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**Final Project Report**

The relationship between plastic pollution and a country's per capita income.

Data Visualization

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Introduction

Plastic is seen everywhere around the world, and it has become one of the world's most concerning problems. It has adverse effects not only on humans but also on the environment and marine life. At the present rate, the accumulation of plastic is estimated to be at 20.56 billion tons by 2030.

In the year 1862 first plastic material was created using cellulose and from then it took prominence. During the phase of the industrial revolution, many countries saw the opportunity of plastic and its daily usage. It was extensively created during World War II by Germany and the United States of America. The first heap of plastic waste was found in the oceans, and it quickly became a place for dumping plastic. The total plastic produced in the year 1950 was 2 million tons and by 2015 it is estimated to increase by 200 folds. It is estimated that yearly plastic production is 7.82 billion tons per year.

With this report, I tried to explore different countries and their plastic waste produced each year concerning the per capita income for the years 2010 and 2015.

Fact:

Gyre: A Gyre is a concentrated area of plastic garbage in the oceans. The North Pacific Gyre, often known as the Great Pacific Garbage Patch, covers an area twice the size of Texas. This is an indication of how fast-paced plastic is accumulating under the oceans.

Ambitiousness:

According to the United Nations Environment Programme (UNEP), one million(1,000,000) plastic bottles are purchased every minute around the world. This would account for 24 million plastic bottles per day. Most of these are microplastics since they end up in the oceans after use. In addition, most of them are single-time use which means after their use they end up in the trash. Marine animals mistake them for food and consume them. This in turn affects the Marine animal population.

According to reports published by UNESCO, more than 1 million sea birds and 100 marine animals die on an average per year due to the plastic waste polluted into the oceans. This is considered a serious effect on the extinction of the marine animal population.

The above sums up the situation in which the world around us is trapped and every human being must try to decrease the usage of plastic. Further, global industrial leaders must find cost-effective alternatives to appropriately manage plastic trash through recycling. It is also important to educate society about plastic waste management.

Research questions presented in the project:

The research questions I tried answering to:

1. Why is there an increase in plastic production across every country each year?

2. Which country is producing more plastic and what is its recycling and mismanagement rate?

3. Is there any relation between the per capita income of a country and its plastic mismanagement?

4. Is the coastal population having any effect on plastic pollution?

5. Relation between Coastal plastic pollution and the highest plastic producing countries.

Data set references:

Most of the data used in the analysis came from:

1. <https://ourworldindata.org/>

2. [Plastic waste inputs from land into the ocean | Science (sciencemag.org)](https://science.sciencemag.org/content/347/6223/768)

3.<https://data.worldbank.org/indicator/NY.GDP.PCAP.CD>

4. https://plasticoceans.org/the-facts/

Methodology

The data sources used in making the visualizations are created from the data sheets taken from the websites mentioned in the references. These datasets are normalized for their respective population for having a standardized visualization. Each data source has its importance. For instance, plastic waste generated by each country in the year 2010 is connected to the per capita of the countries for the same year. The top 10 countries’ plastic production and their mismanagement identification should be considered a significant visualization. Since it helps in answering the various research questions.

Since coastal regions also account for the plastic waste it is important to analyze the reasons behind their plastic waste production and their corresponding mismanagement of plastic debris. In addition, industries are the primary source of creating plastic products, and hence it is important to visualize the sectors producing higher amounts of plastics.

Frequently used column names in tables:

Code, Entity: It consists of every country code present in the world as per the ISO country code.

Total Mismanaged plastic waste: Describes the statistics of the total mismanaged plastic waste in Million tones.

Total Population: Total population of the countries present in the world.

Per Capita Income 2010: Total Per Capita income of a country in 2010.

Global plastic production: Total plastic produced globally in million tones.

Mismanaged plastic waste into Oceans: Total amount of plastic waste dumped into the oceans in kg per year.

Per capita plastic waste: Amount of plastic waste generated by a person in kg per year about the country’s Per capita Income.

Primary plastic production: Describes the amount of plastic produced by different sectors around the world.

Top N Countries: A parameter used to show the top countries and how well they are performing for a particular research question.

There are 12 data sources in total each having its significance. If in the future a datasheet having 2019 Per capita income is obtained, then this can be connected to the 2019 plastic pollution data, and these together can be used for visualizations and could be analyzed for further study.

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Analysis performed

Global plastic waste produced from 1950- to 2015:

Since the quintessence of the overall project lies in plastic waste production, it is important to identify the plastic waste production trends over the years to answer the research questions.

Chart, line chart

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The above line chart shows that the plastic produced has increased exponentially from 1950 – to 2015. It increased from 2million in 1950 to 380 million in 2015. This shows that plastic consumption has increased throughout the years. It is important to identify the reasons behind this increase.

**Top countries producing plastics**

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It is evident from the above visualization that China is the top country producing plastics and it is the highest populated country in the world. If that’s the case India should be second since it is the second most populated country but surprisingly, the United States of America stands second in plastic waste production. This needs to be addressed more for having a clear understanding. All the countries with high GDPs are the top countries producing plastic waste.

Map

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**Plastics waste produced by Continents:**

Since Asia has the two most populated countries in the world it is important to visualize the plastic waste by continent to uncover more insights. The results are seen after normalizing the population and plastic production for a particular country.

Chart, bar chart

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From above Asia and Europe accounts for most of the plastic waste generated. The above does not give the complete picture of plastic pollution. We need to observe how the plastic produced is managed.

**Mismanaged plastic waste share per continent:**

**Chart, bar chart

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The above two visualizations show that although the United States of America and Europe account for half of all the plastic produced, they take care of or handle their plastic wastes efficiently, accounting for only 4.27% and 3.54% percent of global mismanaged plastic trash respectively.

Africa is the fourth continent in producing plastic, but its mismanagement rate is high at 15.50 %.

This clearly states that the developed countries are managing the plastics more efficiently than the developing countries.

**Relation between Per capita Income and Per capita plastic waste(kg/person/day)**

Since per capita tells us the average income earned by a person in a particular country in a particular year, it is important to know the relation between these two parameters. If there is a positive correlation, then it would state that an increase in per capita income might influence plastic waste for a specific country.

Chart, scatter chart

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|  |  |
| --- | --- |
| **P-value:** | < 0.0001 |
| **Equation:** | Per capita plastic waste (kg/person/day) = 1.97719e-06\*Per Captia Income - 2010 + 0.14421 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficients** | | | |  |
| **Term** | **Value** | **StdErr** | **t-value** | **p-value** |
| Per Captia Income - 2010 | 1.977e-06 | 4.547e-07 | 4.3479 | < 0.0001 |
| intercept | 0.14421 | 0.0122289 | 11.7925 | < 0.0001 |

**Inference:** From the above equation since the ‘p-value’ for both the parameter are less than 5% we can accept the null hypothesis that an increase in the per capita would have an increase in the plastic waste for the specific country.

Chart, scatter chart

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The various clusters can be found in the above visualization.

**Mismanaged plastic wastes and Percapita Income Relation**

**Chart, scatter chart

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|  |  |
| --- | --- |
| **P-value:** | 0.0519701 |
| **Equation:** | Mismanaged plastic waste to ocean per capita (kg per year) = -4.39072e-06\*Per Captia Income - 2010 + 0.295978 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coefficients** | | | |  |
| **Term** | **Value** | **StdErr** | **t-value** | **p-value** |
| Per Capita Income - 2010 | -4.391e-06 | 2.241e-06 | -1.95919 | 0.0519701 |
| intercept | 0.295978 | 0.0547759 | 5.40343 | < 0.0001 |

Unlike the Per Capita vs Per Capita waste, mismanaged plastic waste has a negative correlation. This implies that the countries with more Per Capita income can efficiently manage the plastic waste produced. It also indicates that the countries with Per Capita income should effectively manage their plastic wastes produced.

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From the above visualization, it can be seen that the Philippines which has a lower plastic production per person per kg has a higher mismanagement rate.

Application

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Unlike the Philippines, Kuwait has a lower plastic mismanagement rate and a high plastic per person in kg production.

**Coastal Region’s effect on Plastic wastes:**

Since China accounts for most of the plastic pollution it would be naïve not to research more into the factors affecting the cause. Since Asian countries such as China, India, and Indonesia are situated in the coastal area let’s visualize the amount of mismanaged plastic waste in the coastal population of a country.

Scatter chart

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From the above China and Indonesia are having a high rate of plastic waste mismanagement and then followed by the Philippines.

**Plastic share by Countries in Oceans and Rivers:**

**Map

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India and China account for nearly 20% of the global average plastic waste in the oceans and the Philippines accounts for more than 35%. This is a serious problem for producing gyres (refer to introduction).

Chart, bar chart

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This clearly states that most of the plastic wastes produced in China and India are dumped into oceans i.e., North Pacific and the Indian Ocean. This was the main reason behind the formation of gyres on the surface of the ocean.

Graphical user interface, text, application

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Asia also leads in polluting the rivers present in their respective countries. Asia accounts for more than double the percentage of South America and Asia in polluting the rivers. Unfortunately, I had no data access to the rivers and the amount of plastic pollution present in the USA and Europe.

**Plastic waste produced by sectors:**

Chart, treemap chart

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Out of all the sectors, the Industrial sector is producing more amount of plastic waste. Industries are located close to rivers and seas to easily drain out or release their waste. This might be a reason for the huge pollution of plastic waste into oceans and rivers.

**Conclusion**

From the above-made visualizations, it can be concluded that:

* The plastic production has been increasing each year this is due to the increase in the per capita income and due to the industrialization from the years 1950 to 2015.
* From the visualizations it can be seen that per capita income and plastic waste per person /kg have a positive correlation and per capita income and plastic waste mismanagement have a negative correlation.
* Asian countries are the global leaders in the production of plastics and their mismanagement rate is also high.
* Since the two most plastic mismanagement countries are located on the coast, and also their mismanagement rate is high. These are facts clearly defined as to the gyres present in the oceans.

**Steps that should be taken for reducing plastic waste:**

* Government should take an active role in educating the people of their country on the effects of plastic pollution.
* Citizens should feel responsible and support the government in reducing plastic waste.
* Plastic recycling should be taken as a priority and find different ways to recycle plastic.
* Developed countries should help to develop and underdeveloped countries in managing the plastic wastes and help set up recycling methods(machines) in those countries.

The below graph shows the fate of the world and the statistics for Recycled, Discarded, and Incinerated from the year 1950 to 2015

Chart, line chart

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It can be concluded that discarded plastic has been decreasing every year and the rate of recycling and Incineration of plastic wastes have been increasing.

**Further research questions:**

1. Since Covid the use of facial masks and gloves has been increasing rapidly. How does this affect the plastic pollution in the countries?

2. Global warming is a major environmental issue. Is there any relation between global warming and plastic production?

3. Any other effective alternatives that are being used to decrease the rise of plastic waste?

4. Which is more effective: recycling or replacing plastic with something else?

**References:**

1. [Ocean Garbage Patches (noaa.gov)](https://oceanservice.noaa.gov/podcast/mar18/nop14-ocean-garbage-patches.html)

2. [5d4b7dfd-3203-46ca-9178-904f692f2599.pdf (researchsquare.com)](https://assets.researchsquare.com/files/rs-1315062/v1/5d4b7dfd-3203-46ca-9178-904f692f2599.pdf?c=1644856621)

3. [What is Ocean Pollution?- Causes, Effect, Prevention - Engineering Choice](https://www.engineeringchoice.com/ocean-pollution/)

4. [Marine plastic pollution - Wikipedia](https://en.wikipedia.org/wiki/Marine_plastic_pollution)