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Model-based identification of marine plastic sources for the Mediterranean Marine Protected Areas

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Comparisons of six selected Mediterranean MPAs were conducted to find similarities and site-specific differences in coastline fluxes and sources of plastic marine litter. Output from the recently developed 2D Lagrangian model for the Mediterranean (Liubartseva et al., 2018) was post-processed to study (1) the National Park of ses Salines d'Eivissa i Formentera in Spain, (2) Nature Reserve of Bouches de Bonifacio in France, (3) North-East Malta MPA, (4) Specially Protected Area of Porto Cesareo in Italy, (5) Community Importance Site of Torre Guaceto in Italy, and (6) Ethniko Thalassio Parko Alonnisou Voreion Sporadon in Greece. The model used high-resolution sea surface kinematics provided by the Copernicus Marine Environment Monitoring Service (http://marine.copernicus.eu/services-portfolio/access-to-products). Daily analyses of ocean currents and waves at a horizontal resolution of 1/16° (Clementi et al., 2017) were used to force the drift of virtual particles.

The fluxes of plastic onto the MPA's coastlines varied within 0.4–3.6 kg(km day)$^{-1}$, which were relatively low in comparison with an average flux of 6.2±0.8 kg(km day)$^{-1}$ calculated over the Mediterranean 2013–2017. The highest plastic flux of 3.6 kg(km day)$^{-1}$ was found on the coastline of the Torre Guaceto MPA. This stark domination was attributed to a synergy of anthropogenic drivers that emitted plastic and hydrodynamic transport that delivered pollution to the MPAs. In contrast, Ethniko Thalassio Parko Alonnisou Voreion Sporadon demonstrated the lowest level of plastic pollution, with a coastal plastic flux of 0.4 kg(km day)$^{-1}$, which indicated a comparatively higher degree of naturalness as a result of the low level of human-induced activity or disturbance.

To shed light on major sources of plastic for each MPA, the inverse problems were set up and solved for each MPA. With computed contributions of 55%–88%, shipping was identified as the main source of plastic pollution for all the studied MPAs. Site-specific rankings of the most influential land-based sources indicated that plastic litter distribution is controlled primarily by sea surface kinematics (sea currents and waves).

We hope that the applied model approach will help in the assessment of site-specific management of sources of marine plastic litter and the development of mitigation strategies for Mediterranean MPAs to maintain good environmental status in accordance with Descriptor 10 of the EU Marine Strategy Framework Directive (MSFD, 2008/56/EC).

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References

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