Examining production of municipal solid waste for bulk pickup and median household income in Tucson, Arizona

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Senior Capstone

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Abstract

The relationship between socioeconomic factors like median household income and behavior tied to the production of bulk waste has important ramifications for improving municipal waste management systems. This study investigates this relationship among different neighborhoods in the city of Tucson, Arizona. Using direct observation methods in 18 neighborhoods of varying income levels within six waste management districts across the city, this study identifies the physical manifestation of the role household income plays in the production of bulk waste. Observation routes were designed in each of the 18 neighborhoods, keeping the number of parcels in each route constant for consistency. Observations recorded the amount of individual piles of trash placed on the side of the road for pickup, with a unit defined as a pile at least one square meter in size, no more than 10 cubic meters in volume, and at least three feet apart from other piles as defined by the city of Tucson. The study found that neighborhoods with a higher median household income produced more trash than those with lower income levels. This could be due to wealthier households having more disposable income that allows them to purchase more items that will eventually be discarded, that wealthier households move homes more frequently and thus need to discard furniture and appliances more frequently, or that wealthier households have more resources to undergo home renovations and therefore discard more bulk waste in the form of furniture, appliances, and building materials. Based on these results, practical applications of the data are discussed as they pertain to improving local waste management policies and strategies for waste reduction. Future studies should examine all 26 waste management districts and the types of waste produced.

Key terms: Tucson, Arizona, Median Household Income, Bulk Waste, Waste Management

1. Introduction

Urban waste management is an essential service that has a broad impact on environmental conditions, public health, and the overall livability of an urban environment. One type of urban waste is bulk waste, large items that cannot be discarded using standard trash bins, such as appliances, furniture, auto parts, building materials, and more. Like many cities in the United States, the city of Tucson, Arizona provides its residents with a pickup service for yard waste, or brush, and discarded bulk items. The Brush and Bulky program operates in all 26 waste management districts throughout the city of Tucson, giving each district two weeks out of the year to leave their bulk waste on the curb for pickup. The program generates 19,000 tons of waste per year, all of which are deposited in the Los Reales Landfill (City of Tucson, 2023). The production of waste is often informed by the socioeconomic conditions of those producing the waste (Hockett et al., 1995). In a city as socioeconomically diverse as Tucson, the variation in the amount of waste produced by neighborhoods of different incomes may be visible.

The purpose of this study is to examine how the production of bulk waste varies along the median household income of different neighborhoods in Tucson. This study's observations take place in the following neighborhoods, organized by median household income from highest to lowest: Catalina Vista/Blenman-Elm, Saguaro Canyon, Rita Ranch, Saguaro Miraflores, Houghton South, Highland Vista Cinco Via, Starr Pass, Poets Square, Santiago Hills, Blenman-Elm, Elvira, Midvale Park, Enchanted Hills, Rose, Barrio Hollywood, Duffy, Barrio Kroeger Lane, and Rincon Heights. Observations are recorded by piles of trash for pickup, the limit of which the city of Tucson defines as no more than 10 cubic yards in volume, separated at least three feet from other piles of trash. Understanding the relationship between income and bulk waste production can provide public servants with valuable information on the spatial distribution of bulk waste

production broadly. The city of Tucson's Zero Waste Roadmap identifies the city's Brush and Bulky Collection program as the near-term waste reduction option with the most potential for positive impact on waste reduction efforts (City of Tucson, 2023). According to the roadmap, the city plans on reducing waste through the Brush and Bulky program by picking up bulk waste separately from yard waste and diverting it to recycling centers instead of the landfill.

By exploring the relationship between a neighborhood's median household income (I) and the amount of bulk waste they left for pickup, the Brush and Bulky pickup service can be a more effective tool for meeting the goals of the city's Zero Waste Roadmap. The positive correlation of waste generation and income has been observed in other settings in the past. If a neighborhood's median household income increases, then that neighborhood will produce more bulk waste, because the households will have more disposable income to purchase things that will eventually become waste. Wealthier households may also move from house to house more than less wealthy households, producing more waste for bulk pickup during the moving process. Wealthier households also tend to have larger homes which contain more bulk items like appliances and furniture, and they also have more funds for home renovations that would produce additional bulk waste in the form of building materials.

2. Literature Review

From a global perspective, waste management has been a difficult part of the world's modern environmental challenges. An exponentially growing population means exponentially growing waste, and most governments aren't properly equipped to manage it all. In 2018, it was estimated that a third of solid waste was left unmanaged around the world (Alzamora et al., 2022). This is due to a multitude of factors, occurring usually in developing countries that have limited

access to information, technology, and finances. In the Istanbul province of Türkiye, researchers analyzed the variation of municipal solid waste production over a variety of factors including median household income. Households were separated based on a scale of low, medium, and high-income levels. Low-income districts of this province were found to have the highest rate of waste production, while high income districts had the lowest rate of waste production (Ozcan et al., 2016). It is worth noting, however, that these statistics are likely to be quite different from those found in the United States, as the low-income districts of Istanbul tend to be informal shanty settlements that lack proper access to waste management and supply chains. For developed nations like the United States, that have access to proper waste management infrastructure, there is great potential for future improvements on the efficiency of managing municipal solid waste. Developed countries come with their own set of problems, however, as land prices are astronomically higher in these nations than in developing nations. Higher land prices make it harder for municipalities to obtain land for waste deposition (Dederich, 2024). Waste management is not a public utility that can be dialed back, it needs to keep up with the pace of the population's rate of waste generation. If municipalities fail to do so, there will be dire environmental consequences in the form of rampant pollution. Municipalities also need to consider the potential of toxicity and pathogens found within municipal solid waste and maintain measures to ensure the safety of waste management workers and citizens (Policastro & Cesaro, 2022). Tucson's Brush and Bulky pickup service will not pick up the following: compressed gas / air cylinders, concrete, construction material, dirt, stone, rocks, gravel, glass / mirrors, household hazardous waste (paint, oil, pesticides, solvents), and televisions / computer monitors (Brush & Bulky, 2025).

As the population of the American Southwest continues to rise, municipalities are going to need to ramp up efficiency of municipal waste management programs. Upwards of 400 million

tons of municipal solid waste are generated annually in the United States, with 764,000 tons annually in Tucson (Tonjes & Greene, 2012). Increased waste production means more landfills and fuller landfills, and these earthen receptacles of garbage have been documented to harbor pathogens that have the potential to contaminate groundwater and cause populations to fall ill. Waste, specifically food waste, has the highest potential to transmit diseases like fecal coliforms, salmonella, human enteroviruses, and protozoa (Gerba et al., 2011). From a public health perspective, the reduction of municipal solid waste has a good argument in support of it, in the form of disease prevention. Additional risks include chemical leachate, which comes in various forms, such as metals, volatile organic compounds (VOCs), per- and polyfluoroalkyl substances (PFAS), and radioactive material (Gerba et al., 2011).

The first step to managing waste should be figuring out how to reduce it in the first place. The largest producers of municipal solid waste are households, with food waste being the largest portion of the garbage, with total household food waste in the United States amounting to 133 billion pounds annually (Wharton et al., 2021). This large amount of waste has been attributed to consumer behavior and marketing, rather than the practices of the food industry along the supply chain, such as manufacturing, distribution, retail, and hospitality (Graham-Rowe et al., 2014). In Phoenix, Arizona, researchers asked over fifty households to participate in a study that sought to find ways to reduce household food waste. Normal waste behavior was observed for one week, then experts intervened with these households to reduce waste for five weeks, and waste behavior was once again observed for one week. By providing educational material in a variety of forms, the researchers were able to reduce these households' waste by 27.85% (Wharton et al., 2021). It is possible to reduce household solid waste, and municipalities should provide educational material for citizens to reduce overall waste. Programs like the city of Phoenix's Zero Waste Team offer a

variety of educational materials in the form of videos, in-person presentations, community events, and webinars.

Further research is required to determine whether the study from Türkiye can be viewed as an analogue for waste management variance by income in the United States. Differences in culture, development, and wealth inequality between the two countries could be confounding factors that create entirely different situations in these countries. Asking whether there is a correlation between the amount of municipal solid waste produced and median household income in a city like Tucson is necessary for fully understanding how wealth and waste are related in the context of the United States. Answering this question can pave the way for additional research, such as assessing the variance of risk of toxicity in waste depending on a given district's median household income. Many environmental problems in the past have had disproportionate adverse effects on lower-income members of society who make less waste than higher income people.

3. **Research Methods**

3.1. Study Sites

Tucson's Brush & Bulky pickup schedule rotates neighborhoods throughout the year to ensure all districts of the city have a chance to take advantage of the service. As a result of this, the amount of study sites accessible during the duration of this study were limited. Six of Tucson's 26 waste management districts as listed on the city's brush and bulky pickup schedule were observed for waste production habits. Study took place in Zone 10, Zone 26, Zone 3, Zone 4, Zone 1, and Zone 22. Within each zone, three different neighborhoods were observed based on

the median household income relative to the others in that zone. Median household income data was acquired from the City of Tucson's GIS database along with shapefiles containing the city's waste management districts and parcels. The income data was used to separate study sites based on income and the parcel data was used to maintain a consistent amount of 45 parcels along each study route. Line feature layers were drawn to indicate the study routes for each of the study's 18 sites. Specific neighborhoods and their incomes are stated in the text below.

Within Zone 10, the high-income neighborhood was Highland Vista Cinco Via at $79,464, the median income neighborhood was Poets Square at $67,038, and the low-income neighborhood was Duffy at $30,128. For Zone 26, the high-income neighborhood was Catalina Vista at

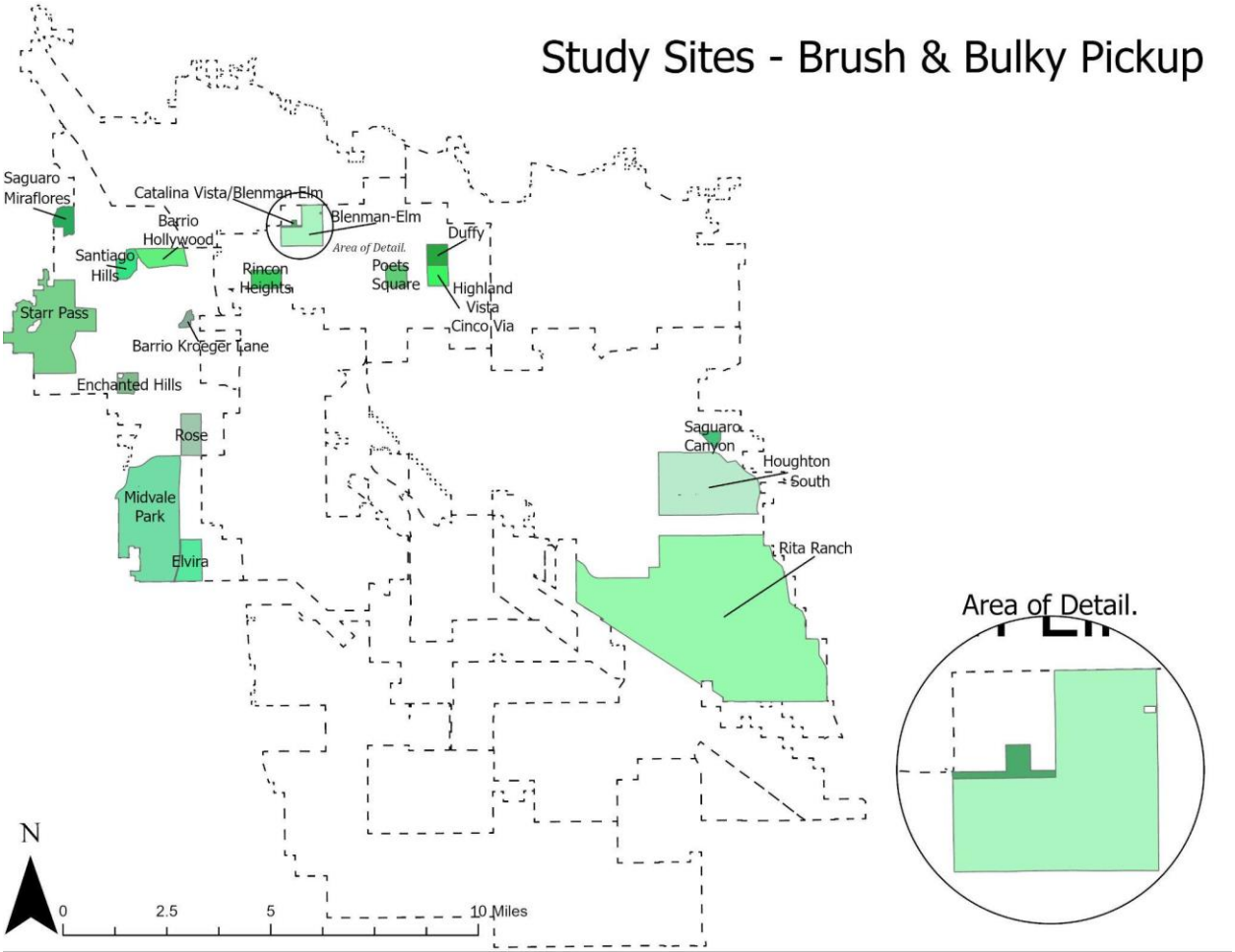

Figure 1. Map of Study Sites (Shapefile modified from Tucson Open Data, 2019)

$115,281, the median income neighborhood was Blenman-Elm at $57,765, and the low-income neighborhood was Rincon Heights at $21,863. In Zone 3, the high-income neighborhood was Starr Pass at $72,693, the median income neighborhood was Enchanted Hills at $40,802, and the low-income neighborhood was Barrio Kroeger Lane at $23,551. Moving on to Zone 4, the high-income neighborhood was Saguaro Miraflores at $83,687, the median income neighborhood was Santiago Hills at $64,541, and the low-income neighborhood was Barrio Hollywood, at $32,736. For Zone 1, the high-income neighborhood was Elvira, at $50,687, the median income neighborhood was Midvale Park at $42,660, and the low-income neighborhood was Rose at $33,367, making Zone 1 the lowest income waste management district in this study. Finally, in Zone 22, the high-income neighborhood was Saguaro Canyon at $100,590, the median income neighborhood was Rita Ranch at $89,700, and the low-income neighborhood was Houghton South at $83,642. Even though some of the "low" income neighborhoods have a median household income above that of Tucson, they are still lower relative to the other neighborhoods in their waste management district. All neighborhoods' waste production behavior will be analyzed using the city's median household income as a break between lower and higher income.

3.2. Data Sampling Methodology

This is a quantitative, cross-sectional study. This approach was chosen because this study required observing quantities of municipal household waste as it relates to median household income. Observations for this study were recorded weekly from mid-February to mid-April of 2025. Each study site is observed during that site's brush and bulky pickup week as designated by the City of Tucson. Observations were recorded along routes designed to pass 45 parcels in each

route. The subjects of recording are the piles of trash that are left on the side of the road for bulk pickup. An observation can be recorded if it is an individual pile of trash no more than 10 cubic yards in volume, or if it is a large object, such as a mattress, toilet, or appliance. Additionally, piles of trash must have at least three feet of trash-free ground visible between them to count as two individuals. These standards are derived from the brush and bulky pickup information page on the City of Tucson website. The city mandates that trash be placed at least one yard from other objects that may hinder pickup crews' capabilities and that one household may leave no more than 10 cubic yards of trash for pickup.

Conducting observations for this study went as follows: begin on study route either on foot or in an automobile (following all safety protocols). Follow the route and count any piles of trash that meet the above criteria, only focusing on the 45 parcels that intersect with the study route made in ARCGIS Pro for consistency.

4. Results

After collecting the data from each of the 18 observation routes, the data was analyzed using simple regression. Higher income neighborhoods tended to produce more waste than lower income neighborhoods. The neighborhood that produced the most bulk waste in this study was Saguaro Canyon with 26 piles of trash. Saguaro Canyon has a median household income of $100,590 making it the second highest earning neighborhood in this study. The neighborhood that produced the least amount of bulk waste was Barrio Kroeger Lane with only 12 piles of trash. This neighborhood is the second lowest earning neighborhood with a median household income of $23,551. Mean income of all the neighborhoods in this study was $60,566, below Tucson's citywide median household income of $67,929. Mean number of piles of bulk waste left for pickup

at all neighborhoods was 20 piles with a standard deviation of 3.68 over 360 total piles of trash observed during this study. The data may be found in Table 1.

Table 1. Neighborhood, Waste Management Zone, Median Household Income, and Bulk Waste

Neighborhood	BB_Zone	Income (I) / (MHI)	Piles (W)
Catalina Vista	26	$115,281	25
Saguaro Canyon	22	$100,590	26
Rita Ranch	22	$89,700	22
Saguaro Miraflores	4	$83,687	23
Houghton South	22	$83,642	23
Highland Vista Cinco Via	10	$79,464	22
Starr Pass	3	$72,693	19
Poets Square	10	$67,038	18
Santiago Hills	4	$64,541	21
Blenman-Elm	26	$57,765	20
Elvira	1	$50,687	21
Midvale Park	1	$42,660	20
Enchanted Hills	3	$40,802	22
Rose	1	$33,367	16
Barrio Hollywood	4	$32,736	14
Duffy	10	$30,128	20
Barrio Kroeger Lane	3	$23,551	12
Rincon Heights	26	$21,863	16

The data was analyzed using a simple regression analysis. As seen in Figure 2, there is a positive correlation between median household income and piles of bulk waste produced. Because the independent variable is median household income (I), a scalar that varies over six figures, comparing it directly with bulk waste produce (W) produces an incomprehensibly tiny number that doesn't have any meaning, as bulk waste is not a unit that can be made so small. To illustrate how waste varies along income, the correlation coefficient of the data is 0.8061, or a very strong and positive correlation. The slope of the regression line in Figure 2 is 0.0001, as in 0.0001 piles of bulk waste accrued per dollar of median household income. To illustrate this better, the slope shows that for every thousand dollars earned, a neighborhood is likely to produce 0.1 more piles of trash, starting at the y-intercept of 13.55 piles. Figure 3 shows the spatial variation of waste production per neighborhood.

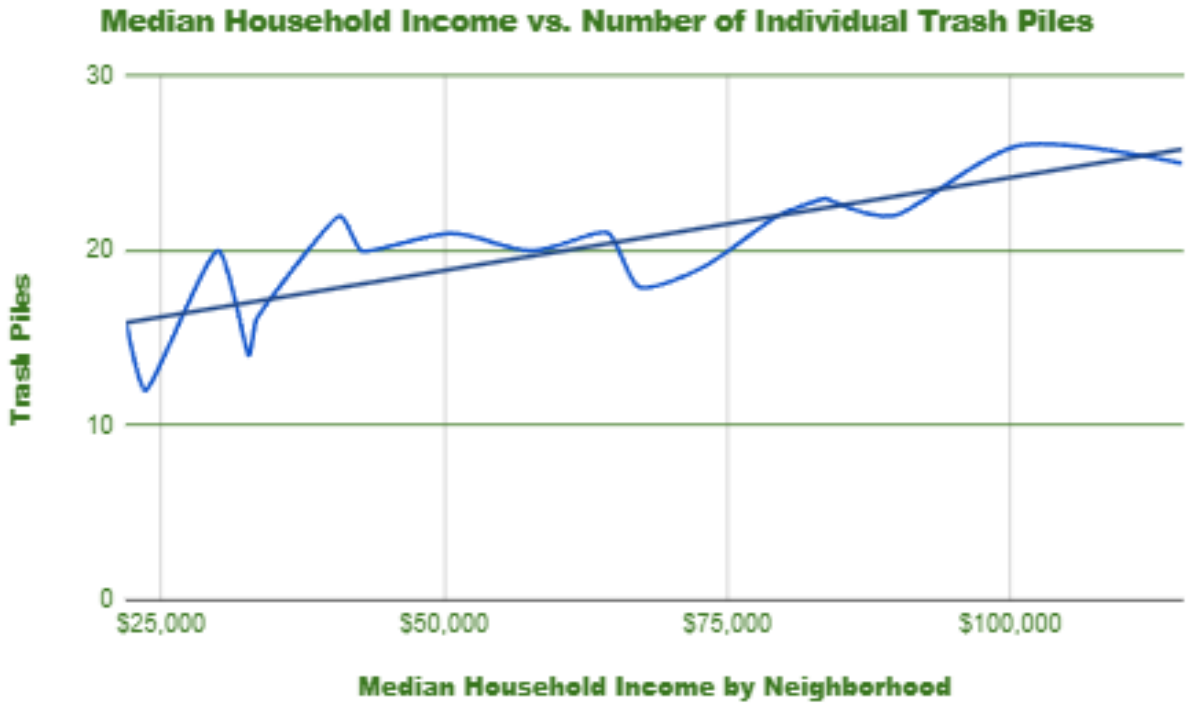

Figure 2: Median Household Income vs. Number of Individual Trash Piles

From the spatial variation illustrated in the map, some patterns can be found. First, the production of bulk waste seems to be larger on the physical periphery of the data. For the neighborhoods in the study closer to Downtown Tucson, bulk waste is significantly lower than the amount of waste produced by neighborhoods further away like Saguaro Canyon and Houghton South. A reason for this could be that lower income neighborhoods are more likely to occur in the inner city than on the periphery which is typically composed of larger parcels.

5. Discussions

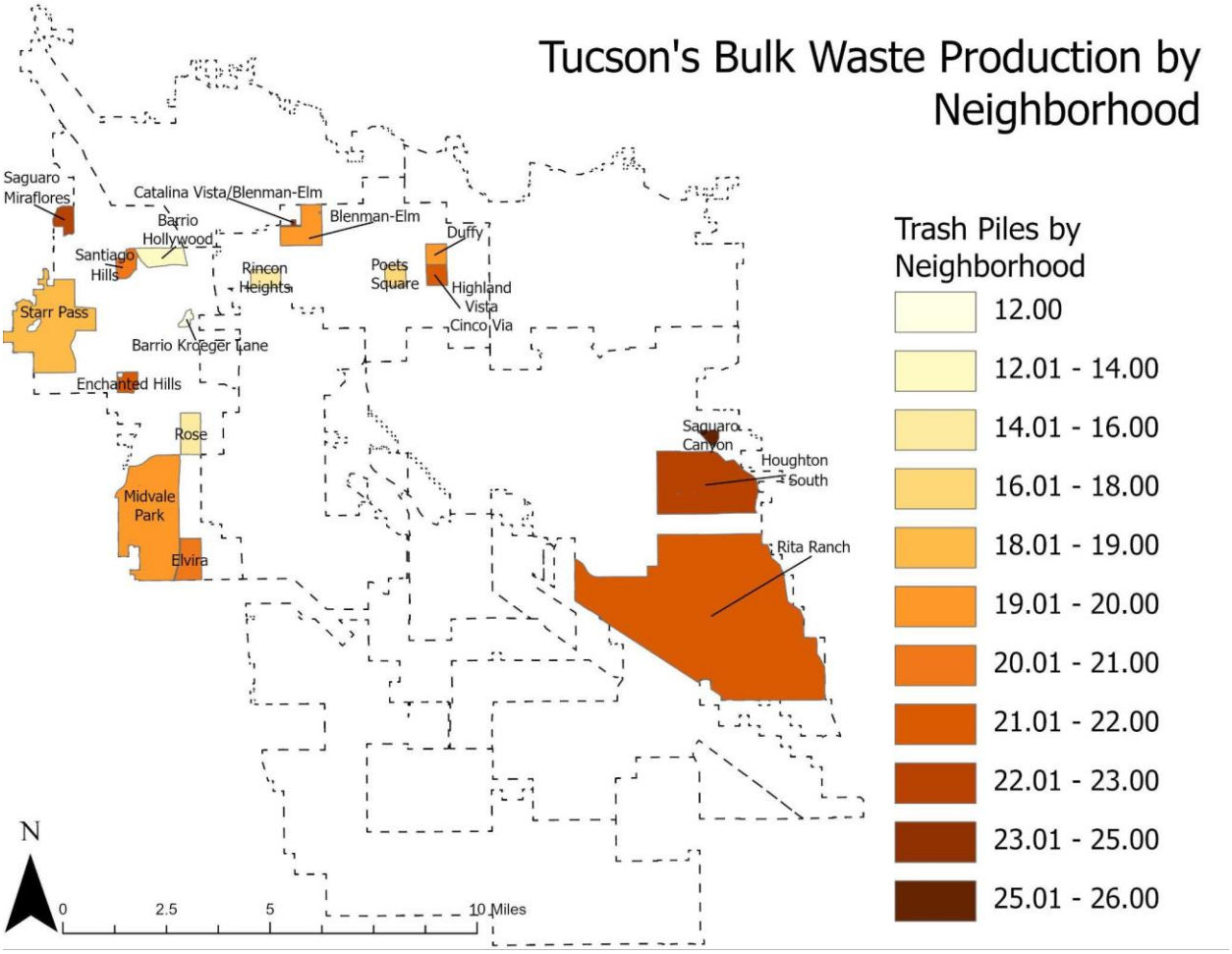

Figure 3: Map of Bulk Waste Production by Neighborhood

The purpose of the study was to determine if high income neighborhoods produced more or less waste for bulk pickup than low-income neighborhoods. The study yielded that on average,

wealthier neighborhoods produce more trash than poorer neighborhoods. The neighborhoods that produced more trash tended to be on the periphery of the whole study site. Analysis through linear regression showed that for every $10,000 dollars of median household income a neighborhood earns, they are likely to produce one more pile of trash, starting at 13.55 piles. The highest earning neighborhood, Catalina Vista, did not produce the most trash. The lowest earning neighborhood, Rincon Heights, did not produce the least either.

The disparity in bulk waste production among neighborhoods of different incomes is interpreted as a symptom of uneven wealth distribution that manifests in three ways. First is that wealthier households have more purchasing power, and therefore have the means to acquire more items that could end up as trash for bulk pickup. Those with lower incomes have lower purchasing power, meaning that they would not be able to purchase as many items as wealthier households, resulting in less trash for bulk pickup. Second, wealthier households have a greater ability to move between houses due to their financial advantage. Moving families often discard items like furniture they feel won't fit in their new house, thus creating bulk waste. Third, home renovations are more common in higher income neighborhoods, so these neighborhoods will have more bulk items to dispose of in the form of construction materials. These findings mirror the findings of studies like the study by Hockett et al. (1995), which holds that wealthier households tend to create more waste, both standard municipal solid waste and bulk waste in the form of furniture, appliances, building materials, and other large objects.

The policy implications of this study can involve targeted waste reduction campaigns, waste diversion through donations and resale, and community partnerships. Many bulk items discarded for pickup are not damaged or broken beyond repair. These still usable items like furniture are often discarded with bulk waste because it is difficult to transport them to donation

centers or to sell them either in person or online marketplaces. Families moving between houses may use bulk waste pickup as a way to get rid of unwanted furniture simply because of its convenience. It allows them to focus more on packing rather than trying to find a new place for their unwanted bulk items. Rather than maintaining the disposal of undamaged or repairable items, these items can be put to better use through targeted waste reduction strategies designed to educate people on services the city can provide to help keep these items out of landfills and in use. The City of Tucson can establish a bulk donation pickup service in addition to the bulk waste pickup service. Moving large furniture items requires large vehicles most people don't have access to, and a bulk donation service can divert waste from landfills by offering to pick up unwanted bulk items and take them to a donation center where they may be given to low-income households or sold at a reduced price. The city may partner with existing donation centers like the Salvation Army to provide storage space for unwanted bulk items. With this strategy, overall waste going into landfills is reduced, moving families have a convenient way to discard unwanted items without generating waste, and those unwanted items may be enjoyed by other families in the future.

This study may suffer from some limitations, such as the study's limited duration due to the constraints of the city's trash pickup schedule. Visiting multiple neighborhoods per week is not always feasible, as the pickup schedule only focuses on one area of the city in each week. The study's timeframe was also constrained by the length of a university semester, meaning not all waste management districts could be observed during their pickup week. This means that the scope of the data is limited, which warrants further research to expand upon this study. There could also be additional confounding variables, such as current socioeconomic trends that could be influencing the behavior of residents in the neighborhoods observed. Further research could involve analyzing the relationship between bulk waste production and income in other

geographical and socioeconomic contexts, such as in other cities, rural areas with municipal bulk waste pickup programs, different states, and other nations. Further research should incorporate all 26 of Tucson's waste management districts and their neighborhood subdivisions for a full analysis of the relationship between household income and bulk waste production.

6. Conclusion

The aim of this study was to explore the relationship between wealth, measured as median household income, and the production of bulk waste. This study examined how median household income impacts the production of bulk waste. By observing the waste production behaviors of neighborhoods of varying income levels, the study found that neighborhoods with a higher median household income produce more bulk waste than those with a lower income. The two neighborhoods with the highest incomes of over $100,000 each, Catalina Vista and Saguaro Canyon, were the highest producers of bulk waste with 25 piles and 26 piles of trash respectively, while the two neighborhoods with the lowest income of under $30,000 each, Barrio Kroeger Lane and Rincon Heights, produced 12 piles and 16 piles of trash respectively.

The results of this study can inform policy decisions as they pertain to the allocation of waste reduction efforts targeting certain "problem areas," or areas that tend to produce more waste. Since the city of Tucson holds the brush and bulky pickup service to be the program with the highest potential for positive impact on waste reduction efforts, it will be very helpful for officials to direct their attention toward neighborhoods that are more likely to produce higher amounts of bulk waste. There are three policy recommendations from this study: First, the city can anticipate higher volumes of bulk waste from higher income neighborhoods and prepare for this increased volume by allocating more collection trucks to those areas. Second, the city can implement

education campaigns targeted at wealthier households to inform them about sustainability efforts in the city such as locations of recycling centers. Third, the city can also foster mutual aid efforts between neighborhoods of different income levels by promoting the exchange of discarded intact items, like undamaged furniture and appliances.

This study features some limitations that may reduce the viability of its findings, mainly in the nature of time constraints. Due to the limited time allotted for research and the fixed, rotating schedule of the city's bulk pickup service, the study was only able to assess a total of 9 sites in both the pilot study and main study, with zone 22 being featured in both. The study was only able to assess these zones over a period shorter than a year, meaning that the findings may be heavily influenced by socioeconomic trends specific to the present. Future research should include all 26 waste management districts of Tucson over a period of multiple years for a more thorough analysis of the phenomenon in a variety of socioeconomic atmospheres. The study would also benefit from a more equal distribution of high income, median income, and low-income neighborhoods. As demonstrated by this study, the production of waste has a positive correlation with a household's income, and policy must change to address this inequity through the spatially targeted allocation of resources.

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