BRIEFING NOTE SERIES

MICROPLASTICS IN AQUATIC ECOSYSTEMS, IMPLICATIONS FOR ECOSYSTEM SERVICES AND LONG-TERM SOLUTIONS.

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Objective – A briefing note aims to provide a concise outcome based synopsis of recent research or expert opinion that may inform decision making and activities by authorities, NGOs and NPOs. The briefing note series complements the academic peer-reviewed literature published by NRF-SAIAB.

Background

The distribution, occurrence and impact of microplastics (MP) in the marine environment is a globally established research theme. In South Africa, research on this topic is still gathering momentum. Recent studies examining solid waste pollutants such as MP in the water and sediments are enhancing our understanding of the problem of plastic pollution in the country. Prior to 2015, baseline information on microplastics were minimal to absent for the South African estuaries, but since then, a growing body of work has established the first baseline datasets for a small number of estuaries in KwaZulu Natal. In a recent publication, Govender et al (2020) estimated MP in the sediment and water column of four mangrove estuaries in this province (Figure 1). Other studies have also contributed data for some of the estuaries in the Western Cape, including Cape Town Harbour, Zandvlei Estuary, Vaal River, Diep River and Agulhas Bank (Nel et al. 2020, Ramaremisa et al. 2022, Julius et al. 2023, Sparks et al. 2023, Samuels et al. 2024, Khan et al. 2025). However, in a country with over 300 estuaries, this leaves a large number of systems where little to no data exists.

MP have been recorded in both rural as well as urban systems, across both terrestrial and marine environments (Govender et al 2020). These MP vary in their type, category, colour and shape, but some trends are evident such as the dominance of fibres in most samples. Rivers and estuaries provide the main pathways through which MP are introduced to the marine environment, but additional inputs arise from commercial fishing or maritime activities. The movement and persistence of plastics in aquatic systems threatens the health and integrity of the biota within them and is considered a global risk (Johnson et al 2023).

A review by Naidoo et al (2020) indicated increasing documentation of microplastic ingestion by aquatic fauna, with information existing for mussel and some fish species, including *Oreochromis mossambicus, Terapon jarbua, Ambassis dussumieri* and *Mugil* sp. Meso plastics have been recorded in sea turtles and seabirds, whereas macroplastics are known to affect whales and seals. In mangrove associated species such as *Uca rapax* (Fiddler crab), microplastics have been found to accumulate in the gills, stomach and hepatopancrease, reflecting exposure through contact, ingestion and digestive processing. The clogging of the gills or the glands of the digestive system can impair key physiological functions such as respiration, nutrient absorption and energy storage. Microplastic accumulation may also trigger hormonal disruptions, potentially leading to delayed ovulation, reproductive failure and a reduction in growth (Vermeiren et al. 2016).

Studies have indicated that fish caught in non-urbanised streams had 5% less microplastics than those from urban estuaries, highlighting the intricate link between human population growth, human activities and the occurrence of microplastics (Phillips and Bonner, 2015). Estuaries and mangrove forests are particularly vulnerable to MP pollution. Accumulation of microplastics in these ecosystems is cause for concern, because they are important refugia and nursery areas for a multitude of animals, and they play a significant role in stabilising the populations. Therefore, any impact on these systems will ripple beyond individual organisms as they can potentially destabilise entire ecosystems.

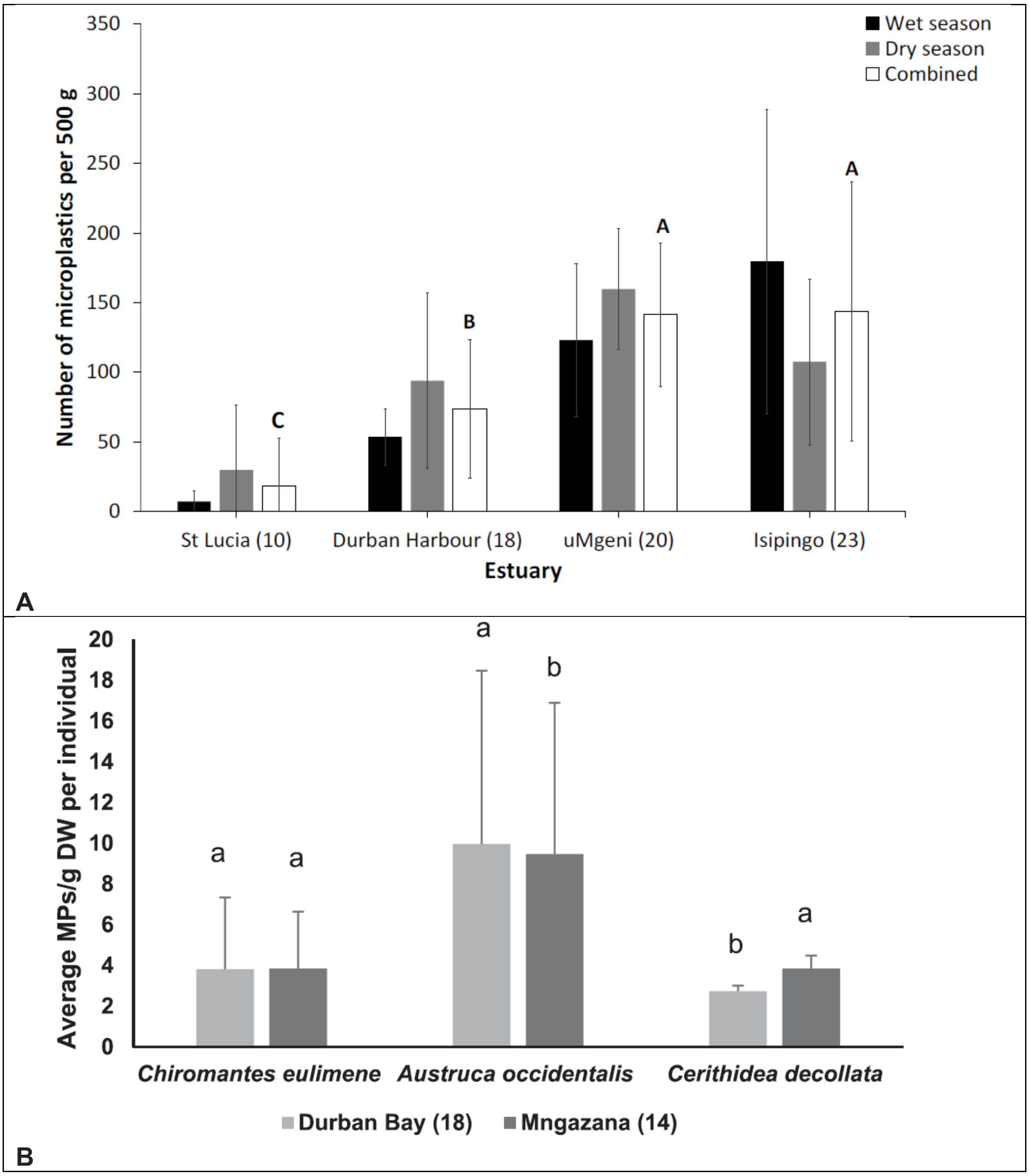

Figure 1: Microplastic abundances in **A)** estuarine water was estimated for sites in KwaZulu-Natal by Govender et al. 2020 and **B)** in benthic animals by Johnson et al. 2023.

Emerging research is also emphasising the need for monitoring heavy metals bound to microplastics as these pollutants may potentially bioaccumulate within organisms and compound the biological risks (Kumkar et al 2021, Vierira et al 2021). For example, Kumkar et al. (2021) investigated microplastics and heavy metals in mudskippers associated with the Ulhas River Estuary, finding mostly filaments in the guts of the organisms and minimal correlation between MP and heavy metals. Similarly, Vierira et al. (2021) investigated the accumulation of microplastics and heavy metals in native oysters (*Crassostrea gasar*) in the Paranaguá estuarine system, Brazil. While MP were found in the oysters (average of 9.6 items per 150 mg of hepatopancreas), the study also reported no clear link between MP concentration and heavy metal accumulation. Although these findings may suggest that microplastics and heavy metals may not always co-occur or interact synergistically, the biological implications are likely to be far from negligible, as for example, this may result in potential loss of keystone species and ecosystem engineers (Brennecke et al., 2015).

A further risk associated with microplastics are the epifauna that attach and live on the particles. Plastics have become so prevalent in our ecosystem that they are considered a new ecological niche, where community level processes may shape microbial communities over time. However, nothing is currently known about this “plastisphere” that may exist in the marine environments of South Africa. This is cause for concern, because this may facilitate the spread of invasive alien species, compromise the health of aquatic life, and may potentially transfer harmful agents to both aquatic animals and humans (Vibrionales). Wright et al (2021) undertook a meta analysis including 35 studies from 2011 to present, looking at the microbial communities that colonise plastics. This review documented that the “plastisphere” or the epiplastic community is composed of bacteria, cyanobacteria, dinoflagellates, coccolithophores, corals, bryozoans, hydroids and several others that have been found on plastics in marine environments globally (Plate 1). However, most of the studies have been undertaken in the Northern Hemisphere and predominantly from Europe, with a notable gap for the Southern Hemisphere, and particularly Africa.

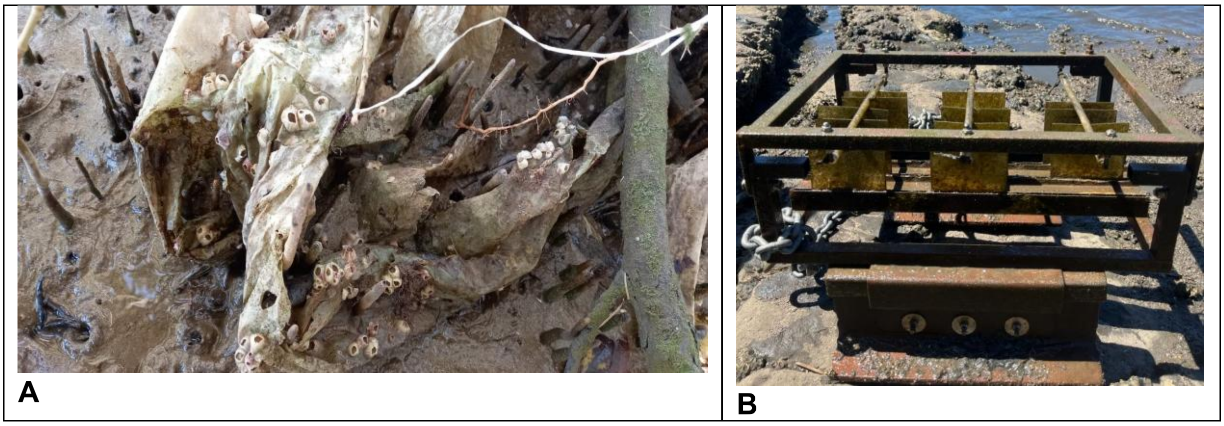

Plate 1: A) Microalgae and sedentary animals colonise macroplastics – contributing to the plastisphere. **B)** Steel cages with polyethylene panels used during an experimental study to understand how diatoms colonise plastics.

Beyond the documented ecological effects, MP also have direct implications for human health. Once they get into the marine environment, due to their size, marine organisms inevitably consume them, leading to their entry into our food chain. The build-up of MP in general can cause inflammation or trigger immune responses, and send molecules to our brains, intestines and lungs. Certain polymers also score high on hazard indices for carcinogenicity, reproductive toxicity, and organ sensitivity. Taken together, these risks emphasise that plastic pollution is not only an environmental issue but also an emerging global health concern. The scarcity of African data highlights the urgent need for region-specific research to inform conservation and policy interventions.

New Legislation

On August 7, 2025, the Department of Forestry, Fisheries and the Environment (DFFE) announced a landmark ban on the production, distribution, sale, import, and export of products containing plastic microbeads. These microbeads are tiny plastic particles less than 5 mm in size, commonly added to personal care and cleaning products for their abrasive properties, but unlike natural alternatives, they do not dissolve and persist in the environment for centuries. This proposed ban is a significant step forward and aligns South Africa with over a dozen other countries, including the UK, US, Canada, and Kenya, which have already implemented similar bans.

While this draft legislation is a vital starting point, its effectiveness will depend on robust implementation and monitoring.

- Standardised Monitoring: To truly measure the ban's impact, a standardised methodology for extracting, counting, and characterising microplastics is critical. The South African Macro-, Meso- and Micro-Plastic Network (SAMP) must play a central role in this effort.
- Implementation & Enforcement: A two-year phase-out plan is proposed, which needs careful consideration to prevent illegal dumping and stockpiling. South Africa can learn from countries like Kenya and the UK, which have successfully implemented bans on shorter timelines.
- Further Research: More research is needed to understand the full extent of microbead pollution in South Africa and to develop viable alternatives to plastic microbeads.
- Holistic Approach: A successful ban on microbeads will not only remove an unnecessary pollutant from circulation but will also send a clear signal that South Africa is serious about tackling the broader issue of plastic pollution. This is an opportunity to show that environmental protection and economic growth can go hand-in-hand

The Way Forward

A critical next step lies in advancing legislative reform that moves beyond fragmented regulations toward a unified national framework. The recent draft ban on microbeads signals political will, but South Africa has the opportunity to go further by considering a phased national ban on the most problematic single-use plastics, such as straws, cutlery, and certain packaging materials. Embedding such bans within the National Environmental Management: Waste Act (NEMWA) and harmonising them with the National Waste Management Strategy would provide legal clarity and stronger enforcement mechanisms. Moreover, complementary reforms could also strengthen Extended Producer Responsibility (EPR) obligations, close loopholes around plastic bag levies, and mandate recycled content in packaging. Together, these measures would not only align South Africa with progressive international practices but also help reduce plastic leakage at source, driving a systemic shift toward a circular economy.

A coherent national response will depend on establishing robust, standardised monitoring protocols for microplastics in water, sediment, and biota. The South African Macro-, Meso- and Microplastics Network (SAMP) should be empowered to coordinate these methods, ensuring comparability of data across estuaries, rivers, and coastal sites. This will allow trends to be tracked over time, strengthen risk assessments, and enable South Africa to contribute meaningfully to global datasets. Additionally, South Africa requires deeper investment into the health, ecological, and socio-economic impacts of microplastics. This includes interdisciplinary studies that integrate polymer chemistry, ecotoxicology, fisheries science, human health and the long-term impacts of microplastics at both the cellular and ecosystem levels. Research into biodegradable alternatives, polymer hazard scoring, and the "plastisphere" will help shape effective, evidence-based interventions. Collaboration between universities, government, and industry should be encouraged to accelerate innovation and applied solutions. South Africa can transform its plastic waste challenge into a circular-economy opportunity by treating plastics as valuable resources rather than refuse. This means designing policies that internalise the social and environmental costs of plastics (polluter-pays), formalize and uplift the informal waste workforce, and align with national mandates (NWMS, NEMWA) and global goals (SDGs).

We have to go beyond just reporting on the pollution and rather find ways to mitigate MP pollution in order to protect our aquatic ecosystems and find ways to prevent reoccurrence and find better ways to manage plastic pollution on a national level by amending current bylaws and finding ways to implement them. Having incentives in place may be a good way to implement these bylaws and bans. Education on all levels is key and so important as the public needs to be informed and educated on how to reduce MP pollution. One of the next steps is to translate science into information that stimulates environmental change. School learners as well as tertiary students should be educated on the detrimental effects of microplastics and be provided with feasible alternatives (and some incentives) such as paper straws, reusing water bottles, changing to reusable cloth diapers, using menstrual cups, boycotting products that contain microbeads (even before the ban is in place) and just reducing, reusing and recycling of plastic in general. This information would hopefully be taken to their respective homes to educate their families and the larger communities and be the start of transformation.

Key Papers for Consideration

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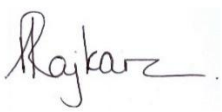

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