

Response to reviewers: (Manuscript ID: os-2020-127)

Plastics in the Indian Ocean – sources, transport, distribution and impacts

We would like to thank and acknowledge the reviewer for their careful reading and constructive comments on the manuscript. We believe that we have addressed the issues raised by the reviewer and the proposed changes to the manuscript are detailed in this document. We trust that the reviewer and the editor will find that the suggested changes will make the manuscript suitable for publication.

Please note that the line numbers referred to in this document are those in the original manuscript commented by the reviewers.

#	Reviewer comment	Author response
61	<p>The manuscript entitled “Plastics in the Indian Ocean – sources, fate, distribution and impacts” written by Charitha Pattiaratchi et al. is a review of plastic pollution in the Indian Ocean. In general, the manuscript has an excellent proposal to show for the scientific community an actual scenario of plastic pollution in the Indian Ocean, mainly when it has scarce information related to other oceans. The manuscript was organized in the following topics: sources (section 2), observations (section 3), transport (section 4), fate (section 5), impact (section 6), prevention and mitigation (section 6) of plastic debris in the Indian Ocean as well as highlight some of the emerging policies and initiatives, knowledge gaps and recommend future research strategies (section 7) (lines 92-95).</p> <p>However, the manuscript does not have a section for methodology. Then, it does not possible to know how the authors found the papers for this study.</p> <p>The authors should be clear in: what platform of science (Scopus, Scholar Google, Web of Science, Science Direct, and other) these papers were downloaded; what keywords were used to find the articles; in what period (time limit) they were downloaded (perhaps from 1980 to 2020 - lines 145-147/Table 01); What criteria were used for inclusion or exclusion of papers?</p> <p>These questions must be answered because a review article should provide a comprehensive foundation on a topic, explain the current state of knowledge, identify gaps in existing studies for potential future research, and/or highlight the main methodologies research techniques. The authors tried to do it during the manuscript, but I do not have not access their methodology so I can not able to understand the database of the article to build this study.</p>	<p>We did not include a methodology section as it is a review paper. It is expected that a reader will refer to papers cited for the methodology.</p> <p>Including a methodology of the different search platforms and search terms as suggested is relevant for a meta-analysis paper but not necessarily for a review paper.</p>
62	<p>I reinforce again that in a systematic review with a focused question, the research methods must be clearly described.</p>	<p>Agreed, we have removed the description of this simulation</p>

	Besides, a review article does not have an input of new data/results. Therefore, the illustration made by the authors should be excluded from the manuscript (lines 298-315).	from the manuscript. We have, however, kept Figure 5 in the manuscript, as it does not show any new data/results, but serves purely as an illustration of the effect of surface dynamics in the northern IO on buoyant objects.
63	Also, I think the name of the program is wrong. The correct would not be ichthyop instead of ICHYTOPOP? (line 300).	Yes this should be Ichthyop, thank you for pointing this out. We have corrected this. (Note that we have removed this paragraph from the manuscript, see our response to comment #62, but we do still mention Ichthyop in the caption of Figure 5.)
64	<p>2.1 Land-based sources</p> <p>This topic needs to have an increment of articles, reports, or data from NGOs local, regional about the situation of waste management or plastic pollution in the land.</p> <p>On Scholar Google, I searched these references:</p> <ul style="list-style-type: none"> - Vidanaarachchi, C. K., Yuen, S. T., & Pilapitiya, S. (2006). Municipal solid waste management in the Southern Province of Sri Lanka: Problems, issues, and challenges. <i>Waste Management</i>, 26(8), 920-930. - Talyan, V., Dahiya, R. P., & Sreekrishnan, T. R. (2008). State of municipal solid waste management in Delhi, the capital of India. <i>Waste Management</i>, 28(7), 1276-1287. - Patti, T. B., Fobert, E. K., Reeves, S. E., & da Silva, K. B. (2020). Spatial distribution of microplastics around an inhabited coral island in the Maldives, Indian Ocean. <i>Science of The Total Environment</i>, 748, 141263. 	Thank you for this comment. What we wanted to cover is the inputs of plastics into the ocean rather than issues that deal with the municipal solid waste management issues on land. We feel that this is outside the scope of this review which has an emphasis on the ocean transport. In contrast we have included the third reference in our paper.
65	<p>2.2 Ocean-based sources</p> <p>Oceanic islands act as a source and/or a sink of plastic waste. Different studies in both the Atlantic and the Pacific Ocean have been discussing it and I think it should be discussed or at least presented on this topic. Oceanic Islands could be a temporary reservoir when plastics items fragmenting on beaches, for example, and physical forcing takes out them to water surrounding. On the other hand, plastic items could stay there for a long time on the supratidal zone fragmenting itself (final reservoir) infinitely.</p> <p>I looked for some articles in the Indian Ocean, but I can find nothing. Therefore, I suggest looking for some articles that could bring this discussion.</p> <p>On Scholar Google, I searched these references</p> <ul style="list-style-type: none"> - Pham, C. K., Pereira, J. M., Frias, J. P., Ríos, N., Carriço, R., Juliano, M., & Rodríguez, Y. (2020). Beaches of the Azores archipelago as transitory repositories for small 	<p>Oceanic islands are considered as a land-based source: they are taken into account in for example Jambeck et al. (2015), where data is available for these islands. So we have not included a discussion on oceanic islands specifically in this section.</p> <p>However, we agree that they are important (temporary) sinks of plastic. We already discuss this a bit in a later section (now in section 4.2.1 after removal of section 5), we have expanded on this and</p>

	<p>plastic fragments floating in the North-East Atlantic. Environmental Pollution, 263, 114494.</p> <ul style="list-style-type: none"> - Monteiro, R. C., do Sul, J. A. I., & Costa, M. F. (2018). Plastic pollution in islands of the Atlantic Ocean. Environmental Pollution, 238, 103-110. 	<p>included the two suggested references: “Finally, plastics do not necessarily remain beached indefinitely, but can also re-float and re-enter the ocean (Zhang, 2017; Lebreton et al., 2019). Several recent studies highlight the potential of oceanic islands to act as transitory repositories for plastic debris (Monteiro et al., 2018; Pham et al., 2020). As a result, it is unknown how much plastic is stored on coastlines in the IO, as well as how permanent this sink is.”</p>
	Section 3 Observations	
66	<p>Perhaps this topic is the most approximated to a methodological topic. Thus, this topic should be worked on to improve the mechanism to search articles in this manuscript. Here, it could be defined the kind of reservoirs (biota - seabirds, invertebrates, mammals, reptiles; sediment – sand mud, water; deep sea) among many other variables.</p>	<p>We are unclear exactly what the reviewer means with this comment.</p>
67	<p>On the Scopus base, I used the following keywords "Indian Ocean" and plastic or microplastic and, I found 227 documents (1972-2021). After It was limited to review papers and, I found only seven articles and no one of them was about the purpose of this manuscript. Therefore, the authors have a great and fantastic study proposal. However, it needs to be improved, mainly in the methodology. After that, this article could be reference in plastic pollution in Indian Ocean.</p>	<p>Thank you.</p>
	Section 4	
68	<p>About the whole physical section (section 4) The proposition of information among these sections with the other is too much different. The topics need an equilibrium because a review is constructed by a global vision of the theme. As a researcher, I know we ended up talking more about what we understand, but we have to control it.</p>	<p>We have shortened section 4 and completely removed section 5, see our response to comment #15. This should bring some more balance to the different parts of the paper.</p>
	Section 5	
69	<p>This topic is good writing in this manuscript because the authors bring a diversity of articles cited. But, because it is the Indian Ocean I think the manuscript should have more information about biological sinks since the literature has some articles about them.</p> <p>Some suggestions of references:</p> <ul style="list-style-type: none"> - Cliff, G., Dudley, S. F., Ryan, P. G., Singleton, N., 2002. Large sharks and plastic debris in KwaZulu-Natal, South Africa. Marine and Freshwater Research, 53(2), 575-581. DOI: 10.1071/MF01146 	<p>We have now removed section 5 from the manuscript, see our response to comment #15. We have added section 4.3.2 about ingestion as a possible (temporary) sink of plastics:</p> <p>“Ingestion of plastics can occur at the ocean surface, in the water column, and on the</p>

- Carey, M. J. (2011). Intergenerational transfer of plastic debris by Short-tailed Shearwaters (*Ardenna tenuirostris*). *Emu-Austral Ornithology*, 111(3), 229-234.
- Roman, L., Paterson, H., Townsend, K. A., Wilcox, C., Hardesty, B. D., & Hindell, M. A. (2019). Size of marine debris items ingested and retained by petrels. *Marine pollution bulletin*, 142, 569-575.
- Ryan, P. G. (2008). Seabirds indicate decreases in plastic pellet litter in the Atlantic and south-western Indian Ocean. *Mar. Pollut. Bull.*, 56, 1406-1409.
- Sparks, C., Immelman, S., 2020. Microplastics in offshore fish from the Agulhas Bank, South Africa. *Marine pollution bulletin*, 156, 111216. DOI: 10.1016/j.marpolbul.2020.111216
- Cartraud, A.E., Le Corre, M., Turquet, J., Tourmetz, J., 2019. Plastic ingestion in seabirds of the western Indian Ocean. *Marine pollution bulletin*, 140, 308-314. DOI: 10.1016/j.marpolbul.2019.01.065
- Crutchett, T., Paterson, H., Ford, B.M., Speldewinde, P., 2020. Plastic Ingestion in Sardines (*Sardinops sagax*) From Frenchman Bay, Western Australia, Highlights a Problem in a Ubiquitous Fish. *Frontiers in Marine Science*, 7, 526. DOI: 10.3389/fmars.2020.00526
- McGregor, S., Strydom, N.A., 2020. Feeding ecology and microplastic ingestion in *Chelon richardsonii* (Mugilidae) associated with surf diatom *Anaulus australis* accumulations in a warm temperate South African surf zone. *Marine Pollution Bulletin*, 158, 111430. DOI: 10.1016/j.marpolbul.2020.111430
- Hoarau, L., Ainley, L., Jean, C., Ciccione, S., 2014. Ingestion and defecation of marine debris by loggerhead sea turtles, *Caretta caretta*, from by-catches in the South-West Indian Ocean. *Marine Pollution Bulletin*, 84(1-2), 90-96. DOI: 10.1016/j.marpolbul.2014.05.031
- Pfeiffer, M. B., Venter, J. A., & Downs, C. T. (2017). Observations of microtrash ingestion in Cape vultures in the Eastern Cape, South Africa. *African Zoology*, 52(1), 65-67.
- Lavers, J. L., & Bond, A. L. (2016). Selectivity of flesh-footed shearwaters for plastic colour: evidence for differential provisioning in adults and fledglings. *Marine environmental research*, 113, 1-6.
- Cherel, Y., Xavier, J.C., de Grissac, S., Trouvé, C., Weimerskirch, H., 2017. Feeding ecology, isotopic niche, and ingestion of fishery-related items of the wandering albatross *Diomedea exulans* at Kerguelen and Crozet Islands. *Marine Ecology Progress Series*, 565, 197-215. DOI: 10.3354/meps11994

seafloor. Estimates of plastic ingestion by vertebrates (van Franeker, 2011; Davison and Ash, 2011), indicate that the global ingestion of plastics could be on the same order of magnitude as the amount of plastics accumulating in subtropical garbage patches (van Sebille et al., 2015). However, plastic ingestion is generally considered only a temporary and not a permanent sink of marine plastic debris.

Throughout the IO (Figure 2b), multiple studies have sampled ingested plastics in a variety of different fauna: benthic invertebrates (Taylor et al., 2016; Naidu et al., 2018), sessile invertebrates (Thushari et al., 2017), fishes (Ismail et al., 2018; Karthik et al., 2018; Baalkhuyar et al., 2019; Crutchett et al., 2020; Gregory and Strydom, 2020; Sparks et al., 2020), including large sharks (Cliff et al., 2002), seabirds (Cherel et al., 2017; Cartraud et al., 2019), turtles (Hoaru et al., 2014), bivalves (Naidu, 2019), and corals (Saliu et al., 2019). Recorded ingestion rates varied widely between species, from only approximately 0.4% of large sharks sampled (Cliff et al., 2002) to up to 90% of fish sampled (Sparks et al., 2020).

These sampling studies are both relatively few and relatively recent, so no estimates can be given about the total amount of plastic ingested by marine fauna in the IO, or about any trends in plastic ingestion. Cherel et al. (2017) did find that the

		<p>wandering albatross chicks they investigated at Crozet and Kerguelen Islands had ingested low plastic loads compared to albatross chicks in the North Pacific Ocean. Crutchett et al. (2020) found low plastic ingestion levels in sardines compared to global levels. They also suggested that sampling plastics in globally common fishes, such as sardines, is a good way to compare and monitor ingestion rates between different locations around the world.”</p> <p>We have also added most of the suggested references to Table 1 (except a few that were not relevant for the IO or discussed land birds).</p> <p>We have also added a section on the impact of plastic ingestion (section 5.2).</p>
70	<p>Please consider the information and suggestions given for improving the article. I think it has a lot of potentials, but we need to improve some points. The work done was a lot and I'm sure it can get even better.</p>	<p>Thank you – we have addressed the majority of your comments.</p>