# Just Plastic!

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## ABSTRACT

Plastic use is a very present problem, and single use plastics account for a significant chunk of the pollutants. Through this narrative project, we try to visualize facts and misconceptions related to plastic pollution in the U.S., and relate them to policies in different states and from around the world. Our project is unique in that it tackles a very wide problem and yet is able to engage the reader with interactivity (tooltips and guessing games), anomaly detection (line chart patterns of plastic production and recycling in US through time), hypothesis verification (global map chloropleths and news articles), and finally brings the story full circle, while leaving the reader to explore plastic legislation in their on state. We thus attempt to create a holistic narration around plastic contamination and its relation with policy making and legislation, both locally and globally, and leave the reader with a call to action.

## 1 INTRODUCTION

It may seem to some that the state of our environment is at the forefront of everyone's mind. Within the last two decades, both government and grass root campaigns have been pushing for environmental awareness. As a result, publicized statements on plastic waste pollution have turned from gloomy omens to current breaking news. Countries such as the United States have since enacted bans, taxes, and other legislation on specific plastic products and plastic waste management in hopes to better the climate. However, it has yet to be widely publicized whether the current measures are effective, and if they are effective to a great enough extent. This report provides an extended analysis of *Just Plastic*, a data-driven narrative web page that highlights some misconceptions about plastic waste at both a domestic and international level, as well as provides users with resources on how to help advance U.S. legislation that will have the greatest environmental impact.

## 2 RELATED WORK

There have been multiple studies and research on waste pollution. There was one research study that was focused on seeing which companies were the main contributors to the plastic waste. The study found that there were 20 companies that produce 55 percent of single-use plastic in the world [5]. Similarly, there was a paper created by multiple organizations that compiled data of the plastic products that are most contaminating to the environment. This study broke it down into the different types of products as well as the specific types of plastics those products were made of [3].

## 3 METHODS

We made use of the following tech stack for our project:

(1) HTML - Webpage building and compilation
(2) CSS - Webpage styling
(3) Python - Dataset munging and creation
(4) Javascript - Interactivity and visualizations
(5) VegaLite API [8] - Visualization

Initially the maps and chloropeths of our narration/webpage were coded in D3, but we chose to switch to VegaLite because tooltips and HTML integration were simply easier in VegaLite.

### 3.1 Datasets and Primary Sources

For Figure 1, we procured data from [3], which is compiled report on several statistics of plastic products an use in the United States. For Figure 2, we compiled data from [1, 4, 6]. For Figures 3, 4, and 5, the global chloropleth maps, we used data from various sources, primarily [7]. This data curated for years 2010 to 2021. We make some changes to the data - find missing values for country codes in the geoJSON files, fill null values with default minimums or zeroes, and lastly, we calculate net exports as "exports - imports". The data for Figure 7 is manually curated, we find laws existing for all 52 states of the United States using sources like [2].

### 3.2 Elements of Visualization

(1) **Interactivity**: We have made all our graphs and visualizations interactive with hovering tooltips for better metadata. This is true for all our graphs, especially the maps. We also used gamification to engage the reader more using certain guess based elements for the first couple of facts of plastic consumption in our webpage.
(2) **Accessibility**: We have written explanations for all our visualizations. The maps that we made used single color hue to demonstrate the most important variable in our visualizations. This ensured that people will color blindness will still be able to see the grayscale imagery. Domains of the colors across the range of values was custom for all graphs, chosen to ensure the visibility.
(3) **Novelty/Creativity**: One aspect of novelty in our project was the datasets themselves - most, if not all, of our datasets were hand curated. The dataset on the US state laws about preemption of plastic bans, was also hand curated.

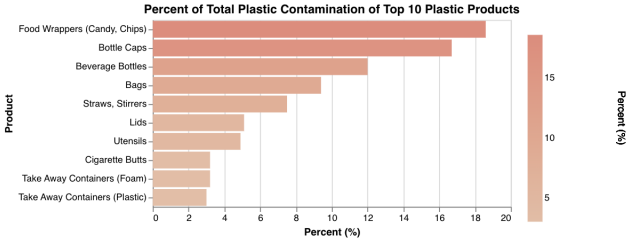


**Figure 1: Top 10 plastic contamination products**

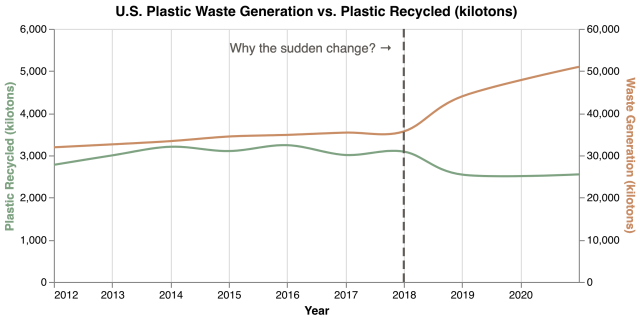


**Figure 2: Line chart showing anomalous behaviours of plastic production and recycling in 2018 in the US**

## 4 RESULTS

In this section, we show screenshots of our data visualizations. While these screenshots are static, all of them are interactive on our website. Please check our website[1] for interactivity and our GitHub for source codes[2]. We now describe the design rationales and the explanations of each visualization. Our narrative that connects all the data visualizations in a story is presented later in Section 5.

Figure 1 visualizes the top ten plastic contamination products. We use bar charts for this visualization because the products are categorical data, while each amount is numerical. The difference between each product is also in a reasonable range, making the horizontal bar chart ideal for this data.

Figure 2 is a multi-axis line chart showing the plastic production and recycling rate on the same timeline, enabling us to pinpoint the anomaly of decrease in recycling in 2018 very clearly.

Figure 3-5 show the plastic produced, mismanaged and exported by countries on a world map chloropleth, which is the most appropriate choice due to its ability to encode the value we want to show in the hue of the map, with the shade being color-blind friendly.

Figure 6 shows headlines from around the world that point out the ban on imported plastic imposed by the Chinese government in 2018, that ties to the anomaly we detected before.

Figure 7 shows the US states in a chloropleth with the hue depicting the plastic facilities (normalized) and the states being clickable to view the legislation of the states. Thus the reader is left to explore the fact that weaker the legislation, more is the plastic produced in that local area as well.

[1]https://cmu-vis-2022.github.io/final-project-justplastic
[2]https://github.com/CMU-Vis-2022/final-project-justplastic

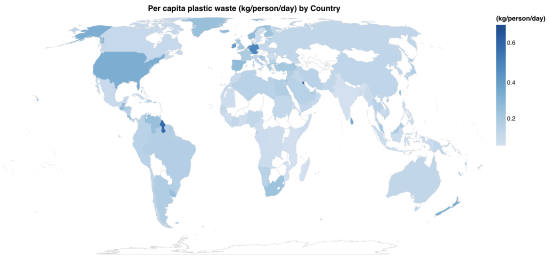


**Figure 3: The total plastic wasted that is generated by each country around the world.**

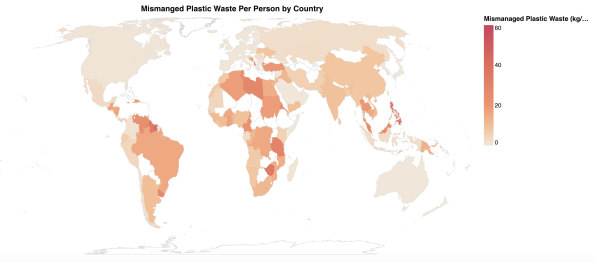


**Figure 4: The amount of plastic waste that is mismanaged within the country.**

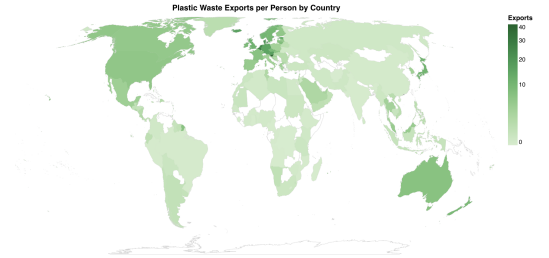


**Figure 5: The amount of plastic waste each country exports.**

## 5 DISCUSSION

The whole narrative of our project was to educate the readers on single use plastics, and more importantly, their connection with policies - both globally and domestically. We hypothesized that weaker policies lead to more plastic mismanagement. We detected an anomaly and solved it using global policies. In order to answer these questions, our narrative discussed the following points in a story format.

(1) **What plastic products are the major contributors to the plastic contamination in the environment?** The top 10 plastic products made up 85% of all plastic contamination. On further investigation using Figure 1, we noticed that plastic food wrappers and bottle caps topped the charts with over 35% of total contamination, instead of the more focused straws and plastic containers that were 5th and 8th respectively.

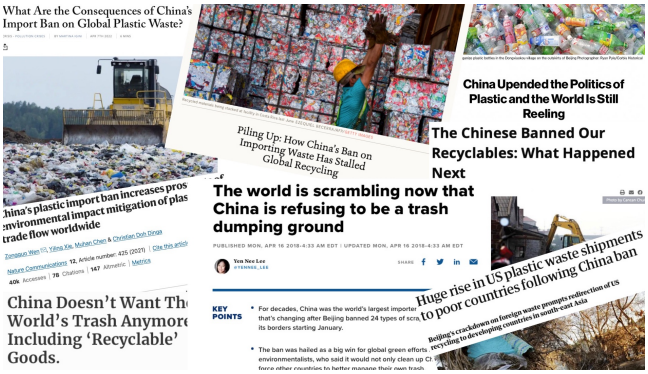


**Figure 6: News from around the world regarding China and Turkey's plastic import bans**


**Figure 7: US state wise plastic pre-emption chloropleth**

(2) **Over time how has the plastic production and recycling in the US fared, and are there any anomalies?** Figure 2 clearly demonstrated that while plastic production is continuously increasing, the year 2018 was an anomaly, because not only did the plastic production increase, but there was a decrease in recycling as well. So what went wrong?

(3) **Did global policies have anything to do with the anomaly detected above?** From Figure 3 to 5, we took our chloropleth map visualizations to step back and pinpoint exactly who is producing plastic, and who is mismanaging it? As it turned out Figures 3 and 4 were complimentary to each other - the countries that produce the plastic (US, Canada, Australia and Western Europe), are not the ones mismanaging it. Instead, looking at Figure 5, we found that these countries are dumping their waste onto other countries with weaker legislation and economies.

(4) **So 2018 anomaly in the US was due to global policies? How?** Now that we know that the US was dumping plastic onto other nations, we realised that the plastic import ban by China and Turkey in 2018 (Figure 6) actually led to the dip in recycling rate of the US, thus answering several of the questions above.

(5) **What about local policies in the US? What is my state's plastic policy?** In Figure 7, we now leave the reader with a self exploring visualization to click on a US state to see if they have a good or bad plastic legislation. This way the reader is educated on facts like the east and western states are doing well on plastic legislation, and thus producing less plastic (per capita) as compared to central US states.

Hence, we were able to concretely answer our questions by stating some plastic product statistics, finding anomalous recycling rate behaviour, explain it with the help of global chloropleths, and then let the reader explore local state laws for plastic.

## 6 FEEDBACK AND FUTURE WORK

We received the following feedback during our in-class presentation. We incorporated most feedback and updated our website within the limited time between the presentation and the deadline. In this section, we first presented the feedback we already addressed. We then documented those that require more time for future work. Here are the **feedback that we already addressed**:

- At the top of the website, the audience found the actual percentage of all environmental plastic contamination hard to see. We adjusted its location and color for increased visibility.
- After showing the news headlines, the audience recommended bringing back the line chart that visualizations the sudden change in 2018. We followed the suggestion to improve the overall narrative.
- Overall the audience recommended adding more instructions on the website to inform readers that the data visualizations are interactive. We successfully added these instructions to help improve the reading experience with more guidance for readers.

Given the limited time between the presentation and the deadline, there are a few great suggestions from the audience that we couldn't implement in time. Still, we document these suggestions as future work that can further improve our visualizations and narrative:

- For Figure 5, the audience recommended finding data and adding arrows that indicate the source and destination of exported plastic waste. It is a promising direction that can significantly enhance both the interactivity of visualization and the memorability of the narrative.
- For Figures 3-5, the audience recommended designing the color encoding to match the narrative from generated, mismanaged, to exported plastic waste. We leave this for future work because it is a design problem that requires more testing rather than a technical issue that we can quickly fix.

Finally, below are web page-specific and data-related future implementations proposed by our team:

- For Figures 3, 4, and 5, we would love to eventually incorporate additional plastic exportation details, such as disposal methods, micro-plastic percentages, and specific plastic product export data.
- For Figure 7, we would like to clarify the definition of a "Plastic Producing Facility." The EPA has not published this directly, so we would need to contact them and ask how they collected such data and what types of establishments are considered facilities.

- Accessibility: While the web page is already fairly accessible as it is a single and linear HTML page, we would like to add more specification to Voice Over descriptions all of our visualizations.
- Compatibility: We would like to extend device compatibility of the web page to include mobile devices as well make the web page responsive to desktop window size changes.

## 7 CONCLUSION

In summary, we create a holistic narration around plastic contamination and its relation with policy making and legislation, both locally and globally, and leave the reader with a call to action.

## ACKNOWLEDGMENTS

We would like to thank Professor Dominik Moritz for his guidance and support throughout the semester.

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