

MARICOPA COUNTY RECYCLING: WHERE DOES IT ALL GO?

by

Isabella G. Foster

A Senior Project Presented in Partial Fulfillment of the Requirements for the Degree
Environmental and Resource Management
April 2021

ARIZONA STATE UNIVERSITY
POLYTECHNIC CAMPUS

May 2021

ABSTRACT

The goal of this research was to determine where municipalities in Maricopa County are sending their plastic recyclable waste after China's major decision to ban the importation of non-commercial plastics and whether or not the amount of waste that is recycled has changed compared to before the ban was implemented. Research was completed to establish a baseline of exports prior to January 2018, questionnaires were sent out to four cities within Maricopa County, and research was then done on third-party companies to determine the results. Maricopa County sells almost all of its Polyethylene terephthalate (PET), high-density polyethylene (HDPE), and Polypropylene (PP) materials to domestic buyers, while the remaining recyclable plastics are landfilled. The amount of waste the U.S. has recycled has not changed significantly in the last decade; meanwhile, the amount of municipal solid waste generated is increasing rapidly.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

Table of Contents

CHAPTER 1.....	1
NEED FOR THE PROJECT	2
STATEMENT OF THE PROBLEM.....	2
GOAL.....	2
OBJECTIVES	3
SCOPE	3
<i>Assumptions</i>	3
<i>Limitations</i>	3
CHAPTER 2.....	3
LITERATURE REVIEW	3
<i>Policy Recommendations to Reinvigorate Recycling in Arizona</i>	3
<i>The Chinese import ban and its impact on global plastic waste trade</i>	4
<i>National Overview: Facts and Figures on Materials, Wastes and Recycling</i>	5
<i>Americans' Plastic Recycling is Dumped in Landfills, Investigation Shows</i>	5
<i>Phoenix, EV losing big in recycling revenue</i>	6
<i>Piling Up: How China's Ban on Importing Waste Has Stalled Global Recycling</i>	6
<i>WM Report on Recycling</i>	6
<i>Republic Services: Advancing Plastics Recycling through Investment, Innovation and</i> <i>Education</i>	7
<i>Renewlogy</i>	7
<i>Chinese firms open up on their US recycling plans</i>	8
CHAPTER 3.....	8
RESEARCH APPROACH.....	8
DATA ANALYSIS AND MATHEMATICAL MODELING	8
DESCRIPTIVE RESEARCH	9

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

CHAPTER 4.....	9
CHINA’S PAST IMPORT DATA	9
NATIONAL TONNAGE DIFFERENCES	10
MARICOPA COUNTY RECYCLING EXPORTATION.....	11
DISCUSSION	14
LITERATURE TO SUPPORT OR DISPROVE FINDINGS	17
CHAPTER 5.....	18
RECOMMENDATIONS	19
REFERENCES	21
APPENDIX	23

Chapter 1

In the United States (US), depending on where you live, there are different rules for what can and cannot be recycled. This is because waste management, recycling included, is done at a municipality or county level (Murphy, 2020). “Local jurisdictions provide public services or partner with industry to ensure solid waste collection and proper disposal” (Murphy, 2020). Rules are typically determined by the commodities market and whether or not a city can make money from selling that particular object after it has been discarded. Plastics are of particular interest due to how long they take to break down and their universal use in everyday human life and throughout industry. Its growth over the past half-century is almost unparalleled, starting at only 2 million metric tons (MT) produced in 1950, growing to 322 million MT produced in 2015 (Brooks, 2018). As of 2017, there has been a cumulative total of 8.3 billion MT of plastic produced, with only an estimated 9% of that being recycled globally (Brooks, 2018).

There are many reasons for this low recycling rate; plastic is difficult to process due to its many uses, additives, and blends, and it also has specific properties that make it less stable the more it is recycled and reused (Brooks, 2018). Not only is the plastic less useable over time, but the process is also more expensive; this is part of the reason that 80% of plastic waste ends up being either landfilled or released into the environment (Brooks, 2018). Contamination also plays a large part in a vast amount being unusable. People do not often think about where their waste ends up after it is thrown away. However, it is important for people to understand that the trash they throw away has a long journey ahead of it, and because of its composition, much does not end up being recycled. Being educated on who is handling the recyclables in your area is imperative so

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

that they be held liable for their actions in the case that materials are being sold to developing countries that do not have the infrastructure to properly store and manage the waste, leading to environmental degradation through pollution and chemical leaching.

Need for the Project

There is much research into waste characterization, contamination, and how to encourage recycling. However, less research has been done on the more significant problem of how so much waste gets released into the environment. Many cities are not in charge of selling their recycling commodities, making the cities largely unaware of where their materials are going; if the cities do not know this information, the public certainly does not. The fewer people that are aware, the more companies can conceal information and act in ways they should not. The more the public is educated on this, the more people will start to care, which in turn will require third-party companies and municipalities to conduct their business in a way that is more ethical and sustainable.

Statement of the Problem

As of January 2018, China enacted a “National Sword” policy banning the importation of multiple plastics and other recyclable materials; this poses a problem due to China receiving nearly half of the world’s recyclable waste for the last 25 years (Katz, 2019). “The equivalent of 19,000 shipping containers of plastic recycling per month, once exported abroad, is now stranded at home;” with this, the question of where all of this misplaced waste is going arises (McCormick, 2019).

Goal

Determine how Maricopa County's recycling commodities market has been affected by China's decision to stop importing recyclables by comparing where the

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

recyclables were sent, where they are sent now, and if that amount has changed significantly.

Objectives

Start with reading published articles and research to establish a baseline for how things were handled prior to January 2018. Then, questionnaires will be sent out to local materials recycling facilities (MRFs). Once responses are received, they are analyzed. Lastly, research will be done into any third-party companies involved, as well as any local processing facilities.

Scope

Assumptions

This research will be representative of densely populated city areas. The same set of questions will be sent to each MRF. Statistically significant data will be needed in before and after data.

Limitations

Only plastic will be exemplified in this research. This research only focuses on Maricopa County, but not every MRF in Maricopa county will be sent the questionnaire. This research does not represent rural areas.

Chapter 2

Literature Review

Policy Recommendations to Reinvigorate Recycling in Arizona

This study looks into the state of Arizona's recycling programs. Interviews were held with city officials and recycling managers from counties across the state on things such as how their recycling programs have changed and the biggest challenges in their

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

programs. It is stated that “almost every interviewee indicated that China had been an important buyer of their recyclables.” They explain that there are not enough recycling facilities in the US for all of the recycling waste produced in the US, and emerging global markets cannot match China’s former pricing. This, in turn, causes the municipalities to sell their materials for much less than normal, reducing overall profits; every municipality interviewed said these market changes impacted their profits. The study also mentions high transportation costs due to the lack of local markets; they mention how most of our recyclable waste ends up being transported outside of Arizona to buyers in California, the Eastern US, or anywhere else around the world.

The Chinese import ban and its impact on global plastic waste trade

This is another study done on the impacts of China’s ban, but this one is global instead of just analyzing Arizona; it is very comprehensive. They discuss how starting even before 2010, China had started introducing strict waste import restrictions. They implemented “the Green Fence” in 2013 for a short period of time, which called for less contamination; this disrupted China’s status as the primary importer of recyclable waste for many people. Then in 2017, the new policy permanently banning the importation of nonindustrial plastic waste was announced. Discussed also are the leaders in plastic waste exports, excluding Hong Kong: Europe and Central Asia making up 32% of all exports, and the US and Canada contributing to 14% of global exports. Identifies the trend that high-income countries are sending their recyclables to low- and middle-income countries that have less established and capable waste management infrastructure than where they originated.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

It is noted that there is a limitation in this study, that being “The UN Comtrade data alone cannot accurately portray what is happening to plastic waste worldwide and does not trace the movement of waste between countries.” This is a significant limitation to note because the data are incomplete in theory. They give the example of the US importing plastic waste from Mexico; the data does not then account for whether it stayed in the US and was processed or if it was sent overseas. The trade of plastic waste between countries is very murky and complex, and they use this reason to suggest it be better monitored so it is accounted for and managed better.

National Overview: Facts and Figures on Materials, Wastes and Recycling

This is a webpage from the EPA that gives a national overview on materials, wastes, and recycling. Total municipal solid waste is defined for 2018 and years prior. A graph is also included that shows the total amount of each different material that is recycled each year in the US. It also gives an overview of the difference in waste generated from 1990 to 2018.

Americans' Plastic Recycling is Dumped in Landfills, Investigation Shows

This is an investigation that the Guardian did specifically on America and how plastic recycling has changed since the National Sword policy was enacted. Has statistics on America's exports and how much will be displaced just from the US. Shares how much is still going overseas and where. Explains the nonexistent domestic utilization of “mixed plastics” and how municipalities are now forced to deal with their own waste. It contains a quote directly from Republic Services about how approximately one-third of the waste is picked up from recycling bins is actually landfilled.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

Phoenix, EV losing big in recycling revenue

The article gives insight into Mesa, Gilbert, and Chandler and how they were previously selling to Uniter Fibers located in Chandler, who then exported their materials to China. They discuss how the drop in price has caused the municipalities to pay facilities to handle their waste instead of being paid for it. Phoenix is reported to have been able to continue making money, but it is a lot less than what it was in early 2017 before the policy. United Fibers CEO also claims they are upgrading equipment to be able to filter out contaminants so much so that they are able to meet China's 0.5% contamination requirement.

Piling Up: How China's Ban on Importing Waste Has Stalled Global Recycling

Yale School of the Environment released an article that has a more global perspective on how things have been affected. Much of the information that is referenced in the introduction to this paper comes from this article. Further supports the other sources and their findings as well.

WM Report on Recycling

Waste Management manages Phoenix's MRF, and the City of Scottsdale is also contracted with Phoenix to use their facility. A recent comprehensive report was done by RSS Consultants on Waste Management to "...help identify gaps in plastic recycling infrastructure, to provide an assessment of WM's material recovery facilities (); and to advance a discussion of WM's policy and advocacy positions related to plastic recycling issues." It gives very detailed national numbers, as well as a set of tables of the waste flows for PET, HDPE, and PP in the US for the year 2019 (See *Figures 2, 3, and 4*). The

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

regions used are the EPA's Region designations. Also have. The report also states their efforts originated in 2013 to start shifting their markets to domestic ones They also claim that "the only plastic that WM exports is high-grade, source-separated commercial film to reputable, high-quality end markets. No buyers or company names were provided.

Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education

Republic Services commissioned "...an independent third-party research firm that specializes in assessing recycling programs across a number of sectors and industries, to conduct research, gather data, and review" their operations. It gives a table made from data made available by the EPA for the year 2018 on how many different types of plastic were recovered and wasted, as well as the recovery rates of each (See *Figure 2*). They also provide maps of the nation that indicate facilities where PET's, HDPE's, and then PP's and others are reclaimed (See *Figures 6, 7, and 8*) in the US

Renewlogy

A company called Renewlogy partnered with the City of Phoenix in order to help get Phoenix to its goal of zero waste by 2050. The company has a unique process in which it turns plastics back into their molecular structure which enables them to "convert non-recycled plastic waste into new valuable products such as high-value petrochemical feedstocks." A press release states that due to Covid-19, they had to wait due to contract delays but that they are working to be able to launch the first phase of the project for Phoenix in 2021.

Chinese firms open up on their US recycling plans

This is an article discusses two companies from China, that as of 2019, were planning on moving to the US. Ecomelida plans on moving to Orangeburg, South Carolina, while Roy Tech Environ plans to open up another location in Grant, Alabama. They also share their reasoning for wanting to come to the US and their thoughts on future expansion.

Chapter 3

Research Approach

Firstly, research will be done to establish how the market was before the ban was put into effect. This will serve as a baseline to compare the new and recent data. Research will also be done on how the market has responded since the ban and recent updates to compare the data that are received. Once the research is collected, questionnaires will be sent via email to the MRFs that were selected. After receiving all the responses, the data will be examined and compiled into tables or graphs, where applicable. Also researched will be the third-party companies that are in charge of each city's recycling and the sales of the commodities. After all the data is collected, it will be combed through to find out where precisely the recycled materials from Maricopa County are sent to be processed.

Data Analysis and Mathematical Modeling

Tables will be used to show the different locations to which the Phoenix, Mesa, Scottsdale, and Tempe MRFs send their materials. Percent's will be used to establish differences in before and after statistics on waste. The following formula will be used to calculate percent difference:

$$\{ |(X_{\text{Final}} - X_{\text{Initial}})| / [(X_{\text{Final}} + X_{\text{Initial}}) / 2] \} \times 100$$

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

X_{Initial} : The initial value that is being compared

X_{Final} : The final value that is being compared

Descriptive Research

The following is the list of the questions that were sent to the cities of Phoenix, Mesa, Tempe, and Scottsdale:

1. What percentage of your plastic recyclables were being sent to China before the laws were made much more stringent? (Pre-January 2018)
2. Was that percentage affected by the ban? If yes, can you estimate/ say by how much?
3. Where does most of your city's plastic currently get recycled? This could mean which county, state, country, or third-party companies, if you can disclose that information!
4. What percentage of plastic discarded in the recycle bin actually ends up being landfilled?
5. Has that percentage been affected by China's more stringent laws? If yes, can you estimate/ say by how much?

Chapter 4

China's Past Import Data

Science Advance's research article discusses just how much recyclable waste was being exported to China prior to the ban in 2018. The article highlights that collectively, China and Hong Kong were the main importation destinations for the world's plastic, importing a shocking 72.4% of all plastic waste (Brooks, 2019). The article indicated Hong Kong acted as a port into China, with 63% of its imports being exported in 2016.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

With the newly implemented restrictions, “the displaced plastic waste (the 111 million MT of waste that is estimated to be displaced by China’s ban as of 2030) is equal to nearly half (47%) of all plastic waste that has been imported globally since reporting began in 1988” (Brooks, 2019). Another article, published at the Yale School of the Environment, also states that before the ban, 70 percent of US recyclables were sold to Chinese companies (Katz, 2019). An Ahwatukee Foothills News article claimed that at the “...zenith of China’s recyclables-buying frenzy, it was receiving half of America’s recyclables exports – most of them from the western United States” (Barrs, 2018).

National Tonnage Differences

According to the EPA, the tonnage in weight for plastics that were recycled did not change significantly. Using the data from *Figure 1*, the percent difference from 2017 to 2018 was calculated to be only 3.0%.

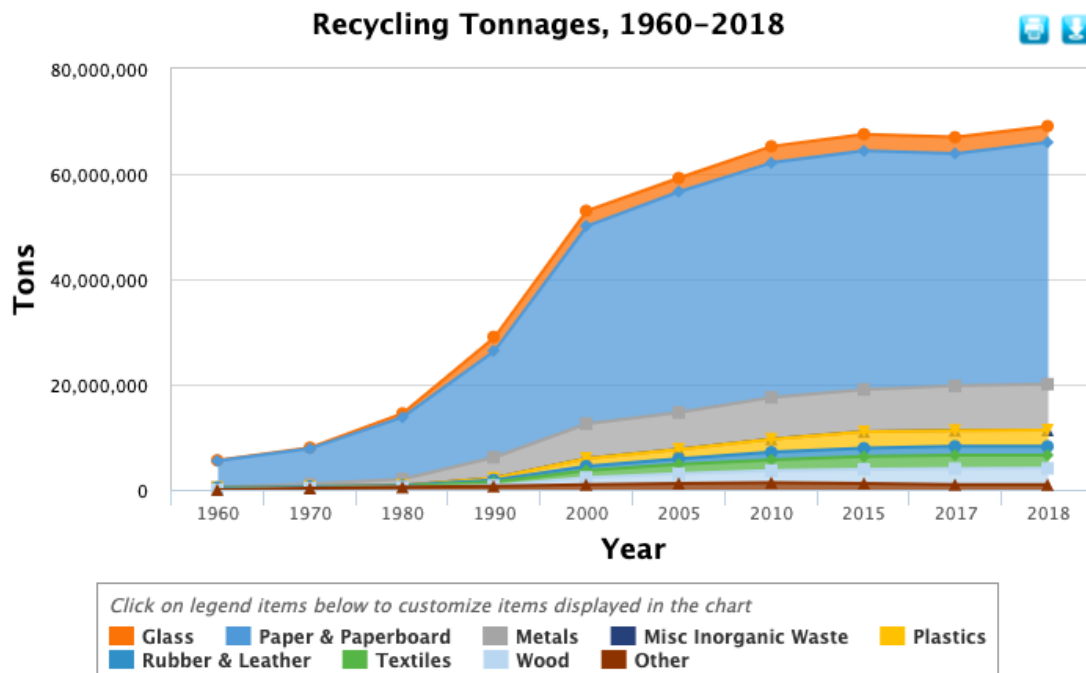


Figure 1. Recycling Tonnages. From “National Overview: Facts and Figures on Materials, Wastes and Recycling,” 2018. EPA.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

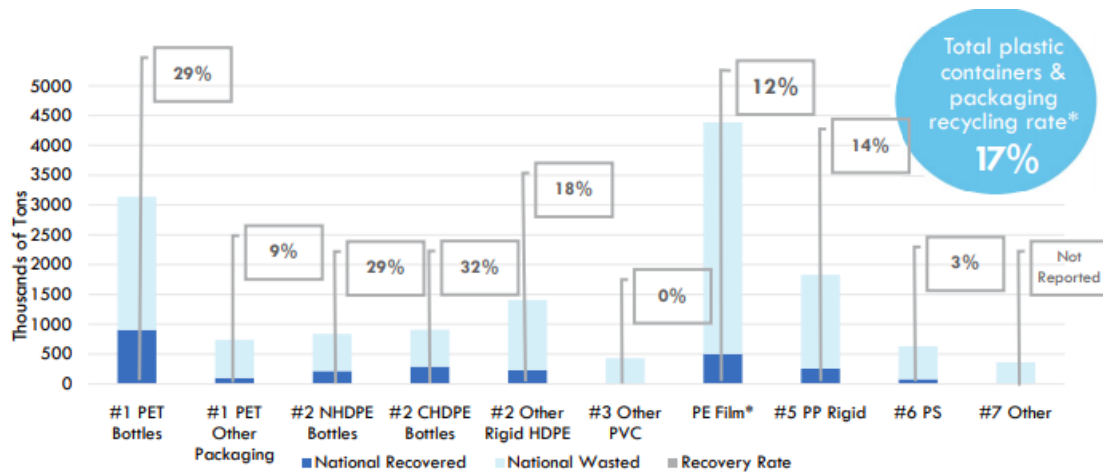


Figure 2. National Recovered, Wasted, and Recovery Rates of Plastics in the US.. From “Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education,” 2020. p. 4.

According to the Republic Services report, about 17% of plastic containers and packaging are recycled in the US. These data were compiled from the National Association for PET Container Resources (NAPCOR) and the Association of Plastic Recyclers (APR) and put together in *Figure 2*; it becomes very apparent that there is a long way to go in terms of achieving better recovery rates.

While the amount that was recycled did not change significantly, the amount of municipal solid waste (MSW) created in total increased by 8.4%. This number was found by calculating the percent difference in the total waste generation values reported by the EPA, “the total generation of MSW in 2018 was 292.4 million tons, which was approximately 23.7 million tons more than the amount generated in 2017. This is an increase from the 268.7 million tons generated in 2017” (National Overview: Facts and Figures on Materials, Wastes and Recycling).

Maricopa County Recycling Exportation

All four of the cities that participated in this study have a private company that manages their recyclable materials. Phoenix is the only city that owns its MRF, but

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

Republic Services is in charge of the commodity sales. Scottsdale sends its waste to Phoenix's facility, meaning they are also contracted with Republic Serves. The City of Tempe is contracted with Waste Management, and Mesa is currently only contracted with United Fibers due to a fire at a Republic Services facility in October 2019, making the location unusable.

The only representative who had information on the locations of their plastic waste was Scottsdale. John Stumbaugh sent an email with a table of the different locations of their plastic commodities from 2019, is shown below.

Table 1

Scottsdale and Phoenix Plastic Commodity Types and Market Locations

Commodity	Is it currently recycled, repurposed or landfilled? <ul style="list-style-type: none">• If combination, please include percentage• If repurposed, indicate in what manner	If recycled, domestic or international market? <ul style="list-style-type: none">• If international, please list which foreign market (China, Malaysia, India, etc.)• If combination, please include percentage
PLASTIC		
PET #1	Recycled	Domestic – GA, TX, MI
HDPE #2	Recycled	Domestic CA, AL
PVC #3	landfilled	
LDPE #4	Recycled	Domestic – AL, TX
PP #5	Recycled	Domestic – CA, AL
PS #6	landfilled	
Other #7	landfilled	

Note. From John Stumbaugh.

None of the other cities themselves had any information on where their plastics were being sold. After doing some research, Waste Management recently hired a company to put together a waste report to analyze their recycling. In that report are waste flow maps that show where certain plastic types (PET, HDPE, and PP) were generated or produced and their destination for processing in 2019. See *Figures 3, 4, and 5* below.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

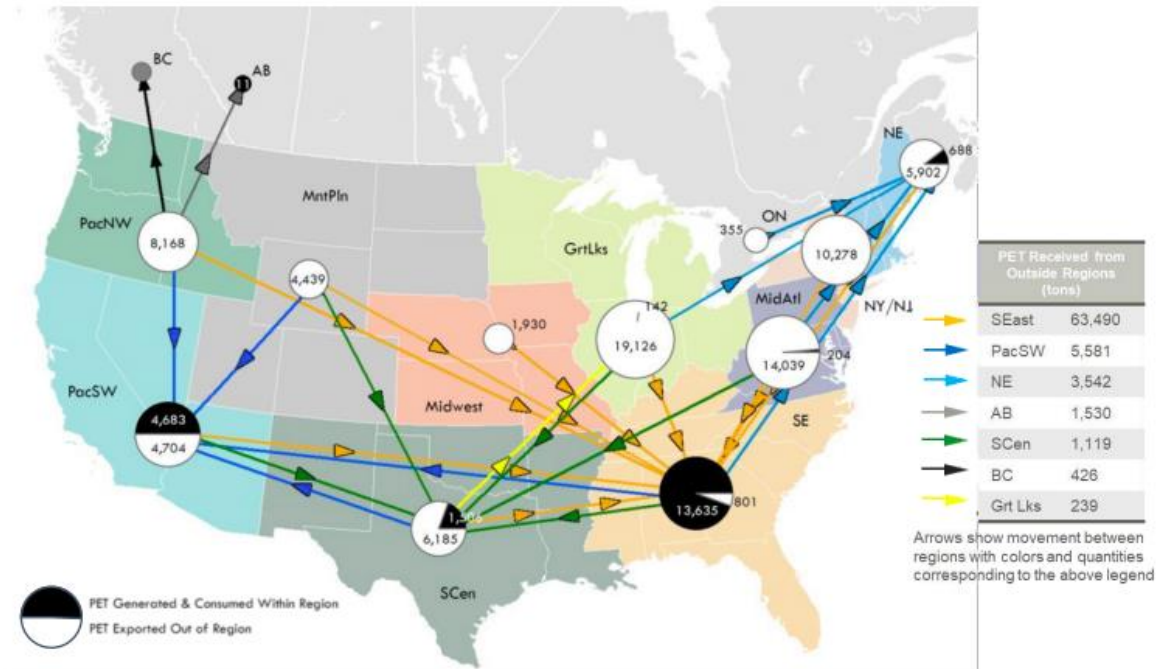


Figure 3. Waste Management's PET waste generation and exports. From "WM Report on Recycling," 2020, p. 11.

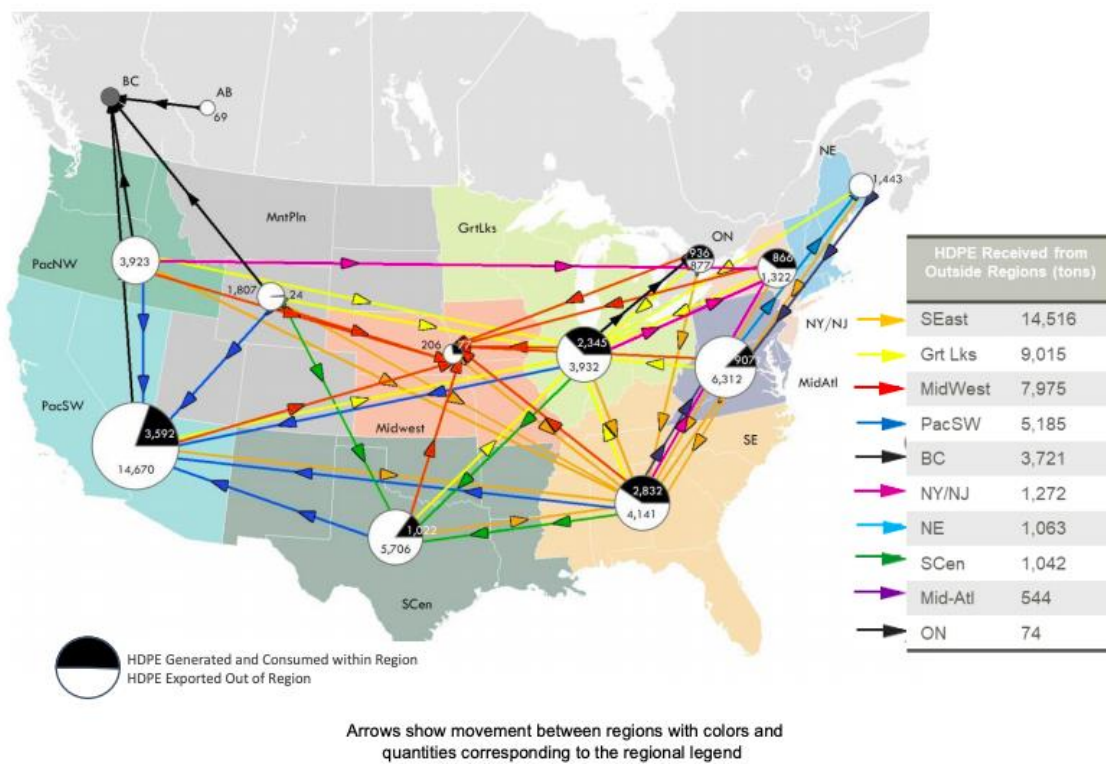


Figure 4. Waste Management's HDPE waste generation and exports. From "WM Report on Recycling," 2020, p. 12.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

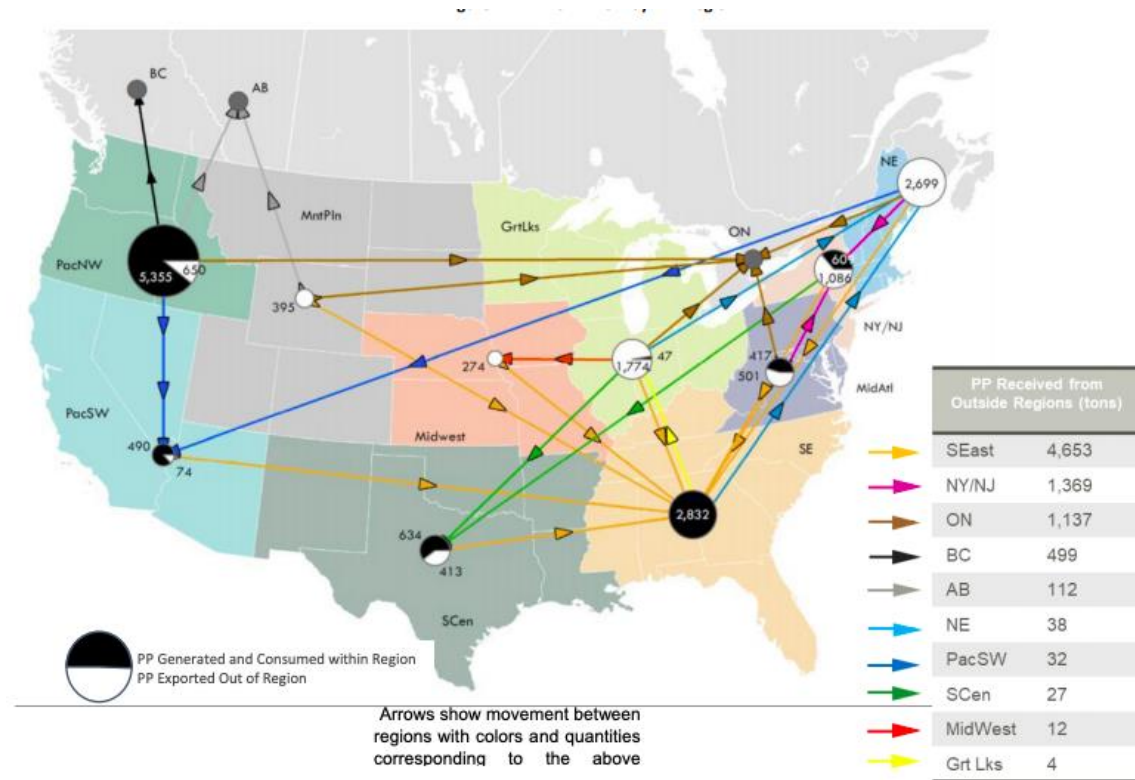


Figure 5. Waste Management’s PP waste generation and exports. From “WM Report on Recycling,” 2020, p. 13.

Waste Management explains their export policy and how they have been steadily shifting their markets to domestic ones since 2013. As of fall 2019, they formalized their “policy of selling residential plastic processed through our only to North American markets” (WM Report on Recycling, 2020). Republic Services had a similar quote in their waste report as well that reads, “Republic does not believe it is good public policy to export recovered plastic material to the developing world and is committed to not doing so” (Republic Services, 2020). No information was available on the website for United Fibers on where their plastics are sold.

Discussion

Looking at the data provided by the EPA, it looks like we are producing more and more waste, but we are unable to recycle any more than what has been for almost a

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

decade. Analyzing *Figure 1*, the curve stays relatively flat in terms of how much has been able to be recycled; it jumps up a bit in 2018, but it is slow progress.

The biggest takeaway from the figures provided by John Stumbaugh and Waste Management is that all of the plastic waste that Phoenix, Scottsdale, and Tempe generates is sold domestically. It was expected that at least some plastic was to be shipped overseas, but it seems as though large companies have had an easier time being able to find domestic buyers. In fact, Republic Services incorporated maps of where in the U.S. these buyers are located, they are shown in *Figure 6, 7, and 8* below, as well as the end markets for PET and HDPE shown in Appendix, *Figure 9 and 10*.



Figure 6. PET reclaimers in the US. From “Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education,” 2020. p. 16.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?



Figure 7. HDPE reclaimers in the US. From “Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education,” 2020. p. 17.



Figure 8. PP and combined (3-7 and 1-7) reclaimers in the US. From “Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education,” 2020. p. 19.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

While there is room for the US market to grow, these maps make it apparent that it is already a somewhat mature industry here in the US. While it might be mature, it is seemingly stagnant; as mentioned previously, the amount of plastic recycled in 2017 only increased by 3.0% in 2018. Due to the lack of information from 2019 and 2020, it is possible this percent has gone up in recent years now that the market has had a few years to stabilize, but it remains to be seen for now.

Maricopa County is having some success in recycling post-ban. However, due to the limited market of plastics, it is noticed that only plastics 1, 2, and sometimes 4 and 5 are able to be recycled while the rest are being sent to a landfill or are incinerated. There is still room for national improvement when it comes to reducing the use of, or recycling plastics 3, 4, 5, 6, and 7. Hopefully, over the last few years, companies have begun to move into the US to help pick up the slack, so to speak.

Literature to Support or Disprove Findings

According to an article by the Guardian, “only about half (56%) of the plastic waste that America once exported is still being accepted by foreign markets in the wake of China’s ban” (McCormick, 2019). The articles also disclose that the materials do still go overseas, are being shipped to Vietnam, Turkey, Malaysia, and Senegal. These quotes make it sound as though much of it is still going overseas, which is different from my findings, but this could be due to the narrow focus area of Maricopa County in this research study.

An article published by the Plastic Recycling Update highlights how China’s new restrictions opened up the door for Chinese investors to start opening up business in the US (Staub, 2018). The article focuses on two companies, Ecomelida and Roy Tech

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

Environ, and why they are choosing to come to the US and also their future plans. Yang Huang, a company representative from Ecomelida, says that they set their plans because “The recycling system is considered more mature in the U.S.... We should be able to get cheaper and better raw materials here” (Staub, 2018). The company “acquired a roughly 200,000-square foot building on about 45 acres of land” in Orangeburg, South Carolina, where they plan on opening their facility where all the pellets processed will be shipped to existing customers in China, with the possibility to extend to markets in the domestic US when more production lines are able to be added and more diverse products are made (Staub, 2018). The other company mentioned, Roy Tech Environ, is in the same situation; they will shred US domestically sourced plastics and send them to their customers in Southeast Asia where they will be further processed and then shipped to China. Lily Zhang who is the CEO of the company, says that the regulations are more predictable in the US, as well as a lot of resources available. Another example is Renewlogy, a company in the process of partnering with Phoenix. The company’s purpose is to decrease the number MRFs of items that are being landfilled (Renewlogy, n.d.). Their technology is supposed to turn non-recyclable waste into new products; this will help Phoenix achieve its Zero-Waste goals. Hopefully, more of these types of companies will open in the US in the coming years.

Chapter 5

The goal of this research was to find out if Maricopa county is recycling more or less plastics after China’s ban on recycling imports, as well as to find out where those plastics are currently being processed. That goal was achieved through researching China’s pre-ban statistics, sending out questionnaires to local MRFs in Maricopa county,

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

and researching the private third-party companies that manage the local MRFs. Even though the MRFs themselves did not give out much information, the private companies are wanting to be more transparent with their exports.

Finding out that almost all of the PET, HDPE, and PP plastics generated in Maricopa county are, in fact, recycled domestically is a positive, due to the growing and somewhat unstable nature of the recycling industry in developing parts of the world. This is a win, considering that many municipalities around the US have been severely affected by China's decision to stop importing such contaminated waste. Recycling of plastics 3, 4, 6, and 7 needs to be improved; these materials are unfortunately being landfilled or burned and both of those options do not have the most positive long-term environmental impacts. The amount of plastics being recycled needs to be improved; the numbers have been stagnant since well before 2018; China refusing to buy the worlds' low-quality waste just exacerbated the issue that was already at hand. The world is producing plastic at exploding growing rates, but the amount able to be repurposed or recycled remains unchanged

Recommendations

Information on the companies that buy the raw materials was not disclosed; this is due to the competitive market with which municipalities and third parties are working. This information is proprietary and almost impossible to gather. The only way people will have any idea of where their recyclables are going is if companies stop being so secretive about their markets, which will only happen once the market balances back out and there is no longer an abundance of resources with no buyers.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

Another question of how the engineering world is dealing with the growing amount of plastic waste being produced arises; is there new technology being invented that can make it more efficient and cost-effective to recycle? This will take some time, for not only does research need to be done, but implementing any changes is very costly. For this reason, the world will be somewhat slow to select this option as their first choice in helping to correct our recycling industry.

Future research needs to be done on private companies to find out where they are selling their commodities and if they are being utilized right away or if they are exported again. Once the waste is sold once it is easy to lose track of where it ends up, making it nearly impossible to know the real final destination of our waste. Due to a global market, this is hard research to collect, but if made a priority, it would be very informative.

References

- Barrs, R. (2018, May 31). Phoenix, EV losing big in recycling revenue. Retrieved from https://www.ahwatukee.com/news/article_8a51cb6a-6396-11e8-bb8597d793d22b65.html
- Brooks, A., Wang, S., & Jambeck, J. (2018). The Chinese import ban and its impact on global plastic waste trade. *Science Advances*, 4(6), eaat0131–eaat0131.
- Katz, C. (2019, March 7). Piling Up: How China's Ban on Importing Waste Has Stalled Global Recycling.
- McCormick, E., Simmonds, C., Glenza, J., & Gammon, K. (2019, June 21). Americans' plastic recycling is dumped in landfills, investigation shows. *The Guardian*.
- Murphy, E. L., Bernard, M. L., Helm, L., Hill, I., & Tuñas-Corzón, Á. (2020). Policy Recommendations to Reinvigorate Recycling in Arizona. *Journal of Science Policy & Governance*, 17(1).
- National Overview: Facts and Figures on Materials, Wastes and Recycling. (n.d.). Retrieved from <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials#recycling>
- Phoenix. (2018). Retrieved from <http://renewlogy.com/phoenix/>
- Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education (Rep.). (2020, November). Retrieved https://www.republicservices.com/cms/documents/sustainability_reports/Plastics-Recovery-Program-Review2020.pdf
- Staub, C. (2019, September 06). Chinese firms open up on their US Recycling plans.

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

Retrieved from <https://resource-recycling.com/plastics/2018/04/04/chinese-firms-open-up-on-their-u-s-recycling-plans/>

Stumbaugh, J. Plastic Recycling Questions [E-mail interview]. (2021, February 26).

WM Report on Recycling (Rep.). (2020, September). Retrieved

https://sustainability.wm.com/downloads/WM_Report_on_Recycling.pdf

MARICOPA COUNTY RECYCLING: WHERE DID IT ALL GO?

Appendix

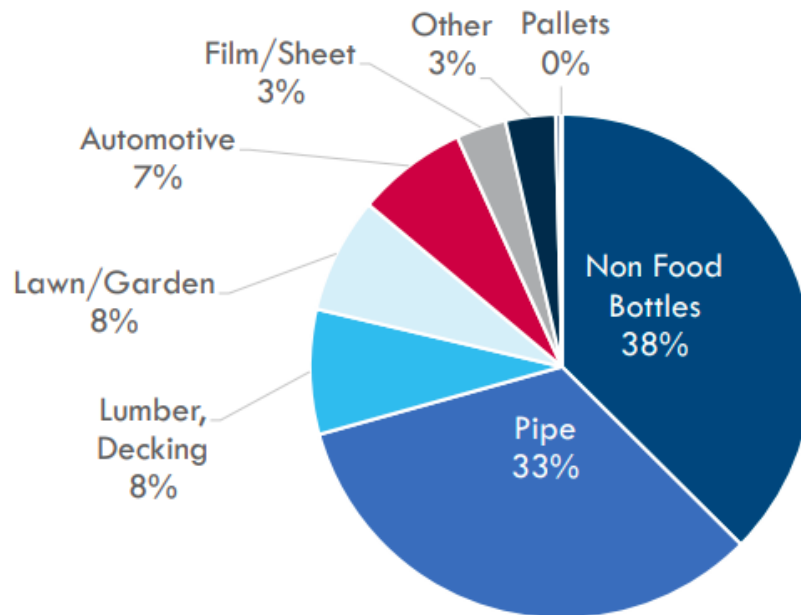


Figure 9. The end market for PET. From “From “Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education,” 2020. p. 17.

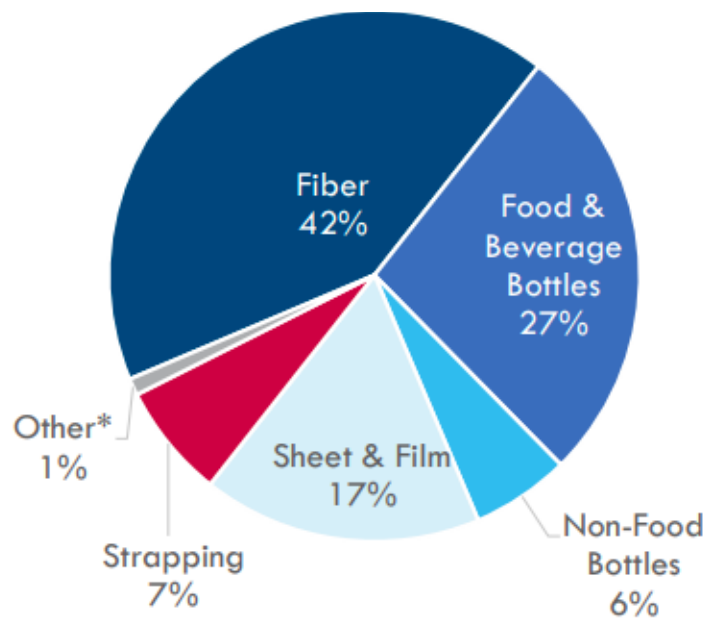


Figure 10. The end market for HDPE. From “Republic Services: Advancing Plastics Recycling through Investment, Innovation and Education,” 2020. p. 18.