The Impact of Brownfield Remediation on Food Stores in Baltimore, Maryland

Thesis

Presented in Partial Fulfillment of the Requirements for the Degree Master of City and Regional Planning in the Graduate School of The Ohio State University

By

Rebecca Anna Carr

Graduate Program in City and Regional Planning

The Ohio State University

2024

Thesis Committee

Bernadette Hanlon, Advisor

Kareem Usher

Abstract

There has been significant interest in the process of brownfield remediation, particularly potential economic benefits to the areas involved. However, there has not been as much research on the potential impact to the food stores within the area. This study looked at the impact of brownfield remediation on the amount of food stores within the city of Baltimore. To do this, a linear model was used. The data selected was from the Data Axle historical business data set to find the grocery stores. The data for brownfields was taken from the Maryland website. The control variables based on food systems and remediation research were taken from the U.S. census bureau.

The model used was a fixed effects panel linear model. This was chosen based on the data because it was suitable to control for other city-level variables. The model was run using the program R.

Dedication

Dedicated to my family for supporting me, and for my friends I have met during this program who I have learned a lot from. Also dedicated to the City of Baltimore for its resilience.

Acknowledgments

Thank you to Bernadette Hanlon, Kareem Usher, Kelsey Badger, and Sahar Khaleel for your invaluable help with this research. Thank you to Jamie Harding and the team behind the Maryland Food Systems map at Johns Hopkins and to the City of Baltimore for providing vital data. Thank you to Randy Bartlett for fostering my interest in city planning.

Vita

Smith College

Major Field: Bachelor of Arts in Economics

Burton Planning Services 2022-2024

Fields of Study

Ohio State University

Major Field: City and Regional Planning

Table of Contents

List of Figures

Chapter One. Introduction

Brownfields are former industrial sites that have or previously had contamination, often in the form of dangerous chemicals. Since the 1990s, the Environmental Protection Agency (EPA) as well as state governments have invested in the remediation of these sites. This remediation can provide different options for the community in terms of the reuse of these sites. Research notes that the reuse of remediated sites can offer the surrounding area economic benefits. The following research focuses on the ways in which the remediation of brownfield sites might increase the number of food stores in the neighborhood where this site is located, increasing local food access for neighborhood residents as a result.

In this study, the hypothesis is that remediation will have a positive effect on the introduction of food stores at the neighborhood level. This means that after the remediation process, there will be a significant increase in the amount of food stores within the census tract of the remediated site.

There is research on how brownfields remediation affects the economy, namely in the form of job gains, however there is not much research on how this impacts the number of food stores in the area or how it impacts food access for the involved residents.

This research will add to the current literature on brownfield remediation by examining impacts beyond economic development and job growth to include specific businesses, in this case food businesses. This study will also add to the literature on food access by identifying any connection between brownfield remediation and food business development.

Chapter Two: Literature Review

To understand the impact of brownfields on the increases in food stores of a neighborhood, it is first important to understand what kind of impacts brownfield have on local communities, and how their remediation relates to local economic development. In addition, it is important to know what factors impact food access across neighborhoods with the intention of identifying what might influence the location of food stores.

Impact of Brownfields on Communities

Brownfields have long term impacts on the communities affecting land use, the economic environment, and population. These factors and their relation to other aspects of the community such as food systems merit additional consideration.

Disinvestment and Perceived Contamination

While brownfields can cause harm to the community directly via toxins and land contamination, they can also have less direct impacts. The following research discusses how brownfields can lead to disinvestment, and this disinvestment can lead to fewer businesses within the area.

One of the reason brownfields continue to be unaddressed is because they pose less of a threat than other, more severe forms of contamination. Consider the difference between a brownfield and a superfund site. Smollin and Lubitow (2019) in their discussion of brownfield sites distinguish brownfields from superfund sites in being less

contaminated, and therefore less likely to be targeted for being cleaned with federal funds. While brownfields can be addressed through smaller or community-lead interventions, superfund sites are often areas that require evacuation or immediate intervention. However, though brownfields are less severe, this does not make them a solved or insignificant problem.

The sites that are identified as brownfields have had manufacturers leave these sites behind to move on, often to more green sites. These old sites are left behind and are left untreated. There is less interest to treat because these sites are seen as not having a high market value, which leads to more disadvantages to the communities where they are located (Eisen, 1996). Brownfields are an indicator of industrial decline, and when a site is identified within a community, it indicates the community has a legacy of industrial decline and economic decline as a result (Bambra et. al, 2014). Brownfields are a physical representation of a loss of industry and jobs.

Having multiple brownfield properties in the same area ("scatter site brownfields") can drive down the property value of each of these sites (Meyer, 2010). This is true even when the properties are nonadjacent to each other and implies that property values can be worsened when there is a larger cluster of brownfields. Meyer (2010, p. 57) writes that "although communities across the United States struggle to regenerate after economic declines produced by business closings and relocations, many confront land contamination issues that compound the problem of depressed property values." This indicates that there are multiple factors which can lead to economic decline,

but these factors can be exacerbated by the presence of brownfields within the community.

Bambra' et. al's 2014 research on brownfields in a community shows that communities can develop a stigma around them. The contamination from the brownfields (real or perceived) has a type of psychological effect. "Indeed, work by Cattell (2001) and Airey (2003) has shown that such environmental place-based stigma can result in psychosocial stress… and feelings of shame. Brownfield land can often be unsightly and is by its very nature disused, derelict, or 'dirty' land." (Bambra et al., 2014, p. 435)

Effects of Abandoned Properties

When areas are seen as unsafe and not worth investment, it leads to vacant properties. Brownfields themselves are, by definition, abandoned areas because they are sites which may be contaminated by a hazardous substance, which makes these sites not safe for regular use. Occupational Safety Heath Administration guidelines indicate that if these sites are used improperly, it can lead to injury. (U.S. Department of Labor, n.d.)

A study done by Garvin et. al in 2013 surveyed several residents of Philadelphia who live in low-income neighborhoods with high amounts of vacant properties. Even within the community, the respondents to the survey felt that there is evidence of a perceived stigma because of the abandoned areas and felt "unfairly judged by outsiders". Vacant areas can overshadow other characteristics of the neighborhood and cause residents to feel their efforts are futile in trying to address the issues. Community members have ideas and interest in wanting to see less vacant properties, but feel they have a lack of resources, which causes feelings of hopelessness. (Garvin et. al, 2013).

Residents also reported feelings of negative emotion surrounding their community due to the vacant properties. While it is important to recognize, from an economic perspective, the lack of outside investment and its detrimental effects, it is important to understand the effects of brownfields on community residents themselves.

Racial Inequality

Like other environmental hazards, there is evidence that brownfields' locations display racial inequity when it comes to the populations of those affected communities. One study examined Black and Hispanic communities to determine exposure to environmental hazards. This research shows that communities with higher amounts of low-income residents and people of color are more exposed to environmental hazards. (Ash and Fetter, 2004). However, it is important to distinguish between different types of environmental hazards and how these hazards may have greater impact in historically Black and Hispanic communities.

The spatial analysis of Baltimore had very unusual patterns compared to the rest of the country, because at a neighborhood level, there are more white neighborhoods that are near industrial sites then predominantly Black neighborhoods. This is due to the racial discrimination that excluded Black families from living near industry earlier on to reduce their access to jobs. (Boone et. al, 2014) The study examined this pattern and found this delineation has remained consistent over a period of 60 years. The case of Baltimore shows that discriminatory practices can have economic ripple effects many years later.

Brownfield Remediation Effects

In addition to toxin removal from an area, there are many other positive effects achieved through brownfield remediation. According to Building Vibrant Communities, the process of remediation should begin with community engagement. The process then involves input from stakeholders. The process of engaging the community is meant to communicate with the stakeholders from the community, identify gaps in the market such as missing utilities (for example, grocery stores) and other types of market failures in order to help address these gaps through remediation. (EPA, 2008, p. 12.)

Urban centers have often been targeted for remediation. Rural brownfields have a "locational disadvantage" when compared to urban brownfield remediation. (Navratil et. al, 2021) This bias is important to consider when reviewing the long-term effects of remediation on a community. This is why Baltimore was selected rather than the broader Maryland landscape of remediated brownfield sites. A greater likelihood of remediation sites, particularly completed remediation sites, exists within the city.

Economic Benefits of Brownfield Remediation

Part of the reason for brownfield remediation is overall economic benefit. The Maryland Brownfield Redevelopment Assistance Program states that the redeveloped brownfield sites can be "assets for revitalization, reinvestment, and redevelopment."(Maryland.gov) Since the development of the EPA's program on brownfield remediation, there has been significant research into the impact of brownfield remediation on the economy.

It is also important to understand the impact of the private market in brownfield remediation. Brownfield sites can have an economic benefit and can be sold after remediation for reuse, but there can be barriers to this resale. While contaminated sites themselves can cause low property values, the presence of contamination at adjacent sites can also have an impact. This means that the brownfield sites do not only impact the site themselves but also the surrounding area or possibly even the census tract. There can also be hesitancy for property owners to buy remediated sites because they are expected to pay for the cleanup. (Howland, 2010). This study implies that the presences of contamination will cause a decrease in the property value. When there is no government intervention to remediate the properties in the form of subsidies or grants, they are often sold at a discounted price.

Related to this, a study by Haninger et. al (2017) found that Brownfield remediation has a positive benefit to housing prices. On page 239 of this study, a cost-benefit analysis of brownfield remediation determined that the economic benefits greatly outweigh the costs.

A 2004 study by Howland found that many former brownfields sites are used for commercial use, even though they were previously industrial use sites. This means they impact economic development by bringing more commercial properties and more businesses into the areas.

In 1994, the National Institute of Environmental Health Services launched a program called Environmental Justice: Partnerships for Communication. (Bullard et. al, 2011, p. 256) This program awarded grants that supported research into worker training

programs. They created the Brownfields worker training program which trained predominantly Black and Hispanic workers in the remediation process. This program allowed workers to transfer these skills for other types of employment after the cleanup process was over. (Bullard et. al, 2011, p. 257) When these programs are properly funded, they allow for job training and job growth.

When reviewing economic benefit, it is necessary to be aware of the tradeoff between job creation and community health. Areas that are considered blighted seem to be less likely to get treated because they are not seen as a viable investment. This is dangerous because it will lead to worse economic outcomes to these neighborhoods and leaves sites untreated. (Howland, 2004) While the remediation seems to have had a positive impact on the areas it happens in, it is most effective in areas that are less contaminated and located within stronger local economies. This means that the socio-economic status of the community is a contributing factor to the economic effectiveness of the remediation process.

This is also present in some of the remediation cases within Baltimore specifically. One example was a riverfront property which was used for remediation across the river from high end condominiums, which needed very little public subsidy. (Howland, 2004) This could present an issue with the current study; where there were already contributing factors such as a better socioeconomic status and might need to be accounted for within the study.

Food Access

To understand the impact of remediation on the food system, it is first important to understand what indicators can influence food access. Once these are identified, it becomes easier to then determine factors that influence the overall location of a grocery store.

Writing by Freedman et. al in 2022 states that "neighborhoods in the United States with a history of disinvestment, sanctioned by racist policies, tend to have fewer stores selling fresh and healthy foods, higher rates of food insecurity, and poorer diet quality." This demonstrates how the issue of disinvestment within a community and systemic racial discrimination are tied into food access. Another study found that predominantly Black and low-income neighborhoods in Baltimore had significantly lower availability of healthy foods than predominantly white and higher-income neighborhoods. (Franco et. al, 2008, p. 565) This was attributed in part to the relatively fewer numbers of supermarkets in predominantly Black neighborhoods. According to Sadler et. al in 2021, toxic exposures have a negative impact on food access. This can result in long term effects in the Black neighborhoods which were studied.

The study by Freedman et. al in 2022 used a qualitative method of engaging community stakeholders to understand the mechanisms behind food systems and food insecurity. The study, performed in Cleveland, OH, determined that addressing racial inequality within food access cannot be addressed solely by encouraging more businesses to be included within the neighborhood, but also by encouraging current businesses to sell more healthy options and ensuring that community members have enough money to

buy healthier food. This implies that consumers need to have adequate funds to be able to purchase food in addition to having better options provided within food stores. This also demonstrates the importance of engaging with the community when trying to find solutions for food insecurity.

According to Whelan et al in 2002, having different options of stores provides variety in food. It has an impact on the consumer and what they will purchase. The study found that participants would shop at stores that were more affordable. A program in Baltimore intended to address this issue of affordability worked with both supermarkets and small corner stores to increase the number of healthy options offered to residents. It is worth mentioning that several of these stores already had relatively healthy options in stock before the intervention, but the program still successfully supplied various residents with more healthy food options. (Gittelsohn, 2010, p. 728).

Location is identified as another important factor in determining where consumers buy food. In Whelan et al.'s 2002 analysis, "physical accessibility to food shops was an underlying issue for the residents of Seacroft /Whinmoor." (p. 2094). Grocery stores that are further away are less accessible to residents who do not own a car. Because of this, grocery stores that are nearby are more convenient. This trend is correlated with income because it is an affordability issue, but also affects convenience. Many women in the study by Whelan et. al would specifically choose stores within easy walking distance to save money on bus or taxi fare. This is another instance where residents could be helped by the inclusion of more food stores within a given area.

There is a significant price difference between budget stores and superstores. This is important because it shows that income is a contributing factor in food access. Budget stores are meant for consumers with a lower socio-economic status, which can be a discouraging factor for other grocery stores to move into these areas. Budget stores can also have a negative effect on the neighborhood, because they do not offer enough variety and encouraging buying food that isn't needed. Whelan et. al (2002, 2091) state that "Many of the participants in the study claimed that shopping at budget stores was a 'false economy' because they either bought tins of food that were not eaten or doubled up on their shopping because the range of food was not adequate." A weak economy can lead to predatory stores that move into the area and do not provide benefits to the food system.

An important indicator when it comes to food systems is transportation. If the location is too remote it will impact what stores are available. Due to the lack of transportation access, this has an impact on the number of consumers who can access the stores. According to a study of the characteristics of food deserts, "comparisons between food desert tracts and other areas suggest that the disadvantaged status of food deserts is also reflected in lower vehicle access rates" (Dutko et. al, 2012, p. 13). This suggests that there is a connection between vehicle access and food availability and that vehicle access could be an important indicator in determining the amount of grocery stores in an area.

Another factor that influences food availability is the size of the stores. This is particularly the case in Baltimore, which has a large number of single-aisle stores (Laska et. al, 2010, p. 1033). This can impact access because it results in fewer food options for

residents when considering food stores specifically, which could be addressed by higher amounts of stores overall in these areas.

Food Store Locations

As stated above in Laska et al's (2010) study, Baltimore has a large number of small, even single-aisle, stores. Another study of randomly selected census tracts within Baltimore found that small and medium food stores, as well as carry-out restaurants, were the predominant food sources within Baltimore. (Gittelsohn et. al, 2007). In Pothukuchi's 2005 discussion on grocery stores, smaller floor areas are less attractive to big box stores and are seen as a less viable economic option, which can lead to smaller storefronts being abandoned by these companies in the name of profit. Stores are interested in reducing operating costs to maximize their profit.

Focusing on large retail development or chain stores is not the only option for improving communities. Investing in small business food stores or farmers markets is also an alternative. These stores do not have the same issues of recruitment that large chain stores have who might not be interested in opening stores in specific areas (Pothukuchi, 2005). However, this does not mean that communities should avoid supermarkets altogether. In a community food empowerment bill, both direct involvement with farmers and markets as well as community development initiatives were highlighted as provisions (Gottlieb and Fisher, 1996). This provision also states that community groups can play a key role in the process to bring big box stores to urban communities.

As transportation is an important factor in food access, it is of great importance in food store location. If the location is too remote, it will impact what stores are available. Due to the lack of transportation access, this distance has a significant impact on the number of consumers who can access the stores. According to a study of the characteristics of food deserts, "Comparisons between food desert tracts and other areas suggest that the disadvantaged status of food deserts is also reflected in lower vehicle access rates" (Dutko et. al, 2012, p. 13). Low vehicle access, as well as diminished access to transportation could be an important indicator in determining the amount of grocery stores in an area.

Population can also give important context to food stores, particularly in urban areas. In a study by Pothukuchi in 2016, stores were more successful in areas with a population which was decreasing at a lower rate than other areas. The focus area for this study was Detroit, a city that has historically had varying trends in population. The study mentions that Detroit's population peaked in 1950 and had been shrinking until the beginning of the study period. Similarly, Baltimore's population has been in an overall decline since the 1950s. However, when broken down by census tracts, the individual variances in population for each census tract can change at different rates than the overall population. This is why population is an important factor in the outcome of food systems. The population will impact the need for food and the number of suppliers. A decrease in population can make it more difficult for a business to survive in that area.

From an economic development lens, there are several potential issues with attracting grocery stores and food stores to low-income neighborhoods. One potential

problem is that there may not be enough business to support the store. This is mainly due the income base of the community (Grocery Store Attraction Strategies, 2007).

Another issue is the stigma within the community about safety. Perceptions of crime and disinvestment within the area, whether real or perceived, can be a deterrent for grocery stores to develop in the neighborhood. The study by Garvin et. al (2013) discussed how many residents can feel more unsafe in areas with abandoned properties, so the remediation of these sites could help to improve the concerns around this. Related to this, the study by Dutko et. al in 2012 mentions that vacant or abandoned properties are a factor in determining food access. More specifically, areas with a higher number of vacant properties are more likely to be food deserts. Given that brownfields are vacant properties, this provides another possibility for improvement within the neighborhood once the sites are remediated.

Density, the amount of people relative to the size of the area, has an impact on food store locations. The study mentioned earlier by Dutko et. al (2012) found that density is associated with food deserts. Less dense urban census tracts were found to have density as a significant factor in a regression model using a list of food deserts. Another study by Nilsson (2023) found that if the density of an area increases, there is an associated increase in food stores, but if the density of the area decreases, it is not associated with a decrease in food stores.

A contentious point around food access is whether dollar stores are likely to result in worse food access and fewer grocery stores within the neighborhood. Chenarides et. al's research (2021) on dollar stores found while that dollar stores are unlikely to enter

established food deserts, they are more likely to establish themselves in areas which have recently become food deserts than other grocery stores. However, most dollar stores have relatively few food options for sale. A policy aimed at preventing dollar stores from moving into an area specifically targets stores which have “less than 500 square feet for storing fruits and vegetables” (Chenarides et. al, 2021, p. 2). Because of the smaller size, these stores can have less space for storing food and do not have the capacity for storing fresh vegetables. This impacts the amount of produce that can be kept in the store.

There are ways to draw food stores more directly into an area. One possible method to attract food stores to areas is the use of grants. Grants are provided to stores within a community through the public sector. (Pothukuchi, 2005) This works as an incentive for a business to develop what otherwise would not be of interest to them due to other barriers (for example, an undesirable location). The nonprofit sector is also influential within food stores. Nonprofits are neither public nor private sector, but instead provide ways for stores to enter communities by helping to streamline the process (Pothukuchi, 2005). Nonprofits can help reduce some of the costs for development by providing money to the business or working to revitalize the area, which can encourage different types of businesses to take risks.

Chapter Three. Case, Data, and Methods

Baltimore Context

The state of Maryland has a history of heavy industry. This in turn has led to a history of environmental issues and contamination. This is especially the case in the city of Baltimore. Because of this, Baltimore has a significant number of toxic sites. Many of these have been classified as brownfield sites.

Baltimore became an industrial city in the 1900's. This was due to the large increase of immigrants to the city. The change in population brought in a new group of workers. It also experienced new technological advances during the industrial age. This led to an increase in manufacturing in the city. The city developed industrial districts. (Muller and Groves, 1979) These districts were based on manufacturing. Manufacturers wanted to cut down on transportation costs and improve efficiency and therefore, for example, settled many manufactures near water fronts. These locations would have lasting impacts in creating a legacy of industrial sites such as brownfields.

Maryland began their remediation process in the year 1997. This was part of a new Smart Growth policy that was focused on economic development. This program was originally focused on providing open space. This program was federally funded. It was one of the earliest types of federal remediation programs.

The areas that were historically polluted and industrial were historically low-income areas. This was due in part to the land use. The dense areas that were industrial were usually the areas that had contamination issues. This caused a continuous environmental inequality within the city of Baltimore (Boone et. al, 2014). Baltimore also has a history of racial discrimination. However, as stated in the introduction, the areas with brownfields are usually predominately white neighborhoods. This does not mean that there are no other environmental issues that have a racial component.

Because of the loss of industry, Baltimore has experienced lots of changes to its population over time. In the 1950s, it was expected that the population of Baltimore would grow. However, due to the loss of the manufacturing jobs associated with the area, the population began to steadily decrease through the 2000s (Boone et. al, 2014). However, while there was loss of jobs, the manufacturing facilities were still running. This mean they were still causing issues with pollution. From 2005-2010, millions of pounds of toxic pollution were released into the air and water. (Boone et. al, 2014) This has created a legacy of environmental contamination. These issues are not limited to brownfields, but this type of contamination n is one of the most common across the state of Maryland.

During Baltimore's time of industrialization, many materials were used within the process. Two of the most common were phosphorous and lead. Lead has been found in brownfields sites. These were imported into the city and had a lasting impact on the environmental history of the city. (Olson, 2007)

Data Selection

Several different data sources were used for this project. The main data sources were the Land Restoration Program (LRP) data from the Maryland Restoration Program, Data Axle business data for Maryland, and data from the U.S. Census.

The LRP data provides the spatial location of remediated brownfield sites in Maryland. ArcGIS and R were used to locate the remediated sites for each census tract in Baltimore City.

The EPA collected data on cleanup sites using the Assessment, Cleanup, and Redevelopment Exchange System (ACRES) database. When looking at sites between the period of 2003-2008, only about 5% of sites that were identified went through the entire cleanup process and were then able to be redeveloped. (EPA, 2012) This is why it is important to distinguish sites that have merely been identified as a remediated site, as opposed to sites which have gone through a full remediation process.

All sites that had completed remediation were included in the initial map. The dataset for the remediated sites contained a variable for the year it received its certificate of completion, “COC”, which was how completion of remediated sites was determined.

After the map of completed remediated sites was created, it was compared to parcel data for the city of Baltimore in ArcGIS. The parcel data was cross-referenced with the remediated sites to determine what each specific site became after it had been sold. None of the former brownfield sites became food stores on the site itself, but one had been used as a restaurant. Most sites were designated for commercial use.

The data axle data set is historical business data. It contains multiple different types of businesses which are sorted based on North American Industry Classification (NAIC) codes and Standard Industrial Classification (SIC) codes. The information in the Data Axle dataset is more accurate if one uses SIC codes rather than NAIC codes. For that reason, SIC codes were used to identify food stores in the dataset. This data included information on whether a store was located within a particular census tract. The number of food stores within each census tract were identified for each year from 2011 to 2019.

The third data source used was information from the U.S. Census. The variables included in this study include the total population, the average income, and the number of car users from year 2011 to year 2019. As mentioned in the literature review, the number of car users is relevant for food access. The amount of people who have access to a car determines access and if someone will be able to purchase groceries more easily. According to Howland in 2004, if the socioeconomic status of a community is higher, remediation is more likely. Income, as an indicator of socioeconomic status, also impacts food access and the food economy (Whelan et. al., 2002, Grocery Store Attraction Strategies, 2007). Population growth has an impact too because a growing population will provide the demand needed for food business success.

Total data included was from the years 2011-2019. These years were selected so that any regression models did not include data during the 2008 recession and data related to the 2020 COVID pandemic. Both these events likely caused multiple businesses to close and could have skewed the results of a model.

After the years of analysis were selected, multiple regression models were considered. One of the models considered was a panel linear regression model. This model analyzes individual factors separately over time, and in this case, it could be used to analyze each census tract and compare them to each other. The panel linear model is a fixed effects model, which holds some factors constant over time. In this case, the model would be used to hold each census tract constant. A second model considered was a linear model of change. This model is completed by taking values of the total change for each factor and running a regression using those variables. In both cases, the dependent and independent variables would remain the same: the grocery stores are the dependent variable, and the remediated sites are the primary independent variable of interest.

To help determine which model, the various factors were combined in R to create a panel dataset. Panel data tracks the same subjects over time. In this case, it can be used to track each individual census tract. Panel data can be separated every year to be able to look at the trend in food stores, from year to year. This was done to observe the data within one table to better view the different variables in an organized format.

The grep code was used to find a specific value in the data set. In this case it was used to find the estimate for population for census tract. The population census data had various items including potential margins of error, and the grep function allowed only the totals to be selected. The total population per census tract, average income per census tract, and number of people who used a car as their primary method of transportation were selected as the representative value for each factor.

Each year of data had the census appended after the year so that the years could be differentiated, and then all census tracts and years for each factor (population, income, grocery stores, etc.) were sorted in order in one big column. The various factor columns were joined together based on census tract and year, then the column with the census tract and year was split in two to become two separate variables. Figure 1 shows the resulting panel data.

	CensusTract	Year	Population	Grocery	AverageIncome	CarUsers	RemediatedSites
1	120500	2011	2086	2	47101	427	1
2	120500	2012	2095	2	45391	463	1
3	120500	2013	2073	2	43288	488	1
4	120500	2014	2110	2	45611	532	1
5	120500	2015	2244	2	53289	590	1
6	120500	2016	2325	3	64562	568	1
7	120500	2017	2340	2	73369	586	1
8	120500	2018	2275	2	84558	649	1
9	120500	2019	2190	3	81578	660	2

Figure 1. A table of data listing the census tract, year, population, food stores (as "grocery"), average income, car users, and remediated sites.

The change variables for each factor were also calculated in order to run the change linear model. These calculations would show the change as one single value rather than specifically from year to year. This could have potentially been a useful model because policy or planning impacts can take time to occur even after they are put in place.

The change variables were also divided per census tract. To calculate these variables, the value at the first year in the data (2011) was subtracted from the most recent year in the data (2019). The difference between them was calculated for each census tract and used to run the change linear model. The linear model was then run

using the change variable for grocery stores as the dependent variable and the others as the independent variables. Figure 2 shows this change dataset.

	Census.Tract	ChangeInGroceryStores	ChangeinPopulation	ChangeinIncome	ChangeinTransportation	ChangeinRemediatedSites
1	10100	1	225	31568	108	1
2	20300	5	482	55173	433	1
3	60400	0	147	17011	113	1
4	70300	3	-361	16656	121	1
5	80200	-1	-142	2312	-79	1
6	80700	-1	-404	29693	20	1
7	90800	-3	-1146	881	-336	1
8	120500	1	104	34477	233	1
9	120700	-2	16	21166	-160	1
10	130804	0	166	27165	371	1
11	150400	1	805	-42	-1	3

Figure 2. A table listing census tract and the change variables for food stores, population, average income, car users, and remediated sites

After the tables were prepared, the panel linear model was run to analyze the results. The panel model was selected for its functionality and its ability to enable analysis comparing the various different census tracts over time, rather than a single representative value.

Chapter Four: Results

The map in Figure 3 shows the location of each complete remediated site within Baltimore since the beginning of the program in 1997. Most of the sites are small in area and many of them are relatively close to one another within the map, creating a more concentrated area of brownfield involvement. If having brownfield sites close to each other can drive down the property value of all the areas involved, removing those brownfield sites gives an increased chance of economic improvement (Meyer, 2010).

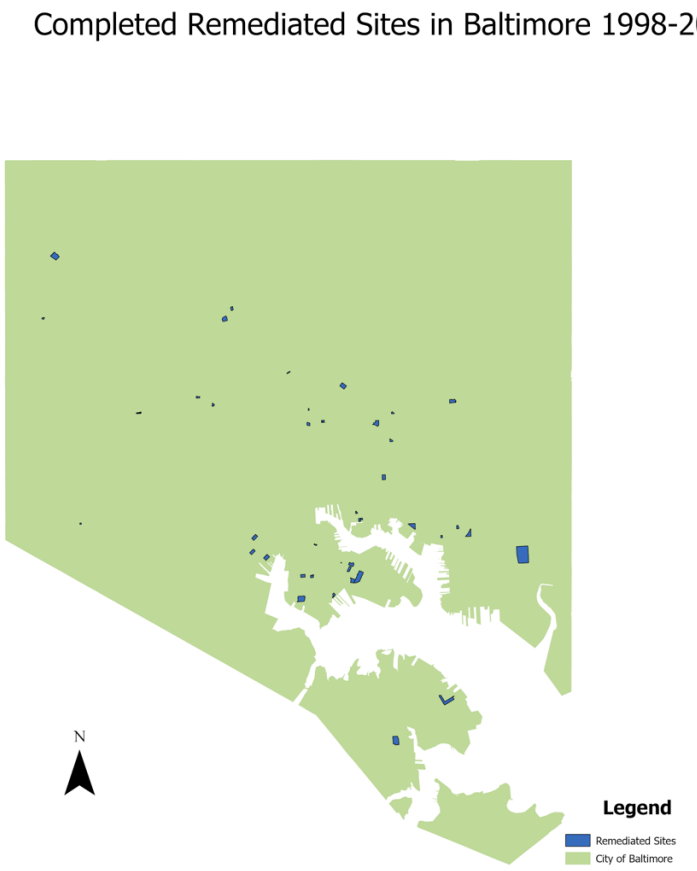

Figure 3. A map of fully remediated sites within the city of Baltimore

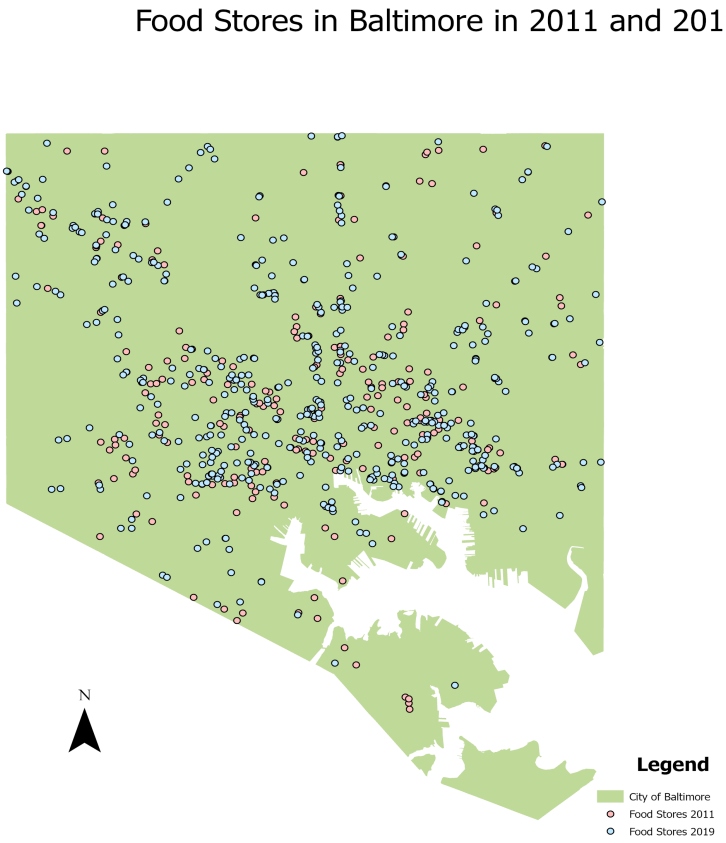

Figure 4. A map of food stores represented by dots within the city of Baltimore, for years 2011 and 2019.

The map in Figure 4 shows the total number of food stores within Baltimore during the year 2011 and 2019. When comparing these two maps, several of the remediated sites are clustered in similar areas to these food stores.

Figure 5 provides the results of the panel model. The dependent variable is food stores. Remediated sites are the independent variable of interest. The coefficient for the remediated sites is -3.8110. This means that there is a negative relationship between the amount of food stores and the number of remediated sites. The p value is 0.9826. This means that the correlation to remediation and grocery stores is not significant. The null hypothesis cannot be rejected based on this evidence.

```
Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-11.081742  -0.470918  -0.035413   0.513404   7.238360

Coefficients:
                  Estimate  Std. Error t-value  Pr(>|t|)
RemediatedSites -3.8110e-03  1.7464e-01 -0.0218    0.9826
CarUsers        -2.5553e-05  3.0929e-04 -0.0826    0.9342
Population       1.2934e-04  1.5001e-04  0.8622    0.3887
AverageIncome   -2.6676e-05  3.8864e-06 -6.8641 9.708e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 5. An image of the estimate, standard error, t-value and p-value for the four factors in this linear model: remediated sites, car users, population, and average income.

The average income control variables had a negative coefficient. This means that the average income calculation in this data set has a negative association with the amount of food stores. It also has the highest correlation which means it is highly correlated with the amount of food stores. The relationship is also statistically significant.

The coefficient estimate for car users was negative. The p-value indicates that this relationship is not significant which means there is not a strong correlation with the amount of food stores and number of car users per census tract.

The estimate represents how well the population relates to the food stores variable. This relationship is negative but not statistically significant.

One possible explanation for the lack of a statistically significant correlation between food stores and remediated sites is that there has not been enough time to observe significant changes because of duration of remediation of these sites. While the remediation process has been in effect since 1997, the data observed in this study was from 2011 to 2019, a period of eight years, which might not be enough time to see significant changes.

Another potential issue is there might be unobserved variables impacting the results. While data after 2010 was selected to try to mitigate the effects of the 2008 recession, there is a possibility of long-lasting economic effects in the Baltimore area. There may be barriers to entry to opening businesses, particularly food stores, in Baltimore that are unaccounted for.

Income was used to measure socioeconomic status but other factors such as property values or educational attainment are influential. Further study into the effects of remediation might observe and include these additional factors.

The fact that Baltimore is a very dense city could have had an impact on the results of the study and give some explanation to the outcome. As mentioned within the literature, density can be a contributing factor to food store locations. A more complex model could be able to control for a created density variable.

Crime within the area is another possible reason for the results. As discussed within “Grocery Store Attraction Strategies” (2007), crime can be a deterring factor for

businesses to enter an area. The model used did not take crime statistics into account, and this could have impacted the results. The crime levels might have differed depending on the census tract.

Another factor influencing results could be other types of vacant properties which are not caused by brownfields. While many of the brownfield remediated sites were categorized as commercial within the dataset, there could be other vacant properties in these areas which are intended for residential use.

There could also be issues with the unit of analysis and the impact a food store can have on multiple different census tracts. A store might serve people in a census tract other than the one where the food store is located. In this case, a model that could measure the impact of food stores on multiple census tracts and control for this would impact the result. Developing a new unit of analysis unique to the study could be a possible solution. The study by Dutko et. al (2012) divided the areas used for the study into a grid and then determined which locations had no food stores within one kilometer, which could be an alternate approach for this current study. The remediated sites, like food stores, could potentially also have an impact outside of their own census tracts. It is important to note there are still several non-remediated brownfield sites within the city of Baltimore.

Chapter Five: Conclusions

One implication of this study is that remediation on its own is not enough to impact the food systems of the area. Howland (2004) suggests that degrees of contamination, the conditions of the community, and the location of brownfield sites are all important factors in economic redevelopment and that remediation on its own may be necessary but not sufficient for economic development. It is likely that the community food system redevelopment would also be influenced by the same factors. (Howland, 2004) This knowledge provides a planning opportunity for utilization of remediated sites. For example, an incentive provided for investors to utilize remediated sites for food related business could be beneficial for both economic and overall community health.

Remediation is still a new and evolving planning policy. The data available to measure long term effects is still limited to specific geographic areas. The goals/indicators of successful brownfield remediation have evolved as well; many stakeholders put economic factors ahead of environmental cleanup. While there is often important economic benefit, there needs to be other considerations in remediation. There are still many brownfields existing in the U.S. that have not been remediated, especially in economically depressed areas. The greater the negative effects of a brownfield on a community or census tract, the less likely remediation alone is sufficient to bring about significant change in economic or environmental health. To evaluate the measurable

benefits on remediation and revitalization, it is necessary to have long term and comprehensive monitoring and data collection.

Brownfields have been shown to have a negative economic impact on the areas around them. This leads to a negative effect on food systems in the area. What was missing from the literature was an understanding of the impact of remediation on the food system and whether remediation has a beneficial relationship, as opposed to the negative relationship to brownfields.

Planning is often defined as intervention when there is a market failure. While brownfields provide opportunities for markets regarding commercial properties, there is often additional government intervention to boost this. From these results, possibly some intervention would be helpful if remediated sites could be used to provide a better variety of food stores. When looking at the markets for remediated brownfield sites and food stores, the market for food stores itself does not inherently benefit from the process of remediation without some intervention from planners in the market for food stores.

While Maryland will continue to remediate sites, especially those within Baltimore, it is important to consider the need for additional funding or types of financing for different remediated sites depending on other conditions. For example, there is a need to understand the difference between remediating sites within low-income areas and how this is different from remediated sites in prospering areas. Future proposals for remediation should also look into measures that will utilize this reinvestment to complete remediation in in a way that will boost food business and not just commercial business.

Maryland has completed remediation of a large number of brownfields. There are many cities within the Rust Belt that continue to have multiple brownfields. Columbus, for example, can learn from the multiple remediation projects and revitalization data from the city of Baltimore.

There are some key factors in planning for food systems that could not be included within this model. One of these is nutrition. While this model addressed the case for food stores, it did not include the quality of these stores. While a larger variety of food stores will increase if the total number increases, there is no certainty that these stores will have nutritious foods. Further research would look more closely at types of food stores and not just their quantity. In addition, if developers are wary of investing in a remediated site or site nearby a remediate site, sites could be used to support farmers markets on remediated sites. Some grants to support such actions might be useful.

While Baltimore had a pattern of brownfields (and thus remediated sites) being located in predominately white communities, many other cities had many of their brownfields in predominantly non-white communities. (Bullard, 2011) This is mainly due to Baltimore's unique history of development and the discriminatory practices in keeping jobs located in predominantly white neighborhoods. When using Baltimore as a case study, this needs to be considered for future remediation in other cities, which may differ based on the historical practices of that city.

This study focused on analysis of quantitative data. The history of planning research into environmental issues, including remediation and food access, involves discussions with stakeholders and community engagement. This would be part of the next

steps in furthering the research of brownfield remediation and is key in monitoring the overall success of remediation programs.

Bibliography

Ash, M., & Fetter, T. R. (2004). Who Lives on the Wrong Side of the Environmental Tracks? Evidence from the EPA's Risk-Screening Environmental Indicators Model*. *Social Science Quarterly*, *85*(2), 441–462. https://doi.org/10.1111/j.0038-4941.2004.08502011.x

Bambra, C., Robertson, S., Kasim, A., Smith, J., Cairns-Nagi, J. M., Copeland, A., Finlay, N., & Johnson, K. (2014). Healthy Land? An Examination of the Area-Level Association between Brownfield Land and Morbidity and Mortality in England. *Environment and Planning A: Economy and Space*, *46*(2), 433–454. https://doi.org/10.1068/a46105

Boone, C. G., Fragkias, M., Buckley, G. L., & Grove, J. M. (2014). A long view of polluting industry and environmental justice in Baltimore. *Cities*, *36*, 41–49. https://doi.org/10.1016/j.cities.2013.09.004

Brownfields—Brownfields QNA | Occupational Safety and Health Administration. (n.d.). Retrieved April 12, 2024, from https://www.osha.gov/brownfields/brownfields-qna

Building Vibrant Communities: Community Benefits of Land Revitalization. (2009). Environmental Protection Agency.

Bullard, R. D., Johnson, G. S., & Torres, A. O. (2011). *Environmental health and racial equity in the United States: Building environmentally just, sustainable, and livable communities*. American Public Health Association.

Chenarides, L., Cho, C., Nayga, R. M., & Thomsen, M. R. (2021). Dollar stores and food deserts. *Applied Geography*, *134*, 102497. https://doi.org/10.1016/j.apgeog.2021.102497

Data Axle (2011-2019). *Historical Business Data*. Retrieved from Data Axle database.

Dutko, P., Ploeg, M. V., & Farrigan, T. (2012). *Characteristics and Influential Factors of Food Deserts*.

Eisen, J. B. (1996). "'Brownfields of dreams'"?: Challenges and limits of voluntary cleanup programs and incentives. *University of Illinois Law Review*, *4*, 883–1039.

Evaluation of the Brownfields Program. (2012). Environmental Protection Agency.

Franco, M., Diez Roux, A. V., Glass, T. A., Caballero, B., & Brancati, F. L. (2008). Neighborhood characteristics and availability of healthy foods in Baltimore. *American Journal of Preventive Medicine*, *35*(6), 561–567. https://doi.org/10.1016/j.amepre.2008.07.003

Freedman, D. A., Clark, J. K., Lounsbury, D. W., Boswell, L., Burns, M., Jackson, M. B., Mikelbank, K., Donley, G., Worley-Bell, L. Q., Mitchell, J., Ciesielski, T. H., Embaye, M., Lee, E. K., Roche, A., Gill, I., & Yamoah, O. (2022). Food system dynamics structuring nutrition equity in racialized urban neighborhoods. *The American Journal of Clinical Nutrition*, *115*(4), 1027–1038. https://doi.org/10.1093/ajcn/nqab380

Garvin, E., Branas, C., Keddem, S., Sellman, J., & Cannuscio, C. (2013). More Than Just An Eyesore: Local Insights And Solutions on Vacant Land And Urban Health. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *90*(3), 412–426. https://doi.org/10.1007/s11524-012-9782-7

Gittelsohn, J., Franceschini, M. C. T., Rasooly, I. R., Ries, A. V., Ho, L. S., Pavlovich, W., Santos, V. T., Jennings, S. M., & Frick, K. D. (2008). Understanding the Food Environment in a Low-Income Urban Setting: Implications for Food Store Interventions.

Journal of Hunger & Environmental Nutrition, *2*(2–3), 33–50. https://doi.org/10.1080/19320240801891438

Gittelsohn, J., Suratkar, S., Song, H.-J., Sacher, S., Rajan, R., Rasooly, I. R., Bednarek, E., Sharma, S., & Anliker, J. A. (2010). Process Evaluation of Baltimore Healthy Stores: A Pilot Health Intervention Program With Supermarkets and Corner Stores in Baltimore City. *Health Promotion Practice*, *11*(5), 723–732. https://doi.org/10.1177/1524839908329118

Gottlieb, R., & Fisher, A. (1996). "First Feed the Face": Environmental Justice and Community Food Security. *Antipode*, *28*(2), 193–203. https://doi.org/10.1111/j.1467-8330.1996.tb00522.x

Grocery Store Attraction Strategies: A Resource Guide for Community Activists and Local Governments. (2007). Oakland, CA/San PolicyLink/Bay Area Local Initiatives Support Corporation. http://www.policylink.org/sites/default/files/groceryattraction_final.pdf.

Haninger, K., Ma, L., & Timmins, C. (2017). The Value of Brownfield Remediation. *Journal of the Association of Environmental and Resource Economists*, *4*(1), 197–241. https://doi.org/10.1086/689743

Howland, M. (2004). The Role of Contamination in Central City Industrial Decline. *Economic Development Quarterly*, *18*(3), 207–219. https://doi.org/10.1177/0891242404266013

Howland, M. (2007). Employment Effects of Brownfield Redevelopment: What Do We Know from the Literature? *Journal of Planning Literature*, *22*(2), 91–107. https://doi.org/10.1177/0885412207306616

Howland, M. (2010). The Private Market for Brownfield Properties. *Cityscape*, *12*(3), 37–54.

Laska, M. N., Borradaile, K. E., Tester, J., Foster, G. D., & Gittelsohn, J. (2010). Healthy food availability in small urban food stores: A comparison of four US cities. *Public Health Nutrition*, *13*(7), 1031–1035. https://doi.org/10.1017/S1368980009992771

Maryland's Brownfield Redevelopment Assistance Program. (n.d.). Planning. Retrieved August, 2023, from https://planning.maryland.gov/Pages/default.aspx

MDE - LRP Map. (n.d.). Retrieved August 2023, from https://mdewin64.mde.state.md.us/LRP/index.html

Meyer, P. B. (2010). Brownfields, Risk-Based Corrective Action, and Local Communities. *Cityscape*, *12*(3), 55–69.

Muller, E. K., & Groves, P. A. (1979). The Emergence of Industrial Districts in Mid-Nineteenth Century Baltimore. *Geographical Review*, *69*(2), 159–178. https://doi.org/10.2307/214962

Navrátil, J., Krejčí, T., Martinát, S., Frazier, R. J., Klusáček, P., Pícha, K., Škrabal, J., & Osman, R. (2021). Variation in brownfield reuse of derelict agricultural premises in diverse rural spaces. *Journal of Rural Studies*, *87*, 124–136. https://doi.org/10.1016/j.jrurstud.2021.09.004

Nilsson, H. (2023). Population decline and changes in food store access. *Regional Studies*, *57*(5), 946–960. https://doi.org/10.1080/00343404.2022.2108542

O'Leary, B. F., Hill, A. B., Linn, C., Lu, M., Miller, C. J., Newman, A., Sperone, F. G., & Zhang, Q. (2023). Exploring the association of Brownfield remediation status with socioeconomic conditions in Wayne County, MI. *Environmental Science and Pollution Research*, *30*(21), 60768–60776. https://doi.org/10.1007/s11356-023-26666-2

Olson, S. (2007). Downwind, Downstream, Downtown: The Environmental Legacy in Baltimore and Montreal. *Environmental History*, *12*(4), 845–866.

Pothukuchi, K. (2005). Attracting Supermarkets to Inner-City Neighborhoods: Economic Development Outside the Box. *Economic Development Quarterly*, *19*(3), 232–244. https://doi.org/10.1177/0891242404273517

Pothukuchi, K. (2016). Bringing Fresh Produce to Corner Stores in Declining Neighborhoods: Reflections from Detroit FRESH. *Journal of Agriculture, Food Systems, and Community Development*, 1–22. https://doi.org/10.5304/jafscd.2016.071.013

Sadler, R. C., Bilal, U., & Furr-Holden, C. D. (2021). Linking historical discriminatory housing patterns to the contemporary food environment in Baltimore. *Spatial and Spatio-Temporal Epidemiology*, *36*, 100387. https://doi.org/10.1016/j.sste.2020.100387

Smollin, L., & Lubitow, A. (2019). *Brownfield Site—An overview | ScienceDirect Topics*. Retrieved April 18, 2024, from https://www.sciencedirect.com/topics/earth-and-planetary-sciences/brownfield-site

U.S. Census Bureau. (n.d.). *Population.*. U.S. Department of Commerce. Retrieved January 2024, from https://data.census.gov/

U.S. Census Bureau. (n.d.). *Income*. U.S. Department of Commerce. Retrieved January 2024, from https://data.census.gov/

U.S. Census Bureau. (n.d.). *Means of Transportation to Work by Vehicles Available.* U.S. Department of Commerce. Retrieved January 2024, from https://data.census.gov/

Whelan, A., Wrigley, N., Warm, D., & Cannings, E. (2002). Life in a "Food Desert." *Urban Studies*, *39*(11), 2083–2100. https://doi.org/10.1080/0042098022000011371