Plastic detection using a multi-method approach: Comparative case studies from coastal tourism sites

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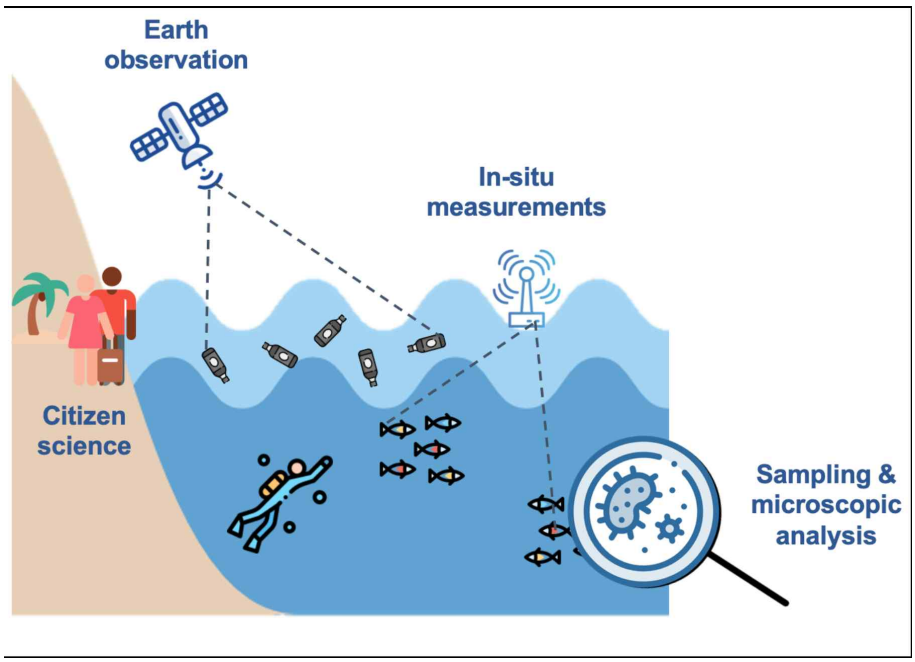
Graphical abstract



Abstract

Floating plastic particles have been documented in water bodies around the world (Derraik, 2002). The effects of marine litter, and especially microplastics, on natural ecosystems have been well documented and range from passive ingestion, to entanglement, or chemical contamination of marine organisms, posing serious risks of species survival (Cózar et al. 2014). Despite a growing body of literature addressing the impacts of marine plastic pollution, the magnitude, distribution, and spatio-temporal variability of plastic accumulations remain open questions (UNEP, 2018, 2019a, 2019b). In particular, detecting the sources and pathways of marine plastic has proven problematic due to the uncertainty and limited traceability of plastic flows in natural ecosystems (Veiga et al., 2016). Furthermore, plastic can enter bodies of water and subsequently be transported via wind or tide (Jambeck et al., 2015), dislocating the problem of plastic pollution from its source. Ocean and current models have proven successful in tracing the pathways and transfer of micro-plastic particles in bodies of water, as well as delivering reliable data on the magnitude of marine plastic pollution. However, existing constraints affect the paucity of real-time, harmonized information on the extent and distribution of plastic entering our seas. To supplement this knowledge gap, the study proposes a multi-model approach that combines a number of data acquisition techniques to advance knowledge

of the effects of anthropogenic human activities on the marine environment in the African and America context, attempting to unveil possible sources of plastic and microplastic pollution.

This study offers a comprehensive, harmonized model for detecting and quantifying marine plastic on coastal sites and coastal waters, leveraging experiences from southern California (USA) and Zanzibar (Tanzania) (Maione, 2019, 2021; Maione et al., 2021). Selected sites present different features related to geography, presence and/or conditions of urban infrastructure and waste management systems, beach uses and users, local economies, and socio-cultural characteristics, that can contribute to plastic pollution policies and be accounted for when building marine pollution models. Data acquisition entails a combination of satellite-based earth observations with in-situ measurements using sensor data, existing water quality analyses, beach litter inventories, and water/specimen sampling among others. Observations are recorded into a database (geographic coordinates of transects and observations, photographic evidence, specimen description, count/weight/size, morphological and chemical characteristics) and processed using lab equipment.

Findings show plastic as the most dominant litter type, at all surveyed sites, with beverage bottles, shopping bags, wrappings, and single-use tableware being the most common litter items. Waste characterization serves the dual purpose of supplementing the existing paucity of data on plastic waste material flows, and, depending on the degradation status of collected items, advance recommendations on their potential recovery. Subsequently, litter information was crossed-validated via interviews with local stakeholders (from the waste and tourism sectors) to evaluate sources and pathways of coastal pollution. This study provides recommendations on plastic pollution monitoring and reporting via the integration of qualitative (e.g., interviews, citizen science) and quantitative data (e.g., observations, sampling, material flow inventories) on beach and marine litter. Finally, the study provides implications for beach users and facilities located along the shoreline to mitigate and prevent plastic material lost at sea.

Keywords: Plastic; Plastic waste; Marine pollution; Coastal sites; Multi-method approach

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Maione is a natural scientist, currently pursuing her doctoral degree in Industrial Engineering. Her doctoral research is focused on monitoring material flows and pollution cycles across the plastic industry-environment-society nexus, and investigating the role of technology in the transition to a circular economy for plastics. Previous works encompass exploration of plastic pollution in the African seas and related impacts on human communities and marine ecosystems, and quantitative analysis of microplastic accumulations in pelagic biota and their effects on species survival. Research interests include marine pollution, microplastics, earth observation, material flow analysis, ocean and coastal management.

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