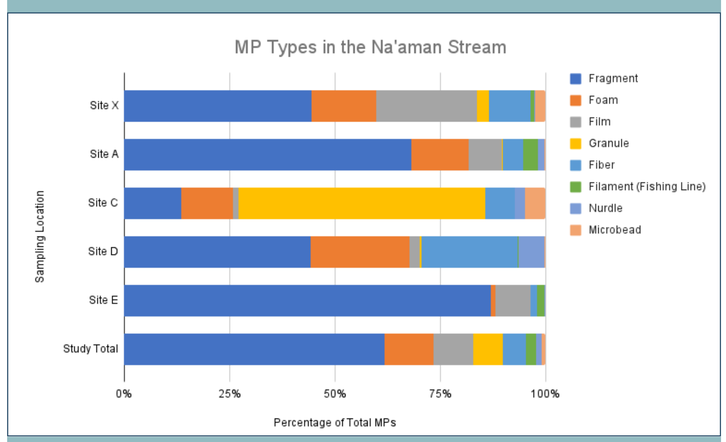
RESULTS



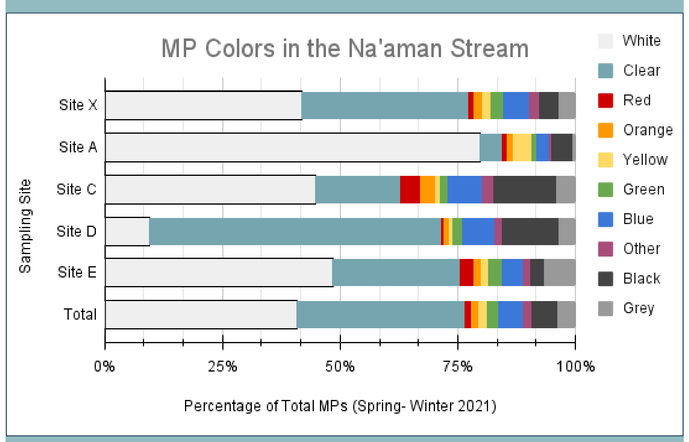
The Fall concentration of microplastics in Site A is considerably higher than in the outlet and nearby beach sediments.



MPs accumulate in Site A, 50m upstream from the stream outlet.



The most prominent shapes across the study are fragments, followed by foam and film.



White and clear are the most common MP colors throughout the study.

DISCUSSION

Microplastics were found to temporarily accumulate 50m upstream from the stream outlet (Site A), where they reached abundances of **1148.29 ± 388.2 MPs/kg (d.w.)** in Fall 2021. The hydrological dynamics of both the river and sea promote the deposition of microplastics into the sediment at this location.

In Site A, there is a significant shift in MP abundances between the beginning of the dry season (Spring), the dry season (Fall), and after the first rain (Winter). This indicates that the Na'aman Stream contributes seasonal pulses of microplastic emissions to the Mediterranean Sea. Therefore, upstream from the outlet (Site A) is a key area to focus pollution management strategies at a city-wide level.

While it is difficult to identify pollution sources with certainty, the large presence of consumer products (fragments) and packaging waste (films and foams) might indicate possible sources of pollution within the watershed.

To our knowledge, this study represents the first systematic attempt to quantify abundances and characteristics of microplastics in freshwater streams in Israel. These findings underscore the importance of rivers and streams as potential transport vectors for microplastic pollution to the sea.

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