A Comprehensive Study of Microplastic Concentrations and its Impacts to the population along the Brazilian Coastline

Team H2Plastic - Detailed Report

In the vibrant landscape of Brazil, contact with beaches is a commonplace experience for many citizens and tourists. It seamlessly intertwines with our cultural identity, becoming integral to who we are as people. Unfortunately, as the years pass, a noticeable difference emerges between the past and present beach-going experience: the quantity of plastic pollution is increasing, and global warming is making the heat almost unbearable.

It is evident that a clean ocean is fundamental to the health of biodiversity: it affects not only the health of aquatic animals, but also us, human beings, and every part of life that we know. A dirty sea can induce several problems, including climate change, causing an environmental imbalance. One of the issues that holds great significance in maintaining life on Earth, despite being relatively underexplored at present, is the concentration of microplastics in the oceans. In July 2022, National Geographic Brazil reported, “In Brazil, 2.3 million tons of plastic are at a high risk of reaching the sea.” Microplastics are now pervasive in every part of the ocean, posing an incomprehensible threat. The issues stemming from sea pollution don't only affect aquatic animals but also humans, especially those living in greater vulnerability without access to information.

For these reasons, our research is a comprehensive examination of the data collected by NASA’s satellite that illustrates the microplastic concentration in the coastal ocean of Brazil.

Our methodology involved the creation of a Python script to process and visualize Ocean Microplastic Concentration data. The data was obtained from NetCDF4 files downloaded from the PODACC website. Our script utilizes various libraries, including Xarray for data manipulation, NumPy for numerical computation, Matplotlib for data visualization, Cartopy for geospatial plotting, and Matplotlib animation for video creation.

To process the data, our script reads 18 NetCDF files, which represent 18 months from April 2, 2017, to September 25, 2018, using the open_mfdataset function from Xarray. The script then selects a time range and a geographical area of interest and plots the average microplastic concentration over the selected period.

Additionally, our script generates an animated map using Cartopy, which includes country and state borders. It uses a logarithmic color scale to represent microplastic concentration in the selected area, with this information being updated for each frame. The completed animation is saved as an MP4 file.

In the end, we exported all the figures and our video to create a dashboard using Figma. This dashboard allows us to better visualize the data we gathered with our Python script and share it with others.

We augmented our research by incorporating Brazilian news articles that delve into the thematic and cultural context of the analyzed regions. With the articles analyzed, it became clear that the regions most affected by microplastics have had a high concentration of plastic pollution over the years. Also, the communities living closer to these areas are mainly socially disadvantaged. Additionally, the living experiences shared by members of our team living in one of the areas affected (Rio Grande do Norte) provided a great start for us to

understand the cultural aspects of the problem, thereby enhancing the depth of our research and bringing us into closer proximity with the studied issue.

Our observation is focused on the coast of 8 states from different regions of Brazil: São Paulo and Rio de Janeiro (Southeast); Rio Grande do Norte and Ceará (Northeast); Bahia and Espírito Santo (Northeast and Southeast, respectively); as well as Amapá and Pará (North), where the accumulation is more evident.

Upon examining the data concerning the São Paulo and Rio de Janeiro coast, a discernible surge in microplastic contamination was evident during July 2017. Furthermore, there was a distinctly elevated peak in May 2018, and, in July 2018, a similar pattern to the previous year (July 2017) was identified.

When we shift to the data from the coast of Bahia and Espírito Santo, it is noted that in May 2017, there was the highest concentration of microplastics, with an extremely elevated peak. In the subsequent months, the concentration level, although lower compared to May 2017, can be observed particularly in September 2017, March 2018, May 2018, July 2018, and September 2018.

In the coastline of Ceará and Rio Grande do Norte, it is also possible to observe a peak, less prominent compared to the previously mentioned coast, in the concentration of microplastics in May 2017. The highest elevation occurred in March 2018, near the period when such an elevation had occurred on the coast of São Paulo and Rio de Janeiro. In May 2018, this peak was considerably smaller.

Observing the coastline of Amapá and Pará, a similarity in concentration patterns becomes apparent when comparing their data with the states mentioned in the previous paragraph: despite a much less pronounced peak in May 2017 compared to São Paulo and Rio de Janeiro, a similarly extremely high peak occurs in March 2018, followed by a decrease in this peak in May 2018.

The collected and analyzed data play a crucial role in identifying microplastic concentrations in various locations. However, it is imperative to underscore that this research is both limited and outdated. This underscored the significance of incorporating new technologies and operational satellites to ensure that such information is consistently available for projects and the general population.

In addition to the noticeable presence of microplastic along the coast, what these states also have in common is the practice of consuming fish and other seafood. According to IBGE (Brazilian Institute of Geography and Statistics), the state of Rio Grande do Norte produces 30% of all the shrimp in Brazil. This characteristic is so distinctive that the state's natives are called “potiguares”, which come from Tupi and means “shrimp eaters”. Additionally, according to the Brazilian Fish Farming Association (Associação Brasileira da Piscicultura), in 2022, the state of São Paulo was the second largest fish producer in Brazil.

A review titled "Microplastics in Fish and Fishery Products and Risks for Human Health” mentions that “most humans ingest a significant amount of microplastic and even nanoplastic particles through food, particularly through the consumption of fish and other seafood”. Another study conducted by the Federal University of São Paulo (Unifesp) off the coast of São Paulo, specifically in the Santos region, analyzed the consumption of microplastics in mussels, revealing the presence of more than 300 microplastics per gram of these mollusks. The study highlights a worrying discovery in finding this high concentration in a single mussel, highlighting the importance of the collection site, which previously housed a

traditional fishing community, now inhabited by around 300 people. "Located on a beach that is difficult to access, only by boat or trail, these residents likely integrate these marine animals into their diet, given the accessibility provided by the nearby rocky wall," emphasizes Victor Vasques Ribeiro, a doctoral student at the Institute of the Sea (IMar-Unifesp).

Considering these issues, our study aims to assess the Brazilian coastline and identify the high-risk points of fish contamination for the population that relies on them as a food source. It is of utmost importance that the government has access to these data to formulate cleaning policies in these areas and properly alert the population. This approach directly contributes to achieving the Sustainable Development Goals (SDGs) of clean water and sanitation, but it also acts in a second manner on climate action and zero hunger goals.

When transitioning to the scientific community, awareness and information about the concentration of microplastics in the ocean are fundamental for studies on mitigation and management of these particles, such as microorganisms capable of degrading them or devices equipped with filters and other mechanisms formulated to effectively collect the particles. By understanding the temporal and geographical patterns of microplastic concentration, scientists can refine their direction for collections and conduct more targeted research. The identification of hotspots is crucial in the planning.

Ethical and equitable approaches to addressing the concentration of microplastics in the oceans and their consequences include:

Intergenerational Justice: Current actions that contribute to pollution and climate change have lasting impacts on future generations. It is ethical to consider the long-term effects of these activities and ensure that future generations have access to a healthy and sustainable environment.

Access to Information and Education: Communities affected by plastic pollution must have access to relevant data and information to understand the impacts on their health and environment. Promoting awareness and education about the importance of sustainable practices is essential.

Global Collaboration: Given the global nature of the oceans, international collaboration is essential. Effectively addressing plastic pollution requires cooperation between countries to share resources, technologies, and best practices.

As possible strategies and approaches to address these ethical and equity issues, we propose:

Regulation and Inspection: Implement strict regulations to reduce the use of single-use plastics and ensure proper waste management, especially in coastal areas and pollution-prone regions. Efficient inspections are crucial to ensure compliance with these regulations.

Incentives for Sustainable Innovation: Offer financial and tax incentives to companies that develop sustainable alternatives to plastic and promote more environmentally friendly production practices. This includes improvements to collection and recycling systems to prevent ocean contamination.

Involve Local Communities: Include local communities in decision-making processes and cleaning and awareness initiatives. Ensure that communities' voices are heard to promote solutions that align with their needs and concerns.

Invest in Research: Invest in research to better understand the impacts of microplastics and develop more effective solutions for their removal and prevention. This

research should be aimed at identifying critical areas and assessing the impact on vulnerable communities.

Promote Consumer Responsibility: Educate consumers about sustainable choices, promoting conscious and responsible consumption. Awareness campaigns can highlight an individual's impact on communities and the environment, encouraging behavioral changes.

By taking a multi-pronged approach that combines regulation, technological innovation, public awareness, and global cooperation, significant progress can be made in reducing the concentration of microplastics in the oceans and mitigating their environmental impacts.

For these reasons, our motivation is not only to bring hope for a clean and healthy Earth for everyone but also to highlight the need for further study and resources for research on this topic. This effort aims to make a significant difference in human development and every aspect of life on this planet. Microplastics can be challenging to detect, and the only satellite responsible for this identification is out of operation. We only have this fragment of data for such a crucial issue. We need to study, investigate, and gather more information and data to benefit biodiversity and to show people that this is a real problem affecting all populations.

Interactive visualization and repository:

To access our interactive visualization, please access the following link::
https://www.figma.com/proto/4c86b8QprAADUKkZKLPlVj/Dashboard?page-id=0%3A1&type=design&node-id=1-11&viewport=2118%2C331%2C0.58&t=brYHqO2GbJaj87Sb-1&scaling=contain&starting-point-node-id=1%3A11&mode=design

To access our repository on GitHub, please access the following link:
https://github.com/Ruvitt/pale_blue_dot_competition_NASA