

Project title:	Predicting and mapping the fate of microplastics in the ocean
Discipline	Engineering & Innovation/Mathematics & Statistics
Key words:	Plastic, Pollution, Oceans, Remote-Sensing, Modelling
Supervisory team:	Carl Boardman, James Bowen, Marc Pradas, Armando Marino
URL for lead supervisor's OU profile	http://www.open.ac.uk/people/cpb247

Project Highlights:

- An exciting multidisciplinary project combining lab work, modelling and remote sensing;
- Contemporary applied research topic;
- Travel opportunities to Scotland (Sterling) and Internationally for conferences;
- Comprehensive skills training package

Project Description:

The use of plastic based materials offers almost unparalleled societal benefits across a broad range of areas that includes health, safety, energy saving and material conservation. Unfortunately, however, a by-product of an economy and lifestyle based around the use of fossil fuel derived polymers (c.350 million tonnes produced globally per year), has been the inadvertent contamination of natural ecosystems by fugitive plastics that evade waste treatment and recycling processes. The world's oceans are one natural ecosystem where it is estimated that there are 5.25 trillion pieces of plastic (270,000 tonnes) present. Plastic here represents a hazard to fauna through entanglement and ingestion, as well as a threat to the food chain from the bioaccumulation of organic pollutants. It has also been shown that plastic pollution in the oceans alters the microbial and chemical composition of seawater (OU PhD student work to be published) which threatens the stability and balance of major ocean biogeochemical cycles, as well as the food chain.

Despite the threat posed by marine plastic pollution, the fate of this material remains largely unknown and focused on a limited number of research papers that form the basis of all predictions. Quantifying the

presence and accumulation of plastics in the world's oceans is challenging due to the spatial scales involved and is currently limited to upscaling data derived from ocean trawls. There remains therefore a requirement for both predictive models based on engineering principles to quantify the likely fate of plastics and a complementary remote sensing technique for detection.

This proposal takes an engineering approach to investigate and model how plastic pollution changes over time and the impact this has on water properties. In the first instance, this would start with theoretical modelling of different types and forms of plastic pollution. This will subsequently be verified by laboratory experiments where the expected outcome will be an enhanced understanding of the residence time of different types of plastic in water bodies (oceans in particular). The data from these experiments would subsequently feed into remote-sensing experiments.



Figure 1. Plastic litter in the marine environment (Source: BBC - <http://www.bbc.co.uk/news/science-environment-34414710>)

Research Methods:

The modelling of ocean and particle properties will be undertaken. A strong background in engineering and/or maths is therefore important. If this is not

present in an applicant's qualifications, this must be demonstrated to undertake this project.

Lab experiments would involve using tanks to simulate ocean conditions. Micro-plastics will be added into the tank and monitored over several weeks using spectrophotometry, electron microscopes and instruments to measure surface properties. The ambient temperature and light levels would be monitored and/or fixed to simulate typical ocean conditions. Ocean waves will be simulated and the interaction of plastic observed and measured.

Background reading:

Andrady, A. L. Microplastics in the marine environment. *Marine Pollution Bulletin* 62, 1596-1605, doi:10.1016/j.marpolbul.2011.05.030 (2011).

N. Maximenko *et al.*, Toward the Integrated Marine Debris Observing System. *Frontiers in Marine Science* 6, (2019).

E. van Sebille *et al.*, A global inventory of small floating plastic debris. *Environmental Research Letters* 10, 124006 (2015).

K. Enders, R. Lenz, C. A. Stedmon, T. G. Nielsen, Abundance, size and polymer composition of marine microplastics $\geq 10\mu\text{m}$ in the Atlantic Ocean and their modelled vertical distribution. *Marine Pollution Bulletin* 100, 70-81 (2015).

L. C. M. Lebreton, S. D. Greer, J. C. Borrero, Numerical modelling of floating debris in the world's oceans. *Marine Pollution Bulletin* 64, 653-661 (2012).

Applications should include:

- A 1000 word cover letter outlining why the project is of interest to you and how your skills match those required
- an academic CV containing contact details of three academic references
- [Open University application form](#)
- Applicants will need to demonstrate good competence in the English language. To be eligible for a full award a student must have no restrictions on how long they can stay in the UK and have been ordinarily resident in the UK for at least 3 years prior to the start of the studentship.

Applications should be sent to STEM-EI-PhD@open.ac.uk by 24.04.20

