

Worldwide Plastic Pollution

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Abstract

Plastic pollution is currently a worldwide issue which may harm our planet in a way of accumulating plastic in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans, which is ourselves, ultimately. This study focuses on studying the severity of this issue. Especially, microplastics is the key research target. To distinct our research from others, we collect primary data on social media so as to predict the possible future trend.

1. Introduction

Generally, plastic pollution is Plastic pollution is the accumulation of plastic objects (e.g. plastic bottle) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans.

There are already thousands of project or studies on this topic. What distinct our project from others is that we are going to use data analysis to show the severity of plastic pollution worldwide.

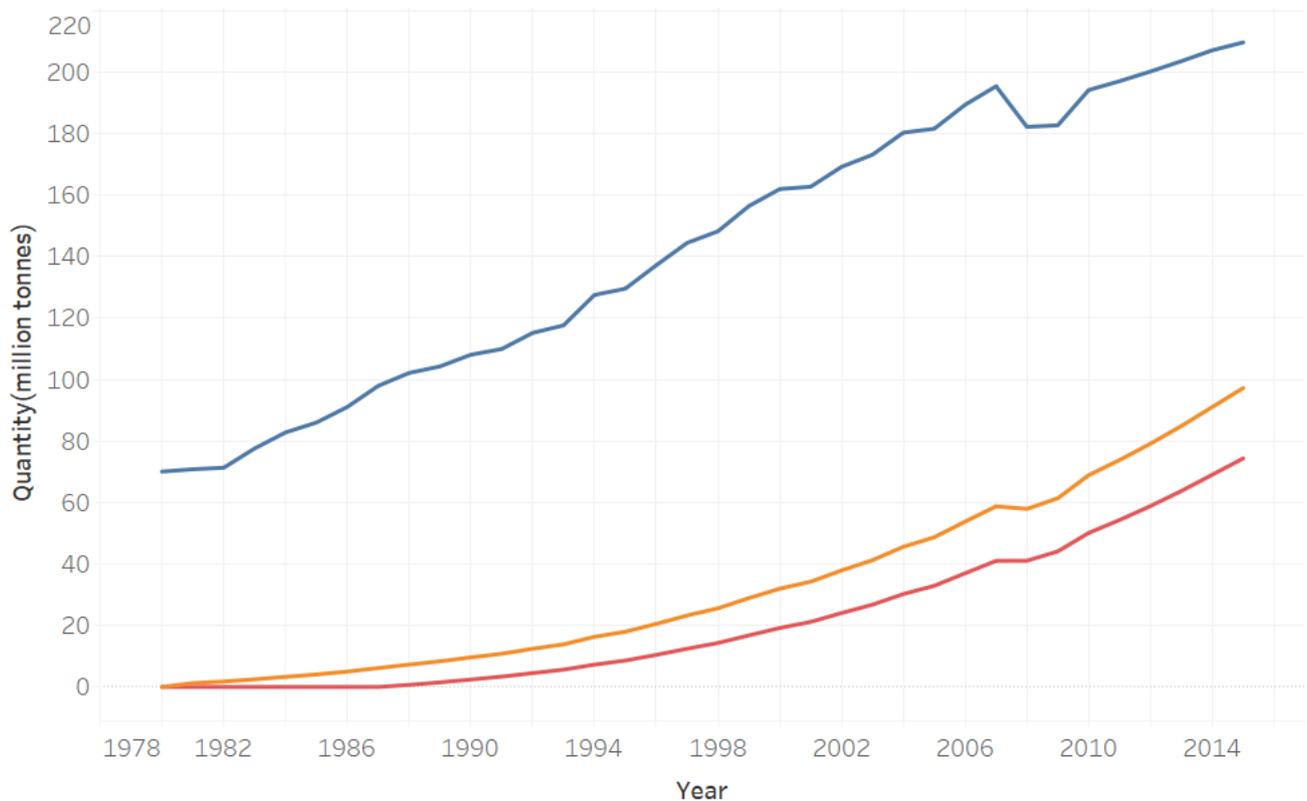
This study on plastic pollution is to study on the data collected, by making graphs and analyzing it, so as to show the severity of this issue which many people may haven't realize yet.

Here is an example:

Measure Names

- Estimated Annual Discarded
- Estimated Annual Incinerated
- Estimated Annual Recycled

How did people deal with the plastic waste



Plastic pollution is getting more and more severe which arouses people's attention all over the world.

1.1 Objective

- To clarify the impact of plastic pollution in the world.
- To clarify the impact of plastic pollution in the world.
- To investigate the public awareness or concern about plastic

pollution

1.2 Research Problems

- How severe is plastic pollution now, how would it be in the future and what are the ways to alleviate the problem?
- What is the distribution of microplastics worldwide and its impact?
- What is the sub-topic under plastic pollution that people are most concerned about?

1.3 Methodology

- To read up resources regarding the pollution of plastics from standard books, websites, papers.
- To research on related research of plastic pollution.
- To find out the data regarding the plastic pollution which can show the severity of plastic pollution.
- To especially focus on microplastic which people have paid less attention in order to further show the severity of plastic pollution.
- To predict the future trend by using graphing making tools by importing past year data collected or regression.
- To show regional severity by using heat map.
- To collect primary data from social media like Tweeter.

1.4 Definition

- Plastic pollution - Plastic pollution is the accumulation of plastic objects (e.g.: plastic bottles and much more) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans.

1.5 Literature Review

1.5.1 Types of Plastic and Their Recycle Codes

Type	Logo	AB.	POLYMER NAME	REPURPOSED TO MAKE	RECYCLABLE	USES
1		PETE or PET	Polyethylene Terephthalate	textiles, carpets, pillow stuffing, life jackets, storage containers, clothing, boat sails, auto parts, sleeping bags, shoes, luggage, winter coats	Yes	Soda bottles Water bottles Salad dressing bottles Medicine jars Peanut butter jars Jelly Jars Combs Bean bags Rope Tote bags Carpet Winter clothing (Fiberfill)
2		HDPE	High-Density Polyethylene	Plastic crates, lumber, fencing	Yes	Milk jugs Juice containers Grocery bags Trash bags Motor oil container Shampoo & conditioner bottles Soap bottles Detergent containers Bleach containers Toys
3		PVC	Polyvinyl Chloride	Flooring, mobile home skirting	Yes - but call your recycler	Some tote bags Plumbing pipes Grocery bags Tile Cling films

						Shoes Gutters Window frames Ducts Sewage pipes
4		LDPE	Low-Density Polyethylene	Garbage cans, lumber	Yes - but call your recycler	Cling wrap Sandwich bags Squeezable bottles for condiments such as honey and mustard Grocery bags Frozen food bags Flexible container lids
5		PP	Polypropylene	Ice scrapers, rakes, battery cables	No	Plastic diapers Tupperware Kitchenware Margarine tubs Yogurt containers Prescription bottles Stadium cups Bottle caps Take-out containers Disposable cups/plates
6		PS	Polystyrene or Styrofoam	Insulation, license plate frames, rulers	No	Disposable coffee cups Plastic food boxes Plastic cutlery Packing foam Packing peanuts
7		N/A	Miscellaneous Plastics (polycarbonate, polycarbonate, acrylic, acrylonitrile butadiene, styrene, fiberglass, and nylon)	Plastic lumber (which is often used in outdoor decks, molding, and park benches)	No	Plastic CDs and DVDs Baby bottles Large water bottles with multiple-gallon capacity Medical storage containers Eyeglasses Exterior lighting fixtures

Address:

<https://www.qualitylogoproducts.com/promo-university/different-types-of-plastic.htm>

1.5.2 Microplastic

Despite plastic bags, furniture or toys, microplastics are also doing harm to people's health by enter natural ecosystems from a variety of sources, including, but not limited to, cosmetics, clothing, and industrial processes.

Microplastics are very small pieces of plastic that pollute the environment. Microplastics are not a specific kind of plastic, but rather any type of plastic fragment that is less than five millimeters in length according to the U.S. National Oceanic and Atmospheric Administration (NOAA).

Two classifications of microplastics currently exist. Primary microplastics are any plastic fragments or particles that are already 5.0 mm in size or less before entering the environment. These include microfibers from clothing, microbeads, and plastic pellets (also known as nurdles). Secondary microplastics are microplastics that are created from the degradation of larger plastic products once they enter the environment through natural weathering processes. Such sources of secondary microplastics include water and soda bottles, fishing nets, and plastic bags. Both types are recognized to persist in the environment at high levels, particularly in aquatic and marine ecosystems.

Additionally, plastics degrade slowly, often over hundreds if not thousands of years. This increases the probability of microplastics being ingested and incorporated into, and accumulated in, the bodies and tissues of many organisms. The entire cycle and movement of microplastics in the environment is not yet known, but research is currently underway to investigate this issue.

Microplastics are common in our world today. In 2014, it was estimated that there are between 15 and 51 trillion individual pieces of microplastic in the world's oceans, which was estimated to weigh between 93,000 and 236,000 metric tons.

(<https://en.wikipedia.org/wiki/Microplastics>)

- In our project, question 2, we will work on finding out the distribution of microplastics by using Tableau, a software that can make graphs by importing dataset. As a matter of fact, the microplastic pollution, one of the most insidious plastic pollutions, however, is least emphasized now. People have hardly realized the significance of reducing microplastic pollution. Hence, our project is aimed to show more people that what we have done is far not enough. By using data analysis, including making graphs, we hope we can raise the awareness of more people on microplastic pollution.

1.5.3 Social Awareness

Plastics' low cost, durability, and versatility have earned them a place in every aspect of our daily lives. The amount of manufactured plastics reached 355 million tons by 2016. Since 1940s, plastic pollution is becoming a global reality. Although the impact of plastic pollution on the environment has been documented, especially in marine ecosystems, the public's view of this issue has not been adequately documented. In this study, we will investigate on society's point of view on plastic pollution. Here is a example of how the investigation would be conducted and how the data collected would be analysed.

Relationships between demographics and some statements

		Pearson Chi-Square	
		Test Value	p
I use plastic bags in market and grocery shopping	Gender	0.901	0.635
	Age Group	8.421	0.39
	Educational Background	4.49	0.81
	Montly Income	4.498	0.81
When I buy anything, I take care that the packaging is plastic or not	Gender	0.872	0.647
	Age Group	10.66	0.221
	Educational Background	8.197	0.414
	Montly Income	7.952	0.242
I sort my garbage in my house	Gender	1.826	0.401
	Age Group	5.489	0.704
	Educational Background	14.626	0.067
	Montly Income	7.468	0.28
I think plastic waste is harmful to the environment	Gender	3.868	0.145
	Age Group	7.538	0.48
	Educational Background	10.729	0.218
	Montly Income	3.598	0.731

For this purpose, a face-to-face survey was conducted with randomly selected 194 people. It was found that the vast majority of participants (96.4%) continued to use plastics in market and grocery (88.7%) shopping, although they knew that plastics were harmful to the environment. The usage of plastic bags of participants were found to 4.19 plastic bags per shopping day. In addition, considering household size and population of Samandağ, it was found that the annual consumption of plastic bags is around 46 million, of which only 26% is separated for recycling. As a result, participants had a high level of awareness of plastic pollution and they are aware that the plastics is harmful to the environment. However, on the contrary, it was determined that the participants were not willing to transform their awareness to act.

- For our study, we will investigate in the context of Singapore rather than in the context of Hatay, Turkey as mentioned above, a comparatively less developed city, and find out the social awareness of Singaporeans.

1.5.4 What are peoples focus points

According to Marine Litter Solutions, a website consist of analysis of the issues of marine litter, it listed 10 most frequently asked questions about plastics pollution in the context of marine, which are

1. Where do plastics in the ocean come from?
2. How much plastic is in the ocean?
3. Do some countries allow more plastic pollution in the ocean than others?
4. How can we prevent ocean pollution due to plastics?
5. What is plastic waste management?
6. What advancements are being made in recycling plastics?
7. Where do microplastics come from?

8. What are microbeads?
 9. How much do plastic straws contribute to pollution in the ocean?
 10. Will a ban on plastic straws help reduce plastic pollution in the ocean?
- What we are going to do about this question is to find out what are the most frequently asked questions about plastic pollution in the context of the whole Tweeter community. Social media like Tweeter help to provide information to tell us about people's focuses. As we collect data from Tweeter, by choosing the date of the first day of months selected, we can group them and find out what are the most frequently asked questions which shows people's focus points about plastic pollution. The data are categorized into Facts, Feelings, Activities, Suggested methods which clearly shows what people are doing to contribute to solving plastic pollution.

2. Results

2.1. How severe is plastic pollution now, how would it be in the future and what are the ways to alleviate the problem?

To solve this problem, we collect the data of global plastic production first and try to have an overall view of the global situation.

2.1.1 Plot all data points on a diagram and estimate which types of regression fits it best. (diagram 1.1)

2.1.2 Since it looks like a polynomial function, it is tested by quadratic regression and cubic regression first.

- Definition of variables

$$x = \text{Year} - 1950$$

e.g. For Year 2010,

$$x_{2010} = 2010 - 1950 = 150$$

Y = Annual Global Plastic Production (million tones)

- Result of quadratic regression:

$$Y = 0.1055467x^2 - 1.478956x + 11.49953$$

$$R^2 = 0.99673734$$

- Result of cubic regression:

$$Y = 7.739956 \times 10^{-4}x^3 + 2.857677 \times 10^{-2}x^2$$

$$+0.7591160x - 0.8559811$$

$$R^2 = 0.99794724$$

- Compare the correlation coefficients of two tests.

$$1 - R^2_{square} = 0.00326266$$

$$1 - R^2_{cube} = 0.00205276$$

$$0.00326266 > 0.00205276$$

$$1 - R^2_{square} > 1 - R^2_{cube}$$

- Since correlation coefficient of cubic regression test is closer to 1, the result of cubic regression test is more fit for the data.

2.1.3 There is no necessity for quadruplicate regression test.

- How powerful is the cubic term?

We remove x^3 term from $Y = ax^3 + bx^2 + cx - d$

$$\Delta Y = a[(x + 1)^3 - x^3]$$

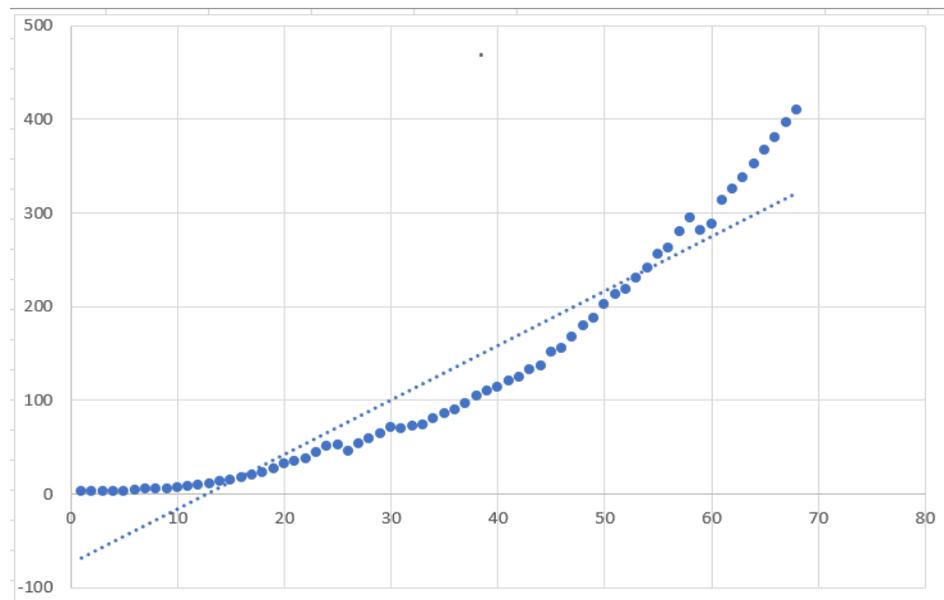
$$\Delta Y = 3ax^2 + 3ax + a$$

If we sub in $x_{2000} = 2000 - 1950 = 50$

$$\Delta Y_{2000} = 7651a = 5.92$$

$$\delta < 3\%$$

- As such, quadruplicate regression is not needed, even if the correlation coefficient, R^2 of quadruplicate regression may be smaller, due to its negligible effect to the result of prediction.

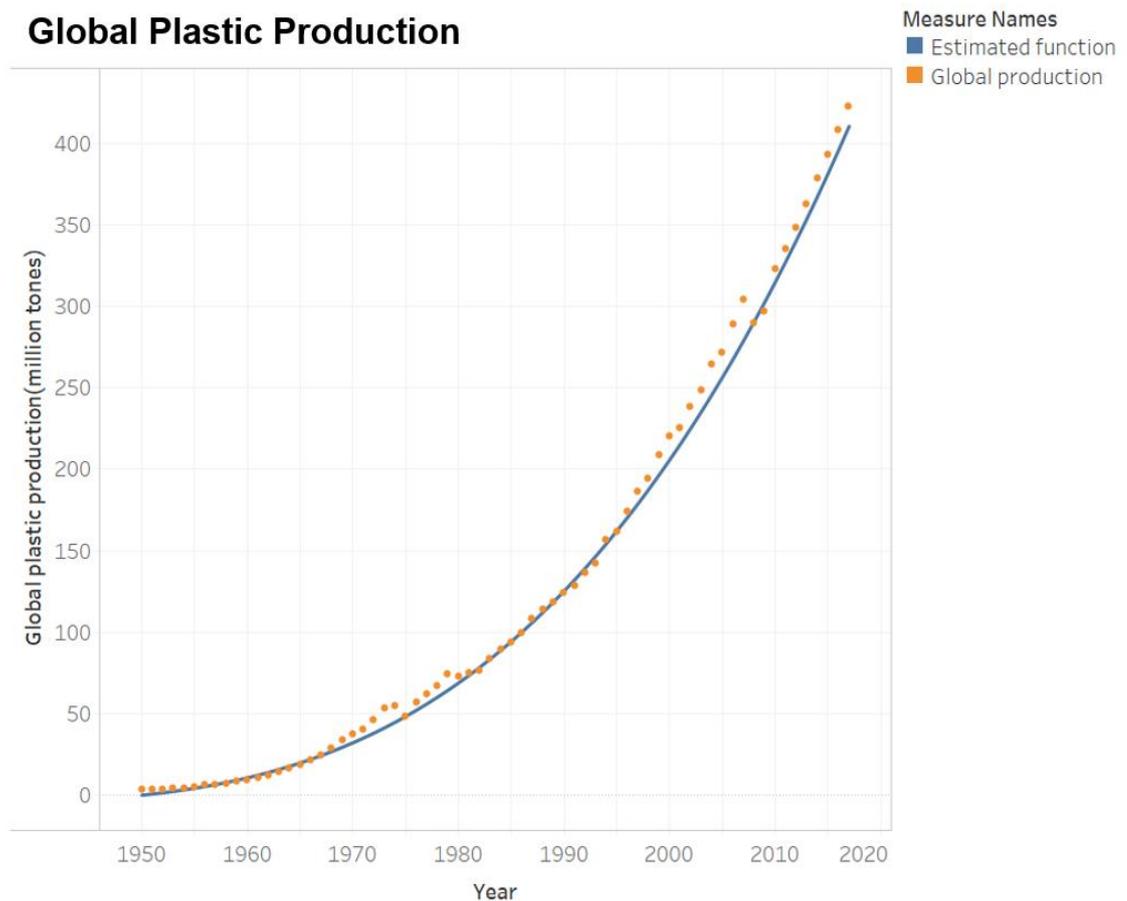


• Diagram 1.1: Graph of all data points

2.1.4 Conclusion of regression test

- The diagram of the result is shown in diagram 1.2.
- We are able to predict the global plastic production in future.

- However, it's predicted by pure math. In reality, things like invention of new plastics and improvement of solving problems will affect the value to a large extent. So there should be a big actual error between the prediction and future situation.

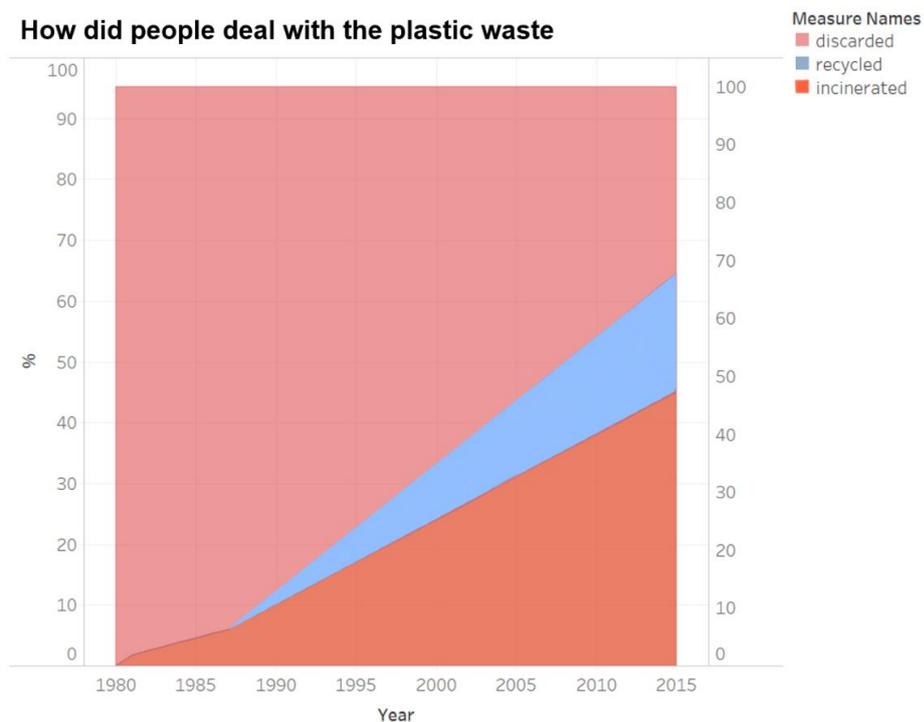


- Diagram 1.2: Graph of cubic regression

•

2.1.5 How did people deal with the plastic waste

- Data of how the fraction of plastic waste that was treated with three main methods which include discard, incineration, recycling, change over time are collected and plotted using the combination of fan diagrams and line diagrams as shown in diagram 1.3.



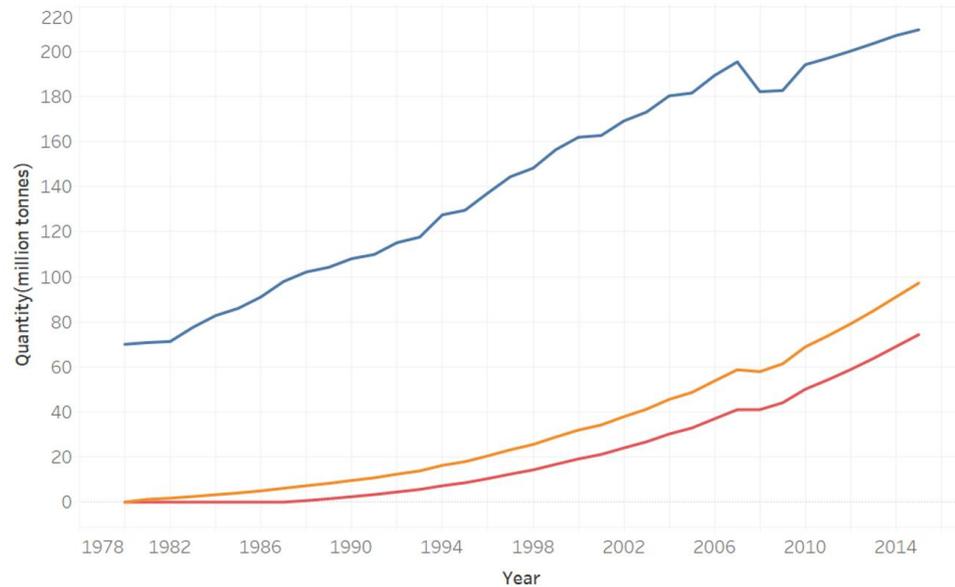
- Diagram 1.3: Percentage of plastic waste that were treated with three methods
- We use the percentage multiple by the annual production to estimate the gross amount of plastic waste that are treated using these three methods annually as shown in 1.4.

2.1.6 Conclusions of estimation of solving approaches and recommendations

Measure Names

- Estimated Annual Discarded
- Estimated Annual Incinerated
- Estimated Annual Recycled

How did people deal with the plastic waste



- Diagram 1.4: Annual gross amount of plastic waste that are treated with three methods
- The percentage of recycling is distinctly increasing over time and the percentage of discard is decreasing on the opposite. However, since the annual global production in fact increases at a frightful speed, the little increase in the percentage of recycle is unable to reduce the annual gross of plastic discard. So the recent situation is still not so considerable.
- Recommendations:
 - For individuals:
 - Use less undegradable plastics in daily life.
 - Recycle more plastics production and reduce plastics

waste.

For governments:

- Unleashing policies to limit the production of plastics.
- Investing in inventing advanced plastics type that can be easily degrade.

2.2 What is the distribution of microplastics worldwide and its impact?

2.2.1 To solve this problem, we collected data about microplastics worldwide from government website to draw the heat map.

- Collecting data from government website and import this set of data to Tableau for graph making. After importing this set of data to the Tableau, the Tableau will automatically figure out dimension included in the dataset.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Latitude	Longitude	MP conc. [particles/cubic metre]									
2	-9.228458205	38.69541628	180									
3	-9.228065256	38.69541526	180									
4	-9.227265641	38.69539872	180									
5	-9.226349872	38.69480256	180									
6	-9.225617436	38.69391282	180									
7	-9.225234231	38.69273526	180									
8	-9.225651154	38.69160141	180									
9	-9.226446667	38.69047141	180									
10	-9.227573846	38.68917756	180									
11	-9.229324103	38.68839551	180									
12	-9.231339487	38.68813718	180									
13	-9.233427308	38.688003872	180									
14	-9.235547436	38.68800205	180									
15	-9.237664487	38.68791295	180									
16	-9.239789615	38.68787538	180									
17	-9.241963846	38.68774038	180									
18	-9.244099103	38.68746295	180									
19	-9.246226538	38.68712474	180									
20	-9.248333205	38.68664526	180									
21	-9.250567692	38.68625821	180									
22	-9.252838333	38.68599205	180									
23	-9.255110128	38.68573654	180									
24	-9.257299872	38.68541064	180									
25	-9.25933	38.68504769	180									
26	-9.260806667	38.68509449	180									
27	-9.2628412628	38.68412628	180									

• Diagram 2.1: Concentration of microplastic across the world

- Process the data by correcting the mistakes inside and show
- As a matter of fact, the origin dataset contains a big mistake that longitude and latitude are labelled wrongly.
- Drag the factors into the scale to from the origin graph.
- Multiple choices of dimensions are provided including: Latitude, Longitude, Concentration of microplastics.
- Change the type of graph to heat map by coloring the regions where plastics pollution is worse than elsewhere with deeper colors.

Sheet 1



- Observe the graph by telling the regions where the color is deeper so as to tell the distribution of plastics.
- Regions where the plastic pollution is the worst are Gibraltar Straits and South Sea of China.



2.2.2 To solve this problem, we also tried to figure out patterns from tables with different kind of data by finding out the relationship.

- Title of the columns includes regions, concentration (particle/kg dry weight), type of particles.

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Location	Concentration (particles/kg dw)	Particle size	Type(s) of plastics detected	Method of microplastics identification	QA	Refere
Asia						
Singapore, coastal mangrove	12-62.7	<20 - >5000 µm	PA, PE, PP, PVC	ATR-FTIR	NR	Hazim
Malaysia, beach		8.58 1-30 mm	NR	NR	NR	Fauziah
Taiwan, northern coast		54.8 0.25 - ≥4 mm	ABS, PE, PP, PS	ATR-FTIR and SR-FTIR microscopy	NR	Kunz e
Hong Kong, beach		50.7 0.315 - >5 mm	NR	NR	NR	Cheun
China, Beibu Gulf, coastline	5,020-8,720	< 1 - <5 mm	PE, HDPE, PET, PS	FTIR microscopy	NR	Qiu et
China, north Bohai Sea, beach	102.9-163.3	NR	Alkyd, PE, HDPE, LDPE, PET, PEVA, PP, PS	ATR-FTIR	+	Yu et a
South Korea, Soya Island, beach	0.9-4,463	50 - >5,000 µm	PE, PP, PS, EPS, PU	Vacuum FTIR and FTIR microscopy	NR	Kim et
Iran, Khark Island, coast	295-1,085	≤100 - ≥5000 µm	NR	NR	+	Akhbar
Iran, Strait of Hormuz, coastline		-1,258 >0.025 - <4.75 mm (diameter)1.4-50 mm (length)	PA, PE, PET	FTIR	NR	Naji et
Europe						
Spain, Mallorca Island and Cabrera Island, coast	100.7-897.3	>0.063 - <2mm	NR	NR	+	Aloma
Portugal, Algarve, coast		10 >1 µm	PP, rayon	FTIR microscopy	+	Frias e
Portugal, western coast, beach		28.9 <1 - >10 mm	PE, PL, PS	FTIR microscopy	NR	Martins
Germany, Baltic Sea, coast	0-7	55 µm - 1 mm	NR	NR	+	Stolte
Belgium, North Sea, beach	92.8-166.7	38 µm - 1 mm	PA, PE, PP, PS, PVA	FTIR microscopy	NR	Claess
Netherlands, North Sea, coast	100-3,600	10-5,000 µm	NR	NR	+	Leslie
Slovenia, beach		177.8 0.25-5 mm	NR	NR	NR	Lagiba
Poland, Baltic Sea, coastline		25 0.1-5 mm	PL	FTIR microscopy	+	Graca
	"53"	PE, PP, PVAc				
	"0-27"	PL				
North America						
Canada, eastern shore of Nova Scotia, beach	2,200-7,400	9-220 µm(median)	NR	NR	+	Mathal
Mexico, Huatulco, beach/sediment			NR	SEM	NR	Retam
(April)	0-4,800	3.0-50 µm(thickness)				
(December)	200-6,900	0.0043-4.5 mm(length)				
South America						
Brazil, Guanabara Bay, beach		NR	PA, PP, PVA, PU, styrofoam	NR	NR	De Car
(during summer)	0.15-1.63					
(during winter)	0.04-9.3					
Uruguay, Punta del Este, beach		0.8 0.3 - >100 mm	PE, PET, PP, PS, PVC	Raman microscopy	NR	Lozoy

2.2.3 Conclusions of distribution of plastic pollution.

- Microplastics are ubiquitous
- The more industrially advanced the regions are, the more polluted its coastal are would be.
- A huge number of species of marine organism are detected to have plastic pollution in their body, and ultimately, these organisms would be consumed by human to harm the health.

2.2.4 Recommendations

- Government can reduce the production of plastics.
- Government can change the method of disposing plastics.

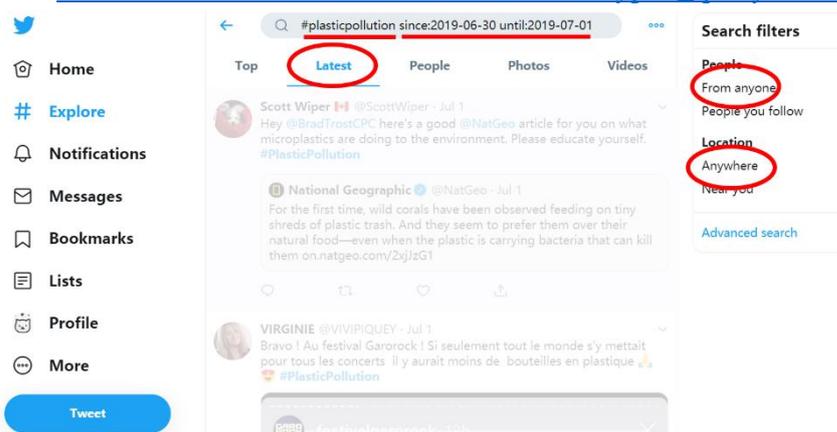
2.3 What are the sub-topics under plastic pollution that people are more concerned about, what types of tweets do people usually publish and what people may ignore about the problem?

To solve this problem, we collect data from Twitter by categorizing people's types of tweets with tag "plasticpollution" and use the data to plot graphs. We then analyse the graphs to conclude what people are more concerned about and what problems they may ignore.

2.3.1 Data collection and categorisation

- Go to the search engine webpage of Twitter
- Type in "#plasticpollution since:20xx-xx-xx until:20xx-xx-xx" (replacing "20xx-xx-xx" with specific dates)
- Set the sort order as "Latest"
- Set "people" as "From anyone"
- Set "Location" as "Anywhere"

https://twitter.com/search?q=%23plasticpollution%20since%3A20xx-xx-xx%20until%3A20xx-xx-xx&src=typed_query&f=live



- Read every tweet and fill in one chart for each tweet
- Collect the results of charts and input all data into excel

2.3.1.1 Details of the chart

- Sample:

Topics

	Wildlife
	Marine
	Packaging
	Daily Supplies
	Microplastic
Types	
	Facts
	Feelings
	Suggested methods
	Publicity

- Remarks:
 - A tweet can be concerned about several topics.
 - A tweet can be concerned about no topic mentioned.
 - A tweet must have one type.
 - A tweet cannot have more than one type.

• Figure 1:



Topics	
√	Wildlife
√	Marine
	Packaging
	Daily Supplies
	Microplastic
Types	
	Facts
√	Feelings
	Suggested

	methods
	Publicity

Figure 2:


Mike Hudema @MikeHudema · Apr 1
 Indonesia produces more than 3.2 million tonnes of plastic pollution every year. They've just launch a plan to cut that by 70%.
 We must all work to end [#plasticpollution](#).
[#Useless](#) [#Buyless](#) [#Needless](#) [#BreakFreeFromPlastic](#)



Topics	
	Wildlife
	Marine
	Packaging
√	Daily Supplies
	Microplastic
Types	
√	Facts
	Feelings
	Suggested methods
	Publicity

Figure 3:



Ctr4BioDiv Oceans @EndangeredOcean · Jun 1

Environmental Justice Activists Are Leading a Green New Deal Revolution -- and urging Louisiana officials to [#StopFormosa](#) and its [#PlasticPollution](#) along the way. truthout.org/articles/envir... via [@truthout](#)



Environmental Justice Activists Are Leading a Green New Deal Revo...

Green New Deal supporters should look to leaders in places like "Death Alley," not Silicon Valley.

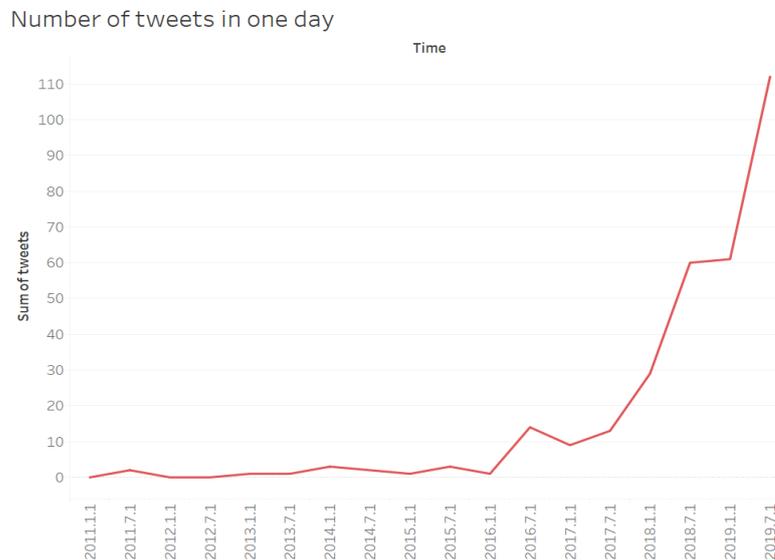
truthout.org

Topics	
	Wildlife
	Marine
	Packaging
	Daily Supplies
	Microplastic
Types	
	Facts
	Feelings
	Suggested methods
√	Publicity

2.3.2 Graphs and Analysis

Data from Twitter														
Time	Wildlife	Marine	Packaging	Daily supplies	Microplastic	Facts (data/sc	Feelings (Prais	Suggested Methc	Publicity/Activity	Special	Aginast	SUM	SUM'	Remarks
2019.7.1	8	24	22	20	4	19	36	20	34	34	3	146	112	Special: Sir David Attenborough halts plastic ban
2019.6.1	7	20	17	15	3	14	40	14	36	0	0	104	104	
2019.5.1	10	15	25	22	0	18	47	17	35	3	0	120	120	Special Event:London marathon
2019.4.1	9	21	17	13	2	16	36	13	31	0	0	96	96	
2019.3.1	9	18	20	18	2	10	45	22	39	1	0	117	117	
2019.2.1	8	20	17	17	0	13	42	11	29	1	0	96	96	
2019.1.1	5	8	12	12	0	10	20	10	20	1	0	61	61	
2018.11.1	6	14	15	13	1	8	47	15	22	0	0	92	92	
2018.9.1	8	11	18	14	2	10	26	9	13	0	0	58	58	
2018.7.1	9	7	10	12	2	11	20	9	19	1	0	60	60	
2018.5.1	8	15	14	16	3	9	42	8	17	0	0	76	76	
2018.3.1	3	6	10	8	0	9	12	7	20	0	0	48	48	Plastic free aisle openin worldwide
2018.1.1	4	4	2	8	2	6	11	2	10	0	0	29	29	
2017.10.1	3	3	2	4	0	3	16	2	2	0	0	23	23	
2017.7.1	3	3	1	2	0	5	2	3	3	0	0	13	13	
2017.4.1	3	4	1	2	2	3	6	1	3	0	0	13	13	
2017.1.1	0	1	1	1	0	1	4	2	2	0	0	9	9	
2016.10.1	0	2	0	0	0	1	3	0	1	0	0	5	5	
2016.7.1	1	1	3	5	1	3	5	1	5	0	0	14	14	
2016.4.1	1	0	1	0	0	0	13	2	0	0	0	15	15	
2016.1.1	0	0	0	0	0	0	0	0	1	0	0	1	1	
2015.7.1	0	0	1	1	0	0	2	0	1	0	0	3	3	
2015.1.1	0	0	0	0	0	0	1	0	0	0	0	1	1	
2014.7.1	0	0	1	0	0	2	0	0	0	0	0	2	2	
2014.1.1	0	2	1	0	0	1	1	0	1	0	0	3	3	
2013.7.1	0	0	0	0	0	0	1	0	0	0	0	1	1	
2013.1.1	0	0	0	0	0	0	1	0	0	0	0	1	1	
2012.7.1	0	0	0	0	0	0	0	0	0	0	0	0	0	
2012.1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	
2011.7.1	0	0	0	0	0	2	0	0	0	0	0	2	2	
2011.1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	

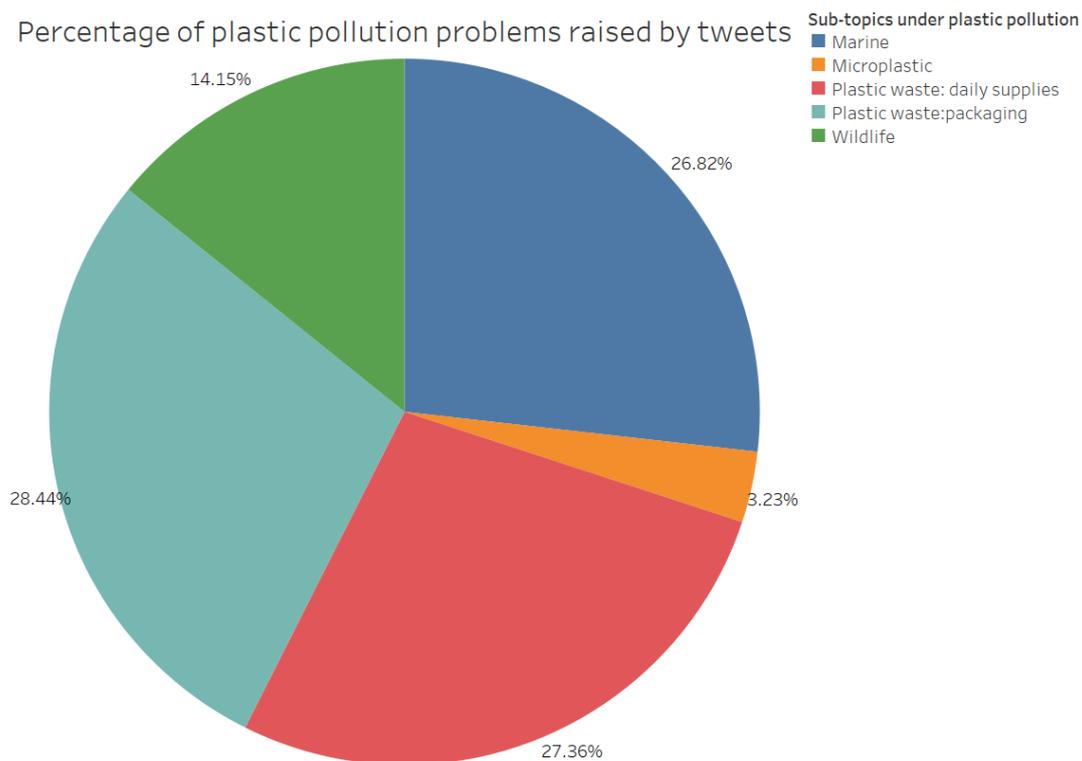
- This is the result of our collected data according to our categorization
- We first plot a graph of Sum of tweets on one day against Time and here is the graph:



- From the graph, it is quite obvious to tell that the number of tweets about plastic pollution increases rapidly, especially in recent years. This is mainly

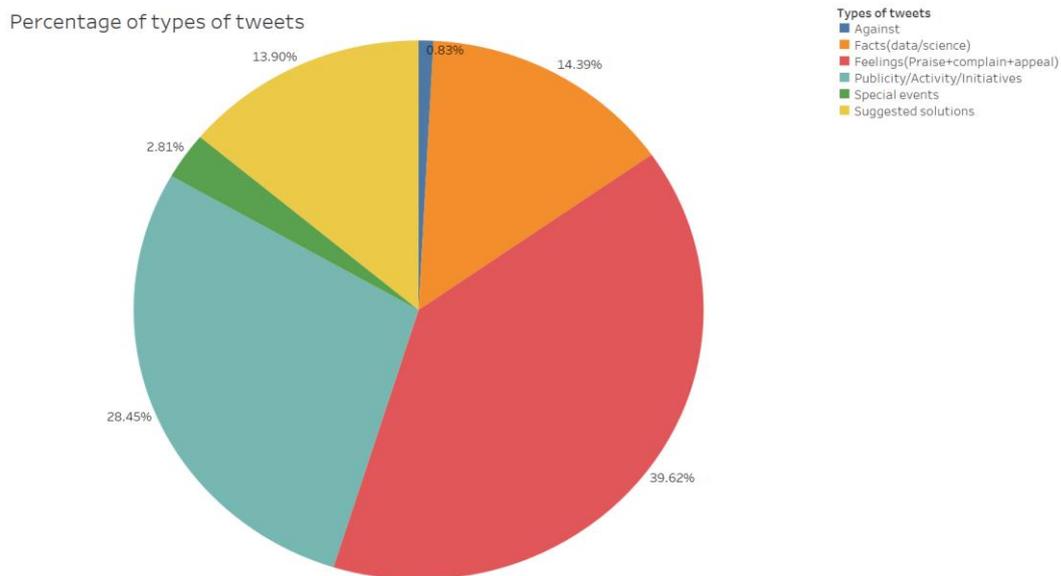
because:

- Social media is getting more and more prevalent
- People are getting more concerned about this issue.
- Then we calculate the sum of tweets of each sub-topics and plot a pie chart:



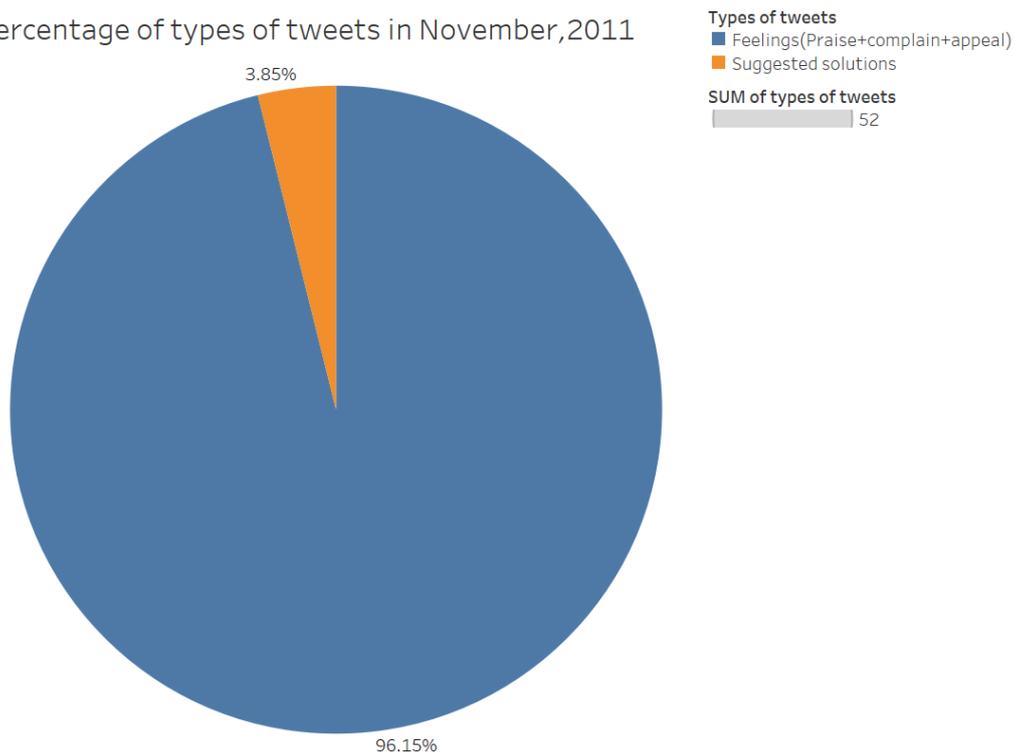
- By comparing, marital pollution, packaging waste and daily waste are three majorities, with tweets about wildlife half of each. However, tweets raised about microplastics are far less than any of them. Hence, it shows that people are less concerned about wildlife comparatively, and even haven't realized the severity of microplastics yet.
- After that, we calculate the sum of each type of tweets

and plot a pie chart:



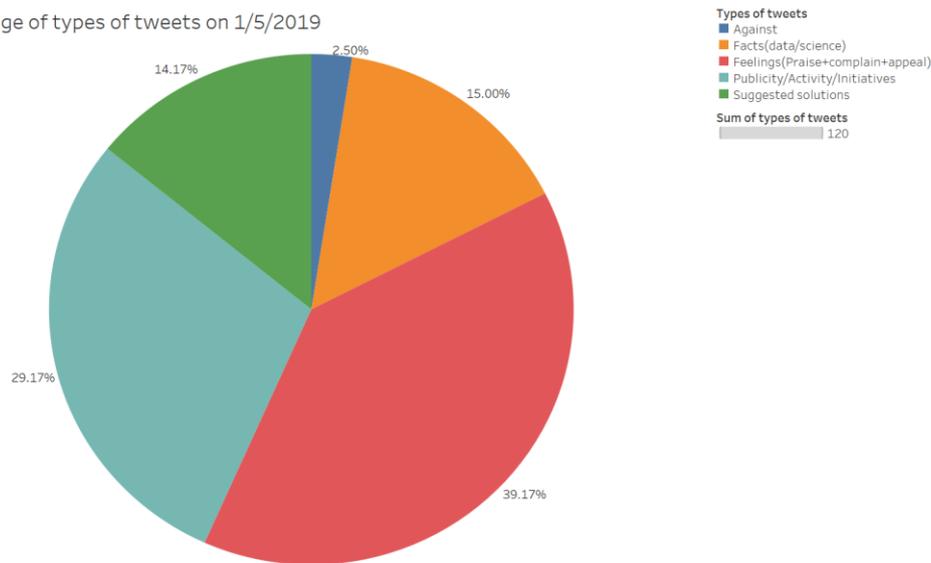
- The chart shows that comparatively, more tweets raised are complaints or appeals. While less people are publishing facts as well as suggested solutions.
- Hence, nearly half of the tweets raised by tweeter users are simply complaining about the current situation about plastic pollution instead of spreading facts and suggesting solutions which can let public get more aware of its severity and showing them how they can contribute to solving this problem, which is a matter of fact we are concerned about as complaints cannot really solve the problem.
- However, the situation is actually getting better in recent years:

Percentage of types of tweets in November,2011



- This problem is actually much more severe a few years ago in 2011, at when only 52 tweets were published in a whole month and nearly all of them are simply complaining. By contrast, suggested solutions are hardly seen and there are no facts, initiatives, or activities at all.

Percentage of types of tweets on 1/5/2019



- When time comes to 2019, there are two obvious improvements.
- The number of tweets a day has increased to 120 tweets compare to 52 tweets in a moth in 2011.
- There are more various types of tweets with more and more people suggesting solutions, taking initiatives, organizing activities and so on.
- However, we are expecting more people who are tweeting complaints to do more substantial works as they are still the majority among all the types,

2.3.3 Conclusion

- People are getting more concerned about this issue.
- They are less concerned about wildlife, and haven't realized the severity of microplastics at all.
- Comparatively, more tweets are complaints or

appeals. While less people are tweeting facts as well as suggested solutions, although the situation is getting better in recent years.

2.3.4 Recommendations

- We expect more people to pay attention to microplastics pollution.
- We also expect more people who are tweeting complaints to do more substantial works.

2.4 Overall conclusion

- Plastic pollution is getting more and more severe with **rapidly increasing** total amount of plastic and plastic wastes produced.
- Though the recycling rate increases, with the total amount increase even rapidly, the **recycled amount is still not considerable**.
- As a matter of fact, the more **developed** a country is, the more probable it would be polluted by **microplastic**, which is the **most insidious but least emphasized topic** under plastic pollution.

2.5 Overall recommendations

- We recommend individuals to **use less undegradable plastics** in daily life while consciously recycle plastic waste by garbage sorting.
- We recommend individuals to **use less undegradable plastics** in daily life while consciously recycle plastic waste by garbage sorting.
- We hope the organisations can **hold activities with explicit purposes** and targets in order to raise the public's awareness on severe but less popular topics like microplastics.

3. Limitations and further extensions

3.1 Limitations

- Problem1: Precision of data is not high enough.
- Problem2: The dataset did not include the statistics collected in the region of land but ocean only.
- Problem 3: There are nonnegligible effects of contingency on data samples.

3.2 Further extensions

- Research on the factors which change the sub-topics the public are most concerned about.
 - To suggest how to lead people to solve less concerned

problems to the ENGOs.

- Subdivide the different types of plastics in the sense of recycling rate and economic cost
 - To suggest the most environmental friendly and relatively economic types of plastics to industries.

4. Reference

- Concentration of microplasticson sea surface.
<https://www.nodc.noaa.gov/cgi-bin/OAS/prd/accession/details/170967>
- Data release for microplastics in water, sediment, fish, and mussels
<https://www.sciencebase.gov/catalog/item/58e7d00ae4b09da6799c0f8a>
- Microplastics in coastal areas and seafood
<https://www.tandfonline.com/doi/full/10.1080/19440049.2019.1585581>
- Our planet is drowning in plastic pollution
<https://www.unenvironment.org/interactive/beat-plastic-pollution/>
- Plastics application
<https://www.bpf.co.uk/plastipedia/applications/default.aspx>
- Survey on awareness and attitudes of citizens regarding plastic pollution in Hatay/Samandağ Turkey

https://www.researchgate.net/publication/328601209_Survey_on_awareness_and_attitudes_of_citizens_regarding_plastic_pollution_in_HataySamandag_Turkey

- Twitter with tag “plasticpollution”

https://twitter.com/search?q=%23plasticpollution%20since%3A20xx-xx-xx%20until%3A20xx-xx-xx&src=typed_query&f=live

- We make plastic. We depend on it. Now we’re drowning in it.

<https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-waste-pollution-trash-crisis/>

- What are the advantages and disadvantages of using plastics?

<https://sites.google.com/site/09scigjasbelle/home/plastic/what-are-the-advantages-and-disadvantages-of-using-plastics>