COMPARISON OF NEIGHBORHOOD DEMOGRAPHICS AND POST-BUYOUT LAND USE DEVELOPMENT IN HARRIS COUNTY, TEXAS, USA

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Recent research suggests that race and ethnicity influence post-buyout land management in Harris County, Texas, yet lacked systematic empirical evidence to fully understand the relationship between management and demographics. To address this gap, this study analyzes post-buyout land use management practices and compares them with the socio-economic characteristics of the adjacent neighborhood at the block level in Harris County, Texas, an area with a long buyout history. I first identified post-buyout land use management practices in Harris County through county records and photo documentation of approximately 2000 buyout sites through fieldwork from 2017-2022. Second, using Ode and colleagues' framework for identifying visual characteristics on the landscape, I developed an index and evaluated post-buyout land use management practices for aesthetics, utility, and function. Finally, I spatially analyzed the socio-demographic composition of buyout neighborhoods using U.S. Census American Community Survey 5-year data (2017-2021) and compared it with post-buyout land use management practices in ArcGIS. From this spatial analysis, I identified differences in post-buyout land management that homeownership status, race, and ethnicity affected post-buyout land management. Most buyout properties in Harris County are managed as mowed, vacant lots regardless of socio-demographics; however, litter and debris were more prominent in predominantly Black neighborhoods. Of note, higher utility land uses were more frequent in predominantly white neighborhoods, but buyout sites developed into parks were located in lower-income and predominantly Hispanic areas suggesting variance in land use by socio-demographics.

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CHAPTER 1

INTRODUCTION

Floods are acts of God, but flood losses are largely acts of man.
—Gilbert F. White

Floods are extremely destructive environmental disasters that cause extensive losses to natural and anthropogenic features every year. From 1970 to 2019, floods took above 2 million lives globally (UN, 2021), causing a financial loss of US$ 3.64 trillion (WMO, 2021). In the United States, more than 10,000 people died between 1970 and 2019 due to floods, with financial damage over the last three decades exceeding $203 billion (WMO, 2021). However, flood risk continues to increase owing to persistent urbanization, the development of coastal and low-lying areas, and climate change; a 26 percent increase in flood loss is expected over the next 30 years in the U.S. alone (Gregg, 2022). Nevertheless, the severity of future floods depends on the actions taken to adapt to these environmental changes to avoid cascading economic impacts, infrastructure deterioration, and loss of life within communities.

To reduce flood losses and adapt to climate change, U.S. government agencies are executing voluntary buyout programs in flood-prone areas to relocate households out of high-risk zones (Binder *et al*., 2019). This mitigation strategy has been utilized across the United States to deal with flooding impacts for more than 40,000 homes over the last four decades (Mach *et al.,* 2019). These programs are envisioned to relocate residents of hazard-prone areas to avoid the future loss of life and property (Binder *et al*., 2018) by offering landowners the pre-flood market value of their damaged properties (Zavar, 2016). Local government agencies implement home buyout programs with federal assistance in flood zones, where structural developments are neither economically nor climatically feasible structures are then demolished, and the land must remain open. Open space land use and management practices are determined by local

communities and range from low-utility vacant lots to well-maintained community parks (Zavar and Hagelman III, 2016). This range of post-buyout land uses is especially visible in Harris County, Texas, which houses one of the country's oldest and largest buyout programs (HCFCD, 2021).

On August 25, 2017, Category 4 Hurricane Harvey landed in Texas, displacing over 30,000 people, and damaging over 200,000 structures (National Weather Service, 2017). Harvey directly impacted Harris County, the 3rd most populated county in the U.S., known for its low-lying and coastal areas, in addition to a diverse population. Racially Harris County's population is comprised of 27.7% white residents, 44.4% Hispanic or Latino residents, and 27.9 % are from other races(U.S. Census Bureau, 2021). Although flooding is common in Harris County, Hurricane Harvey broke numerous records, and the impacts of this hurricane varied among socioeconomic groups (HCFCD, 2021). The Harris County Flood Control District (HCFCD) expanded its longstanding buyout program to address increasing flood risk. As of January 2023, 940 buyouts were completed, with 233 additional properties in the process (HCFCD, 2023).

Despite the increase in buyout programs, both in Harris County and across the U.S., a lack of empirically grounded research underlies these popular programs, especially related to issues of social justice. Fewer studies have examined the issues of equity and post-buyout land use management. This is particularly relevant to Harris County given the diverse socioeconomic status present in the area. Of the existing literature, previous studies highlight the transparency issues of political interventions and identify inequitable or discriminatory practices during the selection and implementation period of buyout programs (Siders,2018). A recent study suggested that race and ethnicity influence post-buyout land management in Harris County yet lacked empirical evidence to evaluate this claim (Elliott *et al.*, 2021). To understand the association

between socioeconomic status and post-buyout land use, my current study aimed to compare post-buyout land use management practices with the demographics of the adjacent neighborhood at the block group level in Harris County, Texas.

Developing awareness of land use after a buyout is crucial for establishing resilience in the community. High-utility post-buyout land uses, such as parks, gardens, and detention basins, can maximize community mitigation practices and increase resilience to future hazards and climate-induced disasters (Zavar and Hagelman III, 2016). For instance, constructing detention basins and wetlands in post-buyout open spaces allows the absorption of excess water and reduces future flood risk. It also filters runoff, which eventually results in a better quality of water in streams (Zavar, 2016). However, the literature suggests that these high-utility uses are rare and maybe even less common in lower-income areas and neighborhoods of color (Elliott *et al.*,2021).

Harris County has a long history of devastating floods; however, despite authorities' ongoing efforts to reduce flood risks, scholars have expressed concerns about discrimination in flood mitigation efforts (Siders, 2018). Yet, limited research has systematically examined equity and post-buyout land use management (Elliott *et al.*, 2022). Therefore, the objective of my study is to analyze post-buyout land use management practices and compare the uses and aesthetics of buyout properties with the socio-demographics of the adjacent neighborhood at the block level in Harris County, Texas. This research will not only contribute knowledge to an understudied area of mitigation but will also influence hazard mitigation practices in Harris County by identifying areas that require improvement. Furthermore, this study can contribute to community-wide resilience goals that seek to address the uneven impacts of climate change. Managing post-buyout land uses equitably is one-way communities can enact more socially just climate adaptation strategies.

CHAPTER 2

LITERATURE REVIEW

The impacts of climate change and its associated hazards are increasing worldwide. This is evident in the United States in the form of hurricanes, flash floods, tornadoes, and storms (IPCC, 2021). A CNN report claimed that nearly 98% of all counties in the United States have historically experienced loss due to flooding (CNN, 2021). According to Federal Emergency Management Authority (FEMA) statistics, floods alone caused more than $155 billion worth of damage across the United States in the last decade (CNN, 2021). However, the severity of future flood loss depends on the actions taken to adapt to these environmental changes.

To mitigate future flood hazards and develop community resilience, governments utilize both structural and nonstructural practices. Structural practices include the application of engineering techniques and physical constructions to develop hazard-resistant built structures (levees, seawalls, or earthquake-resistant buildings) and to avoid the devastating impacts of hazards (UNDRR, 2022). Conversely, nonstructural measures use knowledge, practices, and agreements in the form of community awareness programs, regulatory measures, projects for environmental sustainability, land use planning, and managed retreats to avoid the risks and consequences of future hazards. (UNDRR, 2022). Given the cost of repeated infrastructural elevations, experts have concluded that nonstructural mitigation measures such as buyouts or managed retreats are inevitable in the floodplain areas of United States under the current circumstances of climate change (NOAA, 2017). In the last four decades, this mitigation strategy has been utilized to develop community resilience across the United States by dealing with flooding impacts for more than 40,000 homes (Mach *et al.,* 2019). Resilience is defined as “the ability of a community to resist, adjust, transform, and recover from a risk in a timely and

effective manner through risk management and preservation and restoration of essential structures and functions of society" (UNDRR, 2023, np).

2.1 What are Buyouts?

Home buyouts are non-structural mitigation procedures that reduce cyclical flooding damage by converting infrastructure into open spaces (Zavar, 2015). These programs are intended to relocate residents of hazard-prone areas to avoid future loss of life and property (Binder *et al.*, 2018). These voluntary programs offer landowners the pre-flood market value of their damaged houses, which are later converted to open space (Zavar, 2016). Open space land use and management practices are determined by local communities and range from low-utility vacant lots to well-maintained community parks (Zavar and Hagelman III, 2016). The government acquisition of properties in floodplain areas through buyouts is generally funded by federal agencies and administered by local or state agencies (Mach *et al.*, 2019). The federal government removes previously constructed infrastructure on acquired land; however, after clearance, the development cost is the responsibility of the community or local government (FEMA, 1998). FEMA also offers hazard mitigation assistance in three different forms for buyout programs including (1) Hazard Mitigation Grant Program (HMGP), (2) Pre-Disaster Mitigation (PDM) Program[1], and (3) Flood Mitigation Assistance Grant Program (FMA). All three programs are marginally distinct in their capacity and objectives (FEMA, 2018), as explained in Figure 1.

Studies have shown that, since 1998, authorities in the USA have acquired more than 20,000 properties in floodplains (Zavar, 2016). The most well-known buyout programs across

[1] The PDM funding program ended in 2020 and the Building Resilient Infrastructure and Communities Program (BRIC) replaced it. However, no study sites were funded by BRIC in Harris County, Texas during my fieldwork.

the United States include the Blue Acres state program in New Jersey, the Floodplain buyout program of Charlotte, North Carolina, volunteer property acquisition in the floodplain area of Harris County, and the Church Creek Basin resilience project of Charleston (Environmental Law Institute, NC, 2014).

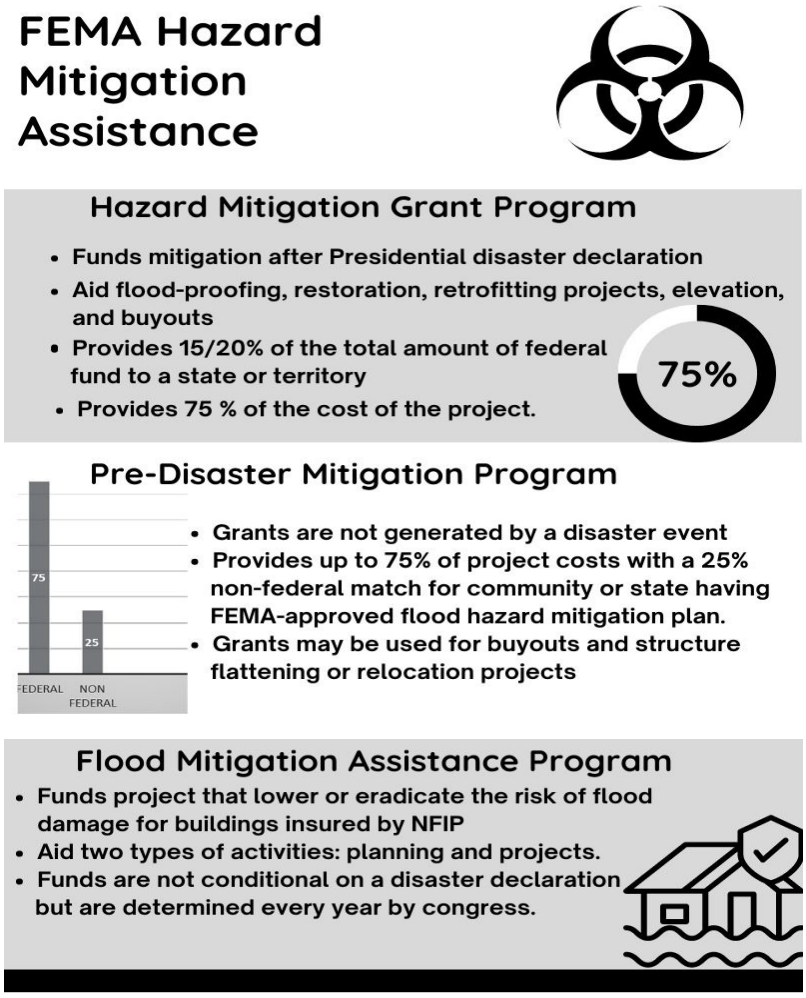


Figure 1: FEMA's funding sources for buyout programs. Source FEMA, 2018

2.2 Buyout as Climate Adaptation Strategy

Buyouts are also known as managed retreat mechanisms in which land and built infrastructure are acquired from the community of flood-prone areas and returned to nature to reduce floods or other hazards exposure (Maldonado, 2021). It is also known as a process in

which the land is returned to the sea by removing any barriers to allow water to enter and allow wetlands and natural habitats to prevail. In this mitigation strategy, both people and infrastructure are removed as part of a climate change adaptation strategy to return land to nature (Koslov, 2016). Generally, three different approaches are being used globally for climate adaptation against flood hazards to elevations, protection, or retreat (Figure 2).

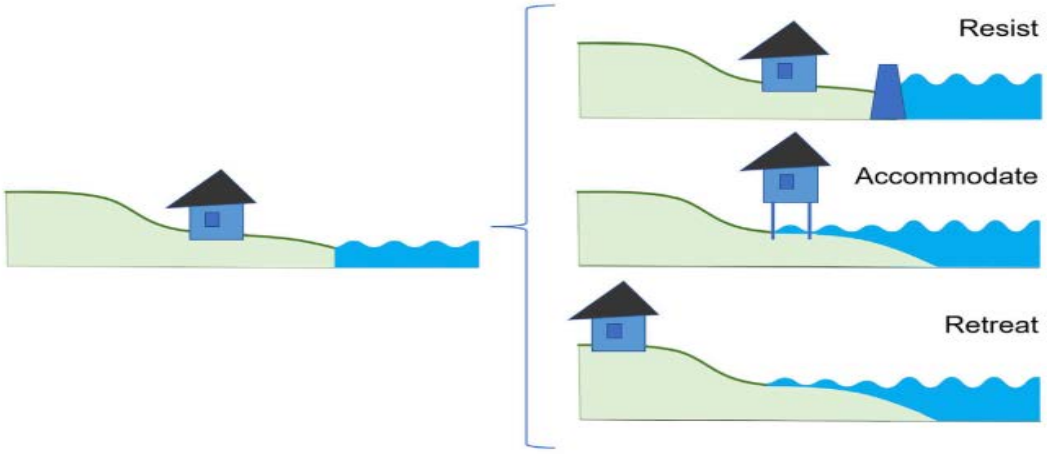


Figure 2: Mitigating Strategies to reduce flood hazard in the context of climate change, (Source: Siders, 2019)

Managed retreat or buyouts are considered a cost-effective and environmentally friendly approach to flooding mitigation (Eichhorst, 2009). Some studies acknowledge the success of flood risk reduction for communities moving away from flood-prone locations and therefore view buyouts as a method for adapting to climate change (Hunter *et al*., 2015). Using it as a mitigation tool not only helps authorities to avoid future disaster losses, but also saves communities from the sudden trauma of movement as a response (Bronen, 2011). However, most buyouts are often considered last resorts rather than mitigation tools (Burkett, 2015).

2.3 Historical Perspective of the Buyout Program

Traditionally, flood control or flood management has relied on structural measures in the

United States. Its history goes back to the first structural response to a catastrophic flood in Dayton, Ohio in 1913. In this project, upstream flood-control storage reservoirs were being built on the Miami River and were lauded by the authorities that the U.S. Congress embraced this type of flood control in the 1928 Flood Control Act (Tarlock, 2012). Further, the federal government approved the Flood Control Act of 1936 through the US Army Corps of Engineers to use structural measures for flood control. From 1936 to 1966, it became a recognized national standard to mitigate flooding by enforcing human-made structural solutions in the form of retention dams, river channelization, or levee construction (Zavar, 2016). Despite a massive federal investment of $12 billion in structural development against floods, annual flood losses rose from $1 billion in 1958 to $3.5 billion in 1975 without any subsequent increase in flood magnitude or frequency (Hoyt, 1955). Although the structural development resulted in some improvements in flood control, it could not solve all flood problems. In contrast, this armoring gave communities and authorities a false sense of security and promoted construction in flood-prone areas, resulting in further devastation (Costa, J., 1978). These “protected floodplain areas” rather suffered devastatingly when flood water appeared above the capacity of structural developments against floods (Hutton *et al.*, 2018).

Despite the country’s preference for structural mitigation as a flood control technique, nonstructural mitigation measures, such as land management and zoning, have contributed to flooding alleviation. The interest of urban reformers in city zoning led to the development of the first official comprehensive zoning law of 1916 (Barr, 2019). These zoning plans were sufficiently successful to control the pattern of urban land use by limiting the mixing of commercial and residential buildings. However, instead of limiting construction in flood-prone areas, authorities often focused on rerouting water through the construction of billion-dollar

developments, which, in the long run, could not stop water from impacting urban areas (Platt, 2012).

However, the failure of built infrastructure to protect communities from floods has often led communities and authorities to opt for nonstructural mitigation. Historically one of the earliest community movements in the U.S. from floodplain areas occurred in 1881 in Niobrara, Nebraska (Pinter, 2021). Niobrara was flooded to a depth of approximately 2 meters (Carter, 1991). In the aftermath of the flood, residents of Nebraska decided to move 2.4 km away from the floodplain area. By April 1882, they moved almost all their residential and commercial built structures to a new place by April 1882 (Pinter, 2021). Another well-known example of buyouts is the Soldier Grove, Wisconsin Relocation Project, in which authorities opted for non-structural solutions rather than structural mitigation projects suggested by the U.S. Army Corps because of the high cost of the projects. Soldier Grove, along with many other communities, suffered through repetitive flooding in the twentieth century. The U.S. Army Corps of Engineers recommended building storage dams and designing a levee system for several localities. However, considering the high cost of levees, project stakeholders started thinking about non-structural mitigation, specifically a buyout program. Consequently, the central business district was moved from the floodplain to the new town, and the once-inhabited floodplains were converted into open spaces (Tobin, 1992). Later, the collapse of structural solutions in the Great Mississippi River Flood in 1993 further emphasized the value and need for non-structural mitigation tools (Interagency Floodplain Management Review Committee, 1994).

Other types of nonstructural mitigation measures implemented include flood insurance and legislative measures. The intense flood damage in the 1960s influenced federal decision-makers to approve the National Flood Insurance Act of 1968 and subsequently the Flood

Disaster Protection Act of 1973 (Zavar, 2016). The National Flood Insurance Program (NFIP) discouraged development in floodplain areas by raising public awareness of flood hazards through the creation of new maps, increasing the cost of development in floodplains by enacting high insurance premiums, and requiring more permits and engineering studies for development. (Interagency Floodplain Management Review Committee, 1994).

2.4 Impacts of Buyout Programs

With a rise in the number and severity of floods worldwide, countries are moving towards strategic property acquisitions for enhanced resilience against environmental hazards. The benefits of managed retreats, which use buyout programs to relocate households from high-risk areas, are generally evaluated in two forms: direct and indirect (Nelson & Camp, 2020).Studies have shown that buyouts are cost-effective in terms of direct benefits. According to the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, any project funded by the Hazard Mitigation Grant Program by FEMA is required to be cost-effective (BenDor *et al*., 2020). Several studies have been conducted to analyze this cost-benefit ratio. In 2017, the National Institute of Building Multi-Hazard Mitigation Council (MMC) conducted an interim research study that concluded that federal grants from the Federal Emergency Management Agency (FEMA), Economic Development Administration (EDA), and the Department of Housing and Urban Development (HUD) for mitigation measures in the form of property acquisition in the last 23 years have provided national fiscal benefits of $6 for every $1 financed (National Institute of Building Sciences, 2017). Buyouts reduce the workload of emergency management organizations. With fewer or no structures in flood-prone areas, authorities will be handling limited response tasks, including debris removal, shelter provision, and evacuation. The most evident direct benefit of managed retreats or buyouts is open space

land, which can be developed into additional parks or open spaces for the community (Zavar & Hagelman III, 2016). These open spaces are key to wetland restoration and stormwater storage (Zavar, 2016).

Buyouts generate numerous indirect benefits that may not be apparent during project implementation. However, they are valuable to society in the long term. To determine the flood damage cost or evaluate the gains from mitigation or recovery actions, research studies largely focused on quantitative measures while avoiding many secondary and hidden benefits behind these statistical gains. The open space created by the buyout program not only provides space for parks and recreation but can act as water absorbent for flood water, promotes natural habitat and biodiversity, and in the long run improves the area's air quality and promote a healthy ecosystem (Nelson& Camp, 2020). Similarly, buyouts allow residents of flood-prone areas to obtain pre-flood market value for their structure and relocate to a safer location, as selling a house or structure located in a floodplain on an open market is difficult while living in the same house and facing hazards from time to time is quite stressful (Siders *et al.*, 2021).

Despite these benefits, there are many challenges associated with the implementation of buyout programs and the management of post-buyout open spaces. First, buyouts are often planned as recovery solutions only after floods, which creates socioeconomic and psychological hardships for people already dealing with the impacts of the flood. Although funded by the government, relocation creates financial burdens for people and may induce psychological trauma while leaving their homes and communities (Binder *et al*., 2019). Property purchased from multiple owners often results in the checkerboarding of land, which later creates hurdles in land development or management in the form of parks or other open spaces (Atoba *et al*., 2021). Researchers have also expressed concerns about social injustice and transparency by

governments in their selection procedures for the targeted areas. Such issues not only result in the ineffectiveness of the program but also give rise to mistrust of the program by the community and reduced public participation in the process (Siders, 2019). Buyout programs are often considered expensive, particularly in areas with high property rates. Therefore, even given equivalent flood risks, buyout programs have historically been implemented more frequently in lower-income flood-prone areas than in higher-income coastal areas. Nevertheless, the cost of buying a house in floodplain areas is relatively low compared to that on beaches (Siders *et al.*,2021). Furthermore, owing to the voluntary nature of the program, it is sometimes difficult to bring the target community on board (Rice University Kinder Institute for Urban Research, 2018). A buyout program is often regarded as a slow process. Following the disaster declaration, the program can only be initiated after the approval of federal funds from FEMA and HUD, which generally takes more than two years. However, owners generally prefer not to wait two years for the final decision from authority and funding. Thus, they upgrade their properties to address structural damage. Once the structure is upgraded by the owner, it is difficult to convince them to move away from it (Song *et al.*, 2017).

2.5 Post-Buyout Land Management

A significant component of the buyout program is the removal of infrastructure in floodplain areas and the conversion of land to public open spaces. After the land acquisition, federal policies, the local government's land management priorities, and the community culture play an important role in deciding the future purpose of the land (Zavar, 2015). The Federal Emergency Management Agency (1998) has developed guidelines for this objective. These policy guidelines state that buyout communities can decide on the future of this land; however, the choice of land use must be a type of open space. Examples of open spaces include wetland

restoration sites, parks, jogging tracks, environmental and ecological centers, playgrounds, and any other type of open space. Authorities limit the land use of vacant lots after buyouts to open spaces only due to financial constraints and environmental protection concerns. Land uses tend to require minimum financial investment and limited post-development management but can generate revenue in the form of tax for the government. These land uses should also promote wetland management and biodiversity and may not reduce the capacity of the land for floodwater absorption and flow (Zavar, 2015).

2.6 Social Equity in the Implementation and Management of Buyout Programs

The United Nation's Habitat reports (2008) illustrated that global cities are suffering from a high level of inequality in terms of urbanization, substandard infrastructure, unemployment, limited access to health, education, and nutrition rights, and deficient public services (Flores, 2017). However, these inequalities are not limited to the development of cities only. Persistent climatic change, floods, and their adverse effects have generated scholarly debate regarding social vulnerability and social equity in disaster response, recovery, and mitigation projects. Social vulnerability and social equity are parallel concepts concerning the suffering of marginalized communities. However, social vulnerability is related to differences in communities' susceptibility to loss during disasters, whereas social equity relates to people's access to equal resources for hazard mitigation and recovery (Tate & Emrich, 2021). Social inequities are prominent drivers of devastating flood effects. Researchers at Washington University have compared social vulnerability to hazards across the United States. Their results indicate that communities of color are more vulnerable to hazards (Loomis, 2018). In the context of this project, our focus is on understanding social equity in buyout areas. Specifically, we study whether all areas have experienced similar opportunities for mitigation and post-buyout land

management or if there were any differences based on social demographics.

With the increasing use of buyout programs in the United States, scholars have raised concerns regarding social inequity in the implication of projects from the property acquisition stage (Mach *et al.,* 2019) to the administrative stage (Cartier, 2019), to the post-buyout land management stage (Elliot *et al.,* 2021). Some studies have claimed that vulnerable populations of flood-prone areas have been forcefully placed into buyout programs by misguiding them about flood risks and eventually moving them to even more hazardous areas (Cartier, 2019). Others have stated that the selection criteria for land acquisition are biased, and only low-income, less educated, and more racially diverse communities have been moved from flood-prone areas (Tate & Emrich, 2021). Natural disasters develop a type of communalism in communities, promoting communities to manage and share resources. It prompts new patterns of land use and ownership, with localities regaining vacant properties and constructing fresh public areas. However, this communalism is not always inclusive and communities with lower socioeconomic status (SES) may not take advantage of this opportunity(Zavar & Schumann, 2020). The results of a case-based investigation of Houston's buyout neighborhoods revealed that f federal disaster funding for flood mitigation and recovery favors high-income communities (Hersher *et al*., 2019). Similarly, a recent study suggested that race and ethnicity influenced post-buyout land management in Harris County, Houston yet the analysis lacked a systematic review (Elliot *et al*., 2021).

2.7 Introduction to Case Study: Harris County, Texas

The case study focuses on Harris County, situated on the upper Gulf Coast in southern Texas, United States. It is the county seat of Houston City, which is the largest city in Texas (Henson, 2022). As of July 2021, the U.S. Census report is comprised of 16% of the total Texas

population. The San Jacinto River and Buffalo Bayou run through the county, and much of the region lies in floodplains. Geographically, it is only 50 feet above sea level and is vulnerable to floods and hurricanes (Jones *et al.*, 2008).

Owing to its location, Harris County has a long history of floods. According to the Harris County Flood Control District (2022), Harris County suffers from floods on average every two years. Since the area was developed on the bank of Buffalo and White Oak Bayous in 1836, the city of Houston has endured historically devastating floods. One of the earliest documented catastrophic events occurred in 1900 in Galveston, Texas, south of Harris County, Brazil. It was a Category 4 hurricane on the Saffir-Simpson scale, killing 6000–8000 people in Harris County alone (HCFCD, 2022). In 2001 tropical storm Allison caused the worst flooding in Harris County Texas. 73,000 homes and 95,000 cars were submerged in Harris County only in this flood, displaced 30,000 people and caused a loss of $1.76 (RMS, 2001).The most recently recorded storm was Tropical Storm Imelda in September 2019 which flooded 3990 homes in Harris County. County records show that 48 devastating environmental disasters impacted Harris County from 1900 to 2019. However, Hurricane Harvey in 2017 was the most prominent, resulting in the flooding of 154,170 homes and total damage of US$ 125 billion. It was counted as the first major hurricane in southern Texas after Celia in 1970 (HCFCD, 2022).

In response to Hurricane Harvey, Harris County expanded its long-standing buyout program managed by the Harris County Flood Control District (HCFCD). The HCFCD was developed by Texas Legislature in 1937 in response to the catastrophic floods of 1929–1935 (HCFCD, 2022). The HCFCD has included non-structural mitigation activities in the form of buyouts since 1985. Before Hurricane Harvey, the HCFCD successfully acquired 3100 properties and restored more than 1060 acres of land in the floodplain areas of Harris County

funded by FEMA (Zavar *et al*, 2022). As of January 2023, HCFCD purchased 940 buyout properties, of which 233 were in process. Overall, more than 4000 homeowners volunteered to participate in this program. Of these, 1600 properties were approved for purchase. Figure 3 (Zavar *et al.*, 2022) compiles the history of major flood events in Harris County and buyout property acquisitions from 1920-2021, in graphical representation.

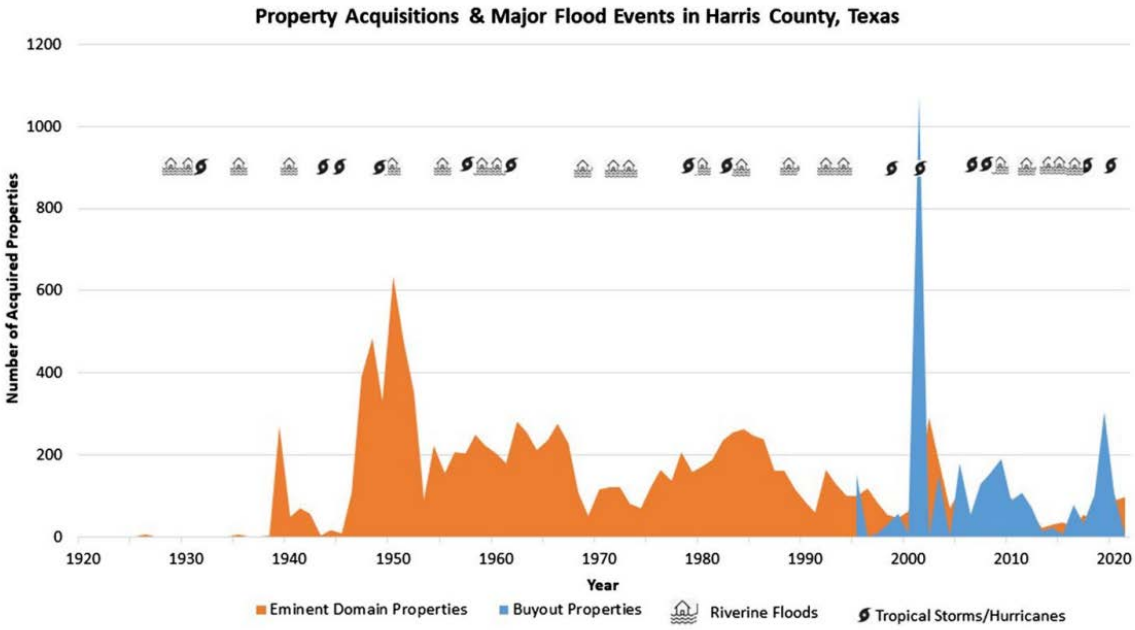


Figure 3: Property acquisition & major flood events in Harris County, Texas, Source: Zavar et al, 2020

CHAPTER 3

RESEARCH METHODS

Repetitive flooding is common in Harris County, where the Harris County Flood Control District (HCFCD) estimates that 25% of the county lies within a floodplain. However, Hurricane Harvey in 2017 broke numerous records, and the impact of the hurricane varied among socioeconomic groups (HCFCD,2021). In response to Harvey, and to avoid future flooding, the HCFCD adopted buyouts as a mitigation strategy in floodplain areas (HCFCD, 2022; Figure 4).

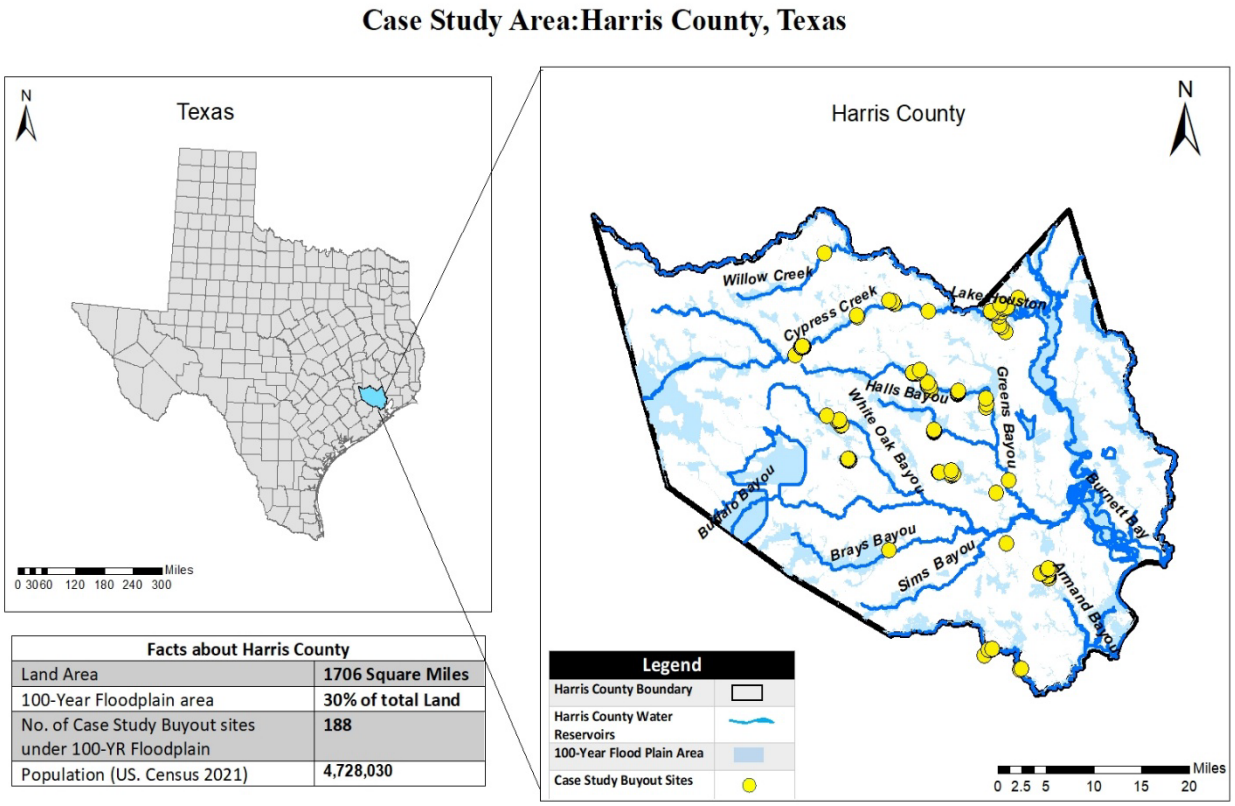


Figure 4: Site map of buyout locations in Harris County, Texas.

These sites occur across socio-demographically diverse areas of the county and provide a case study site to analyze issues of equity in post-buyout land management (Elliott *et al*., 2021). Therefore, the objective of this study is to analyze post-buyout land use management practices in relation to the demographics of the adjacent neighborhood at the block group level in Harris

County, Texas, USA. Specifically, my guiding research questions with five hypotheses ask how neighborhood demographics coincide with post-buyout land management practices.

Table 1: Study Hypotheses

Hypothesis	Statement	Reference
H1	Predominantly white neighborhoods experience regular lawn mowing	Elliott *et al*., 2021
H2	Debris and trash are more frequent in lower SES neighborhoods	Pellow, 2004 Chakraborty *et al*., 2011
H3	High-utility uses are less frequent in lower-income areas and neighborhoods of color	Elliott *et al*. 2021; Zavar and Hagelman III 2016
H4	Neighborhoods with higher income areas experience more amenities on post-buyout sites	Rigolon, 2016
H5	Homeownership status impacts post-buyout landscape management and development	Yun, 2012

Based on the literature, this study developed five hypotheses related to the influence of socioeconomic status and post-buyout land management (Table 1). To address the research question and test the hypotheses, this study used photo documentation for data collection and visual content analysis techniques for the analysis stage. Photo documentation records and documents landscape data. This data collection technique provides an accurate understanding of actual field circumstances (Trine, 2012). Wagner (1979) discusses in his research studies that photographs help us understand social phenomena systematically. Visual content analysis is a research approach that entails the organized and objective assessment of visual resources, such as photos, films, and other forms of visual data. It is used to recognize and evaluate patterns, themes, and other important aspects of visual content. (Krippendorff, 2004). Utilizing this approach, we divided our study into three phases: 1) identification and photography of post-buyout sites in Harris County, Texas; 2) development of a framework of indicators to evaluate post-buyout land use management and coding of photographs of post-buyout sites; and 3) spatial analysis in ArcGIS of the socio-demographic composition of buyout neighborhoods using U.S.

Census Data American Community Survey 5- year data (2017-2021) compared with post-buyout land use management practices.

In Phase 1 of the research, the research team identified post-buyout land-use sites and management practices in Harris County using county records. A purposive sampling technique was used for sample selection. It is a widely recognized method that deliberately and strategically chooses participants or situations according to research objectives (Creswell & Creswell, 2018; Patton, 2014). Once identified, the research team conducted fieldwork over four one-week visits to Harris County between 2017 and 2022. Among the many visual research techniques (Philips, 2014), we utilized photo documentation to collect data from a primary resource.

The post-buyout study sites were selected purposively to include diverse geographical distributions (e.g., urban, rural, and suburban) and ranges of socioeconomic status. As the goal was to include as many buyout sites as possible in Harris County, we prioritized clustered buyout properties. This study covered 188 buyout sites and all these buyout sites represent almost 75% of total buyout properties in Harris County and span diverse social, geographic, and economic characteristics. For this study, we define a buyout site as a group of contiguous buyout properties owned by HCFCD. As HCFCD manages (e.g., mows, blows leaves, and trims trees) all properties in a neighborhood at one time, buyout sites are suitable units for analysis. Furthermore, many post-buyouts land uses make it difficult to identify individually acquired parcels. Some sites in this study consist of only one parcel but other contain hundreds (e.g., parks and detention basins), the size of land has little impact on county management practices as reported by HCFCD standards of maintenance (HCFCD,2023).

Photographs from the field were captured following specific protocols to acquire similar

details at all sites to the best possible level. Photographs of each buyout site were captured from the curb or sidewalk as available, and secondary photographs were taken within the properties to capture details (e.g., signs, debris, playground, etc.). For each site, a minimum of three photos were taken, but for large buyout sites representing many contiguous parcels, as many as 20 photos were captured. In total, this study analyzed over 2,000 photographs. As I wanted to get as many details as possible about each site for stewardship analysis, so there were no set limits on the number of photographs taken per site.

Table 2: Concepts describing landscape characteristics and respective theories*

Concept	Codes	Theory	References
Land use	Park Detention Basin Trails Return to Nature Vacant lot Athletics Informal use Other	Visual Structure of Landscape	Ode *et al*., 2008
Stewardship	Natural Environment 1) Mowed grass (+1) 2) Tall grass (-1) 3) Tree limbs (-1)	Aesthetics of Care	Nassauer 1995, 1997
	Built Environment 4) Trash (-1) 5) Signs (+1) 6) Cultural Elements (+1) 7) Fence (+1) 8) Accessibility (+1) 9) Active (+1/-1) 10) Utilities (-1) 11)Violations (-1)		
Confidence Level	High Medium Low	Intercoder Reliability	Connor and Joffe, 2022

*Codes definitions in Appendix

In Phase 2, I developed a framework of indicators to visually assess post-buyout land management practices. This codebook consists of concepts designed by Ode et al. (2008) to classify the land use and stewardship of each site (Table 2). The first concept, land use, assesses

the utility of land and describes the visual structure of the landscape, based on the work of Ode et al. (2008). Within Land Use, there are eight codes to access the use and function of the following site (Table 2). The second concept is stewardship, which evaluates the level of care and aesthetic qualities. Different levels of stewardship can reflect the management priorities of the local entities responsible for the maintenance (Nassauer ,1995; 1997; Ode *et al.*,2008). Stewardship can be further divided into two types: (1) natural stewardship and (2) built environment stewardship (Ode *et al*., 2008). We refined the codes within these two management types based on observations during the field visits. Finally, we coded the confidence level to account for photograph quality. By developing this codebook, the research team utilized a structured coding approach (Bogdan and Biklen, 1992) to acquire analytically significant features of the data.

This codebook (Appendix) was first developed in Microsoft Excel and was used to analyze photographs of each site and evaluate the site in terms of land use type, stewardship, and confidence level of the person analyzing the photograph. Each photograph was assigned a site number, which was recorded in Excel, along with the geospatial coordinates of the site. Note that some sites had more than one photograph, depending on the size of the parcel, land use, and details present during fieldwork.

To increase the intercoder reliability, all members of the research team coded a subsample of photographs to maintain a level of uniformity among all researchers. The codebook was then refined based on these findings. Dividing the photographs among research teams, we had a minimum of two coders for all photographs. The two sets of codes (one set per code) were compared, and any discrepancies in the data were discussed until both coders agreed upon. This ensured an understanding between different coders of how the data should be analyzed (Connor and Joffe, 2022).

During Phase 3, I spatially analyzed the socio-demographic composition (racial/ethnic composition, average household income, and renter/homeownership status) of buyout study site neighborhoods using data from ACS 5-year 2017-2021 (US Census Bureau, 2021). I acquired data files of racial demographics, median household income, and household characteristics at the block group level in Harris County, Texas, from Social Explorer, a data mapping platform.

To address the five hypotheses, I needed to organize census data in three different forms: 1) racial/ethnicity distribution in Harris County, 2) household income status at the block group level, and 3) housing ownership status divisions on a block group level. To understand and classify racial and ethnic distribution, I classified Harris County block groups into one of four population majority categories: White, Black, Asian, or Hispanic. Furthermore, utilizing median household income data from the ACS 5-year 2017-2021(US Census Bureau, 2021). I separated the area into two divisions based on block groups with households earning more than the living wage and block groups with households earning less than the living wage. The MIT living wage calculator (MIT, 2023) was used to calculate living wage. The MIT living wage calculator determines the anticipated cost of living in a community based on local living costs in it. Similarly, for housing ownership status, I classified the case study area in renter-occupied and owner-occupied majority areas by utilizing demographic data from ACS 5-year 2017-2021 (US Census Bureau, 2021). All these base data developed from demographic data was compared with landscape management index score developed in phase 2.

From this spatial analysis, I identified patterns of post-buyout open space management practices related to socioeconomics in Harris County and developed recommendations for improving land utility in an equitable and socially just manner. The extensive research method is summarized in Figure 5.

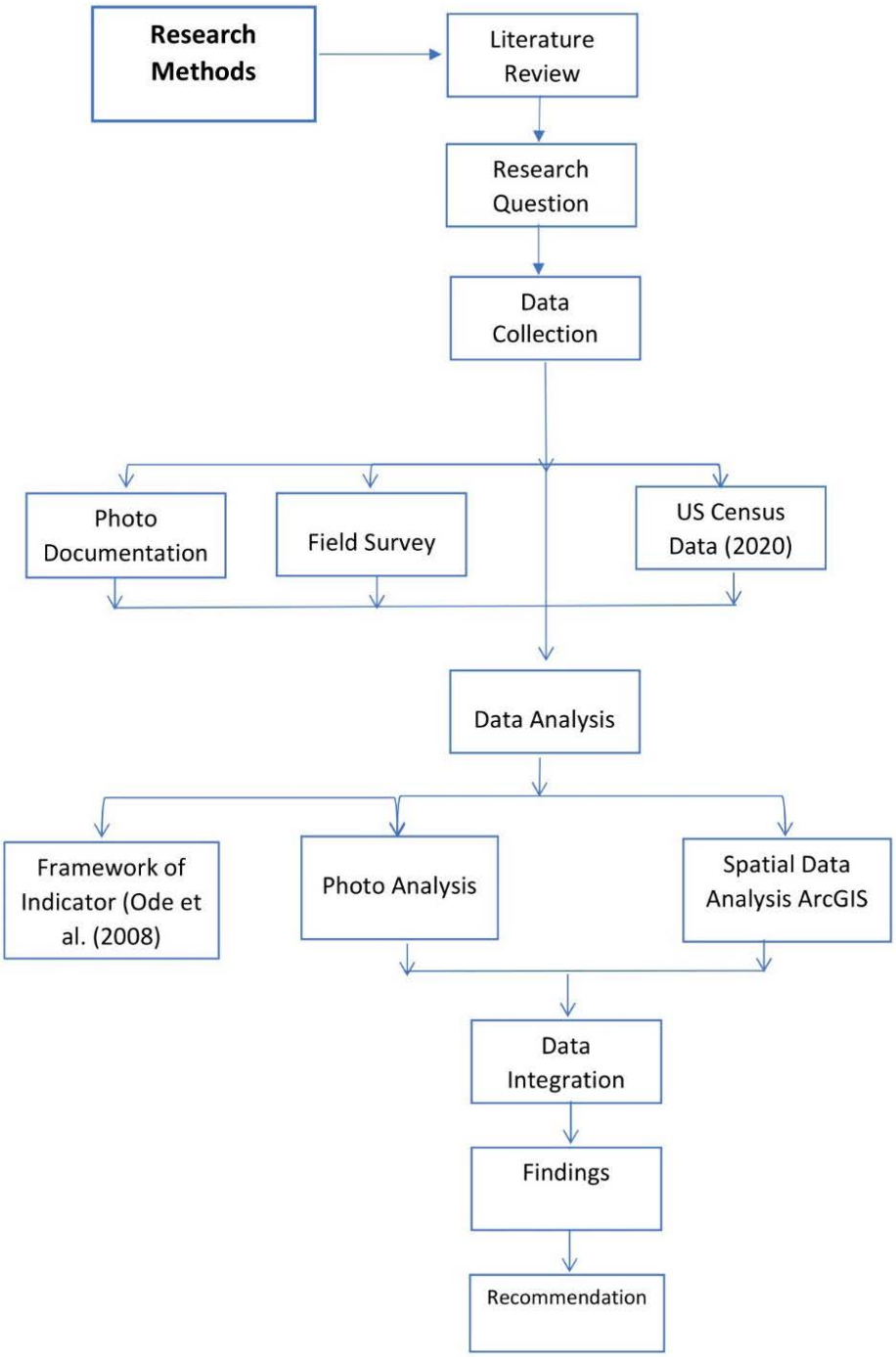
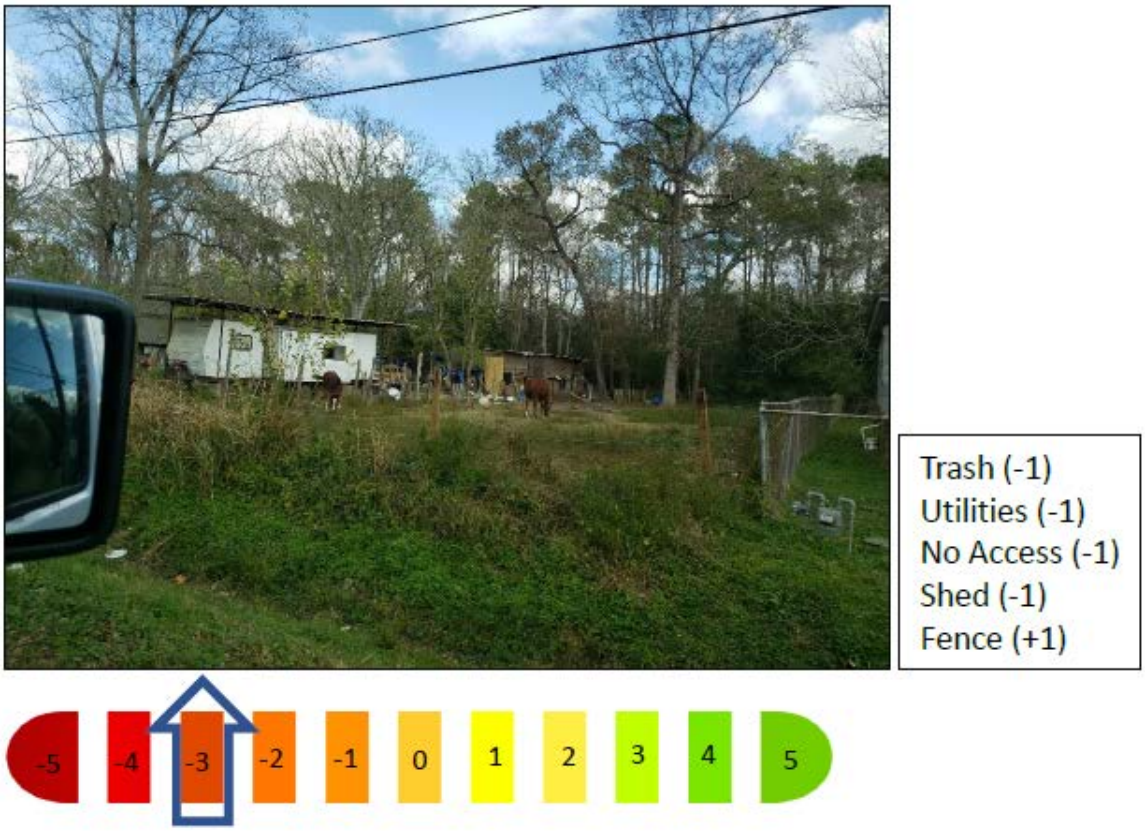


Figure 5: Research methods flow chart.

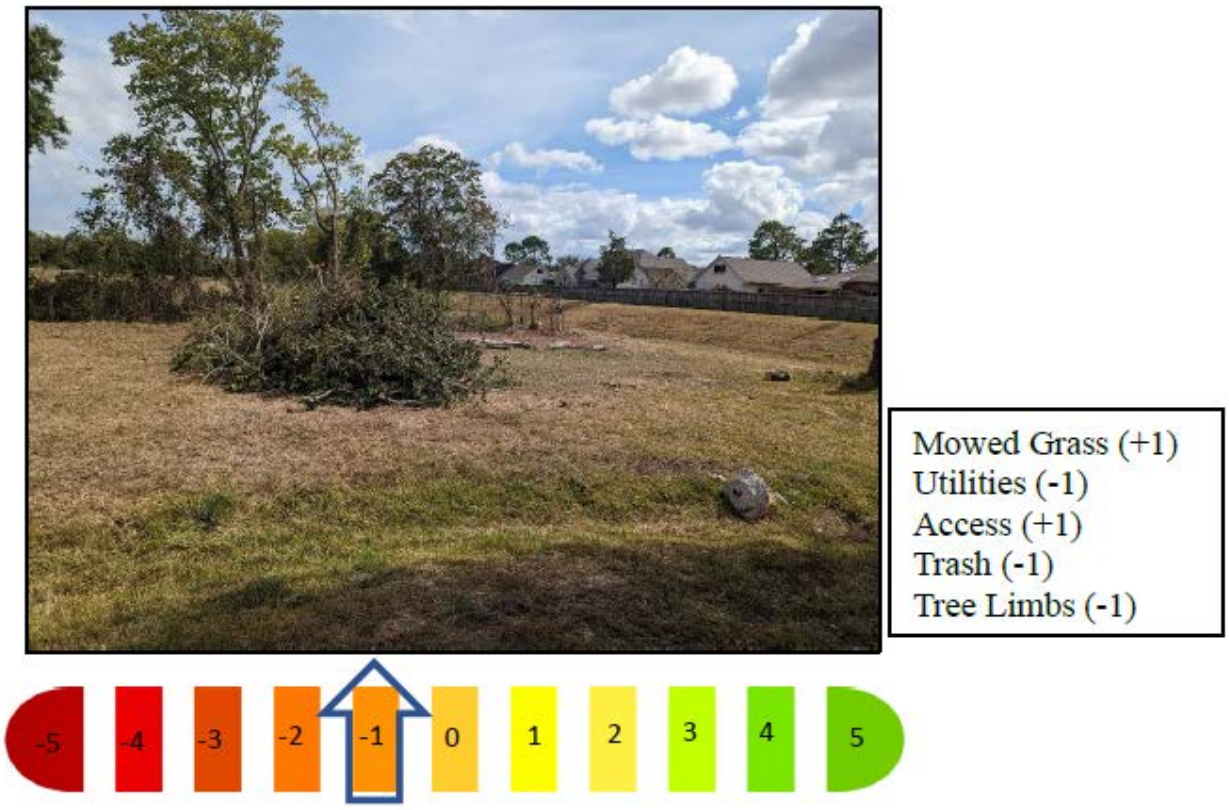
CHAPTER 4

RESULTS

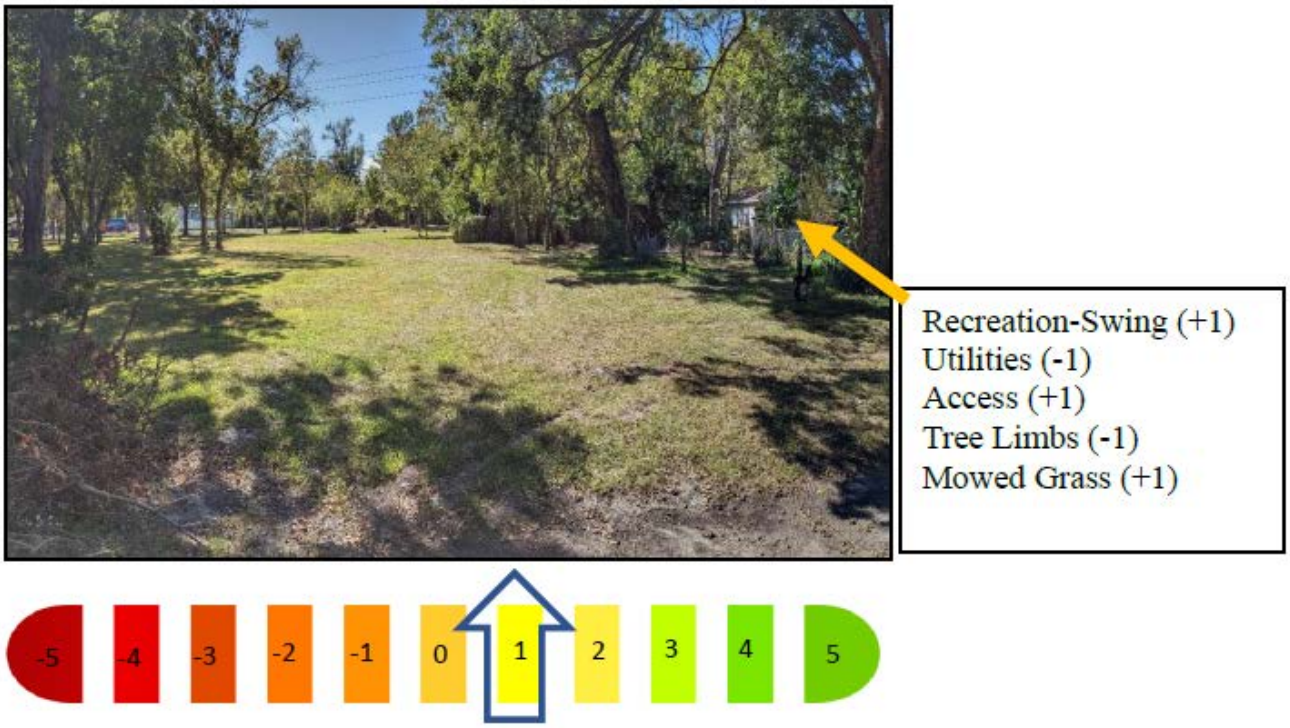
Post-buyout landscape management in Harris County, Texas, varied significantly based on the 188 sites analyzed in this study. The coding of photographs resulted in a landscape management index score for each buyout site (Fig. 6). The scores on this index ranged from -5 to 5 reflective of land management practices with negative indicating poor practices and positive scores indicating more aesthetically pleasing practices (Table 3). These indexes were then compared with secondary data collected from ACS 5-year 2017-2021(US Census Bureau, 2021) to understand spatial patterns related to sociodemographic and post-buyout land management. To address each research question and hypothesis, I compared the landscape management index score for each study site with the related block group level Census data.



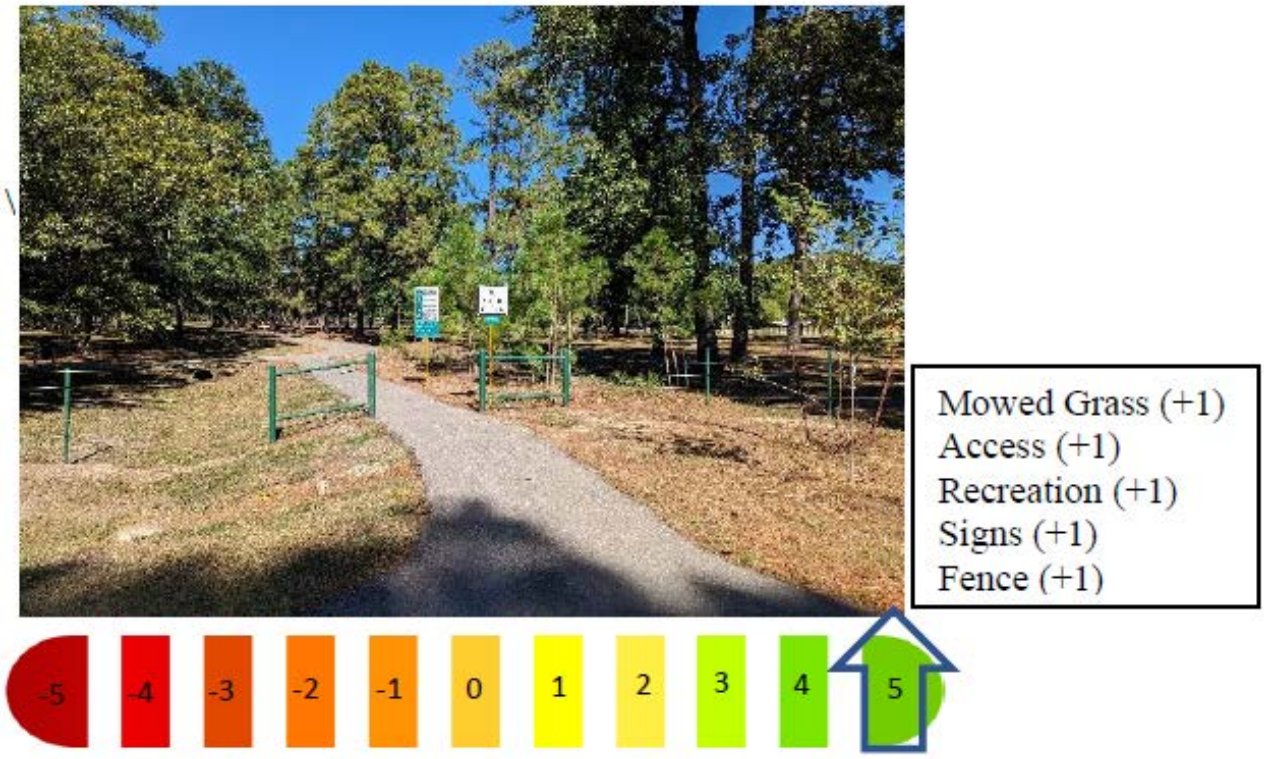
(a)


Mowed Grass (+1)
Utilities (-1)
Access (+1)
Trash (-1)
Tree Limbs (-1)
-5
-4
-3
-2
-1
0
1
2
3
4
5

(b)


Recreation-Swing (+1)
Utilities (-1)
Access (+1)
Tree Limbs (-1)
Mowed Grass (+1)
-5
-4
-3
-2
-1
0
1
2
3
4
5

(c)



(d)

Figure 6: Examples of study sites and their associated landscape management index score along with the positive and negative features that contribute to the score.

Table 3: The range of landscape management index scores per study site (n=188).

Index Score	% Buyout Sites
-5	1
-4	5
-3	15
-2	24
-1	19
0	12
1	12
2	6
3	4
4	1
5	1

4.1 Race, Ethnicity, and Income Analysis

According to a recent study, Harris County's post-buyout land management is influenced by race and ethnicity (Elliott *et al*. 2021). To analyze this statement with empirical data, I began my investigation by comparing the Harris County landscape management practices score (index) with racial and ethnic demographics, i.e., specific neighborhoods with a majority of white, Black, and Hispanic residents (Fig. 7). The findings indicate that, of the 188 case study buyout locations, 46% were in areas with a predominance of white people, 9% were found in areas with mostly Black people, and the remaining 44% were found in areas with a Hispanic population majority, while none of the case study buyout sites were in Asian majority population areas. The analysis did not show significant differences in landscape management index scores, by race and ethnicity; however, the range of index scores and modes identify more nuanced results. For neighborhoods with a majority Black population, 44% of study sites have negative landscape management index scores. However, none of the study sites in Black-majority neighborhoods scored higher than a 2 on the landscape management index; instead, index scores ranged between -5 to 2 with a mode of -1 (Fig. 8a). Scores among white and Hispanic-majority neighborhoods were similar with 79% of Hispanic-majority neighborhoods scoring positive indexes and 77% of white-majority neighborhoods. The mode values were 2 for both ethnic/race majorities (Fig. 8b and c). Hispanic-majority neighborhoods received land management index scores ranging from -5 to 5, yet there were fewer scores above 2 than in white-majority neighborhoods. This data indicates that white- and Hispanic-majority neighborhoods more frequently experienced positive land management index scores as well as higher positive index values suggesting more aesthetically pleasing practices in these neighborhoods compared to Black-majority neighborhoods.

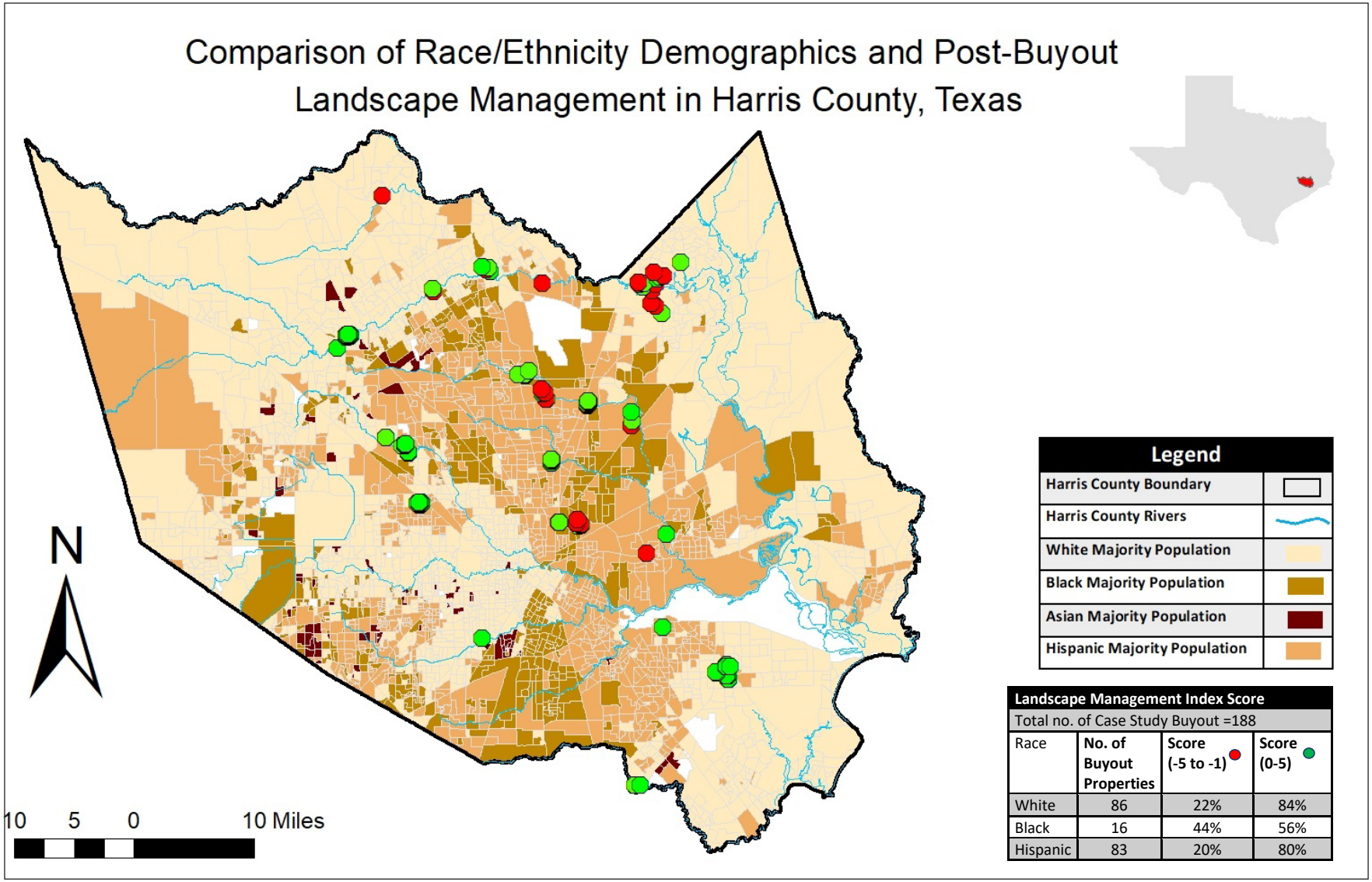
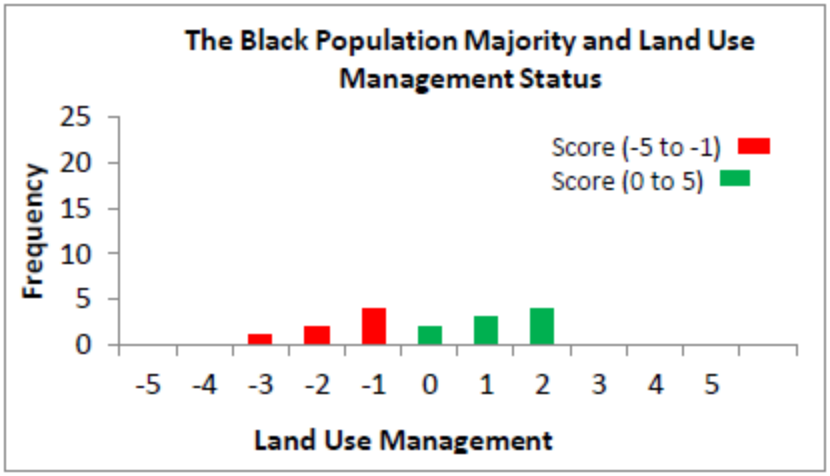
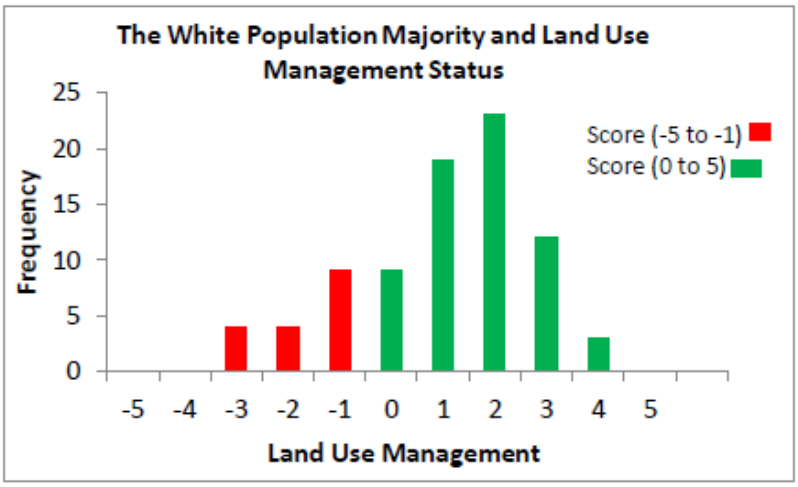


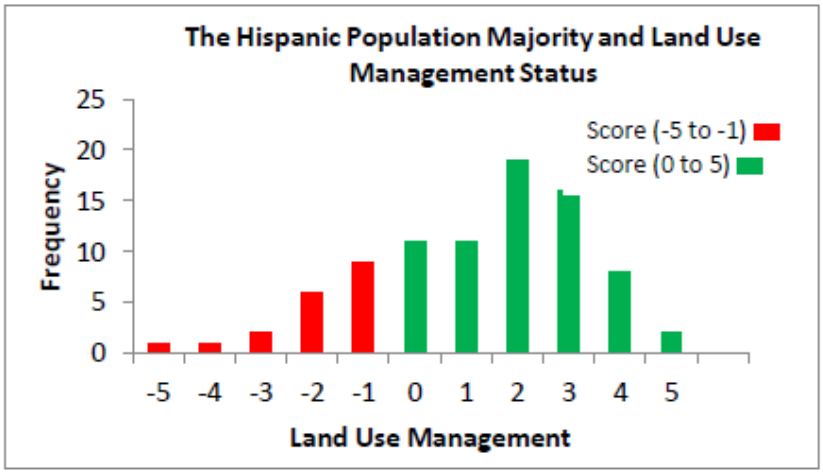
Figure 7: Comparison of racial & ethnic demographics and post-buyout landscape management in Harris County, Texas.



(a) Black majority population



(b) White majority population



(c) Hispanic majority population

Figure 8: Frequency distribution of landscape management score index for (a) Black majority; (b) white majority; (c) Hispanic majority population neighborhoods in Harris County.

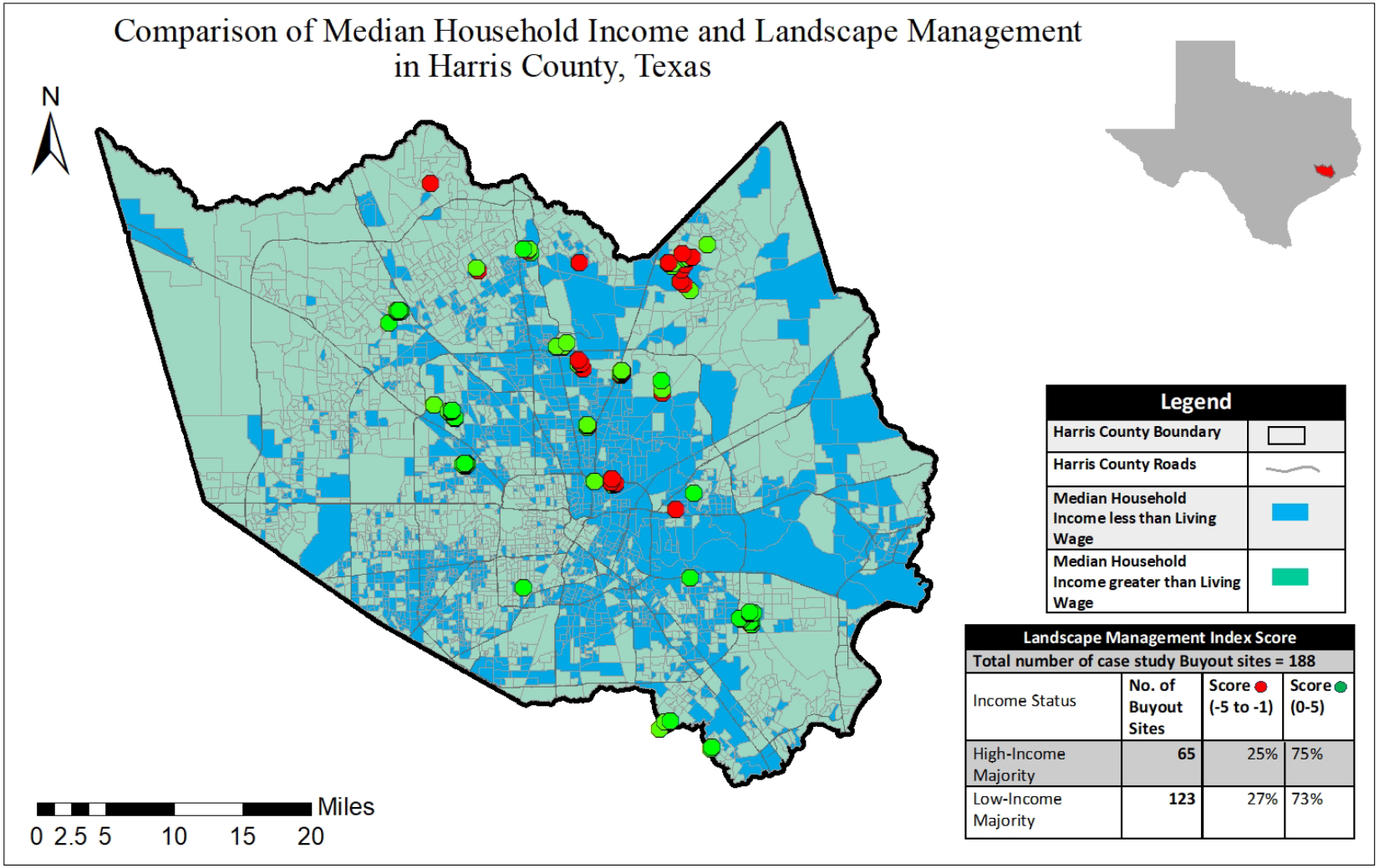
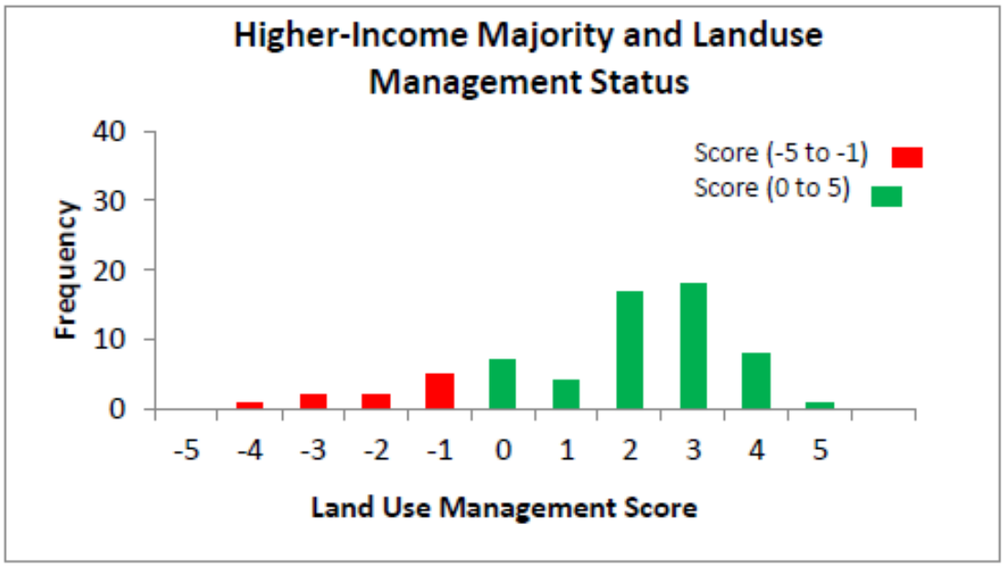
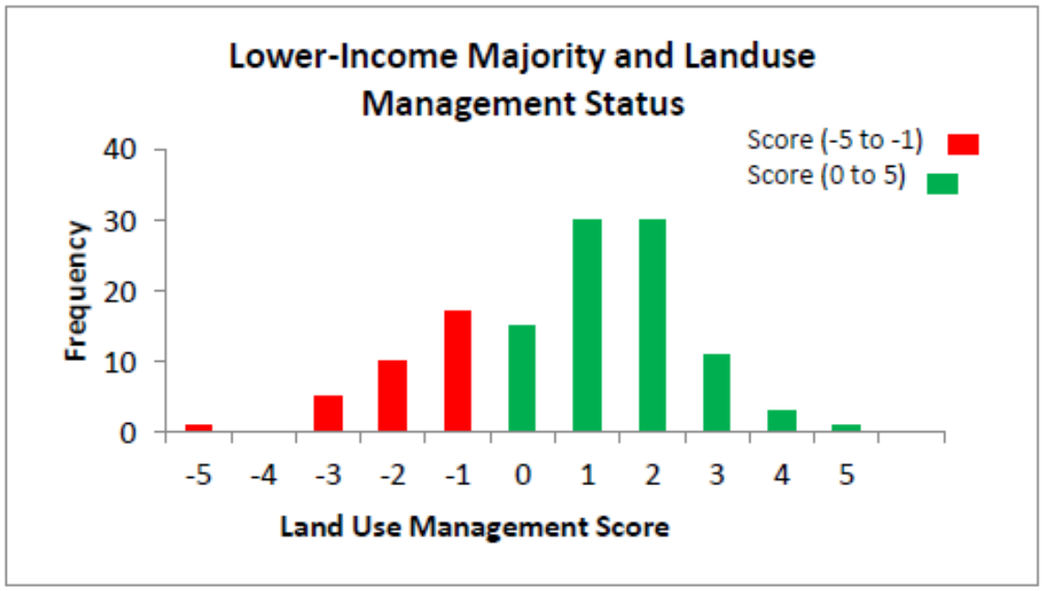


Figure 9: Comparison of median household income and landscape management in Harris County, Texas.

Next, I examined household economic status with land management practices in the study site neighborhoods. For this, I developed a spatial comparison of Harris County's median household income at the block group level with the landscape management index score (Fig. 9). First, we observe that over 56% of the buyout, study sites occur in lower-income areas while the remaining 47% are in higher-income areas. The analysis of the landscape management score in comparison to the economic status of residents of Harris County did not show significant differences between lower and higher income areas (Fig. 9). Seventy five percent of the higher-income population has a positive landscape management score (0-5) and 73% of the lower-income community has a positive landscape management score. Similarly, the mode value of the index score in the higher-income majority was 3 while in the lower-income majority, it was 2, which cannot be considered a substantially different (Fig. 10a and b).



(a)



(b)

Figure 10: Frequency distribution of landscape management score index for the (a) higher income majority and (b) lower-income majority population.

4.2 Hypothesis 1

Following the analysis of race, ethnicity, and income, I then addressed the hypotheses of this study to better understand land management practices and the utility of the buyout study sites. The first hypothesis of this study states that predominantly white neighborhoods experience regular lawn mowing. Studies suggest that racially diverse communities are less likely to receive regular lawn maintenance and mowing services than mostly white areas (Elliot *et al*., 2021). The results from my photograph analysis and subsequent land management index scores for grass maintenance showed variations (Fig. 11). When comparing white-, Black- and Hispanic-majority communities, Black-majority populations had the highest percentage of buyout sites with tall grass (50%), compared to 37% of white-majority and 24% of Hispanic-majority neighborhoods. The predominantly Hispanic neighborhoods experienced the largest percentage of buyout study sites with mowed lawns (24%). Based on these findings, the hypothesis is unsupported, as Hispanic-majority neighborhoods experienced mowed lawns in Harris County than white- and Black-majority sites.

4.3 Hypothesis 2

The second hypothesis of this research study is that debris and trash are more frequent in neighborhoods of lower socioeconomic statuses. Scholarship suggests that low-income communities are more likely to experience higher rates of dumping and trash due to lower levels of community engagement, reduced social capital, and lack of access to municipal resources (Pellow, 2004). I coded the photographs for the presence of trash and debris and compared these with the socio-economic status of that block group as represented by income, race, and ethnicity. I identified trash/debris on 55% of the buyout study sites in lower-income neighborhoods while only 22% of the buyout study sites in higher-income areas exhibited trash and debris on the landscape (Fig. 12).

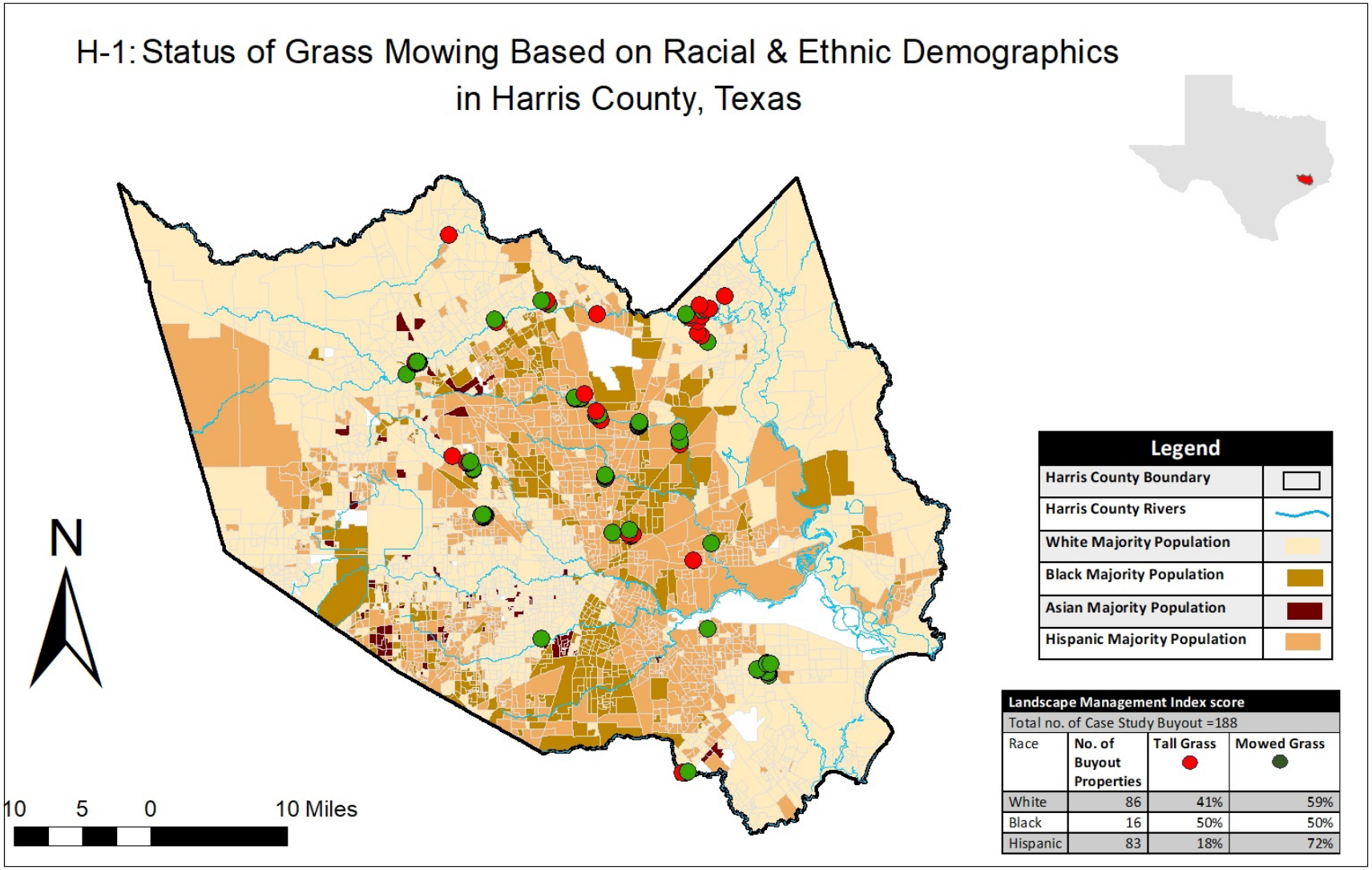
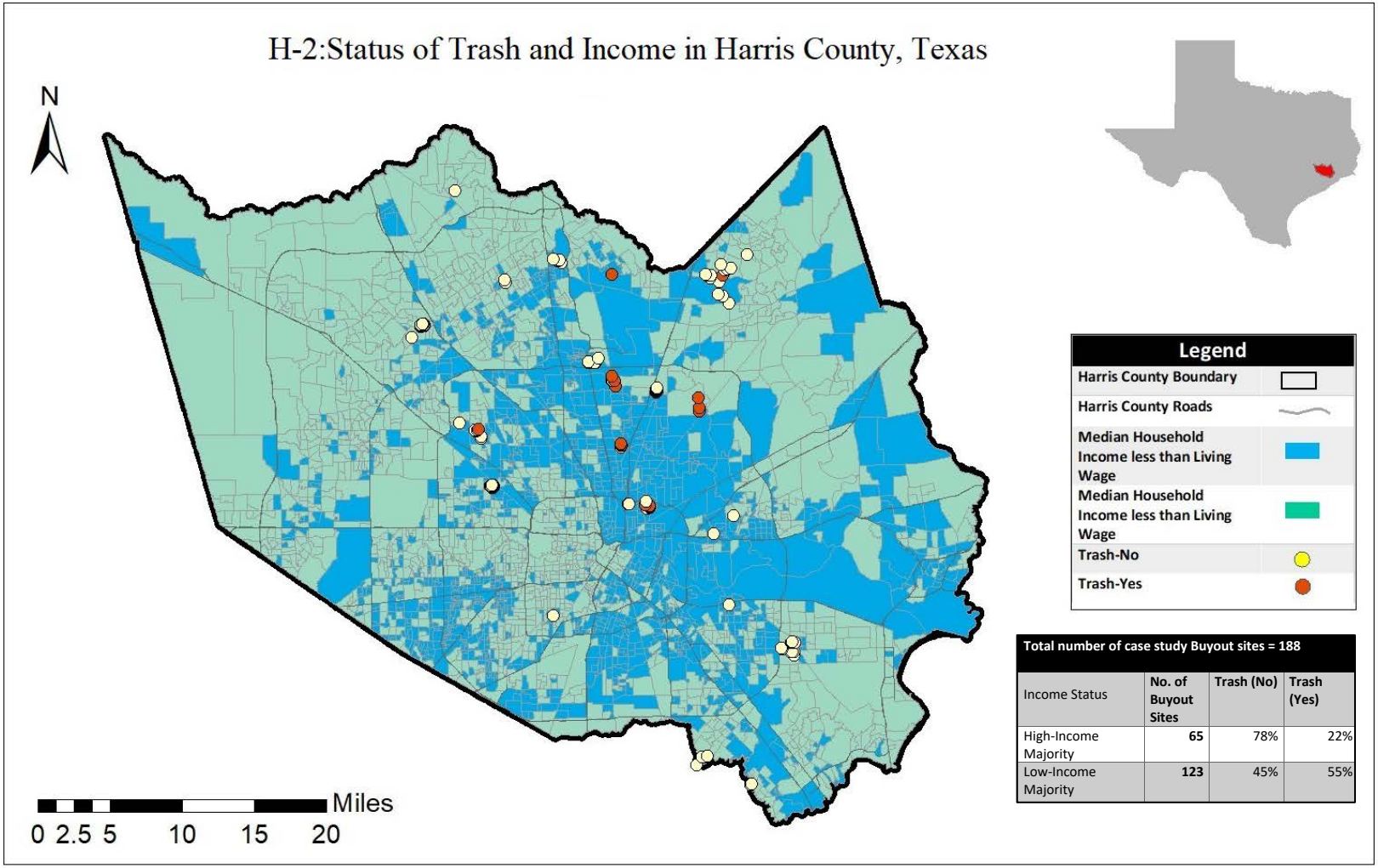


Figure 11: Lawn care as indicated by grass length compared with racial and ethnic demographics in Harris County, Texas



Total number of case study Buyout sites = 188

Income Status	No. of Buyout Sites	Trash (No)	Trash (Yes)
High-Income Majority	**65**	78%	22%
Low-Income Majority	**123**	45%	55%

Figure 12: Presence of trash and debris on buyout study sites compared with neighborhood income status.

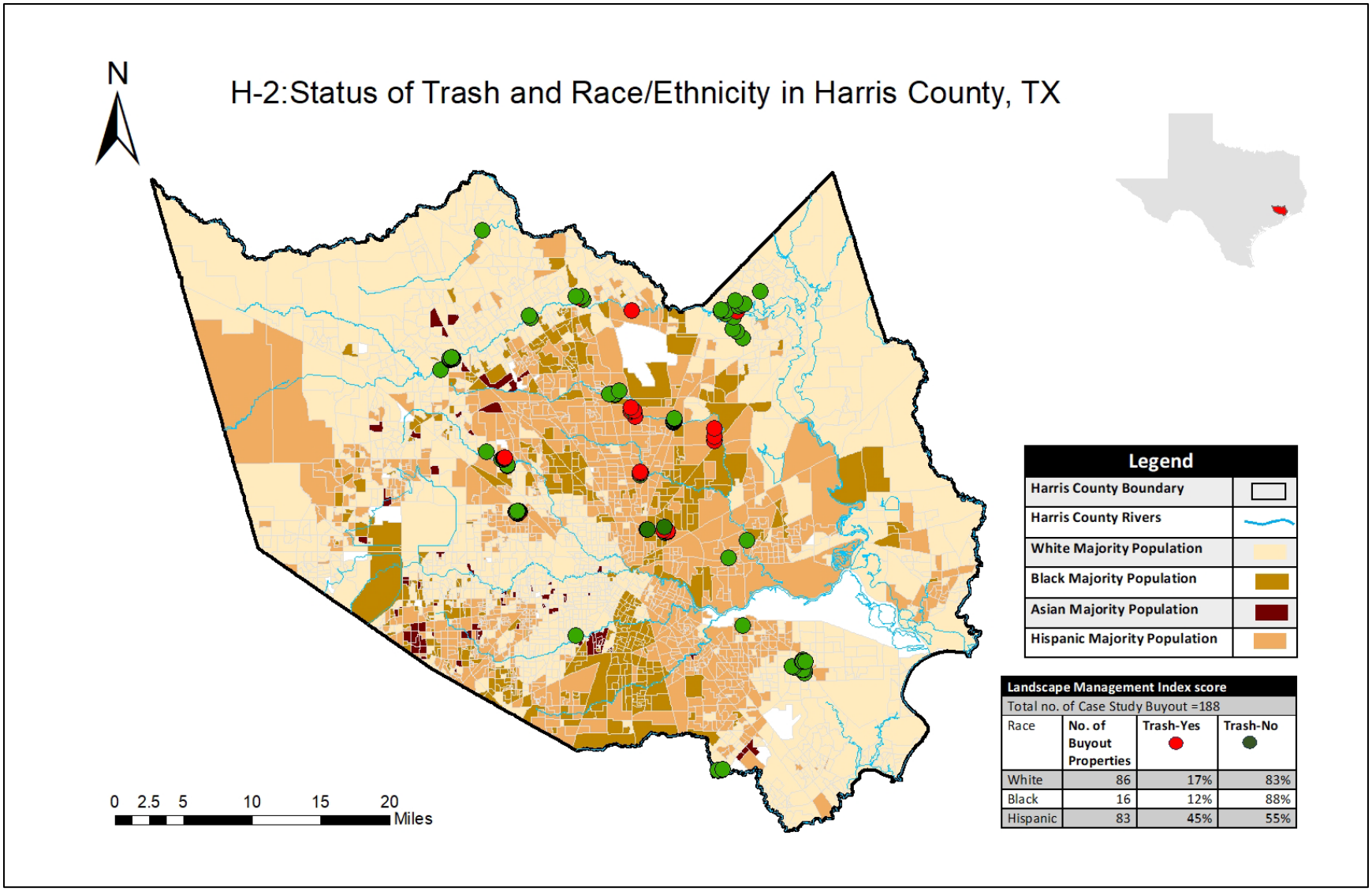


Figure 13: Presence of trash and debris on buyout study sites compared with neighborhood race/ethnicity distribution.

Similarly, a comparison of trash/debris removal compared to race and ethnicity statistics discovered that the Hispanic population majority areas have the highest percentage of buyout sites facing heaps of garbage and trash (45%) as compared to non-Hispanic communities (White population majority at 17%, Black population majority at 12% (Fig. 13). These results indicate that rates of litter and illegal dumping reflect the socioeconomic status of the neighborhood in Harris County. Therefore, the second hypothesis is confirmed.

4.4 Hypothesis 3

The third hypothesis of this research study is that high-utility uses are less frequent in lower-income areas and neighborhoods of color. The land utility is referred to as, "the usefulness of a site for a particular purpose, taking into account its physical characteristics, location, and regulatory context" (Platt, 2014, p.96). Specifically, high-utility land uses are considered those uses that offer more social, ecological, or economic value. Research studies indicate that high utility land uses such as parks, green space, and trails, are less frequent in neighborhoods of Color and lower-income areas leading to social and economic disparities (Elliott *et al.* 2022). In this study, I observed 11 types of land uses as defined by Dascher *et al*. (in press) amongst the study sites, and across all income levels, there were more examples of low-utility (83%) than high-utility (17%) uses.

I identified six different categories of low-utility land use including buyout sites fenced by adjacent neighbors, serving as parking lots, and hosting sheds (Table 4). Despite this variety, vacant lots are the most prevalent type of all land use in both lower-income and higher-income areas. Seventy-four percent of case study buyout sites were managed as mowed vacant parcels. Parking lots are the second most popular usage in lower-income areas, and none were found in higher-income areas. I also observed a variety of informal land uses, such as sheds, mobile

homes, and neighbor-managed sites that were maintained and used by the adjacent neighbors.

Table 4: Low utility land uses on buy-out sites in Harris County, Texas

Types of Low Utility	Higher Income (%)	Lower Income (%)
Vacant lots	70	70
Parking lots	0	8
Sheds	3	4
Neighbor Managed	0	3
Mobile Homes	0	3
New Construction	1	0
Total	74	88

I identified five types of high-utility land uses on the study sites (Table 5). In Harris County, the ratio of high utility to low utility land uses is quite low. The most common high-utility land use type was athletics such as sports fields. Lower-income areas had fewer athletic uses when compared to the higher-income areas. Study sites left to return to nature, which offers ecosystem benefits to the community, are the second most frequent land use in both income categories. Overall, the land utility status is unsatisfactory in both high and low-income majority areas (Fig. 14). However, only 12% of buyout sites in the low-income majority have high-utility land uses whereas, 25 percent of buyout sites in the high-income majority have the privilege of high-utility uses.

Table 5: High utility land uses on buyout sites in Harris County, Texas

Types of High Utility	Higher Income (%)	Lower Income (%)
Trails	3	1
Parks	5	2
Detention Basin	3	2
Return to Nature	5	4
Athletics	10	3
Total	25	12

I further analyzed the status of land utility in terms of racial and ethnic demographics in

comparison to land utility in Harris County (Table 6). Results from data analysis from the field revealed that the buyout sites in Black population majority areas have the least percentage of high utility land uses (6%) while areas with the white population majority have the highest ratio of high utility land uses (18%) (Fig. 15). The White population majority neighborhoods also had access to more types of high utility land uses while only detention basins were present in Black majority neighborhoods.

Table 6: High utility land uses on buy-out sites and race/ethnicity in Harris County, Texas

High Utility	White (%)	Black (%)	Hispanic (%)
Trails	2	0	1.5
Parks	3	0	4
Detention Basin	2	6	0
Return to Nature	7	0	2
Athletics	4	0	0

When calculating the low-utility land uses in Harris County in comparison to race and ethnicity, the variation was quite interesting. The buyout sites with the Black population majority have the highest ratio of overall low-utility land uses but have a lower percentage of vacant lots (69%) as compared to the white and Hispanic majority areas (76%) (Table 7). In the Black majority population buyout sites, a significant number of buyout sites are used as parking lots and are either managed by neighbors for their personal use. Hence comparative analysis of data justified the hypothesis statement that high-utility uses are less frequent in lower-SES areas.

Table 7: Low-utility land uses on buy-out sites and race/ethnicity in Harris County, Texas

High Utility	White (%)	Black (%)	Hispanic (%)
Vacant lots	76	69	76
Parking lots	3	12.5	6
Sheds	3	0	5
Neighbor Managed	0	12.5	1.5
Mobile Homes	0	0	4
New Construction	1	0	0

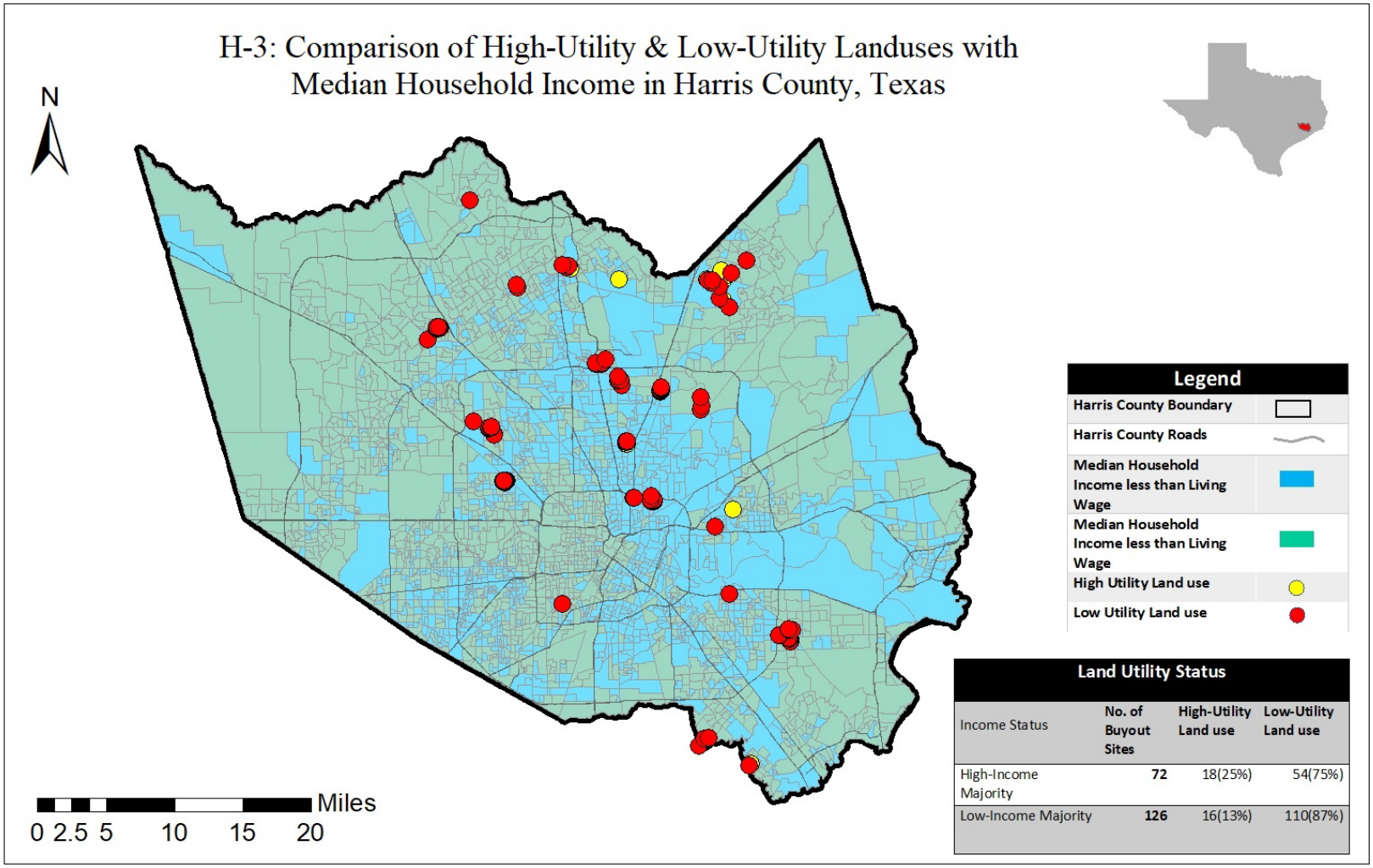


Figure 14: Comparison of high-utility and low-utility land uses with median household income in Harris County, Texas.

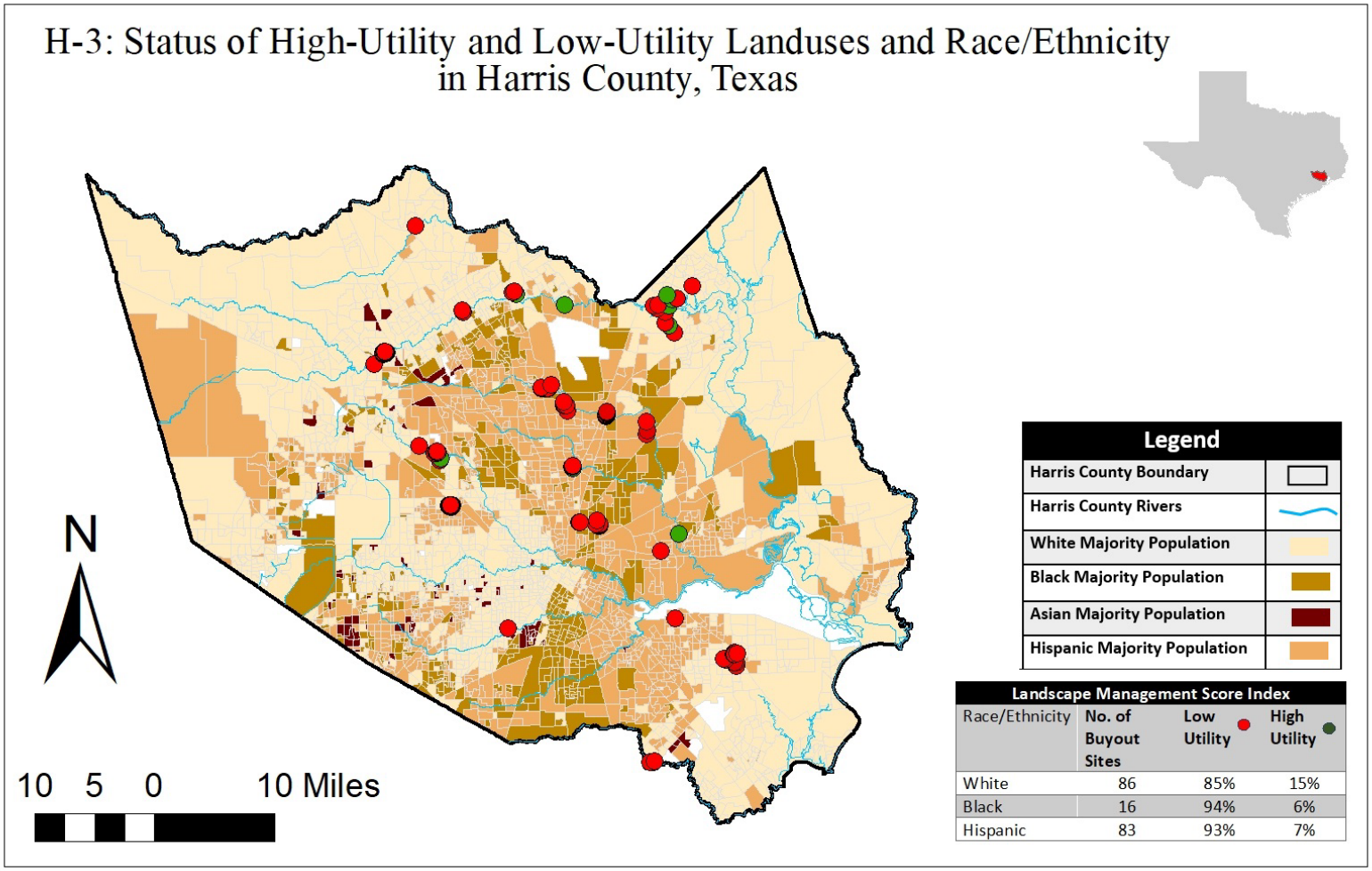


Figure 15: Comparison of high-utility and low-utility land uses with race/ethnicity in Harris County, Texas.

4.5 Hypothesis 4

The fourth hypothesis is also related to the utility of land use. It states that post-buyout sites in higher-income neighborhoods have more amenities compared to low-income neighborhoods (Rigolon, 2016). According to the findings (Table 4), the percentage of available parks, trails, and athletics in higher-income areas is slightly higher than in lower-income areas. However, because the overall availability of amenities is low across all incomes, it is difficult to support this hypothesis. Therefore, our findings support hypothesis four but acknowledge the limitation of low utility across the county's buyout sites.

4.6 Hypothesis 5

The fifth hypothesis of this research study states that homeownership status impacts post-buyout landscape management and development. Homeownership versus renter status may influence post-buyout landscape management practices due to the social capital of residents, the ability to invest in the property, and interest in maintaining property values. Local government decisions on land use practices can be influenced by the housing characteristics of a specific area. If most residents on the buyout sites are renters, authorities will have more freedom to develop any type of land use without fear of negatively impacting land value (Yun, 2012).

The results from the spatial analysis (Fig. 16) uncovered that renter-occupied properties with negative post-buyout land management scores (-5 to -1) were almost double (45%) the number of owner-occupied properties (23%). Meanwhile, the mode value of buyout sites with majority owner-occupied status was calculated as 2 while for renter properties it is -1. I observed a definite variation in the trends of landscape management scores for the renter and owner-occupied buyout sites (Fig. 17a and b). Therefore, our outcomes support hypothesis five and show the impact of homeownership status on post-buyout land use management.

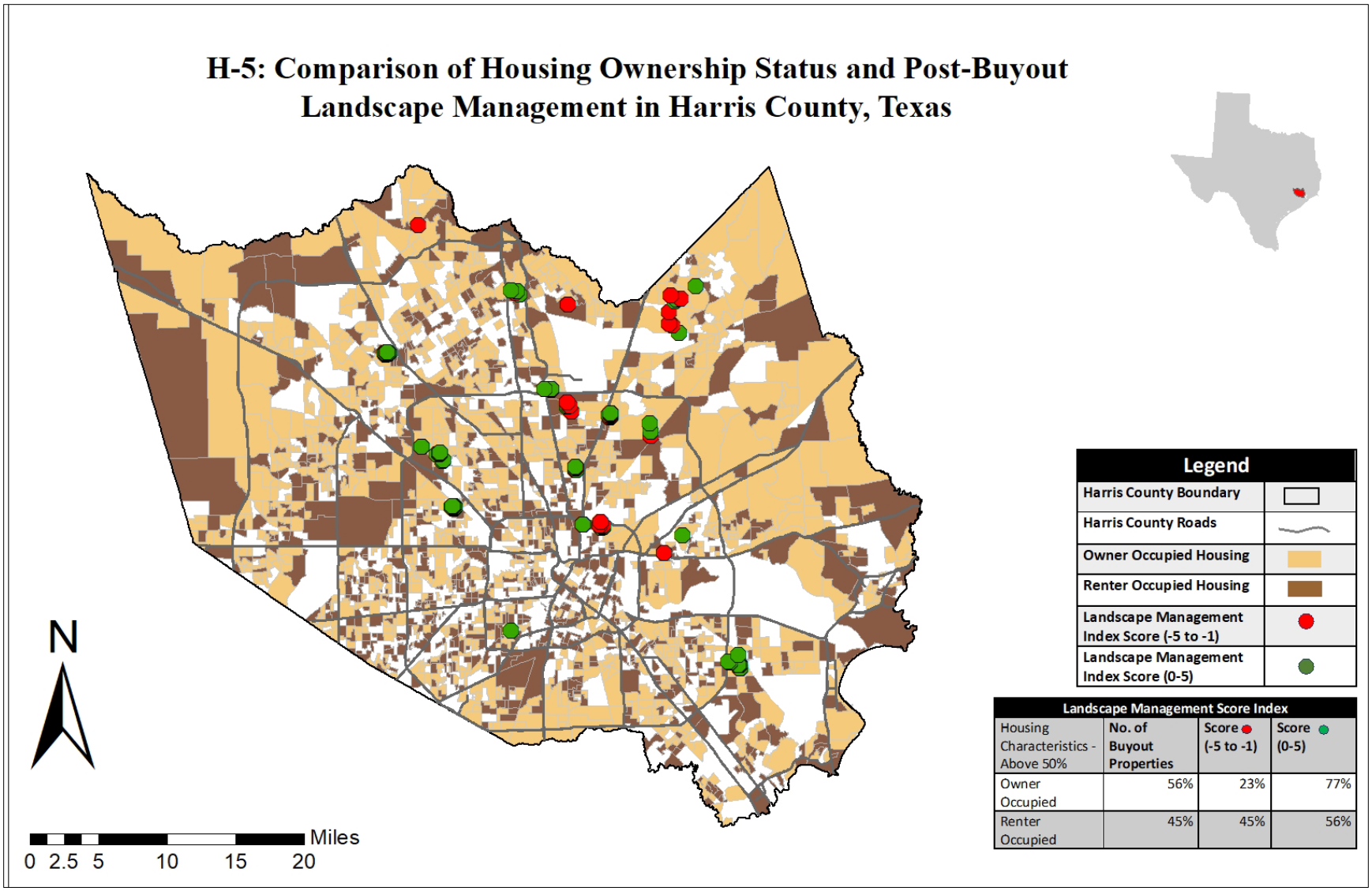
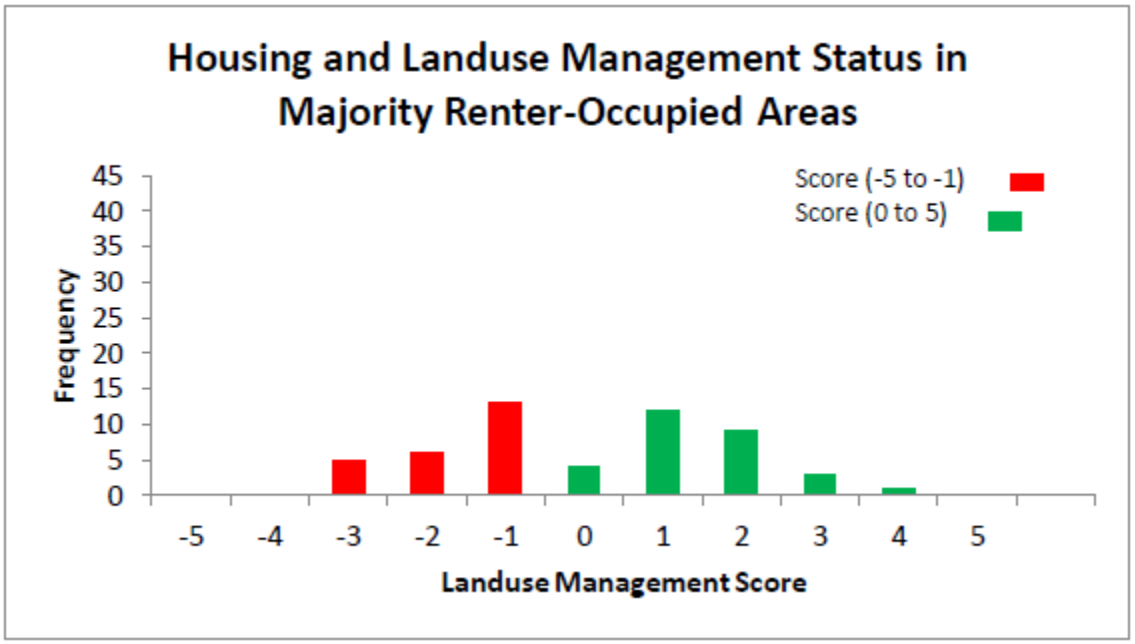
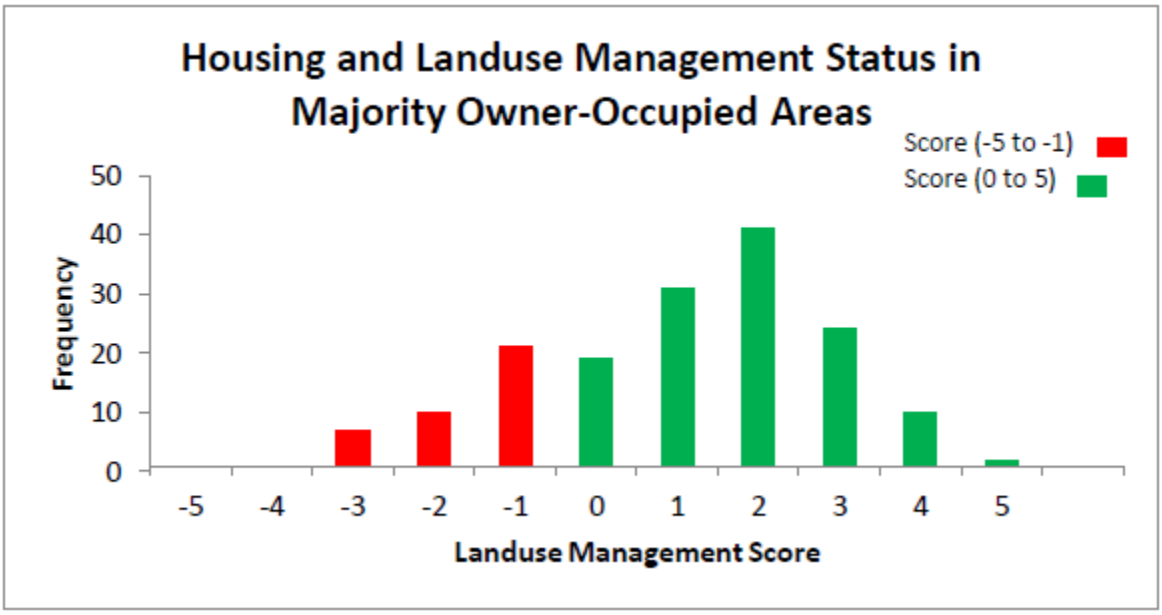


Figure 16: Comparison of housing ownership status and post buyout landscape management in Harris County, Texas.



(a)



(b)

Figure 17: Frequency distribution of landscape management score index for (a) renter-occupied and (b) owner-occupied housing areas in Harris County, Texas.

CHAPTER 5

DISCUSSION

With the growing implementation of buyout programs across the U.S., scholars increasingly are questioning the equity of buyout programs as a hazard mitigation strategy (Mach *et al.*, 2019). Specifically, a recent publication suggested that race and ethnicity influence post-buyout land management in Harris County, Houston, yet the analysis lacked a systematic review of these uses (Elliot *et al.*, 2021). Undoubtedly, social inequities are prominent drivers of the devastating flood effects (Rufat *et al.*, 2015); however, the linkage to post-buyout land management has only been inferred rather than empirically evaluated. Although Harris County Flood Control District mows each acquired property eight times per year, maintenance and aesthetics varied amongst the study sites. This may be in part due to some communities requesting additional maintenance services. For example, any Municipal Utility District (MUD) can request or take over mowing for channels in their area, while residents can also temporarily acquire adjacent buyout lots and maintained to for personal use (HCFCD, 2023).

Despite the policy to regularly provide lawn care services for all buyout properties, my findings show that race influences landscape management index scores. The lowest index scores were observed in areas with a majority Black population. However, areas with a majority of white residents and Hispanic populations share similar outcomes suggesting ethnicity is less of a driver in Harris County, Texas which hosts a majority-Hispanic population (U.S. Census, 2021). The literature extensively documents that communities of color and lower-income residents are more vulnerable to hazards due to socioeconomic factors and the affordability of insurance and management facilities to avoid future hazards (Loomis, 2018). Communities of color and lower-income residents also receive fewer resources to mitigate hazards (Tate & Emrich, 2021).

However, this study did not observe substantial differences in post-buyout land-use management regarding economic status. Yet, the lack of investment in post-buyout land management in predominately Black neighborhoods can contribute to declines in property values and other detrimental effects on neighborhood well-being.

Previous studies indicate that racially diverse communities are less likely to receive regular lawn care and mowing services compared to predominantly white areas (Elliot *et al.*, 2021). This is due to historic racial segregation, where white neighborhoods had greater access to resources such as land, money, and political power. Discriminatory housing policies, such as redlining, further reduced investment in racially and ethnically diverse areas (Zavar and Fischer, 2021). My analysis reflects some of this history, yet the results are more nuanced than often represented in the post-buyout land management literature. My data illustrated that compared to the white majority areas, the Hispanic majority study sites had higher instances of manicured lawns in Harris County. Nevertheless, areas with a Black population majority had the highest ratio of tall grass. Although the historic distribution of resources influences current land management practices, grass mowing is predominately influenced by HCFCD practices. The buyout lots with more care likely received additional services paid for by residents or neighbors who tended lots adjacent to their properties as we observed during our fieldwork (HCFCD,2023). Beyond a more aesthetically pleasing space and impact on property values (Irwin, 2002), improved lawn maintenance can enhances air quality, reduces the impact of urban heat, and greatly benefits urban ecosystems (Smith *et al.*, 2014) thus improving quality of life and health of residents.

Maintenance of buyout lots also includes trash removal yet litter and illegal dumping, especially construction materials and beds were observed. According to studies, illegal dumping

is a major policy concern for local governments because it not only harms the environment but also deteriorates public health and reduces property values (Gardinetti, 2022). Amongst my study sites, areas with a Hispanic majority population frequently experienced debris and trash accumulation compared to non-Hispanic communities. Post-buyout land management is the responsibility of local administrative authorities, with local funds managing the properties (FEMA, 1998). HCFCD offers each neighborhood an equal amount of service, eight routine mows during the growing season, but the residents' ability to pay for additional services or devote their own time to managing adjacent properties reflects systematic inequities (Heynen *et al.,* 2006).

Beyond maintenance, the utility of the study buyout sites varied. High-utility post-buyout land uses, such as parks, gardens, and detention basins, can maximize community mitigation practices and increase resilience to future hazards and climate-induced disasters (Zavar and Hagelman III, 2016). For instance, constructing detention basins and wetlands in post-buyout open spaces allows the absorption of excess water and reduces future flood risk. Additionally, it filters runoff, which eventually results in a better quality of water in streams (Zavar, 2016). However, the literature suggests that these high-utility uses are rare and maybe even less common in lower-income areas and neighborhoods of Color (Elliott *et al.,* 2022; Zavar and Hagelman III, 2016). The empirical evidence from my study sites also indicated such trends in Harris County, where lower-income communities and people of Color have a smaller number of high utility land uses at post-buyout sites as compared to higher-income, white, and Hispanic communities. However, the two parks in this study created or expanded by buyouts are in lower-income, neighborhoods of Color. During fieldwork, our research team observed residents of all ages using the recreation amenities and both parks also incorporated detention basins into the

design to reduce flood risk for the surrounding neighborhoods. The development of both parks involved many local government departments, community groups, and area partners spotlighting the need for engaged stakeholders to drive the construction of high-utility uses, particularly in historically underserved neighborhoods. This is consistent with previous literature on the role of engaged community members, or magnetic agents, who can spearhead the development of post-buyout land uses (Zavar, 2016).

Despite these two parks, across Harris County, there is a prevalence of low utility post-buyout land uses, especially in Communities of Color. There are many potential reasons behind these trends including hurdles in the development and management of land use due to checkerboarding of land and financial constraints at the government level for the development of high utility land uses including parks and trails. Residents with more trust in local government, political power, and resources may be more likely to persuade those limited resources to be invested in their neighborhoods. Whatever the reasons are, the prevalence of low-utility land uses counteracts the benefits to the neighborhood in terms of amenities and risk reduction (Zavar, 2016). In such scenarios, lower-income and minority communities are disproportionately affected by the negative effects of low-utility uses, including air and water pollution and future environmental hazards.

The open space acquired through the implementation of buyout programs can be used to develop sustainable amenities for residents, which can not only provide the community with the opportunity to protect areas from future flood losses but also serve as a source of recreation and environmental protection. For instance, community gardens, parks, water reservoirs, and trails provide many benefits for residents adjacent to buyout properties (Dascher *et al.*, *In Press*). These amenities may even increase home values for adjacent properties (Bin *et al.*, 2008).

Despite the benefits, high-utility uses are infrequent, especially in historically underserved areas. Higher-income neighborhoods have better access to amenities on post-buyout sites as compared to lower-income areas (Rigolon, 2016). Yet my results found that in terms of amenities, all residents of Harris County regardless of economic status or race/ethnicity are lacking amenities and higher-utility land uses on buyout sites. Given that HCFCD operates one of the largest buyout programs in the country and the high percentage of properties in the floodplain (HCFCD, 2021), post-buyout land use development may remain a lower priority at this point.

Land use management and development is a complex process that is influenced by a variety of factors. One such factor, highlighted by previous research studies, is the homeownership status of residents (Yun, 2012). Homeowners are more devoted to their neighborhoods due to their financial investment and social attachments. Therefore, they not only push government authorities to regularly maintain communities but also take time out of their schedules and offer their resources to provide volunteer services to achieve well-maintained neighborhoods. Conversely, renters can be less attached to their neighborhoods due to instability in their housing situation and often have limited decision-making power compared to homeowners. These differences can result in different levels of maintenance, aesthetics, and amenities in neighborhoods. Yun (2012) argues that management authorities often find land use development decisions easier to take and implement in renter-occupied areas as compared to owner-occupied ones. For renter-occupied areas, residents are less concerned about changes in property values. My study buyout sites exhibited similar trends as reported in these studies. In an area with the most homeowners, post-buyout land use management index scores were higher than in areas with most renter properties. This suggests resident engagement plays a critical role in influencing post-buyout land use management practices in Harris County, TX.

CHAPTER 6

CONCLUSIONS

This study examined the relationship between post-buyout land-use management practices in Harris County, Texas, and neighborhood demographics. To evaluate this dynamic, I formulated a set of five hypotheses, serving as the foundation for detailed empirical analysis. This mixed-methods study was divided into three phases: (1) the identification of post-buyout land use management practices in Harris County using photographic documentation; (2) the development of an index to evaluate post-buyout land use management practices by evaluating the acquired sites for aesthetics, utility, and function; and (3) a comprehensive spatial analysis of the demographic composition of buyout neighborhoods using U.S. Census Data (2021) compared to the post-buyout land use management practices.

My analysis identified several patterns in Harris County's post-buyout land use management practices. First, my study sites demonstrated that white- and Hispanic-majority neighborhoods experienced more aesthetically pleasing land management practices than Black-majority neighborhoods. Whereas economic status did not impact post-buyout land use practices. Similarly, the study confirms that debris and trash are more frequent in lower socioeconomic neighborhoods and that high-utility land uses, such as wetlands, parks, and trails are less frequent in lower-income areas. Although suggested in the literature, this study is the first to confirm that neighborhoods of Color and neighborhoods with high rates of renters more frequently experienced less maintained buyout properties with tall grass and litter. Based on lawn mowing conditions recorded analyzed by this study in Harris County, it did not indicate that white-majority neighborhoods experienced more regular lawn mowing as compared to other population majorities. Furthermore, my results indicate a lack of amenities and high-utility land uses on all

buyout sites across Harris County, and that higher-income neighborhoods did not experience more amenities on post-buyout sites than lower-income areas.

Based on this empirical data and previous academic research studies, I developed suggestions to improve post-buyout land use practices with an equity focus. First, community engagement in designing post-buyout management practices through co-production addresses many of the observed buyout land use issues. The goal of co-production is to generate knowledge through collaboration and equal participation of researchers and stakeholders, sharing of skills and resources, and the development of pertinent and actionable solutions (Bezerra *et al.*, 2023). While community engagement is frequently viewed as a one-way process of transmitting knowledge to the community or raising awareness in society, co-production involves collaboration from the stage of problem formation to the stage of implementation, resulting in more practical and meaningful solutions (Stilgoe *et al.*, 2014). Collaboration between researchers, local government administration, and stakeholders on the sharing of knowledge, experiences, resources, and skills, as well as the dissemination of results in policy and practice, can have long-term effects on post-buyout land-use development problems.

Second, interdepartmental collaboration and coordination have the utmost significance for the complex projects of urban development (Huang & Tzeng, 2011). One such project, the Shady Lane Park playground, has already been successfully implemented in Harris County, however, the need is to adopt this interdepartmental collaboration strategy in multiple projects for sustainable city growth. This park was redeveloped after being devastatingly hit by Tropical Storm Allison in 2001. It is an area having a Hispanic population majority of 79% and a Black population of 14% (Stallins, 2021). It is an excellent example of community engagement, participatory design, and long-term collaboration among numerous departments, including the

Harris County Flood Control Authority, the Houston Parks and Recreation Department, the Houston Public Works and Engineering Department, the National Recreation and Park Association, and others. The community was involved in the project from its conception to its completion (Shady Lane Park Revitalization, 2023). Even in terms of funding, it was supported collaboratively by several departments, including Texas Parks and Wildlife, Gametime, and NRPA. Sharing expertise, sources, and knowledge not only solved flood problems through the structural development of a detention basin but also provided much-needed amenities to surrounding communities (Stallins, 2021). In the future, such multifaceted projects should be promoted to not only help communities with their recreational needs but also to distribute the financial burden of development among multiple departments. Nevertheless, community engagement at all stages will make projects more socially equitable.

Third, adequate funding for the development of high-utility land uses is critical to any project's success. Scholarship stresses the value of dedicated financial aid provided by local governments to facilitate environmental justice and upgrade target communities of lower SES status (Cohn *et al.*, 2017). However, rehabilitation of neighborhoods with lower SES should be managed in a way that may not cause gentrification as it will further raise these communities but increase the land value and eventually impact the cost of living. So a balanced approach is required that devotes resources to underserved areas without displacing long-term residents (Zimmermann and Lee, 2021).

While this study identifies needed research on post-buyout land management practices, an understudied area, there are some limitations to this work. First, this study does not involve interviews or surveys with community members or government administration. Interviews and surveys with stakeholders can yield valuable insights and emic perspectives that are likely to be

missed in other types of data. Future research should involve interviews with stakeholders to develop a deep understanding of the land management practices, especially how residents interact with the acquired land, and yield more community-oriented solutions. Secondly, this study is not a longitudinal study, so I couldn't record the change in the type and condition of land uses over a period. Any such future study will develop new insights about land use management facts from field. A third limitation is that this is a case study and is limited to one geographic area. The results may not be generalizable outside of this location. Consequently, I suggest repeating this study in other communities implementing buyouts. Post-buyout land use practices may differ depending on rural versus urban areas, government experience implementing hazard mitigation programs, and level of community engagement in the community. As buyout programs continue to increase in the face of climate change, additional research is needed to understand this hazard risk reduction technique and the associated (in)equities involved at each stage of these programs.

APPENDIX

CODEBOOK

Category	Code	Definition	Example
Land Use	Park	Recreation area- playgrounds, splash pads, dogs, pavilions, walking path. identified by local government as park	Partnership Park
	Detention Basin	Shallow pond-like area with or without water- usually grassy, trees may be present around outside	
	Trails	dirt or gravel or paved trail	walking path, bike trail
	RTN	Return to Nature: grass is left long (knee high), leaves left, trees planted with stakes, little to no lawn care; no signs of utilities, sidewalks, driveways, development	
	Vacant lot	Grassy or muddy with no defined use; looks like lawn without house; still sidewalks or driveway cuts; house address remaining on curb, telephone lines/utility boxes/fences may be present	
	Athletics	Fields, courts with defined purpose established by gov't	basketball courts, soccer fields, sports fields
	Informal use-[type]	The resident put place; not sanction by gov't	swing, soccer nets, sheds, fire ring, seating
	Other	Anything not captured in above categories	
Stewardship	Mowed grass	Looks recently mowed (under 4 in height), grass does not bend over due to length; Shrubs, and grass on the buyout lot are the same height or lower than privately owned neighborhoods' landscaping.	
	Tallgrass	Looks less maintained, grass more than 4 inches tall. Grass may bend due to height; grass seed heads present. Grass taller than privately owned neighborhood's landscaping.	
	Trash	Debris, tires, and litter left on land; construction material dumped	Beds, furniture, paint cans, drywall, garbage bags
	Accessibility	Limited or lack of access to buyout property from street-- road closed signs, no trespassing signs, gates, curbs without wheelchair access	
	Signs	Government signs or other official signs	HCFCD signs
	Cultural elements	informal- things people added to an area	signs, statures, windchimes, decor, geocache
	Fence	Wood, metal, brick permanent structure around periphery of lot. If present on the landscape; neighbors' fence or from the old house were still there	
	Tree limbs	Downed trees or limbs left lying on the property	
	Active	Evidence of people actively maintaining areas, new construction, digging, equipment, lawn mowing, leaf blowing by commercial/gov't (not residents)	workers present, signs, equipment,
	Utilities	Remnants of utilities present on open space. Still maintained in area by government despite relocation	telephone lines, utility boxes,
Coder Confidence	High	Image details are clear, and no questions describing use/stewardship	
	Med	The main image is clear, some are details less obvious	
	Low	The images are unclear, inferred on details	

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