# Listening to the People: The Effects of an Unregulated Landfill in Salamanca, Guanajuato, Mexico

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## ABSTRACT

Improper waste management practices have led to public outcry to demand closure of a landfill in Salamanca, Guanajuato, Mexico. To assess the environmental and social impacts of the landfill on residents, I collected air quality measurements and conducted surveys and interviews in three towns: La Labor, Valtierra, and Buenavista. Buenavista exceeded the federal standard for particulate matter ($PM_{2.5}$ micrometers or smaller) 8 out of 10 days of data collection. There are many elderly residents in the town who have a heightened sensitivity to potential respiratory and cardiovascular effects due to poor air quality. A majority of the respondents were willing to accept the placement of the landfill near their towns as long as proper regulations were enforced and illegal dumping ceased. My analysis of political leaders' statements about the landfill suggests an apolitical rendering of issues faced by residents has led to multiple ongoing environmental injustices. In this case, policy intervention is not needed: only proper regulation and compliance with standards already in place. Otherwise, residents suggest landfill closure. The findings from this study offer insights into adverse health effects, environmental injustices, and methods that can be used to encourage enforcement of existing regulations in landfills across Mexico.

## KEYWORDS

waste management, environmental justice, environmental health, political ecology, air quality

## INTRODUCTION

Waste management in Mexico is poor, and very little municipal solid waste (MSW) sorting takes place. MSW is disposed of or transported to different landfill types, including sanitary landfills, uncontrolled dumps, open dumps, and recycling plants (Ojeda-Benítez and Berau-Lozano 2002). In Mexico, only 10.9% of all the waste generated is sorted (Góngora-Pérez 2014). This has led to poor recycling practices; 35% of the MSW is recyclable, but only 4.9% of it is actually being recycled (Aldana-Espitia et al. 2017). Due to poor sorting, in densely-populated Mexico City, organic matter compromises half of all MSW generated (Moreno et al. 2013). Urbanization has increased waste generation in Mexico, requiring procurement of land to establish more landfills, further exacerbating issues regarding poor waste sorting (Ojeda-Benítez and Berau-Lozano 2002, Góngora-Pérez 2014). Consequently, landfills have introduced negative impacts on air quality and human health.

Landfills contribute to high levels of PM of sizes 2.5μm and 10μm, causing poor air quality and adverse effects on people's health (Herrera Murillo et al. 2012). $PM_{2.5}$ is able to enter the respiratory system through the lungs, inflaming epithelial cells (Dagher et al. 2005, Macklin 2011). Poor air quality poses immediate health risks to children, elders, and individuals with pre-existing heart and lung conditions (WHO 2003, Herrera Murillo et al. 2012). Observational indicators of poor air quality include foul odors and visual intrusion associated with landfills (Giusti 2009, Macklin 2011). In addition to health risks, the siting of landfills near residential homes and privately-owned properties decreases land values due to increased health risks and nuisances (Ready 2008, Giusti 2009). The amount of decrease in land values is influenced by the volume of waste transported to the landfill and proximity to properties (Ready 2008). The main method Salamanca monitors air quality is by measuring the abundance of particulate matter (PM). However, there are only a few PM stations scattered around Salamanca. The average annual amount of $PM_{2.5}$ in Salamanca in 2011 exceeded the Mexican standard by 200%, reflecting poor air quality control and monitoring (Herrera Murillo et al. 2012). This suggests the need for monitoring of air quality throughout potentially affected areas.

The landfill of interest is positioned on the outskirts of Salamanca, next to three small towns: Buenavista, La Labor, and Valtierra. The landfill is classified as an uncontrolled dump, which is characterized by unsorted MSW being disposed of with limited control on a site (Ojeda-

Benítez and Beraue-Lozano 2002). The landfill is situated next to a long dirt road where increased vehicular traffic from garbage trucks on the dirt road has caused an increase in suspended dust (PM). Residents from eight different communities (including Buenavista, La Labor, and Valtierra) convened to stop waste collecting trucks from entering the landfill in 2016, demanding that the road be paved and the landfill be shut down (Ortiz 2016a). The city complied with the popular demand to fix the road, but did not close the landfill (Ortiz 2016b). However, the road had yet to be paved until two years later. This lack of proper attention to the landfill and residents surrounding it continues today, suggesting the need to document perceptions of residents regarding the landfill along with relationships between communities and decision makers.

My main research question was: How has an unregulated landfill in Salamanca, Guanajuato, Mexico, affect the local environment and residents? To address this, I explored two sub-questions: (1) How has the unregulated landfill affected air quality?; and (2) How has the unregulated landfill affected perceptions of public wellbeing? I collected air quality data and conducted surveys and interviews to answer these questions. Overall, the aim was to provide scientific data that demonstrates the effects of the unregulated landfill on residents living in close proximity to be utilized to effectively advocate for change.

**The Salamanca landfill**

Before the landfill examined in this study was created, there was another landfill just on the outskirts of the heart of the city of Salamanca located in Guanajuato, Mexico (Figure 1) (Cardenas, M. A. 2017). In the past several years, it has remained closed due to trash overflowing and exceeding the landfill's capacity. The city of Salamanca decided to create a new landfill just under a decade ago, when they were faced with the dilemma of finding a new location to put the waste (Ortiz 2016b). The City of Salamanca purchased some of this land from a man by the name of Leonardo Sarabia, who had inherited four hectares of land from his father Carlos Sarabia. The City of Salamanca saw this as a large enough plot to hold the city's waste, located 1.5 kilometers from the closest town, Buenavista (Cardenas, M. A. 2017).

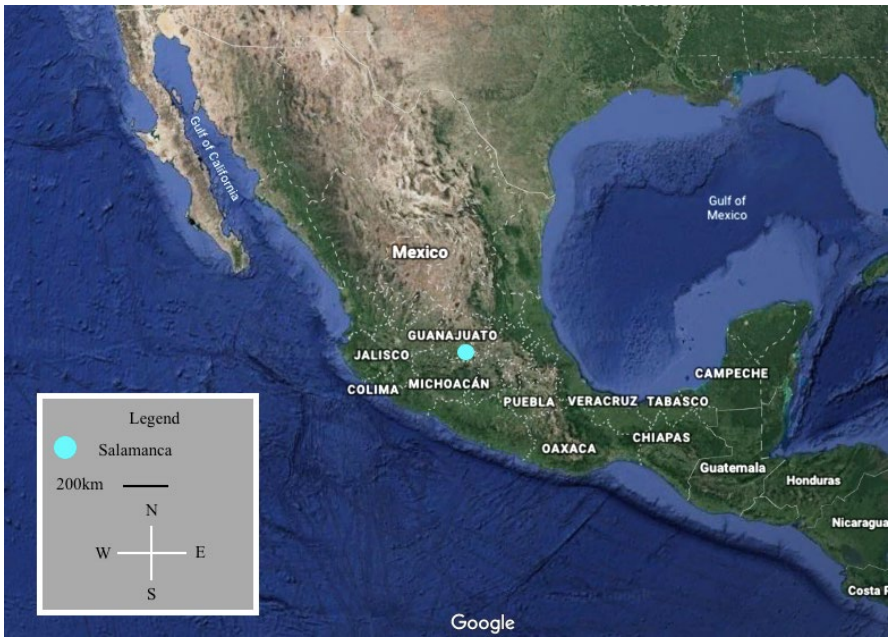


**Figure 1. Salamanca location.** Map of Mexico. Source: 2019. Google Earth

The coordinates of the Salamanca landfill are 20°30'10.35"N 101°16'01.14"W. Three towns are located southeast of the landfill: Buenavista, Valtierra, and La Labor (Figure 2). The towns are comprised of a total of 2,000 residents and located southwest of the main city of Salamanca (SEDESOL). Residents in Buenavista are slightly less economically well off, practice more traditional forms of farming and cattle ranching than the other towns, and are closer to the landfill.

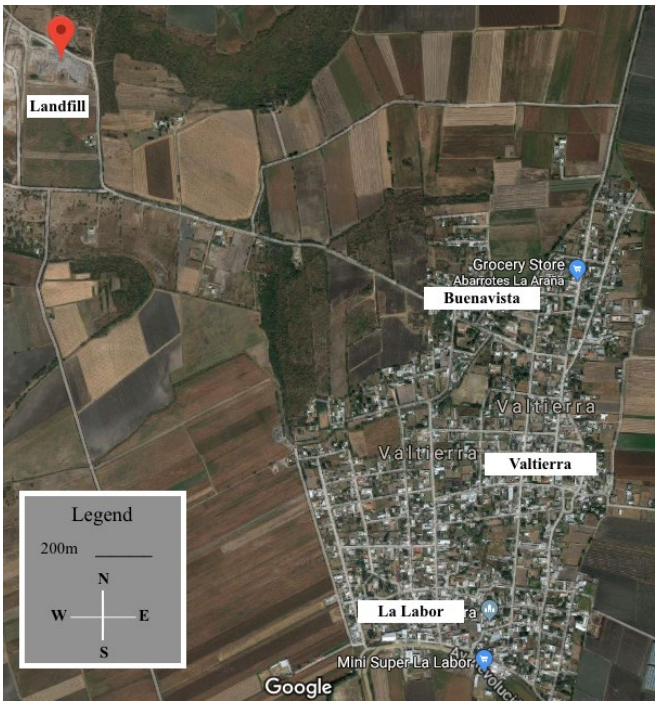


**Figure 2. Landfill location.** Towns of interest. Source: 2018. Google Earth.

As of 2001, Salamanca produced 141,508kg per day of municipal solid waste, 94% of which was disposed in an open dump and 6% by other means (Bhada-Tata and Hoornweg 2012). According to the most recent study conducted by the federal government, the average daily per capita generation of MSW is 0.99kg per individual (SEMARNAT 2013). There has been no record of the total MSW produced in Salamanca explicitly, however, using the metric found by the federal government, the average MSW produced in Salamanca according to the total population in 2015 is 270,853.3kg of daily MSW (INEGI 2015). It has been reported that a large portion of this burden, more than half, has been placed in the landfill of interest (Ortiz 2016b). With such a large waste burden, negative ecological and health threats have arisen.

Residents' protests against the negative ecological and public health effects of the unregulated landfill in Salamanca have been met with legal threats from the Salamanca Town Hall Secretary Guillermo Maldonado. Secretary Maldonado confirmed that the landfill is not operating under municipal standards because of limited funding, creating a rise in local ecological damage and public health threats (foul odors and garbage trucks dropping waste on streets) (Montecillo 2018a). For example, during rains early in 2018, leachate from the landfill entered two farmers' plots, negatively impacting soil quality. A total of 130 thousand pesos were

given to the two farmers to compensate them (Rojas 2018). The issues faced by local inhabitants situated next to the landfill in Salamanca have also been experienced by residents in Oaxaca.

The establishment of the landfill in the town of Guillermo Gonzales Guardado in Oaxaca led to increased health risks and decreased standards of living for its residents, similar to the situation in Salamanca. Guillermo Gonzales Guardado is located on the outskirts of the main metropolitan city in Oaxaca. Residents mobilized to block the entrance of waste into the landfill to show their discontent with the health risk it poses. As a result of the blockade, waste accumulated in the main city in Oaxaca (Moore 2008). Residents of Guillermo Gonzales Guardado and Zaachila were able utilize their mobilization as leverage allowing their demands to be met (Moore 2008, Schroeder et al. 2008). Issues faced by residents in Oaxaca are a mirror image of those faced by inhabitants of Salamanca. The environmental hazards these marginalized communities currently face in several states in Mexico are environmental injustices.

**Waste and environmental justice in Mexico**

In Latin America, the most marginalized communities often experience the worst impacts on their health and the local environment—environmental injustices (Moore 2008). Environmental justice issues in Latin America have similar dimensions as those present in the United States. Racism in Latin America is replaced with racialized identities produced by structural racism, classism, and ethnic prejudice (in the form of a divide between indigenous peoples and 'whites'). Environmental justice movements in Mexico face added challenges in comparison to the United States due to a lack of support from organizations, corporations, or entities with financial power. Therefore, community organizing is one of the main (and in some cases, the only) methods to gain leverage to address environmental injustices as social capital acts as the largest force to confront environmental disparities (Schroeder et al. 2008).

In Mexico, there are only a few municipal dumps that comply with national regulations; a majority of the city council leaders do not allocate funds appropriately to ensure proper infrastructure and compliance (Global Media 2018, Montecillo 2018a, Rojas 2018). According to the Environmental Procurement and Land Management representative, the landfill near Buenavista, along with 47 other municipal landfills in the state, were not complying with

municipal government standards (Montecillo 2018b). Several city and state officials have announced plans to regulate the landfill appropriately but have not fulfilled these promises. This highlights the power imbalances between marginalized communities and elite stakeholders, who are able to influence the development and implementation of policy.

**Stakeholder influence on environmental justice and political ecology**

The politics of waste management, involving various stakeholders, predominately local communities and state agencies, disguises environmental injustices by rendering issues that arise as common occurrences and apolitical. Political ecologists have argued that private benefits may induce social or ecological cost as unintended consequences of modernization (Peet et al. 2011). Agustin Carrillo, the Director of City Services of Salamanca, responded to a congregation of townspeople protesting against the landfill by saying "I'm trying to convince them that it is beneficial for the entire city, not just for some or few people (Ortiz 2016)." Individuals are devalued in this case when there is a possibility of benefits for a larger population. By formulating his response in such a manner, Carrillo didn't address protestors' concerns, and failed to acknowledge that there are negative externalities associated with the landfill (Guthman and Mansfield 2015). On the other hand, the Town Hall Secretary, Guillermo Maldonado, announced potential legal actions that would be taken against future residents who protested the operation of the landfill by blocking waste delivery (Montecillo 2018a). Residents were continuously advised to concede impeding their ability to challenge the apolitical rendering of the landscape.

The townspeople can be described as "environmental subjects", who come together under a single political identity that cuts across towns, gender, and class, which unites them through struggles linked to their environmental conditions (Peet et al. 2011). By not acknowledging the concerns or even the group of people collectively, Carrillo further rendered the landfill as apolitical and devalued the group of individuals, hindering their mobilization and undermining their collective identity when challenging the politically contested space.

### Environmental justice and political ecology methodologies

My methods were influenced by the concept of environmental justice informed political ecology as I acted as an intermediary, focusing on advocacy-oriented science by providing open-ended questions for people to frame the research. The surveys allowed residents to share their experiences with the landfill and any potential nuisances it poses. Using interviews, I acquired more information on how the individuals have been impacted by the landfill, future changes they want to see, and beliefs behind why they believe nothing has been done to correct the issues of various stakeholders. By being in the area myself and interacting with the individuals affected by the landfill, I procured data that accurately depicts public sentiment towards the landfill in a more comfortable setting than an online survey or government survey. My role as a researcher was to provide a way to gather and transfer scientific information by utilizing advocacy-oriented science to record and present injustices occurring to the appropriate parties.

## METHODS

### Data collection and analysis

I collected particulate matter concentration measurements in the three towns of interest using four Particulate and Temperature Sensor Plus' (PATS+) from the Berkeley Air Monitoring Group. PATS+ is a portable rechargeable monitor that records particulate matter concentrations ($PM_{2.5}$), temperature, humidity, and battery voltage.

To assess air quality, I measured particulate matter (PM) of size 2.5μm for the duration of 10 days, two times each day at 9:00am and 5:00pm. Before commencing data collection, I recorded temperature, wind direction, wind speed, and precipitation at the starting point for mobile data collection (blue dot) (Figure 3). I began measuring PM and recording approximate locations at several times as I drove between La Labor, Valtierra and Buenavista (route depicted in Figure 3). Three air quality monitors were left stationary in each of the three towns to collect continuous data for 10 days. The La Labor monitor was located 2.25km from the landfill, the Valtierra monitor was positioned 2.14km away, and lastly, the Buenavista monitor was 1.63km from the site (Figure 3). I aggregated the air quality data to acquire averages for the different

times of day from 9:00am to 8:00pm for the duration of ten days for each of the three towns. I compared these averages to the allowable PM federal standard in Mexico.

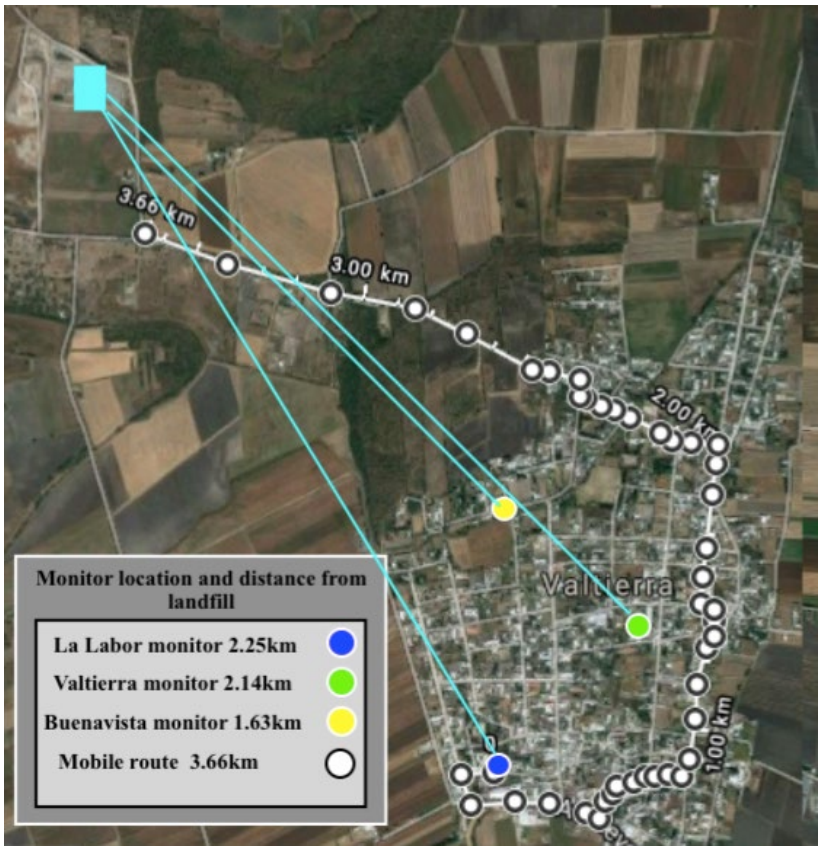


**Figure 3. Monitor locations and distance from landfill including daily mobile route**. Monitor location distance was calculated by measuring direct distance, linearly, from landfill to monitor location (blue line). Source: 2019. Google Earth.

*Public wellbeing*

To assess perceptions of public wellbeing, I administered surveys, collecting data on demography, knowledge of the landfill, and asthma incidence. I distributed and administered 40 surveys in La Labor and Valtierra and 59 in Buenavista by going door-to-door. Additionally, two town Delegates, where Delegates are elected town officials who represent the best interest of their respected towns, aided in survey distribution. I gave 6 surveys to the Delegate of La Labor and 13 to the Delegate of Buenavista. I processed the data by finding the rank, frequency, and percent of the different issues and questions.

*Public perception*

To assess public perception of the landfill, I conducted interviews. One resident from each town participated in interviews consisting of questions about their knowledge of the landfill, their experiences with the landfill, and their sentiment towards it. I also interviewed one delegate from each town. Finally, I analyzed municipal government representative actions and opinions pertaining to the landfill to understand their reasoning for the lack of government intervention in addressing environmental and health concerns. This revealed how stakeholder influence and perception were interwoven regarding the establishment of the landfill. The main arguments from residents and Delegates were complied into a table. Arguments were translated, categorized, and paraphrased by the author.

## RESULTS

*Landfill effects on particulate matter concentrations*

The town of Buenavista exceeded the federal standards for permitted levels of PM (2.5 micrometers or smaller in size) 8 out of 10 days of data collection in Salamanca (Figure 4).

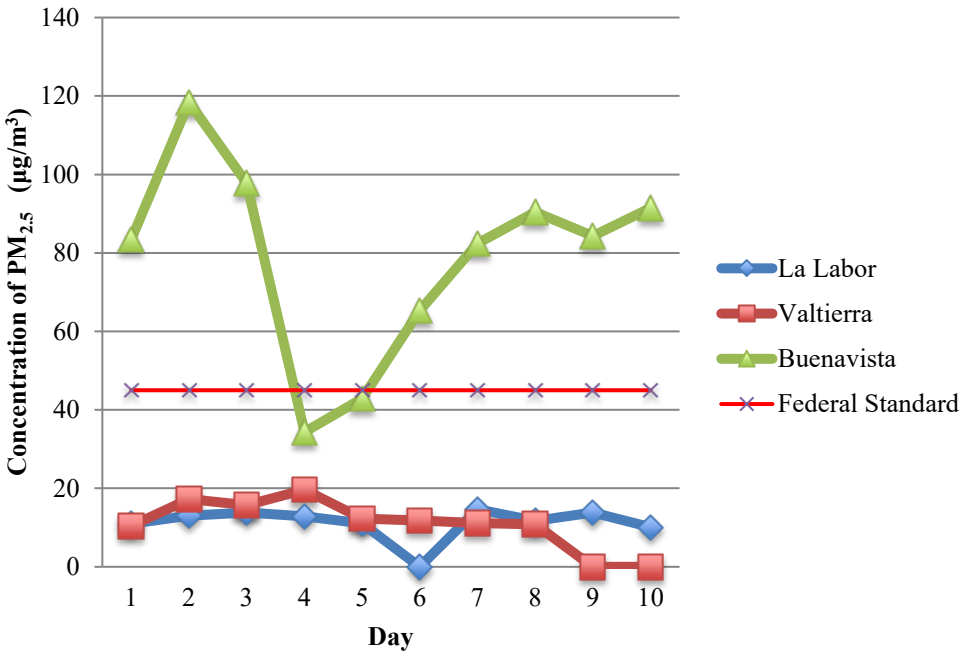


**Figure 4. Particulate matter daily means over the 10-day data collection period.** Buenavista had concentrations of $PM_{2.5}$ that exceeded the federal standard 8 out of 10 days. Distortions were created through monitor malfunctions, which caused no data to be collected being collected in Valtierra on day 9 and 10 and no data to be collection on day 6 in La Labor. Rain occurred on day 9 which may have decreased average PM and be the reason for Valtierra monitor malfunction.

*Landfill effects on public perception*

Residents identified refineries (31.68%) as having the greatest perceived environmental impact in Salamanca. Waste management ranked second, with just above one quarter of residents believing it to be the greatest environmental issue (Table 1).

**Table 1. Rank of type of environmental impacts.** Based on public opinion data from surveys, the highest ranked type of impact is refineries. Rank determined by frequency of response.

| Type of impact | Frequency | Percent | Rank |
|---|---|---|---|
| **Refineries** | 51 | 31.7% | 1 |
| **Waste management** | 44 | 27.3% | 2 |
| **Water pollution** | 27 | 16.8% | 3 |
| **Air pollution** | 12 | 7.5% | 4 |
| **Bad odors** | 8 | 5.0% | 5 |
| **General health** | 7 | 4.4% | 6 |
| **Factory** | 5 | 3.1% | 7 |
| **General pollution** | 5 | 3.1% | 7 |
| **Other** | 2 | 1.2% | 8 |

All individuals surveyed had heard of the landfill, and almost all had visited or passed by the landfill (Figure 5). Buenavista had the highest percentage of residents who reported experiencing foul odors from the landfill in their homes (98%). More than 90% of residents heard of public protest actions taken to close the landfill or demand it be properly regulated. Buenavista had the highest percentage of residents who heard of protests that took place to demand the pavement of the road (92.3%) (Figure 5).

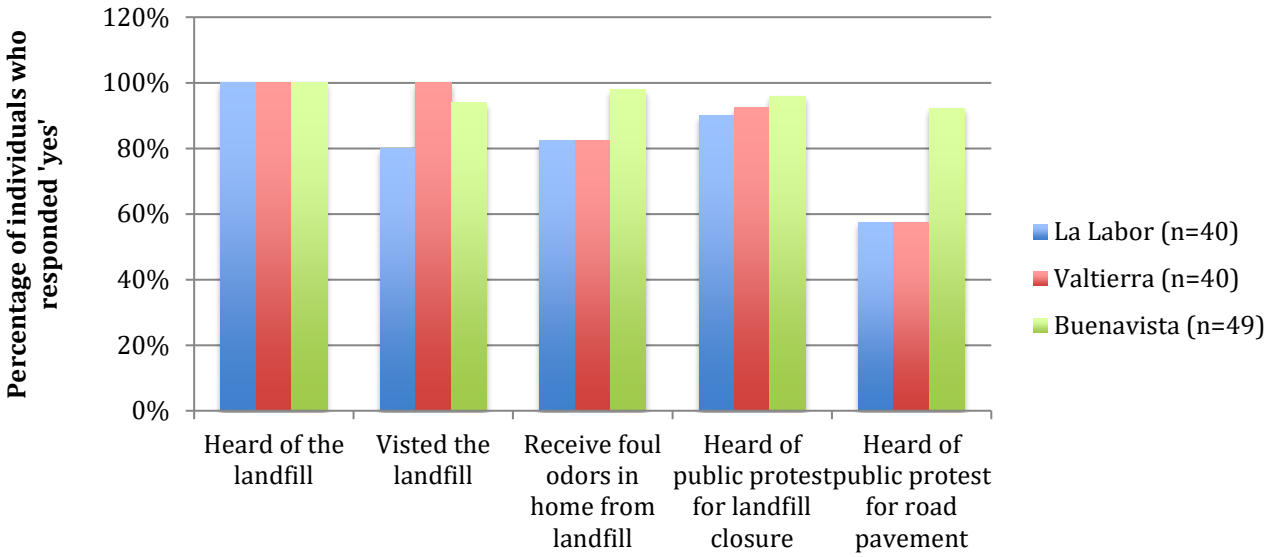


**Figure 5. Knowledge about the landfill.** Landfill impacts and awareness of landfill politics, by town residence.

A majority of residents interviewed were above the age of 65 (23.7%) (Table 2). Residents in La Labor had the highest incidence of asthma, 10%, while there were no reports of asthma in Valtierra. In Buenavista, 8.16% of individuals reported having asthma.

**Table 2. Age group of respondents.** A majority of residents surveyed are older (over the age of 65), which is classified as a vulnerable population that may be vastly affected by poor air quality. However, it must be noted that the sample size and these results may not be representative of the whole population as it is a small subset.

| Age group | La Labor (%) (n=39) | Valtierra (%) (n=40) | Buenavista (%) (n=49) | Total (%) (n=128) |
|---|---|---|---|---|
| 18-34 | 7.7% | 32.5% | 26.5% | 22.7% |
| 35-44 | 15.4% | 10.0% | 24.5% | 17.2% |
| 45-54 | 10.3% | 17.5% | 12.2% | 13.3% |
| 55-64 | 28.2% | 20.0% | 12.2% | 19.5% |
| 65 and above | 38.5% | 20.0% | 24.5% | 27.3% |

The interviews with public officials and residents represented an array of sentiments, experiences, and hopes for the future of the landfill (Table 3). The Delegate leading the greatest resistance against the landfill is Flores from Buenavista (the closest town studied to the landfill).

**Table 3. Opinions on the landfill from Delegates and residents.**

| Interviewee | Position | Opinion |
|---|---|---|
| Marisela M. Flores | Buenavista Delegate | The maintenance of the landfill is heavily politicized which is harming the environment and people. |
| Maria Armenta | La Labor Delegate | The maintenance of the landfill is poor and illegal dumping takes place. |
| Jesús García | Valtierra Delegate | In disagreement with the landfill due to resident health risks. |
| M. Cardenas | Buenavista resident | The creation of the landfill and its maintenance is heavily politicized which leads to marginalization. |
| H. Moreno | La Labor resident | The landfill's main issues and risks to individuals include foul odors and pose a public nuisance. |
| C. Jasso | Valtierra resident | Salamanca has various issues especially social ones, which affect incentives for public involvement with the landfill. |

I conducted further research into discourse concerning the landfill from government officials and entities present mixed arguments as residents and Delegates (Table 4).

**Table 4. Opinions on the landfill from government officials and entities.**

| Government Official/Entity | Position | Opinion |
|---|---|---|
| Gabriela Ledesma García | Director of Social Development | Believed that by residents blocking the road for waste trucks to enter, they affected more people. Stated they are in the process of beginning road pavement (July 2018). |
| José Hugo Hernández | Director of the Environment and Ecology for Salamanca | Stated that the processes and maintenance of the landfill were not being met, however, it is the Environment Secretary who needed to intervene (October 2018). |
| Antonio Arredondo Muñoz | Mayor of Salamanca | Stated the road pavement to the landfill would be completed by asphalt donated by Pemex or dealt by the federal program, SCT, as it was not within his authority. Also stated the needs of the rural population were a priority. (December 2016). |
| David Pérez Alvarado | Director of Public Services | Affirmed he is working to address the issue of the lack of machinery to compact waste (Rojas 2019). |

## DISCUSSION

Examining the relationship between environmental and social factors associated with the politics of waste in Salamanca offers insight into environmental injustices experienced by residents, and points to the need for the enforcement of existing MSW regulations by local government. Residents engaged in public protests and other tactics to gain political attention and demand their voices and complaints be heard. A majority of the individuals participating in these protests were middle-aged people who are discontented with how waste was being handled, and were mainly from the disproportionately affected communities of Buenavista and Cerro Blanco.

I identified the need for political attention and action to address current issues, as otherwise they will continue to be rendered as apolitical and not be resolved. Yet structural and political forces impede the wellbeing of residents in the three towns studied due to improper MSW management.

**Air quality and health**

Poor air quality in Buenavista based on elevated levels of $PM_{2.5}$ introduces heightened potential health risks. In Mexico, measures have been introduced in the last five years to assess and monitor air quality, where previously there were no limits or restrictions on $PM_{2.5}$ prior to 2014 (Vega et al. 2002, Fernández-Bremauntz 2008, SEGOB 2014). Federal standards introduced in Mexico are stricter than corresponding ones in the United States, where the Mexico federal standard states: $PM_{2.5}$ or smaller should not exceed 45$\mu g/m^3$ on average during a 24 hour period (annual average limit is 12$\mu g/m^3$) (SEGOB 2014). I had predicted that overall air quality in the three towns would be poor, and $PM_{2.5}$ exceeded the Mexican federal standard in the town of Buenavista 8 out of 10 days of data collected, while the averages of $PM_{2.5}$ in La Labor and Valtierra were acceptable (Figure 3). There is a well-established relationship between increased $PM_{2.5}$ exposure and respiratory morbidity, mortality, augmented respiratory ailments, and increased mortality of cardiovascular disease (Vega et al. 2002, Anderson et al. 2012, Wu et al. 2019). My results unexpectedly revealed a low incidence of asthma in all three towns. However, this this may be explained due by the small sample size, and requires further research. Elevated PM concentrations in conjunction with an older population make for a higher likelihood of potential respiratory and cardiovascular effects (WHO 2003, Herrera Murillo et al. 2012, Wu et al. 2019).

Children are also more sensitive to poor air quality; they are dramatically more susceptible to contracting respiratory ailments as they are still developing (Mathew et al. 2015). Where the elevated levels of PM were found (Buenavista), there is a local primary school nearby that is just on the edge of the town, located approximately less than 1km away from the landfill.

**Public wellbeing and environmental justice**

A majority of the residents ranked refineries as the having most severe environmental

impact, followed by waste management (Figure 1). Less than a 30-minute drive away, approximately 17.5km from La Labor, is the Pemex oil refinery. These oil refineries not only pollute the air, but also pose a danger to general safety as in recent years there have been explosions due to poor management (Davis 2006). In the bordering state of Jalisco, a similar study yielded parallel results in the metropolitan area of Guadalajara (Castro et al. 2016). In Guadalajara excessive generation of waste ranked first and vehicle smog emissions ranked second in terms of the greatest mode of contamination (Castro et al. 2016). Most of the survey participants indicated they had heard of the landfill and were aware of protests against it (Figure 4). Due to mild support from public officials, little traction has been gained to address the landfill appropriately. Consequently, community organization has proven difficult sometimes due to economic and childcare restraints, which limit continuous mobilization by residents (Schroeder et al. 2008).

The question regarding residents' experience of foul odors in their homes elicited unexpected responses. In addition to answering yes, several residents also pointed out that large green flies began to appear on their properties. In a study conducted in West Midlands, the abundance and presence of several fly families were identified (Howard 2001). In accordance with descriptions provided by residents (the repeated mention of bright green bodies), the likely fly type would be *Calliphoridae* ('blue' and 'green' bottle flies mainly) (Howard 2001). Such flies pose nuisances and also have the potential to carry disease (Howard 2001). Clearly, the wellbeing of the public is being jeopardized through various modes of environmental injustices.

**Apolitcal ecological rendering**

The rendering of the landfill as a politically contested space has led to public protest and discontent. The actions undertaken by residents regarding the landfill are a means of challenging the apolitical rendering by local government officials. Through interviews and research, several statements and experiences the resident and Delegates have had in relation to the landfill justify their negative sentiment towards it.

The landfill poses several health risks to communities and workers through environmental contamination through illegal practices. In several surveys, along with testimonies from the Delegates Flores and Armenta, they identified the illegal dumping of viscera and waste

from animal slaughterhouses (Armenta, M. 2018, Flores, M. M. 2018). When such waste is dumped into a landfill, the risk of bacterial, viral, or parasitic infections increases (Franke-Whittle and Insam 2012). A recent newspaper article by Eugenia Rojas reported that this practice had ceased (Rojas 2019). Since then, there have been no reports of further slaughterhouse waste dumping in the area. I visited the landfill and noticed the lack of proper attire and safety equipment such as masks, leaving workers exposed to several pathogens and inappropriate working conditions, which may hinder their ability to properly perform their jobs. Delegate Armenta mentioned that improper methods of waste layering were occurring (Armenta, M. 2018). The anatomy of a landfill includes layers of soils, plastics, clay, drainage, and leachate systems (Waste Management 2003). After every working day, soil layers should be placed above compacted daily litter in order to diminish odors and keep waste from scattering (Waste Management 2003). However, soil is being omitted from the waste layering in Salamanca (Armenta, M. 2018, Rojas 2019). Moreover, there have been rumors of individuals selling the soil that was supposed to be used for the landfill.

Flores was one of the individuals affected from leachate leaking out of the landfill and penetrating her crop soils. She showed me several images and videos of the black-brown liquid. She and the townspeople refer to leachate as “black venom” (Flores, M. M. 2018). During heavy precipitation months, leachate readily leaks out of the landfill and into nearby unpaved public dirt roads and local residents’ backyards less than 50 meters away (Rojas 2019). Leachate readily and frequently leaks from the landfill, suggesting that a leachate collection pipe system is not present, or is not sufficient. Leachate can comprise several toxics and metals that can easily infiltrate groundwater supplies and nearby soils that can contaminate the human body and crops (Akinbile and Yusoff 2011). In a broader context for Guanajuato, this is a major public health issue. Guanajuato heavily relies on groundwater, so improper vigilance of landfill practices may potentially put their largest source of water at risk of contamination (Rodriguez et al. 2002). The Delegates stressed that improper monitoring and compliance with regulation jeopardizes health.

The residents spoke to the disconnect between the government and the people. All three residents who were interviewed indicated the landfill was placed there without the consultation or consent of the residents. Initially residents fought for paving of the roads leading to the landfill. The focused then shifted to forcing the landfill to follow proper regulations, and now the residents are demanding its closure. Broken promises have left residents with no hope for it to be

properly maintained. The mayor of Salamanca, Antonio Arredondo Muñoz, heard the constant complaints from residents for the pavement of the road, and responded by stating that it is not within his authority to address it (Table 4). The pavement of the road was to be completed by asphalt donated by Pemex or the federal program SCT (Table 4). However, initiating and completing the project took several years. Mayor Muñoz stressed that the rural population was his priority in an interview, however, his actions showed otherwise (December 2016). It seems avoiding responsibility over who must address the landfill's issues occurs quite often, as nobody wants to take direct actions to address the inappropriate management of the landfill.

Several survey respondents referred to the landfill as 'clandestine', indicating that they believe the lack of municipal involvement is a technique to keep it concealed and continue to operate. Recently, José Hugo Hernández, the Director of the Environment and Ecology for Salamanca, acknowledged that the landfill was not being properly managed. However, he stated that the Environmental Secretary must intervene, as it is not an issue he could address himself (Table 4). Hernández acknowledged the fact that the landfill is operating inappropriately, however, all of the effects on residents and even the environment are omitted (González 2018). Gabriel Ledesma García, the Director of Social Development, responded to blockading entrance into the landfill by residents by saying they were affecting more people unintentionally (Table 4). Similar to how Carrillo failed to acknowledge the negative externalities of the landfill residents face, García did the same. In doing so, the protestor's concerns and suffrage were seen as less than those of the larger population, rendering these issues as apolitical and attributed to the residents' actions (Guthman and Mansfield 2015). It seems that in the eyes of city officials, this is a small price to pay for the benefits the landfill poses for the majority (including themselves).

More recently, fires and poor maintenance of the landfill has left residents wanting the landfill closed. A fire broke out on January 25$^{th}$ of 2019 that began at approximately 3:00pm and continued until 9:00pm due to a local pasture, which was burning 1.5km away, eventually reaching the landfill (Domínguez and Rojas 2019). The incident was particularly alarming because nobody contacted the residents nearby to warn them of the fire. The Delegate of Buenavista, Flores, had to evacuate 5 families that live closest to the landfill, as no authorities who contacted them of the fire or what they should do (Domínguez and Rojas 2019). In a separate incident in March 2019, four days went by while piles of daily waste accumulated

without being compacted (Rojas 2019). Due to this, mounds of loose waste accumulated, leaving residents fearing their collapse (Rojas 2019). David Pérez Alvarado, the Director of Public Services, stated that they were utilizing four borrowed compactor machines, and were in the process of purchasing some (Rojas 2019). These issues could have been avoided or minimized if proper practices and maintenance were taking place. Little has been done to address the larger issues of the landfill, which means that incidence such as these will continue to occur.

Similar to the apolitical stance representatives in Salamanca have taken when addressing the negative externalities the residents mention, the case in in Zapopan, Jalisco presents a mirror example. Zapopan is a city that contains more than 100 hectares of land dedicated for waste disposal in two large landfills. Since 2009, residents have voiced complaints of effluent being discharged into the nearby Grand River of Milpillas, and have demonstrated their discontent with the landfills by blocking entrance of waste vehicles into the landfill for up to 72 hours, in addition to paying 23 million pesos out of their own pockets to test the water contaminated by the effluent (Castro et al. 2016). The results yielded traces of heavy metals and organic volatile compounds that are known carcinogens and endocrine disruptors (Castro et al. 2016). The residents presented this information to the municipal government, which dismissed the results and absolved any responsibility it had to control and monitor activity from the landfills (Castro et al. 2016). This is similar to what residents have experienced in Salamanca. Their experiences and proof of environmental contamination and injustices were met with dismissive government officials/entities to relinquish responsibility. In the case of Zapopan, the Secretary of the Environment and Territorial Development (SEMADES) went as far as to test the water, where their results differed from those that the residents obtained. Their results indicated that there was not any contamination near the zone of the landfill and the environmental impacts were smaller (Castro et al. 2016).

The case in Zapopan has been occurring for more than 10 years, during which time residents have taken extensive measures to prove the environmental and health damages the landfills are having on them. Environmental injustices are seen across Mexico, where municipal and government officials attribute environmental degradation to consequences of living in metropolitan areas or for the need of the greater good of society. As previously mentioned, several states across Mexico including Oaxaca are facing injustices similar to those of residents in the town of Buenavista (Moore 2008). Residents closing off entrance into waste sites allows

for waste to become visible in the streets from which it is collected. Waste tends to be collected from usually 'cleaner' cities and then disposed of in landfills located by marginalized communities, which must deal with the consequences of poor zoning. In the case of Oaxaca, waste piled up in the city where the municipal government was forced to comply and increase the wage of workers as residents were complaining of the foul odors and pests that arose due to no MSW collection (Moore 2008). Waste is utilized as an asset to gain leverage to meet their demands and have their issues become visible (Moore 2008). Mexico presents a pattern of environmental injustices being overlooked and normalized by rendering them as apolitical; however, identifying these issues is the first step to address them. Through advocacy-oriented research the process of politicizing the issues is achieved.

**Limitations and future directions**

Most of this study's limitations are the result of a limited data collection period. The same air quality testing protocol could be implemented over a longer period to account for weather variability and reduce the impact of distortions from monitor malfunction. Permission was not granted to install a monitor at the landfill for this study, which did not allow for a direct connection of poor air quality in Buenavista due to the landfill. Due to a limited survey sample size, this may generalize responses by town inaccurately. Additionally, only one question associating poor air quality with a health consequence was asked. Most of the limitations were posed by limited time, where future directions of the study can account and address these limitations by allocating more time to data collection.

Future studies could also account for several limitations posed by time constraints and include questions that account for other health risks the landfill poses/augments. My findings suggest that future research may be needed to monitor air quality during different seasons to account for seasonal variability, which may elevate or diminish $PM_{2.5}$ concentrations. Since elevated levels of $PM_{2.5}$ were found in the town closest to the landfill, this would indicate that there is a possibility the landfill may be causing augmented levels of PM in the town, however, this is not verified. Proper permits can be attained in order to place a monitor in the landfill, which would allow for on site measurements to measure worker exposure and direct concentration of $PM_{2.5}$ emitted from the landfill. Additional key questions could be asked to

measure plausible health risks directly and indirectly caused by the landfill. For example, a question asking how many children under the age of 18 live in the home would allow to account for child exposure (which I did not), as they are more susceptible to suffer from respiratory ailments (Mathew et al. 2015). In addition, a question asking how often children wheeze should be included, as it has been identified as a key indicator for asthma according to several epidemiological studies (since preventative care is not practiced) (Mathew et al. 2015). Finally, a question asking individuals if they have diabetes or cardiovascular disease can be include, as these individuals have increased likelihood of stroke in the presence of elevated levels of air pollution (Anderson et al. 2012). As the number of individuals diagnosed with diabetes is only on the rise due to poor diet, this is a very important variable to consider (WHO 2017). Although there are several future directions this study can take on, as is, there are several implications that can be drawn from the results to illuminate potential local government actions.

**Broader implications**

This study provides insights into public sentiment and strategies that can be taken by residents to engage local government in Salamanca and other cities with uncontrolled dumps to accommodate both the city and local residents by challenging apolitical renderings of the landscapes. Poor air quality may be a result of limited funds being allocated for public infrastructure such as the pavement of roads. Although the government currently offers partial payment for road pavement, residents are still required to pay a portion of the costs by paving for each kilometer of their property along the public road. Subsidies based on income are not provided. Consequently, some individuals cannot afford the costs. In 2015, flat screen televisions were distributed to individuals who qualify as low-income or participate in one of the several government social services programs in the country of Mexico. The reason for this was to switch from analog to digital TV, which the US also accomplished in 2009. Approximately 600 million dollars were spent on this project, where they could have easily reduced costs per individual by half by purchasing digital converter boxes instead, however, there are rumors of potential negotiations that occurred for private benefits (Sewall 2011, México Hace 2015). This money could have been put to better use in increasing medical aid or investment in public infrastructure to better the lives of residents. I found the highest PM concentrations in Buenavista, where no

monitoring had been taking place. With this in mind, the city of Salamanca could invest in larger subsides to pave the roads leading to the landfill to diminish PM.

I found that a majority of residents were willing to compromise on the placement of the landfill near their towns, as long as there was proper regulation, and illegal dumping ceased. In this case, policy intervention is not needed: only proper and regulation and compliance with standards already in place. There have been many broken promises regarding the regulation and monitoring of effects of this landfill. Now, effective regulation and enforcement are no longer only demanded, but needed. Survey participants voiced numerous quality of life concerns, like large green flies invading their homes and foul odors penetrating their clean clothes hanging out to dry. The residents hope that with the new mayor in office, broken promises cease and are replaced with much overdue actions. With this case study, I have highlighted the voices, opinions, and experiences of the residents of Buenavista, Valtierra, and La Labor. They reveal many environmental injustices exacerbated by an apolitical rendering of the landfill. Residents demand and have acted to assure proper enforcement of regulations to protect themselves, their environment, and the earth by re-rendering the landscape as a politically contested space through protest and the use of advocacy-oriented science.

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