HIGHWAY TO "PLASTIC" HELL

By Daniel Marcus Otterlei Hansen, Halvor Jensen, Helene Monsen Instebø,
Kajsa Elisabeth Urstad Dugan, Leyna Hauge Isik, Mia Håvik and Ronja Stine Fagertun

213.2

1 BACKGROUND

Research question

Can the spatial distribution of marine litter hotspots along the Norwegian coastline be explained by oceanographic transport like surface current direction or surface current speed, and what are the ecological impacts of marine waste?

What is marine waste?

Marine litter refers to any long-lasting, human-made solid material that ends up in the ocean or along coastlines.

How does it enter the ocean?

It ends up in the ocean by being dumped, carried by rivers, wind or sewage, lost at sea (like fishing gear or cargo) or left behind on beaches.

How does it spread in the ocean?

It spreads by currents, streams, waves and wind that carry marine litter across the seas.

Why is plastic damaging to the environment?

Plastic litter can stay in the ocean for decades or even centuries, making it one of the most persistent threats to marine life.

2 METHODS

- Marine litter data were obtained from In The Same Boat (2021–2026), and mean surface-current data from NorKyst (2013–2022).
- Litter amounts were standardized to kg/km of cleaned coastline.
- Litter observations were matched with current data within a 2 km radius, resulting in 2,406 observations.
- Hotspots were defined as the top 10% of litter observations (≥641.9 kg/km).
- The coastline was divided into three regions: South/West (<63°N), Central (63–67°N), and North (>67°N).
- Current direction and speed were compared between hotspots and other observations. Permutation tests (10,000 shuffles) were used to assess differences in current direction.

3 COASTLINE MAP

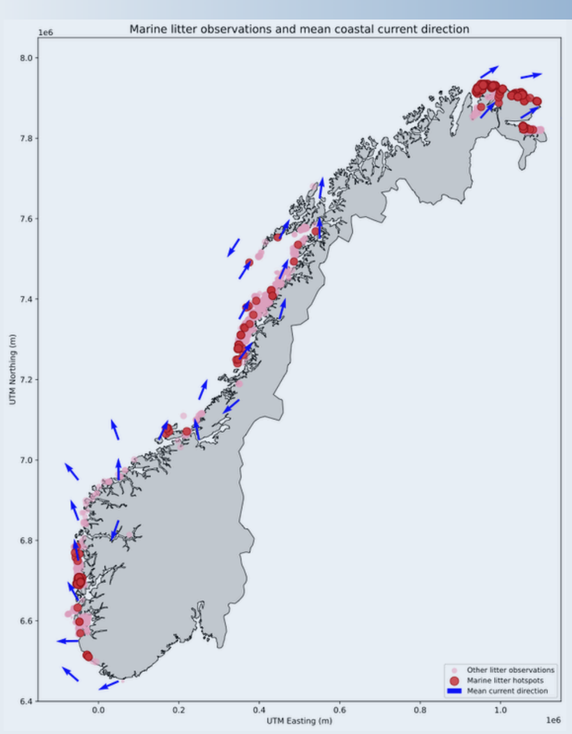


Figure 1: Spatial distribution of marine litter observations along the Norwegian coast (2021–2026) and mean coastal current direction (2013–2022). Pink circles represent general marine litter observations, red circles indicate marine litter hotspots by weight(kg/km), defined by top 10%. Blue arrows indicate the mean direction of coastal currents.

4 CURRENT DIRECTION

(Figure 2.1 mean surface-current direction by region)

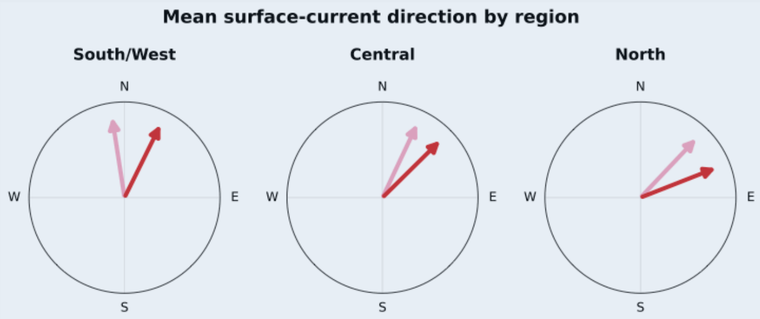


Figure 2.1: Distribution of mean surface-current general directions in three geographical regions along the Norwegian coast (South/West, Central and North). Red arrows represent marine litter hotspots (top 10% of observations by kg/km), while pink arrows represent the remaining observations.

(Figure 2.2 P-value)

Current direction: p=0,001 | Current direction: p=0,004 | Current direction: p<0,001

Figure 2.2 P-value for the mean surface current direction in three geographical regions along the Norwegian coastline. P-value < 0.005 indicate statistical significance.

5 CURRENT SPEED

(Figure 3.1 Marine litter hotspots and coastal current patterns)

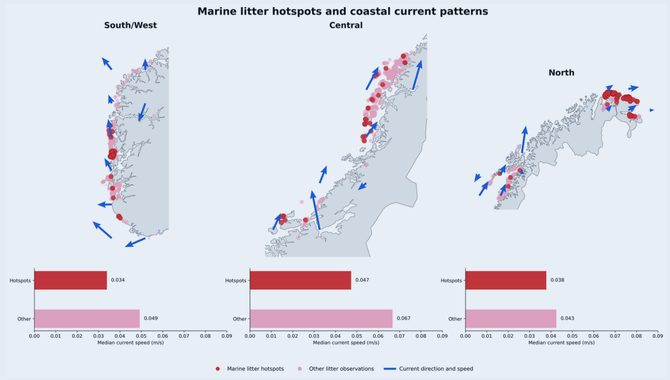


Figure 3.1: Distribution of surface-current speeds in three geographical regions along the Norwegian coast (South/West, Central and North). Red circles indicate marin litter hotspots (defined by top 10% litter observations by weight), pink circles indicate general marine litter observations. The direction of the blue arrows indicate the mean surface current direction and the length of the arrows indicate the mean surface-current speed.

(Figure 3.2 P-value)

South/West p = 0.004 | Central p = 0.128 | North p = 0.731

Figure 3.2: P-value for the mean surface current speed in three geographical regions along the Norwegian coastline. P-value < 0.005 indicate statistical

UNIVERSITETET I BERGEN

6 DISCUSSION

- This study indicates that marine waste accumulation has some correlation with surface current direction and speed, but this correlation has some limitations.
- In all regions
- Hotspots showed a statistically significant more eastbound median current directional pattern compared to other observations across all three regions. This suggests that onshore currents accumulate more marine waste along the Norwegian coastline.
- In Southwestern Norway, current speeds were statistically significantly lower at hotspots, while there are indications of surface current speed correlation, there are no statistically significant differences found in Central or North Norway
- Our study suggests that current speed and current direction may influence marine litter accumulation, but neither alone clearly explains the observed hotspot patterns. We hypothesize that a number of factors contribute to the accumulation of marine waste, this may be factors like intensity of regional fishery activity, indicated by the high amount of waste found in the north.
- The accumulation of plastic waste in the ocean has an exponential impact on the environment and our study has shown us that it is crucial to limit the influence human waste has on wildlife.
- This study is based on datasets from two different sources respectively from 2013-2022 (current measurements) and from 2021-2026 (waste-observations), we therefore acknowledge that the specific waste observation may not necessarily have a direct connection with the respective current-measurements in the same area.

7 ECOLOGICAL EFFECTS

Plastic ingestion: Ingestion of plastic debris can cause digestive obstruction, internal injuries and reduced nutrient intake, potentially leading to malnutrition and mortality.

Ghost fishing: Abandoned or lost fishing gear continues to capture marine organisms, causing unintended mortality and prolonged ecological impacts.

Microplastic contamination: Fragmentation of larger plastic debris introduces microplastics into marine food webs through ingestion by organisms at different trophic levels.

Benthic habitat degradation: Accumulation of marine litter on the seafloor can alter benthic habitats, affecting habitat quality and organisms associated with the sediment.

Ecological significance of hotspots: Identifying areas of concentrated marine litter can support targeted cleanup efforts, reducing ecological risks and protecting vulnerable coastal ecosystems.

8 CONCLUSION

Marine litter hotspots along the Norwegian coast are associated with differences in mean surface-current direction across all three regions, while current speed shows a less consistent relationship. Although ocean currents may contribute to litter transport and accumulation, they cannot fully explain the observed distribution. We therefore conclude that the spatial distribution of marine waste is affected by a combination of many physical and human activity-related factors. Given the ecological threats posed by marine litter, including ingestion, entanglement, ghost fishing and habitat degradation, understanding these patterns could help identify vulnerable coastal areas and improve targeted cleanup efforts.

9 SOURCES

https://www.imo.org/en/mediacentre/hottopics/pages/marinelitter-default.aspx
https://arctic-council.org/explore/topics/ocean/plastics/
https://marine.copernicus.eu/explainers/phenomena-threats/plastic-pollution/from-plastic-marine-pollution
https:/oap.ospar.org/en/ospar-assessments/quality-status-reports/qsr-2023/thematic-assessments/marine-litter/climate-change/
https://app.hubocean.earth/catalog/dataset/6b6bb741-f427-4679-9166-8c8325fd5bc9/plastic-pollution-data-in-the-same-boat-daily-cleaning-actions-2021-2026%C2%A0https:/data.norge.no/nb/datasets/93d93c8f-b1f4-3472-bab6-24c7249fceea/norkyst-gjennomsnittlig-stromstyrke-og-retning?tab=overview
https://data.norge.no/nb/datasets/93d93c8f-b1f4-3472-bab6-24c7249fceea/norkyst-gjennomsnittlig-stromstyrke-og-retning?tab=overview