

PREDICTION OF MICROPLASTIC HOT-SPOT AREAS IN THE EASTERN MEDITERRANEAN SEA: THE CASE STUDY OF THE AEGEAN SEA.

Christos Ioakeimidis ^{1*}, Dimitris Politikos ² and Kostas Tsiaras ²

¹ UNEP/MAP MEDPOL - cioakeim@hcmr.gr

² Hellenic Centre for Marine Research (HCMR) Institute of Oceanography

Abstract

A particle-tracking model was coupled to a circulation model to simulate transport and accumulation of floating microplastics in the Aegean Sea (Eastern Mediterranean), Greece. The aim of the study was to identify floating microplastic hot-spots, predict corresponding accumulation zones and identify microplastic circulation paths and later target future survey cruises on the corresponding spots. The prediction of the accumulation zones for floating microplastics, in the Aegean Sea seems to follow an irregular pattern. The usefulness of the simulation results as a management tool is also discussed.

Keywords: Pollution, Models, Plastics, Aegean Sea, Water transport

Floating plastic pollution is a substantive, emerging threat for marine and human life, being present in massive quantities to world's oceans, reaching up to 5 trillion particles (Eriksen et al., 2015). There is a growing interest for both field and model studies aiming at finding the areas that foster the accumulation of floating debris (Mansui et al., 2015; Yoon et al., 2010; Lebreton et al., 2012; Cozar et al., 2015), the so-called marine litter "hot-spots". In this model study, a hydrodynamic model (~3Km resolution), based on Princeton Ocean Model (POM, Blumberg and Mellor, 1983), currently operational within the POSEIDON forecast system (Korres et al. 2010, www.poseidon.hcmr.gr) provided the surface current fields as forcing to simulate the transport of floating plastics in the Aegean Sea (Greece). A particle-tracking model, based on Pollani et al. (2001), followed the fate of thousand particles in space and time for a total period of one year. As a risk exposure index, we defined the residence time (in days) of floating particles in different areas of the model domain. Based on existing studies (Lebreton et al., 2012), initial sources of plastic pollution were identified, corresponding to major rivers, cities, fishing grounds and shipping routes (Fig. 1a), while the residence time of floating litter particles, categorized in months (Fig. 1b) is also illustrated. The distribution and accumulation of floating microplastics in the Aegean Sea seems to follow an irregular pattern.

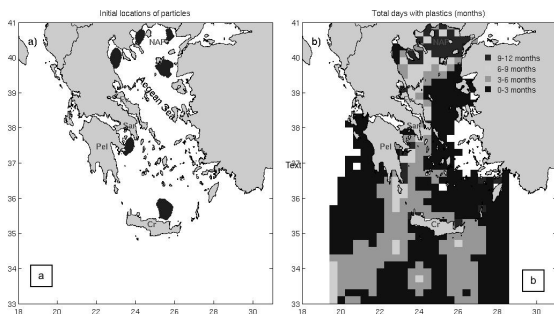


Fig. 1. Initial locations of particles (a) and residence time (b) of floating particles (categorized in months), over the whole Aegean Sea.

Higher residence time was identified in the northern part of the Aegean Sea, the Evoikos gulf (Ev) and the western part of Peloponnese (Pel). In the North Aegean Sea, one of major fishing grounds exists (North Aegean Plateau, NAP), which is of special concern for the accumulation of microplastics in the marine biota. For the western part of the Peloponnese, the high abundance of microplastic pollution might be related to the effect of the adjacent Saronikos Gulf (Sar). Future survey cruises should be conducted in the predicted areas in order to assess standing stocks of floating microplastic that can be used to evaluate the simulated microplastic spatial distribution. The application of particle tracking models on the identification of microplastic "hot-spots" has shown encouraging results that are still need to be confirmed. However, it is believed that it can surely be used as an effective management tool. The authors acknowledge the PERSEUS (FP7) Research Project for supporting the present

work.

The present work has been conducted within the framework of the IRIS-SES (DG ENV GA no: 07.0335/2013/659540/SUB/C2) and ActionMed (DG ENV GA no: 11.0661/2015/712631/SUB/ENVC.2) projects

References

- 1 - Blumberg, A.F., Mellor, G.L. (1983). Diagnostic and prognostic numerical circulation studies of the South Atlantic Bight. *Journal of Geophysical Research: Oceans* 88, 4579-4592.
- 2 - Cózar A., Sanz-Martín M., Martí E., González-Gordillo J.I., Ubeda B., Gálvez J.Á., et al. (2015). Plastic accumulation in the Mediterranean Sea. *PLoS ONE* 10(4): e0121762. doi:10.1371/journal.pone.0121762.
- 3 - Eriksen M., Lebreton L.C.M., Carson H.S., Thiel M., Moore C.J., et al. (2014). Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. *PLoS ONE* 9(12): e111913. doi:10.1371/journal.pone.0111913.
- 4 - Korres, G., Nittis K, Perivoliotis L., Papadopoulos A., Triantafyllou G. (2010). Forecasting the Aegean Sea hydrodynamics within the POSEIDON-II operational system, *Journal of Operational Oceanography*, 3, 37-49.
- 5 - Lebreton, L.C.M., Greer, S.D., Borrero, J.C. (2012). Numerical modeling of floating debris in the worlds oceans. *Mar. Pollut. Bull.* 64, 653-661.
- 6 - Mansui J., Molcard A., Ourmières Y. (2015). Modeling the transport and accumulation of floating marine debris in the Mediterranean basin. *Marine Pollution Bulletin* 91, 249-257.
- 7 - Pollani A., G.Triantafyllou, G.Petihakis, K.Nittis, K.Dounas and C.Koutitas (2001). The POSEIDON Operational Tool for the Prediction of Floating Pollutant Transport, *Marine Pollution Bulletin*, Vol. 43/7-12, pp 270-278.