

Global Plastic Waste Accumulation in Ocean Gyres From 2000 - 2019: An Analytical Comparison of Regional Microplastic Concentration

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Abstract

Oceanic plastic pollution has significantly increased over the past decades and has accumulated into ocean gyres creating great garbage patches, including the North Pacific Garbage Patch (NPGP), South Pacific Garbage Patch (SPGP), North Atlantic Garbage Patch (NAGP), South Atlantic Garbage Patch (SAGP), and Indian Ocean Garbage Patch (IOGP). The largest patches, the North Pacific and North Atlantic, are well studied but little is known about the other 3 patches or the origins of plastic pollution. This study aims to create a comparison of the 5 garbage patches, address how plastics are discharged into the ocean, and the policies surrounding the issue using public online data sets and papers. The Global Marine Microplastics Database from the National Oceanic and Atmospheric Administration (NOAA) and the ‘Plastic Waste Accumulated in the Ocean’ dataset from My World In Data were used to compare microplastic concentrations, total plastic amounts, and garbage patch sizes. Data analysis showed a majority of plastics emitted into the ocean originated from China, Europe, and the Americas as major economic contributors and trade communities. In 2000, the ocean contained 8.47 million plastic tonnes, with Asia (2.65 million tonnes) and the Americas (2.58 million tonnes) accounting for most plastics emitted. Over the span of 2 decades, countries with increased manufacturing contributed to a sharp increase in oceanic plastic. As of 2019, out of 30.41 million plastic tonnes in the ocean, Asia contributed an estimated 12.94 million tonnes, the Americas contributed 7.56 million tonnes, and Europe contributed 5.05 million tonnes. National organizations and countries have implemented policy change, but it is difficult to abolish single use plastic due to widespread use. Ultimately, more studies on plastic effects on the environment are important to generate a more complete perspective of the problem and engineer solutions.

Introduction

- The widespread human use and pollution of plastics contributes significantly to the degradation and damage of the environment. In the span of 65 years, from 1950 to 2015, humans have produced 6.3 billion tonnes of plastic [1].
- Oceanic waste materials, primarily composed of plastics and marine debris, accumulate in giant circular currents known as gyres. These large garbage patches contain materials from fishing industry equipment, household items, and plastics, with trash pieces ranging in size from large ship debris to microscopic pieces [2].
- Five major oceanic garbage patches have been documented: the North Pacific, South Pacific, Indian Ocean, North Atlantic, and South Atlantic garbage patch [3].
- The full scale of the environmental, ecological and oceanic impacts of these garbage patches are still unknown and will be seen for many years to come.
- This paper provides a policy-linked regional interpretation of marine debris by conducting a qualitative and quantitative comparison of oceanic plastic waste accumulation across the GPGP and other major garbage patches using data sets from the NOAA and other publicly available sources.

Methods

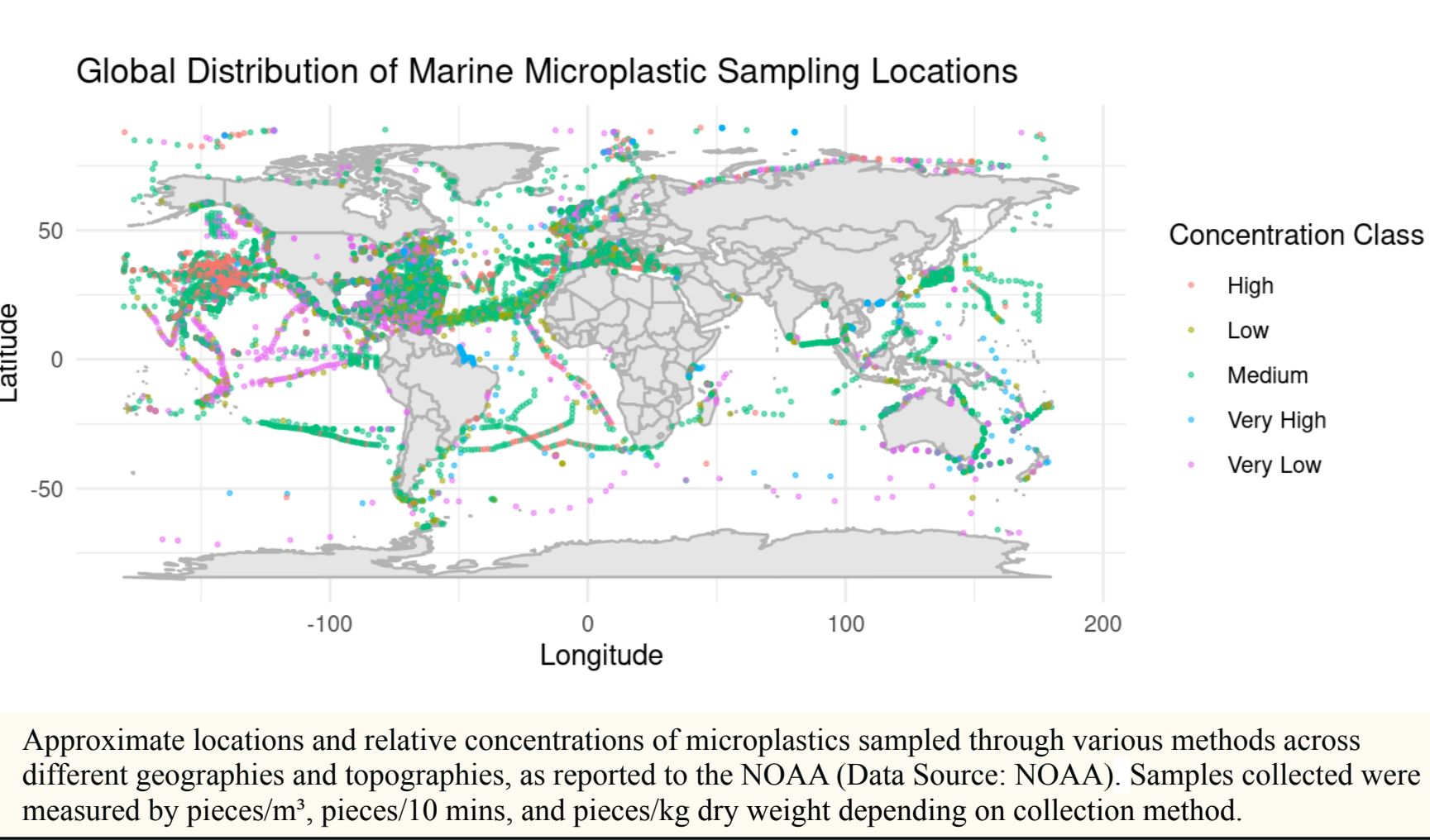
- This analysis used three publicly available datasets to compare plastic concentration measurements among 5 ocean gyres and discharge of plastic from several regions.
- The NOAA and Our World in Data datasets were selected for longer term data collection, and the peer-reviewed Lebreton et al. was selected for its accessibility and comprehensive data.
- The datasets were analyzed to assess the similarities and differences in plastics from different garbage gyres and geographic regions. These analyses do not directly equate emission estimates with ocean concentration measurements, but instead, analyze them as complementary indicators of plastic discharge pressure and the state of marine pollution.

Limitations

- Measurements taken from one region cannot be directly compared to another region, due to differences in collection methods, measurements and sample size.
- Further, while collection of data from the North Pacific and Atlantic regions in the Northern Hemisphere were abundant, collected data were scarce from other regions, resulting in potential bias in the amounts and concentrations of plastics measured.

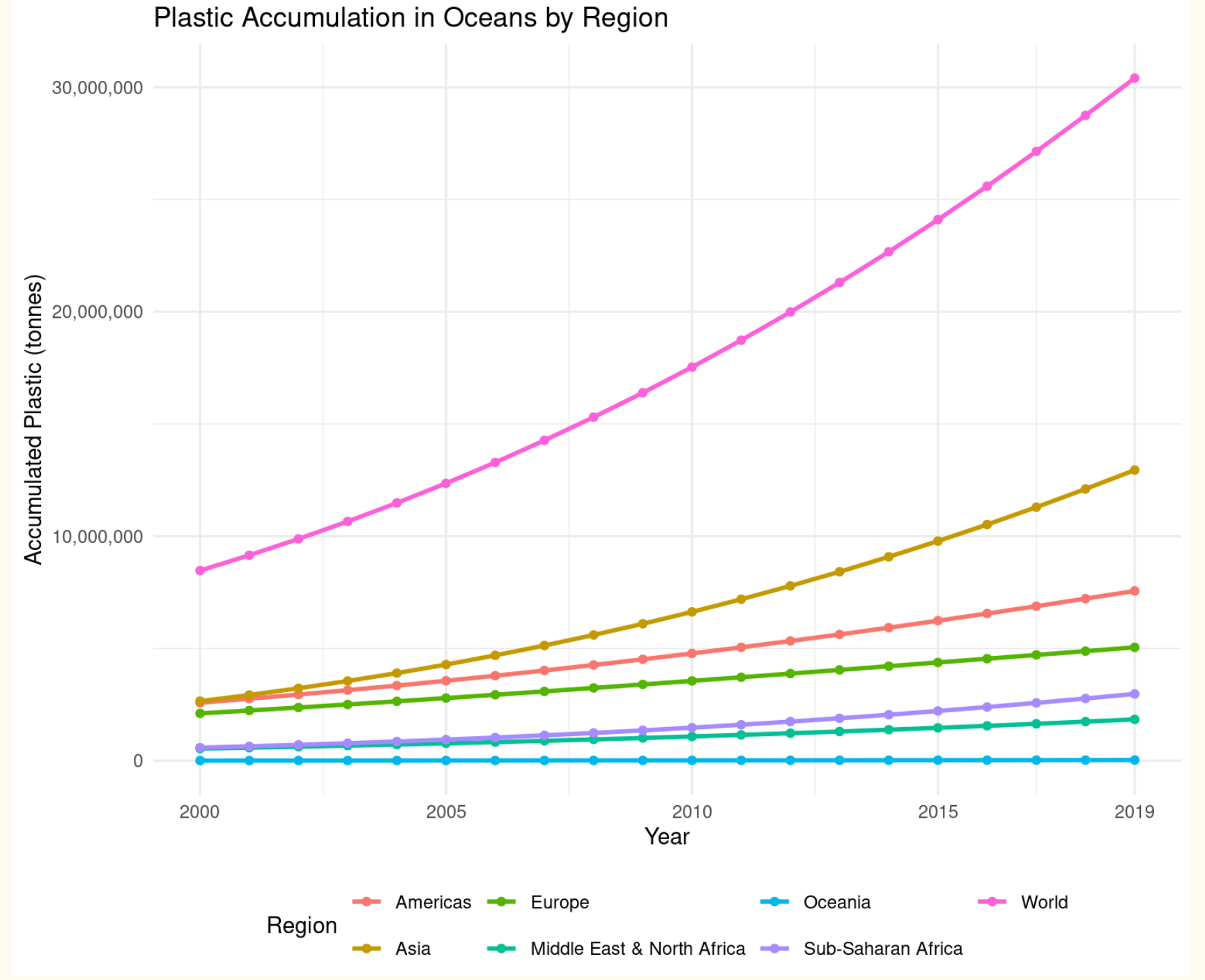
Majority of Microplastic Debris Found in Pacific and Atlantic Oceans

- The highest concentrations of microplastics (very high and high) were mapped to the Pacific Ocean, primarily GPGP location, followed by the Atlantic Ocean. These coasts also represented a higher density of sampling measurements and collection.
- In sampling of debris from the GPGP, microplastics measuring 0.15 - 0.5 cm in size accounted for over 90% of the pieces sampled [4].



Plastic Accumulation More than Tripled From 2000 - 2019

- In 2000, an estimated 8.47 million tonnes of marine plastic were recorded, which more than doubled to 17.53 million tonnes in 2010. From 2010 to 2019, the accumulated plastic nearly doubled again to 30.41 million tonnes.



Discussion

- All global regions have contributed to the rise in plastic accumulation, however, Asia and the Americas have played a more significant role in marine plastic waste accumulation.
- Leading world organizations and countries progressed in implementing policies to mitigate plastic waste effects and reduce plastic production, but progress is slow and decades of plastics pollution may not be reversible.
- The United Nations (UN) established an Intergovernmental Negotiating Committee with to create a global plastic treaty addressing plastic production, product design, waste management, pollution and certain plastic bans [5, 6].
- The Association of Southeast Asian Nations (ASEAN) has created the ASEAN Regional Action Plan policy [7] for Combating Marine Debris, targeting plastics at the production level, while also managing current production.

Conclusion

- This paper adds to the overall body of literature on plastic pollution and describes the regional and global differences in plastic discharge, which contributes to ocean pollution.
- While leading world organizations and countries have made strides in the implementation of policies to mitigate the effects of plastic waste and reduce plastic production, progress is slow and the effects of decades of plastics pollution may not be reversible.
- Continued research is warranted to understand the sources of plastic pollution, and impacts of microplastics to the environment and to human and animal life.
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References

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