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Building Resilience Against Flash Floods: A Tale of Two Communities in Des Moines, Iowa, USA

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Abstract: Global climate change is increasingly affecting weather patterns and putting communities through disaster shocks with which they have no previous experience. Many cities in the United States are operating on infrastructure and stormwater drainage systems that were not designed to handle increasingly turbulent weather patterns, including extreme flood events. They are adapting both green and gray infrastructures to build longer-term resilience in communities. There is a lack of systematic analysis on community choices, government priorities, and the effectiveness of different flood mitigation strategies, especially in small and medium-sized cities in the United States. Using the case study of the 2018 flash flood in Des Moines, Iowa, this paper compares nature-based solutions (NBS), green infrastructure investments, and property buyouts, examining how community members perceive these different methods of flood mitigation following a major flash flooding event. Fifteen inter-views with key informants and government officials, and secondary evidence are used. The results show a detectable resistance within communities towards funded gray infrastructures and relocations that fracture neighborhoods after disasters. The findings add a comparison of green infrastructure investments, property buyouts, and gray infrastructure improvements as methods of flash flood mitigation in Des Moines, Iowa, and their effectiveness in the contexts of affected communities. The study concludes that context-specific and community-focused approaches, combined with pre-disaster recovery planning, are more effective in building longer-term resilience to floods and other climate-induced disasters than following popular prescriptive approaches.

Keywords: flood mitigation; buyouts; gray infrastructures; green infrastructures; Des Moines; Iowa

1. Introduction

Beginning in the Industrial Revolution and continuing to the present day, greenhouse gas emissions from energy production in developed countries have accumulated in the atmosphere, leading to a measurable increase in the Earth's temperature [1]. Effects are felt differently in different areas of the world. Across the mid- to high-latitude regions and the American Midwest, a notable trend has been observed in climate data, indicating longer periods of drought each year, interspersed with significant precipitation and flooding events [2]. Because many cities worldwide were planned and constructed during a time when climate change did not have the same impact as it does today, their infrastructure may be unequipped to handle the growing threat associated with the above-average rain events predicted to occur in the future [3]. Property and infrastructure damage from Hurricane Katrina,

a single storm event in the United States, surpassed USD 100 billion and was the direct result of inadequacies of floodwater management systems [4].

There are numerous scholarly works that emphasize the significance of various urban flood mitigation measures for cities and regions in minimizing the exacerbating impacts of flash floods and climate change. Measures include green, gray, and soft infrastructures. But there is a real gap in the social [5], economic [6], and environmental benefits of these infrastructures in different communities within urban areas. Previous studies have demonstrated the role and contributions of various green and gray infrastructures in urban flood mitigation [7], but a gap remains in understanding how the combination of these infrastructures and relocation strategies (e.g., buyouts in the United States) functions in diverse urban communities.

Three strategies are widely employed to recover from such flooding events in urban areas worldwide. They are property buyouts/relocation [3], nature-based solutions [8], and strengthening gray infrastructure in combination with green infrastructure [9]. Despite these commonly used strategies, there is a limited understanding of how flood-impacted communities are affected by these strategies, which is the primary research question this study strives to answer based on an analysis of two different flood-impacted neighborhoods in Des Moines, Iowa. In some communities, they can be foundational tools for disaster resilience, but in others, they can create disturbances leading to additional vulnerabilities.

Intensive weather events, such as the 2018 flash flood in Des Moines, Iowa, in the United States, are occurring across the world with an alarming frequency, and their impacts are growing [10]. In 2008, a record amount of rain occurred across the State of Iowa, forcing the US Federal Government to declare 85 of the 99 counties as federal disaster areas [11]. Seventeen fatalities and USD 2.7 billion were attributed to the impacts of the flooding event in the Great Flood of 1993 [12], which also affected Des Moines. Again in 2024, Iowa's Governor had to issue a disaster proclamation, this time for 32 counties on the western side of the state due to record-high river levels [13].

The 2018 Des Moines Flood was a unique event in the month of June. According to the National Weather Service (2018), an average of five inches of rain fell in the Des Moines Metro area, with some localized areas receiving up to ten inches of rain during this high-intensity event [14]. The creeks that meander through Polk County were inundated and spilled out of their banks, most notably Walnut Creek (Beaverdale area), which cuts through the Des Moines metro, and Fourmile Creek (East Des Moines area) (Figure 1). During this event, both usually tranquil water bodies set new records for the highest crest ever recorded [15]. A maximum peak discharge was recorded at a National Oceanic and Atmospheric Administration (NOAA) weather station along Fourmile Creek during the event, showing 10,000 cubic feet per second [16]. Storm drainage across the county was overrun; it had not been designed to deal with such a high flow event [15].

The property damage caused by the 2018 Des Moines flash flood event was historic, with more than 1,800 affected homes [17] and hundreds of damaged cars [18]. Damage to homes ranged from minor flood damage to complete structural destruction, causing unprecedented debris within the city as a result of building materials discarded due to inundations [15]. Des Moines city leaders utilized local, state, and federal funds to purchase and demolish nearly 100 homes deemed uninhabitable due to the floods [17]. The storm brought focus to the community's aging drainage and sewer systems, which were neither designed nor built to withstand such a powerful precipitation event [19]. Polk County had never received such a large amount of precipitation within such a short amount of time in recorded history. Knowing who was most negatively affected by the flash flood and where they currently stand in their recovery can be a useful tool when Polk County and the city of Des Moines work to build their resilience to future storms. Socially vulnerable households may require a longer period of time and additional support to recover after a disaster compared to their less socially vulnerable neighbors [20].

Beaverdale and East Des Moines, the two areas most severely impacted by the 2018 flash flood event (Figure 1), serve as a critical case study for examining disaster recovery in the context of unforeseen weather events. City planners and policymakers may use this analysis to enhance their preparation for socially vulnerable communities, ensuring that property buyouts, gray infrastructure projects, and nature-based solutions align with community needs and values. This knowledge can direct funding to make the most efficient use of disaster management resources when a disaster happens. In this context, this study strives to analyze the community experience and perception of the 2018 Des Moines Flood and its recovery efforts through property buyouts, infrastructure upgrades, and the installation of nature-based solutions and green infrastructures.

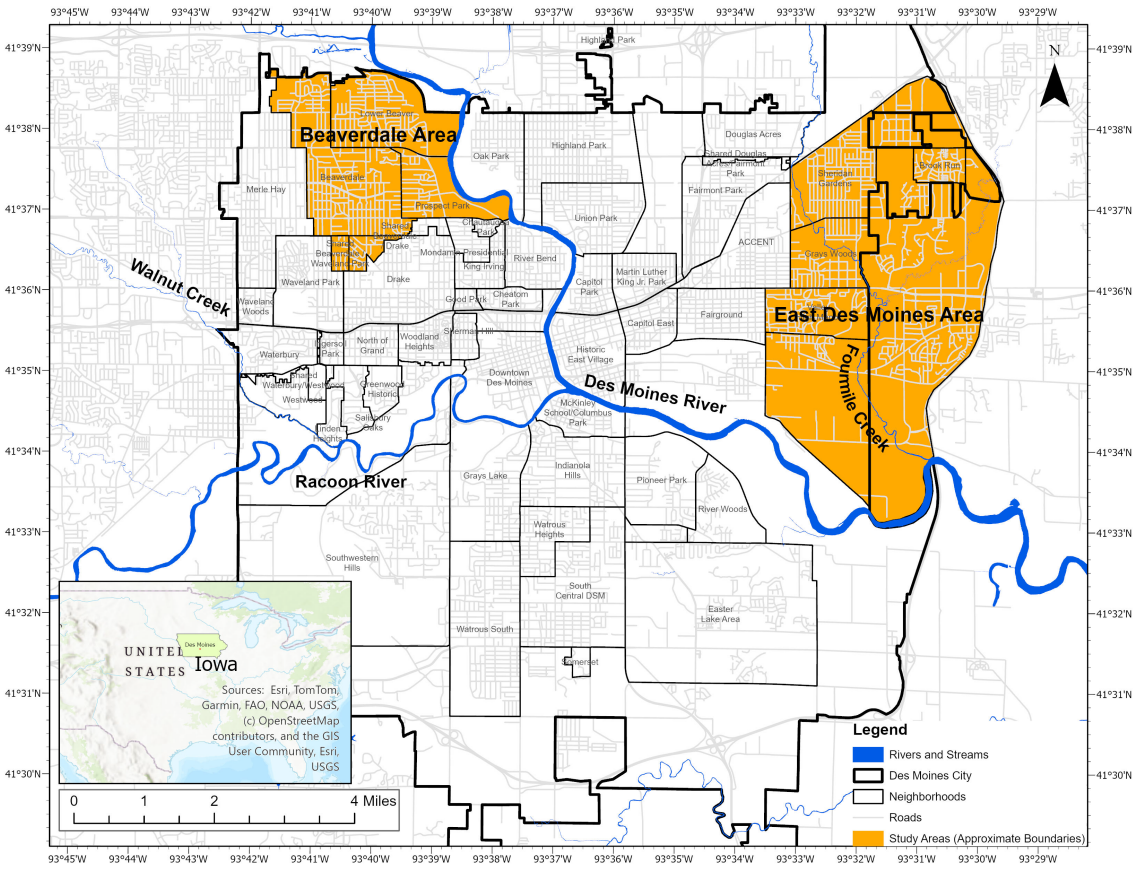

Figure 1. Two Study Areas: Beaverdale and East Des Moines (Source: The authors).

2. Materials and Methods

We used information collected from residents and homeowners of two areas that had first-hand experience living through or dealing with the aftermath of the 2018 flash flood event in Des Moines, Iowa, and combined it with ancillary data we found in the published literature and in the local media to develop a broad understanding of the impacts of the event and how residents in two impacted Des Moines communities (Figure 1) perceive the flood mitigation efforts deployed by city leaders, comparing lot buyouts, upgrades in stormwater drainage systems and green infrastructure development. The research uses a qualitative descriptive approach [21–25] to develop a deeper understanding of the impacts and experience of recovery strategies on flood victims. Information collected from interviews offered insight into how residents in these two areas of the Des Moines Metro felt their communities recovered after the flash flood, and how city officials perceived the flood recovery effort. The ancillary data helped to flesh out the overall picture of the magnitude of the storm and the diverse ways that financial investments were deployed in the two neighborhoods for flood recovery. These two streams of information allow us to develop a meaningful description of communities' perception of flash flood mitigation efforts and their areas of concern regarding the way tax dollars are spent. This yielded an analysis of the various flood mitigation efforts through different stakeholder lenses.

2.1. Study Area

Beaverdale and East Des Moines in the Des Moines River watershed were selected for this study. Despite stark social and economic differences between the selected two areas, the 2018 flood impacted both areas tremendously, and recovery efforts were carried out by implementing property buyouts, infrastructure upgrades, and nature-based solutions in both areas. Although the recovery from the historic 2018 flood has been quoted as successful, there remain questions about the different flood mitigation approaches implemented in both areas and their successes.

2.1.1. East Des Moines

East Des Moines is the area to the east of Interstate Highway 235 as it tracks its way north out of the downtown Des Moines Metro (Figure 1). It is nestled in the 50317 postal code and lies between the incorporated

areas of Pleasant Hill and the 50316 postal code that encompasses the downtown Des Moines area east of the Des Moines River. Approximately 10.2 percent of families in this area live in poverty, and the median income in 2022 was $61,170 [26]. The average home price in 2024 was $199,000 [27], and a significant percentage of the houses in this area were built prior to 1939 [28]. East Des Moines is intersected by Fourmile Creek as it meanders in a north-to-south flow until it spills into the Des Moines River. All land within 200 yards of each side of Fourmile Creek is in a FEMA floodplain (Figure 1).

2.1.2. Beaverdale

Beaverdale is a neighborhood near the center of the city of Des Moines and is situated in the center of the larger metropolitan area (Figure 1). There are no perennial creeks or rivers that run through Beaverdale; however, the area features deep ravines and steep hills that span multiple blocks, capturing precipitation in the Des Moines River watershed and draining into the Des Moines River [29]. Beaverdale residents who live in lower topographic points in the neighborhood or in areas where the stormwater infrastructure was the oldest have lived through multiple flooding events in the basements of their homes [19]. Approximately 6.7 percent of the families in Beaverdale live below the poverty level [26], and a significant percentage of the houses were built in the 1950s [27].

2.2. Research Design and Theoretical Framework

This study has employed disaster recovery planning, flood resilience, and social aspects of disasters as an inspirational theoretical framework for urban flood management strategies (Figure 2). Disaster recovery, including flood recovery, presents cities and regions with significant opportunities to build resilience for the future if implemented correctly [30]. The flood recovery and mitigation efforts in the city should be planned through a comprehensive approach that integrates social, ecological, and technical systems, rather than relying solely on the existing engineering approaches [31]. Urban flood resilience necessitates an integrated and comprehensive approach to assessment and planning that addresses the growing and uncertain flood risk landscape [32]. This approach should prepare cities to be ready for periodic floods and extreme events, while strengthening their longer-term resilience [33,34].

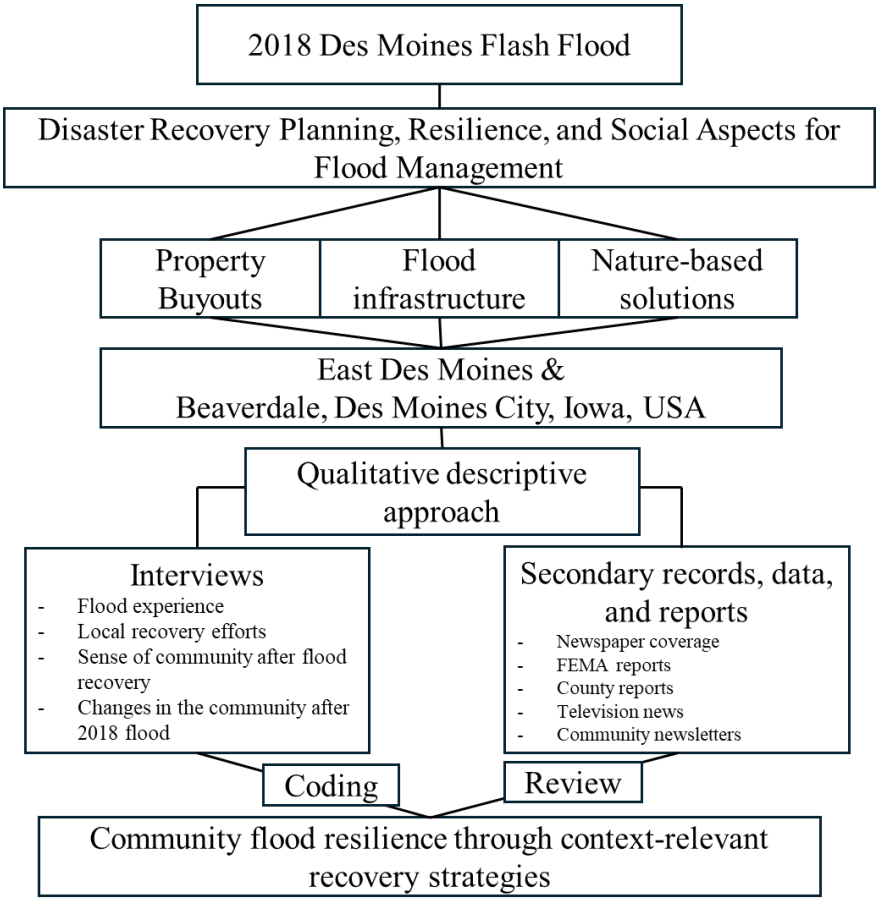

Figure 2. Research Design Framework.

Recovery efforts for building resilience in cities should adopt a multidisciplinary approach, encompassing multiple strategies that target broader flexibility, endurance, and adaptability. Multiple strategies are necessary to develop such an urban system, including top-down and bottom-up flood risk management approaches [35]. Infrastructure development should be integrated with citizen engagement and local perspectives to enhance its effectiveness [36].

Multiple strategies should be employed, including engineering, nature-based, and sociocultural approaches. Previous studies have presented engineering and adaptive measures as enhancing urban flood resilience [37]; however, there is a lack of scientific evaluation on how engineering, adaptive, and nature-based solutions interact with context-specific urban planning challenges and distributional impacts [38]. Based on the 2018 Flash flood event in the Des Moines Metro in Iowa, this study strives to untangle to explain the context-specific urban resilience implications of flood recovery strategies.

2.3. Data Sources

Following the qualitative research approaches recommended by previous studies [39], targeted interviews were conducted with 12 households that were directly affected by the 2018 flash flood event and were either living in or interacting with the East Des Moines or Beaverdale communities at the time of the flood. Additionally, three flood managers and government policy makers were interviewed to understand the recovery projects implemented in the area.

Using a snowball approach, residents were approached to participate in the research, allowing the team to gain a detailed understanding of how these two communities feel about their recovery and flood mitigation efforts following the disaster. The participants were adults directly affected by the 2018 flash flood. Interviewees' ages ranged from 25 to 60 years old. Each interview lasted between 20 min to an hour. All interviews were transcribed and then coded using Nvivo 14 qualitative analysis software [40].

Interviewees were found using local knowledge of community members and snowballing techniques that led to additional participants [41]. The same process was used in both East Des Moines and in the Beaverdale community for an even-handed approach to data collection. The snowball approach had dual benefits: it provided the study with additional interview participants with significant direct experience with the flash flood event and gave the interviewer a first-hand view of the post-flood event neighborhoods. These impressions were incorporated into the analysis of the neighborhoods along with Google Street View images of the impacted neighborhoods and informal conversations.

Interview questions were both broad enough to allow interviewees to voice their opinions yet focused enough to glean valuable insight into the 2018 flash flooding event and local recovery efforts. Example questions include:

- Describe your experience with the 2018 flash flood recovery efforts.
- Have you ever had flooding in your home or workplace before? Could you describe them?
- How was the 2018 flash flooding event different?
- How have things changed for you since the flash flood?
- Describe your experience with the 2018 flash flood.
- How did the reconstruction and recovery in your area take place?
- How have things changed in your area since the 2018 flood?
- Do you feel worried or anxious when you hear a major storm is going on?

Secondary data sources, gathered from websites, local newspaper articles, television newscasts, and community newsletters, were analyzed by the researchers to gain a comprehensive understanding of the impacts of the 2018 flash flooding event and the recovery efforts, including buyouts and nature-based solutions, in both Beaverdale and East Des Moines. This data provided insights into the level of resilience that Beaverdale and East Des Moines have developed since the flooding occurred. The data also helped to supplement and triangulate findings from interviews. Data collected from these sources included facts about the cost of city buyouts, maps of the affected areas, pictures from the event, and quotes from city administrators during this time. The corpus of visual and textual materials gathered was analyzed to offer more depth and context to the data gathered from the interviews. The use of these secondary sources is considered by researchers to be a reliable way to build out a case study with additional layers of meaning and cross-validation of evidence [42].

2.4. Data Analysis

A qualitative method [43] with content analysis for coding and themes [44] in interview transcripts was used in this study. The major purpose of using a qualitative method is to better understand the residents' flood experience and perspectives on flood recovery methods and the effectiveness of the methods in their context. This approach captured the individual lived experiences of residents of both neighborhoods [38] during the 2018 flood, and the mitigation approaches after the event. The research design and interview questions were reviewed and approved by the Office of Research Ethics of Iowa State University.

The interview recordings were transcribed and reviewed multiple times to identify nodes and themes inductively [45], and then coded manually using NVivo 14 software. Researchers detected recurring themes and trends in transcripts [46]. The coding began with high word counts to understand the patterns in the transcripts. Then, systematic coding [40] was conducted to understand the landscaping, landcover changes, infrastructure improvements, and community perceptions in both neighborhoods. Coding was focused on the flood mitigation measures and residents' experiences and perceptions of flooding and recovery through property buyouts, flood infrastructure upgrades, and nature-based solutions.

Previous studies have employed interviews to evoke memories of past ecological disasters and to gain insights into emotional and intellectual responses to these events [17,41]. The interviews allowed the researchers to gain an understanding of the changes in perceptions of flood response and recovery because of the flash flood event and to learn how impacted individuals felt about the changes to their communities after the implementation of various flood mitigation strategies in those communities during the recovery process. Ancillary data collected from different news sources and reports were interwoven with the findings from the interviews to supplement and validate them.

3. Results and Findings

The 2018 flooding in the Des Moines Metro area has prompted numerous interventions to enhance community resilience against flash flood events in the United States and other countries worldwide. Findings from interviews and document reviews related to the 2018 flash flood recovery efforts in two neighborhoods of the metro area revealed trends in investments, the focus of recovery strategies, and the effects of recovery efforts on residents.

3.1. Infrastructure Upgrades and Property Buyouts

One of the major findings, based on interviews, news coverage, and reports, is that the 2018 flood event in Des Moines drew attention from city authorities to invest in flood mitigation efforts throughout the city, including the Beaverdale and East Des Moines neighborhoods. A growth rate of more than 40 percent was observed in flood mitigation projects. Prior to the 2018 flash flood, Des Moines spent an average of USD 8 million per year on stormwater projects. After the flood, the city began allocating approximately USD 14.5 million per year to stormwater infrastructure improvements [47]. Many of the historic neighborhoods around the Interview results and news report analyses found that city leaders recognized the additional investment needs in the city's stormwater management systems and committed $145 million to upgrade different stormwater infrastructures, including storm drains, detention and retention basins, box culverts, storm pump stations, and levees, with the assumption to withstand the next extreme precipitation event [47]. The majority of interviewees from Beaverdale and East Des Moines mentioned that many stormwater management projects were implemented in their neighborhoods following the 2018 flood.

Reviews of reports and interviews with city officials revealed that Des Moines offered property buyouts to forty-five homeowners whose houses were destroyed in East Des Moines and five in Beaverdale (Figure 3) following the 2018 event. The buyouts were offered at 110 percent of the home's assessed value at the time of the 2018 flash flood, which would have cost the city $11.5 million [48]. The buyout was the city's method of removing these houses from flood-prone areas in a way that was both permanent and economically feasible for the property owners (Figure 4).

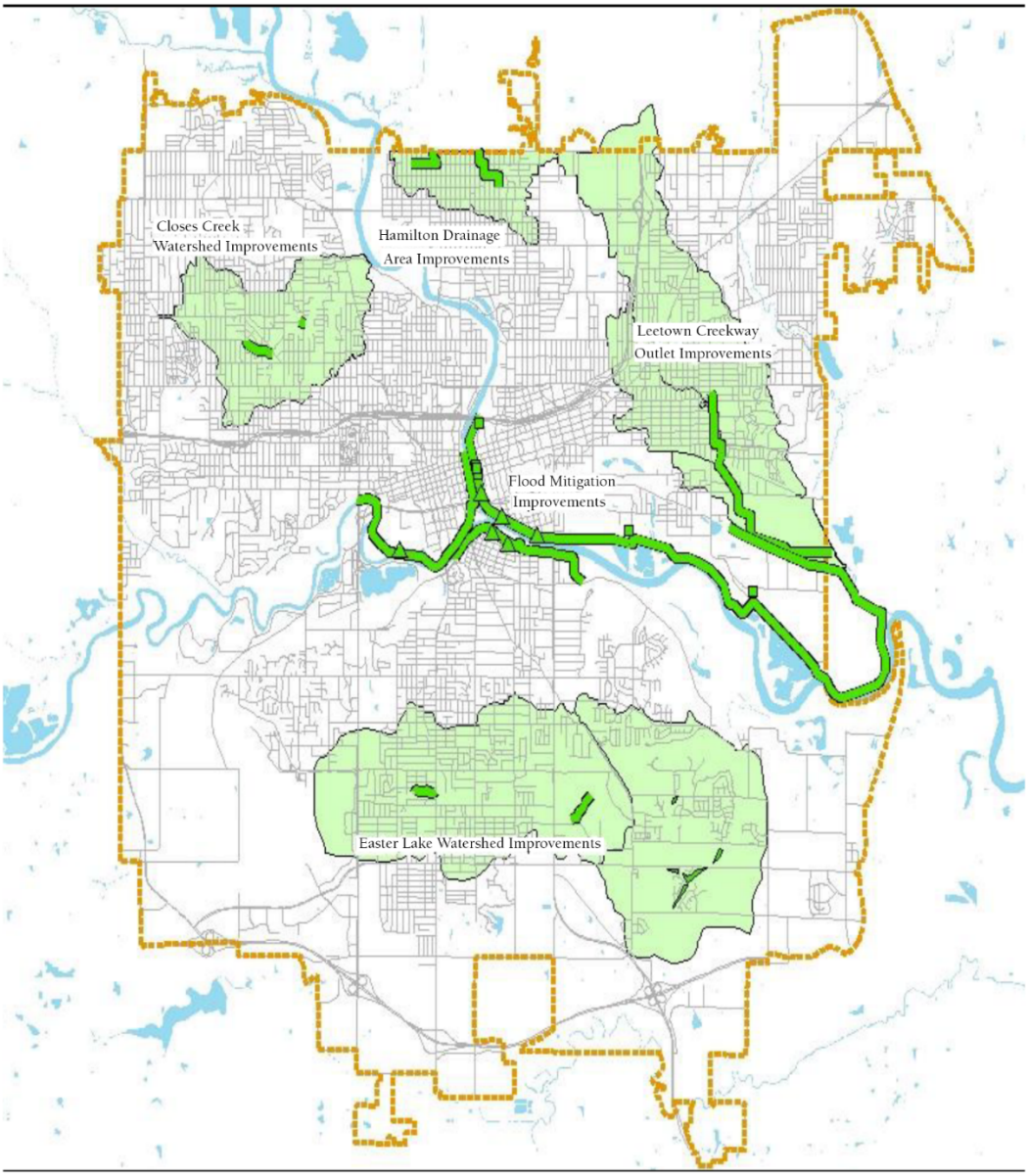

Figure 3. Map showing locations of significant city investments in the 2018 flash flood recovery. Beaverdale and East Des Moines communities are in the green areas of the map [49].

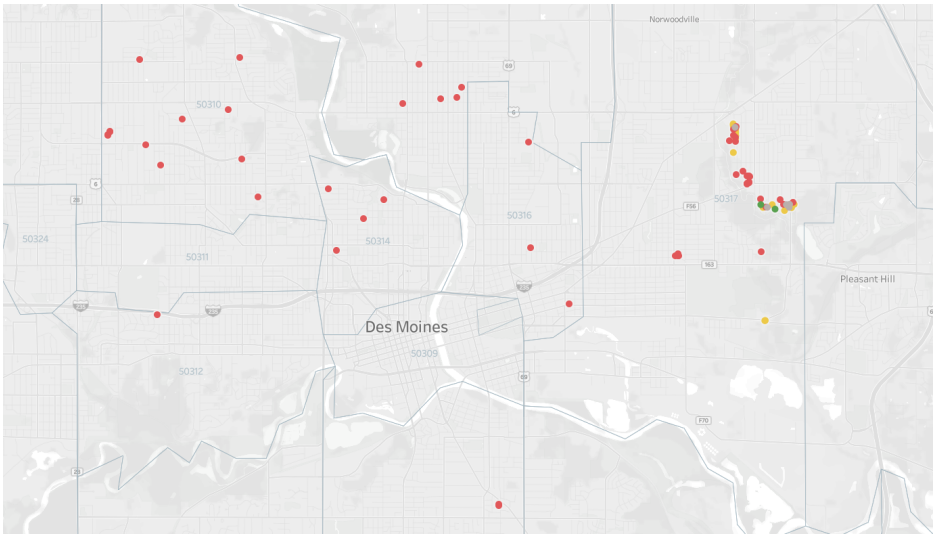

Figure 4. Buyout locations in Des Moines. Des Moines city leaders used property buyouts to help affected residents recover from the flash flood, in addition to permanently keeping homes out of the flood-risk areas [47].

3.2. Different Impacts of Property Buyouts

Interviewees in both communities have described the abnormality of the 2018 flood and its impact on their neighborhoods. Residents of Beaverdale have a higher appreciation and stronger communal feelings towards the gray and green infrastructures and buyouts after the 2018 flood than in East Des Moines. Residents in the East Des Moines neighborhoods that were affected by the 2018 flash flood had mixed opinions on the city's response to the event. Because of the position of the affected neighborhoods in East Des Moines on a known floodplain, and due to the immense amount of development occurring in the larger Fourmile Creek watershed (Figure 1), those homes had a much higher chance of experiencing another flooding event in the future.

During the interviews, residents from both areas demonstrated a lower overall awareness of the city's efforts to build resilience during the recovery process. They knew the city had demolished several damaged or destroyed properties after the 2018 flash flood, but they did not know much about the process used. They reflected that the post-storm neighborhoods where buyouts had happened looked and felt different, not necessarily improved. In this regard, one resident reflected:

> *It feels weird because, like I said, we were used to seeing those houses there, having those neighbors there...right two blocks from us, all of those houses are gone now, like all of that area. There used to be a little park. It's, it's all gone.*

The flash flood had changed the fabric of her neighborhood by taking away from the community in the East Des Moines area, with many references to what had been lost. The area is restored with a walking trail. Residents of East Des Moines reported that they were unable to use it. The sense of lost neighbors and a loss of infrastructure was a noteworthy theme in interviews with East Des Moines residents.

In the historic Beaverdale neighborhood, interviewees had a noticeably great appreciation for buyouts due to the repurpose of the open spaces to beautification and nature-based solution (NBS) infrastructure investments brought to the area. One interviewee observed:

> *Now there's sort of this beautiful prairie restoration project surrounding this massive drainage basin. ...For a flash flood situation, they [the city] have moved here in Beaverdale, at least I think, very, very quickly to improve our systems*.

Interviewees understood the necessity of buyouts to stabilize their communities, but clearly felt buyouts should be used sparingly and only when other options were not available. In East Des Moines, where buyouts occurred on a larger scale and affected numerous houses on a given block, the feeling that buyouts substantially altered the neighborhood's fabric was apparent. One interviewee expressed that sentiment in the comment:

> *I know the city's trying to protect us by tearing all those houses out, but, to me, it's like they moved the country to me instead of me moving to the country.*

During the interviews, the government representatives mentioned that the Des Moines City Council recognized the potential for another flooding event in Des Moines due to the unpredictable weather patterns caused by climate change [50]. Homes that were part of the buyout program were identified as being unlivable after the 2018 flash flood. Due to the number of houses affected on some streets in East Des Moines, the lot buyouts have given the landscape an appearance of an expansive grassland savanna broken up by the now dead-end streets that cross through it, as highlighted by multiple interviewees in the area.

3.3. Access to Nature-Based Solutions and Green Infrastructure Improvements

During the interviews, the council representative and city officials mentioned The Rain Campaign as an initiative to manage the flash flood. It was initiated in 2019 to encourage private property owners and municipalities to reduce stormwater runoff. Through this program, city residents can be reimbursed up to USD 2000 for implementing landscaping techniques that reflect stormwater best management practices. These techniques include the use of rain barrels for storing rainwater, rain gardens to hold large amounts of stormwater in a yard, converting turf grass to native vegetation, which can better absorb rainwater, improving the soil quality of a yard so it can better support vegetation and absorb rainfall, and various projects to stabilize streambeds [51]. The Rain Campaign has led to the installation of 106 rain gardens, which absorb overland water flow, and 591 rain barrels that prevent excess amounts of water from spilling into the sewer systems across the entire Des Moines

Metro [52]. There are many households in the Beaverdale area that have taken advantage of this program to establish green infrastructures on their lots to slow down the runoff after intense rain events.

Home values in the Beaverdale neighborhood rose at a higher rate than the prices of homes in East Des Moines since the 2018 flash flood. The gray infrastructure improvements, introduction of nature-based solutions in the private yards, built comprehensive resilience than in Beaverdale. Multi-million-dollar investments in the stormwater systems of the Beaverdale neighborhood demonstrate that the city of Des Moines recognizes the current storm drain infrastructure may be under-engineered to handle the intensity of storms predicted to occur due to global climate change. Compared to the East Des Moines, Beaverdale residents who were interviewed had no complaints about how the city handled the flash flood recovery in their neighborhoods, and some were quite pleased with how things were handled. One neighbor described some NBS work the city had done near her home, saying:

> *I love the way it looks on the bike trail. It looks very pretty with the rocks down there and there's still a lot of trees and still beautiful. So yeah, I don't mind what the what the city did. I think it desperately needed to happen.*

3.4. Disproportionate Information, Leadership, and Resilience

Both neighborhoods, served by the same city council member, received different responses from the city. However, regardless of the response or one's feelings about it, those with stronger connections to city leadership understood the response more comprehensively than those without such connections. Interviewees who referred to their elected council representatives by name during the interviews were the same people who knew about what had been done to improve their community's resilience and knew what the city had planned for continued resilience improvements, as found in an interview with a Beaverdale business owner:

> *The response (from the city) seems as swift as it realistically could be, and I trusted that what they put in was the best option available for you know a number of different reasons.*

Those with fewer connections were only aware of city-level investments they could see, such as buildings being torn down, and were not as informed about why these things were done or how the investments impacted them. Many were unable to attend the meetings organized to inform residents. One of the East Des Moines residents explained:

> *They host town meetings or stuff like that, maybe they shared information there, but otherwise, just like letting you know, the affected areas know, like, what was going on, or what efforts they were making, they might have (shared information), and I just missed it.*

NBS infrastructure investments in the community were poorly understood by community members. Residents were generally unaware of the ecosystem services that the NBS infrastructure provided; they instead viewed it as a combination of sacrificial rainwater storage and aesthetic improvements to that storage. The residents did not connect the plants and land forming to a functional improvement in the city's storm drain capacities.

3.5. Psychological and Behavioral Factors in Household Resilience

There was a different attitude towards individual preparedness and resilience between Beaverdale and East Des Moines, all of whom acknowledged considering flood risks whenever there was heavy rain. Beaverdale residents described experiencing what he called 'rain anxiety' during heavy rains, and numerous references to proactive behaviors, such as sump pumps, drain plugs, and flood insurance, were made during interviews with Beaverdale community members. These residents were adopting some household-level resilience measures.

In affected neighborhoods in East Des Moines, most interviewees expressed an acceptance of the possibility of more flooding but were less concerned about being proactively prepared; they did not have flood insurance and did not describe worrying about their property during heavy rain events. The attitude could be summed up by this East Des Moines resident's comments when asked about future flood risks to her property.

> *You know, I'm really not worried about it, but I know it could happen, right. But yeah, not really worried.*

The members of this community were less likely to have household-level resilience measures. This same resident reflected that she did not feel the need to invest in flood insurance. She was, however, aware of how

flooding could impact her own home, talking about buying a house on the east side of Des Moines since the 2018 flood:

> *Brand new house. And you know, I gave a good look at the foundation and made sure that we weren't in a floodplain when we when we purchased it. So I pay attention to those things. But you know what? I'm 75 years old and I realize that stuff happens. You cannot prepare for everything that might happen in your life. You just can't. You do the best you can and you live your life.*

These comments also reinforced a general feeling of inevitability or powerlessness in the face of future flooding in communities that are historically located in floodplain areas with limited access to flood mitigation green and gray infrastructure.

3.6. Eroding Community Fabrics

There are mixed opinions from the Beaverdale and East Des Moines communities on the impacts of property buyouts in their neighborhoods. Some of the impacts are the formation of dead-end streets, breaks in contiguous neighborhoods, and discontinuation of bonding social capital. Besides buyouts, the interviewees felt that money could have been spent on other methods of flood protection that still would have kept their neighborhoods intact, one interviewee from the East Des Moines area explained:

> *Just put a levee through there on the east side of Fourmile Creek. And I thought that would keep that creek from coming into these neighborhoods here…they could rebuild all these houses through here. But I don't know. Evidently, it was easier to buy out the houses than to build that levee.*

The buyouts have impacted the social capital among residents of East Des Moines. The flood impacted residents of East Des Moines and Beaverdale, have mentioned the absence of their neighbors in their communities. In one instance, an interviewee discussed how he missed neighbors who were targeted by the home buyout programs.

Interviewees mentioned that the dead-end streets left behind after the home buyout process have created a sense of danger in the remaining homes, as cars from outside the area are now seen congregating in the unlit areas of the streets late at night. A city official acknowledged the challenges that these situations present for remaining neighbors, saying:

> *...thinly populated neighborhoods will attract bad behavior and dumping and ATV riders and all sorts of activity like that, that naturally goes to places that are less occupied.*

Beaverdale residents, by and large, did not feel that their community fabric was diminished because their neighborhoods were not directly targeted for mass property buyouts in the same way some blocks of East Des Moines were (Figure 4).

4. Discussions and Recovery Planning Implications

Traditional flood recovery and mitigation in cities is typically geared towards the gray infrastructure (engineering flood control methods) [53]. However, the experience from two neighborhoods in Des Moines, Iowa, has demonstrated that combining green and gray infrastructure with community-informed relocation of households from high-flood-risk areas is a more effective strategy for improving longer-term resilience in cities.

Buyouts, gray infrastructures, and nature-based strategies were implemented in the Beaverdale and East Des Moines neighborhoods, which are common approaches to urban flood recovery in other parts of the United States and around the world. However, there is a mismatch between community needs and recovery intentions [54], especially regarding buyouts, relocations, green infrastructure installations, and maintaining the community fabric. The differences in satisfaction expressed by residents of the two different areas within Des Moines concerning flash flood recovery underscore the importance of 'place-based' approaches to disaster recovery and mitigation. Using a standard one-size-fits-all approach to every disaster recovery scenario may inadvertently sever the social connections that are built through connected neighborhood networks. This is clearly evident in the recovery efforts in the study area, with broader implications for cities and regions experiencing rapid urban growth and extreme flood events. This study has also demonstrated that vulnerable communities are less likely to participate in property buyouts [55] and green infrastructure installations [56]. As a result, they remain trapped in a vicious cycle of disasters, despite efforts such as buyouts, gray infrastructure improvements, and nature-based solutions in the recovery planning.

Gray and green infrastructures for flood resilience are effective in combination with incentives and soft approaches in urban areas to provide social and ecological co-benefits for communities and environments [57]. Having hard infrastructure and restoration as legal obligations are approaches of recovery in the United States and other parts of the world. However, implementing household initiatives with incentives (e.g., rain gardens and green infrastructure in private properties, as seen in Des Moines' recovery efforts) helps build a resilient future against floods in urban neighborhoods. But the special programs must be developed for the marginalized communities, which are facing higher vulnerabilities and lower attention in the course of recovery.

The lack of engagement from impacted communities in flood recovery projects results in negative impacts on the community fabric, sentiments, and ownership of recovery efforts. In this process, historically marginalized communities are disproportionately affected by the relocations and displacements that occur during recovery [58]. The experience of the East Des Moines neighborhood is representative of other communities following major disasters [59]. It was observed in other parts of the US [60], India [61], and disaster-prone countries worldwide, where pre-event community feelings and situations were compromised among marginalized communities during the recovery process.

Relocations and displacements of households impacted social capital, which is proven to be the foundational infrastructure of resilience [62] in communities like East Des Moines. Residents of East Des Moines ultimately survived two disasters: the initial high-intensity rain event itself and the subsequent erosion of their social capital resulting from the city's mitigation strategy. When viable, future disaster management responses should prioritize '*in-situ*' adaptations and recovery that are both functional and preserve the cultural investment of the residents in the study area and other urban areas.

The Beaverdale and East Des Moines communities had distinct experiences with flood recovery, utilizing property buyouts and nature-based solutions. US Federal Emergency Management Agency (FEMA)'s buyout programs are a widely used strategy to permanently remove homes from flood risks [63], and because the city of Des Moines used FEMA funding in its disaster recovery, the ways the FEMA money could be spent may have been targeted towards a property-buyout response in neighborhoods located on the high-risk floodplains. But each community is unique, and buyouts may not create the same level of resilience across flood-impacted communities [64]. It should be used in combination with other flood mitigation priorities determined by the community.

Empowering soft institutions and flood governance [65] in communities helps maintain community cohesion and enhances the effectiveness of green and gray infrastructures in building long-term flood resilience in cities and regions. Including the perspectives and input of residents in disaster responses may help enhance public buy-in to developments designed to help neighborhoods and increase the viability of disaster response investments (e.g., those with more direct connections to community leadership were better informed about what was being done in their neighborhoods and why in both East Des Moines and Beaverdale neighborhoods). When residents are involved in disaster management in their neighborhoods, they transition from being passive actors in their household disaster resilience to active participants.

By acknowledging the secondary trauma experienced by neighborhoods when disaster mitigation efforts effectively split them apart, city officials and disaster management planners may gain a broader appreciation of how their efforts impact the neighborhoods they interact with. Ultimately, utilizing disaster recovery techniques collaboratively designed with neighborhood residents may help foster improved relationships among community members, city officials, and disaster management planners, and transform disasters into neighborhood-wide opportunities.

5. Conclusions

Flash floods are growing challenges to cities across the US Midwest and other regions worldwide. The 2018 Des Moines flash flood has offered a valuable case study of the impacts and local dynamics of flood recovery efforts. It identified flood recovery as a complex process, customizing gray infrastructure, capital investments, green infrastructure, and incentives tailored to community contexts, needs, and priorities through a hybrid planning process. Special attention must be paid to communities that are historically marginalized in disaster management, city planning, and recovery efforts. Beaverdale residents who were interviewed were generally more socially connected to their local politicians and/or were more aware of the flood management infrastructure that the city of Des Moines was deploying in their neighborhood. They knew why the city was using that particular investment and were happier with the outcome. On the other hand, East Des Moines residents were dissatisfied with the outcome of the infrastructure investments and buyouts implemented in their neighborhoods, and in some cases, felt less safe due to the way vacant streets were attracting late-night visitors and questionable activity. East Des Moines residents also felt that the community fabric that existed prior to the flood was torn apart due to the home buyouts the city conducted to permanently relocate residents out of the danger zone.

Buyouts, when paired with appropriate NBS infrastructure and participatory planning frameworks that include educational sessions and public forums, provide spaces for input from community members and improve how residents feel about their neighborhoods in the aftermath of a flash flooding event [63]. This is the major lesson from the 2018 Des Moines flood recovery case that can be applied to other cities and regions worldwide. When buyouts and relocations happen without thoughtful consideration of what will happen to the land, residents are disappointed and, in some cases, uneasy. In East Des Moines, the vacant lots left over from the buyout program are now largely overgrown with vegetation and flood-ravaged trees, a testament to the intensity of the flash flooding event that occurred. Residents were unsure of what these ravaged and untended lots would become and felt unhappy about how they were being used. Beaverdale residents may not have understood entirely how nature-based solutions worked to slow overland water flow through their neighborhood, but they did see the city make investments in their neighborhood's stormwater resilience that kept them in place rather than forcing the residents to move somewhere else.

The flood recovery situations of Beaverdale and East Des Moines demand pre-disaster recovery planning for communities that are living in high-risk areas of flooding. The pre-disaster recovery plans will guide communities in recovering from flood events while building longer-term resilience. As the climate-induced disasters are growing in cities around the world, the pre-disaster recovery planning must be carried out before the event strikes. This will allow each urban community to recover from flooding and other hazards based on its unique situations, priorities, and dynamics.

City leaders did not effectively use public forums to educate community members about how the city planned to use its resources to protect them from flash flooding events. If they had, the neighborhoods affected by the flash flooding event may have been more appreciative of the efforts the city was taking and potentially more likely to take steps to protect their own property and belongings from future flooding events. During the pre-disaster recovery planning, public awareness and community empowerment can be carried out about future disaster risks and climate change impacts, which will connect government disaster management authorities with at-risk urban communities in terms of flood mitigation and recovery.

This research has multiple limitations. The first limitation is that the number of interviews conducted during the research could have been higher, covering multiple perspectives and experiences of the 2018 Des Moines flash flood. There should be representatives from local businesses, neighborhood boards, care homes, schools, and nonprofit organizations in the interviews. Having a larger sample size will establish higher rigor for research. The second limitation is the longitudinal statistical and geospatial analyses of the flood, urban growth, and demographic changes. The study could benefit from the spatial modeling of flooding patterns and the hydrology of the study area. It could have a better understanding of demographic changes and flood events in the city of Des Moines. The third limitation is the geographic scope for generalizing flood recovery planning. There should be more studies from other parts of the United States and other countries to propose specific flood recovery planning for rapidly growing cities.

Future research into community perceptions of flash flood infrastructure investments in their neighborhoods should consider investigating communities where educational events were deployed by city leaders to inform residents of their plans related to stormwater management. Research should be conducted prior to plans being implemented, to gauge whether these educational events increase public support of the methods and to explore community priorities on flood recovery and mitigation. Investigating how the public perceives city leaders' ability to help the communities they serve recover from or prepare for emergency flooding events could help elected officials maintain their positions and navigate future social biases. This research project was limited due to only having two neighborhoods to work with through limited interviews. Additional case studies of property buyout practices must be conducted in Iowa and other neighboring states using both qualitative, quantitative, and spatial approaches to better understand the community experience and priorities on future flood resilience planning.

Author Contributions

Conceptualization, D.K., L.Y., and J.G.; methodology, D.K., L.Y., and J.G.; software, J.G.; validation, D.K., L.Y., and J.G.; formal analysis, D.K., L.Y., and J.G.; investigation, D.K. and L.Y.; resources, D.K., L.Y., and J.G.; data curation, D.K., L.Y., and J.G.; writing—original draft preparation, Kapyou, L.Y., and J.G.; writing—review and editing, D.K., L.Y., and J.G.; visualization, D.K. and J.G.; supervision, D.K., L.Y., and J.G.; project administration, D.K., L.Y., and J.G. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Institutional Review Board (or Ethics Committee) of Iowa State University (protocol code 23-345, Approval date: 8 November 2023) for studies involving humans.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

There is no quantitative data collected for this study. Interviews were conducted in both recorded and handwritten styles. They will be made available upon request as permitted by the Office of Research Ethics at Iowa State University.

Conflicts of Interest

The authors declare no conflicts of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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