How Can Cities Unleash the Flood Mitigation Potentials of Urban Parks? The Example of Houston, Texas

A policy-focused story told with maps from The Place Database

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June 2019

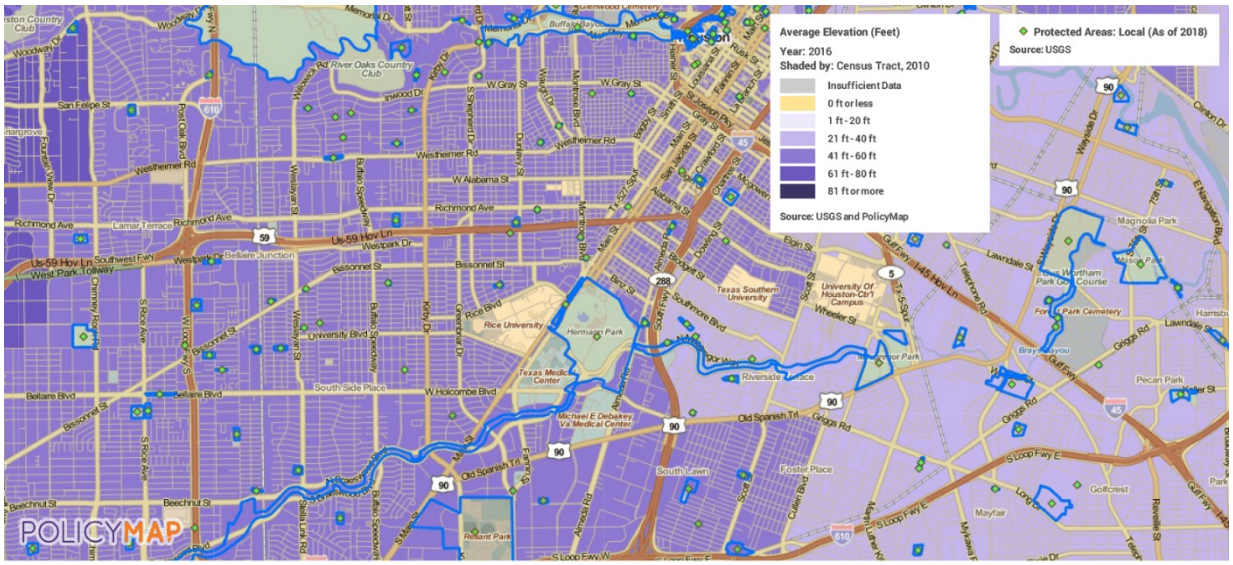
The findings and conclusions of this narrative reflect the views of the author and do not necessarily represent those of the Lincoln Institute of Land Policy.

Photo: A Bellaire resident paddled along the street in the aftermath of Hurricane Harvey. Credit: Melissa Aguilar for the *Houston Chronicle*.

Introduction

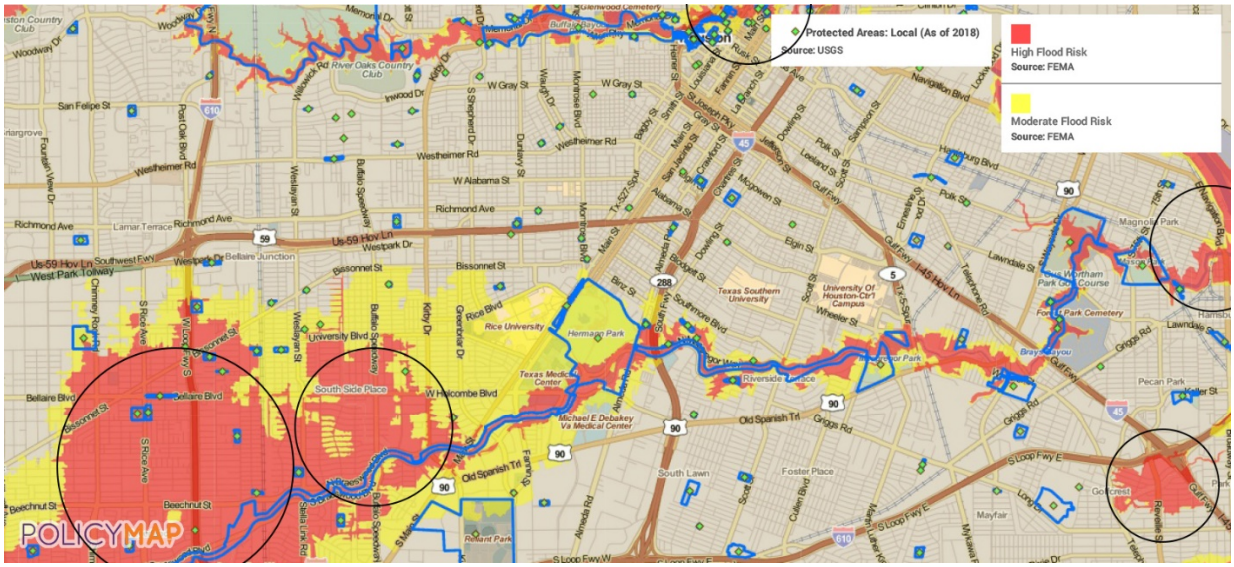
With the increasing effects of climate change, Houston, Texas, and other coastal cities are experiencing more frequent and extreme weather such as hurricanes, flooding, and sea-level rise. In 2017, Hurricane Harvey and the heavy rain aftermath dropped 50 inches of rain onto Houston over the course of four days. The intense rainfall coupled with the city's flat terrain and urbanized watersheds led to extreme flooding in many areas of the city, especially in communities such as Bellaire, Southside Place, and West University Place, which are labeled as special flood hazard areas by FEMA. This unprecedented event reconfirmed the fundamental role of flood mitigation planning in reducing the impacts of natural disasters.

As Houston sits about 50 feet above sea level, its gradual slope does not allow floodwater to move well. Consequently, during Hurricane Harvey, every bayou in Houston and Harris County was flooded at the same time. Floodwater exceeded the design capacity of structural flood mitigation measures and continued to flow into nearby streets, parking lots, residential houses, and buildings, resulting in huge amounts of damage.



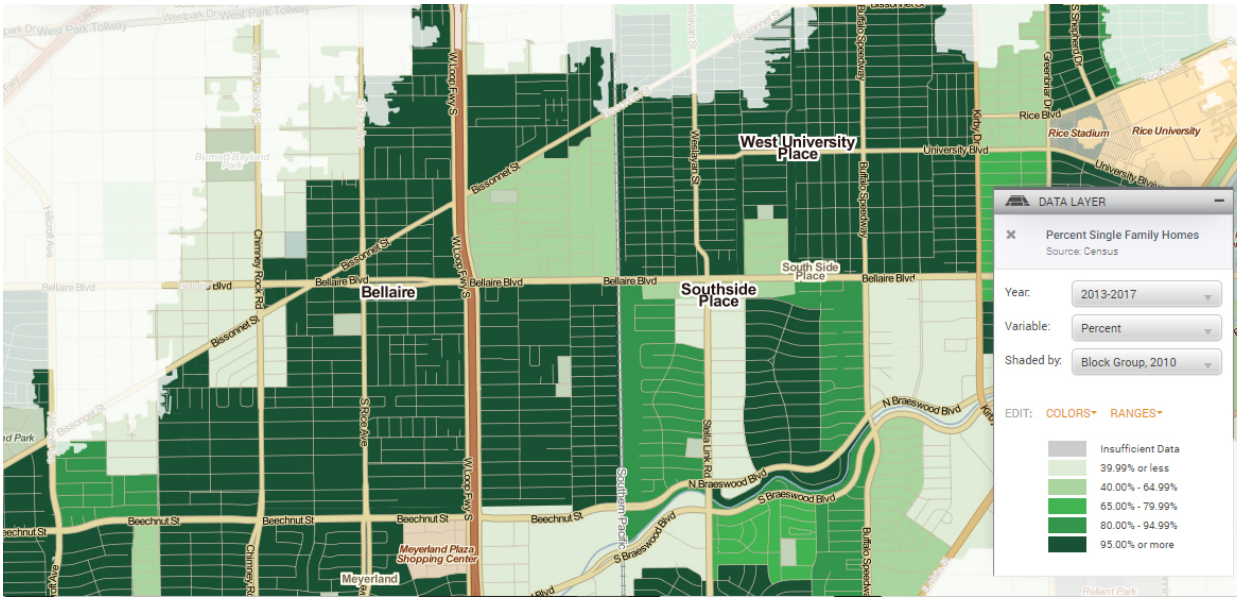
Map: Average elevation of Houston area and local protected areas. Credit: The Place Database, https://plcy.mp/2dbhgS1.

In Houston, the city of no zoning, the increasingly dense development and growing populations in low-lying areas have put more and more people, infrastructure, and property at risk to future flooding and storm surge damage. This map shows urban development areas along the waterways in Houston, Texas, with the location of the urban park system (local protected areas in blue) overlaid with the high (red) and moderate (yellow) flood risk areas. The areas with the highest flood risk shown on the map are Bellaire, Southside Place, and West University Place.

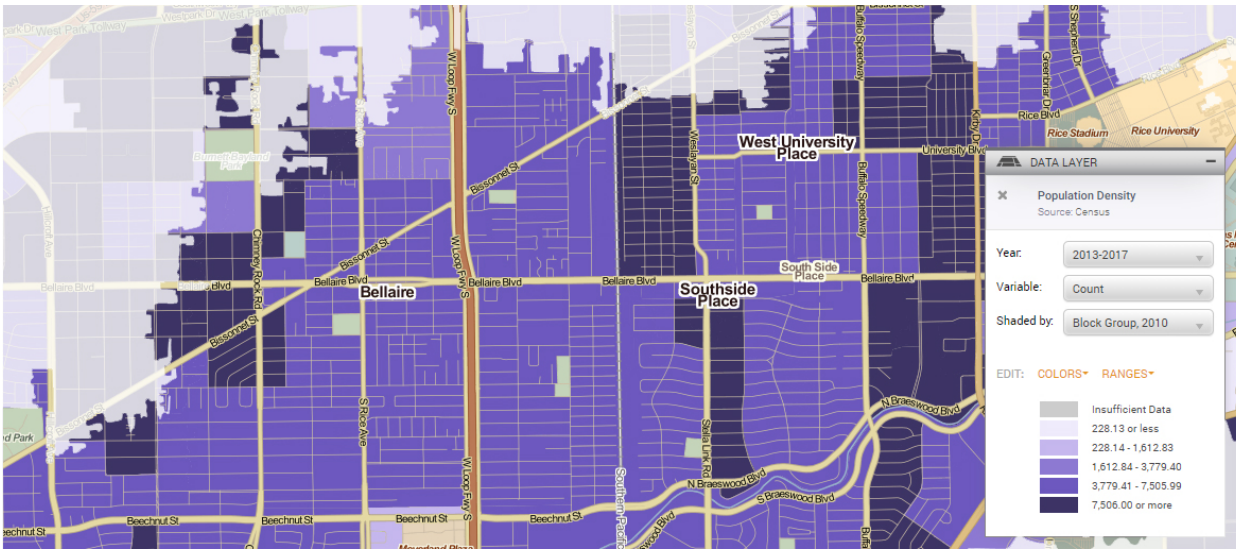


Map: Food risk in Houston area and local protected areas. Credit: The Place Database, https://plcy.mp/GMLnwLQ.

Most of the moderate and high flood risk areas in the Bellaire-Southside Place-West University Place area are single-family homes. Average population density across these areas is about 6,500 persons per square mile (or 10 persons per acre). Hurricane Harvey in 2017 was a wakeup call – it destroyed and damaged around 127,600 single-family homes across the Houston area. Many homeowners in Bellaire were forced to decide either to lift or demolish their homes in order to ensure their safety before the next flood event of Harvey's magnitude.



Map: The high concentration of single-family homes in moderate and high flood risk areas in Bellaire, Southside Place, and West University Place indicates that action is required to protect Houston's families. Credit: The Place Database, https://plcy.mp/p7Rnh04.



Map: The very densly populated and flood-prone areas of Bellaire, Southside Place, and West University Place indicate a serious need for effective flood mitigation measures. Credit: PolicyMap, https://plcy.mp/CWxmyZ8.

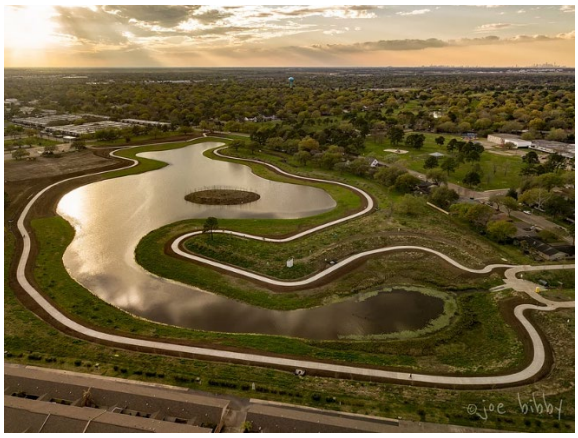
Floodwater Management

The conventional approach to floodwater management is to widen, deepen, and straighten waterways. However, the increasing urban development and scarcity of vacant lands in Houston has made this approach insufficient. The urban park is a common element in the sprawling pattern of urban areas. It is intentionally designed and deployed primarily for widespread public use and benefit (Matthews et al. 2015). In Houston, where most of the open land has been developed for residential and commercial uses, urban parks and other green spaces become even more valuable for protecting the public health of urban populations. But urban parks can also play important functions for the flood-prone city, including collecting and cleaning water, reducing run-off, capturing floodwater, and mitigating the overall damage caused by flood events. Rather than adding more engineered solutions, such as flood barriers, levees, and reservoirs, which often require extensive investment in buildings and infrastructure and sometimes result in unintended ecological consequences (Schwab 2014), Houston should consider creating more room for floodwater, particularly turning urban parks and other green spaces into floodwater retention or detention facilities.

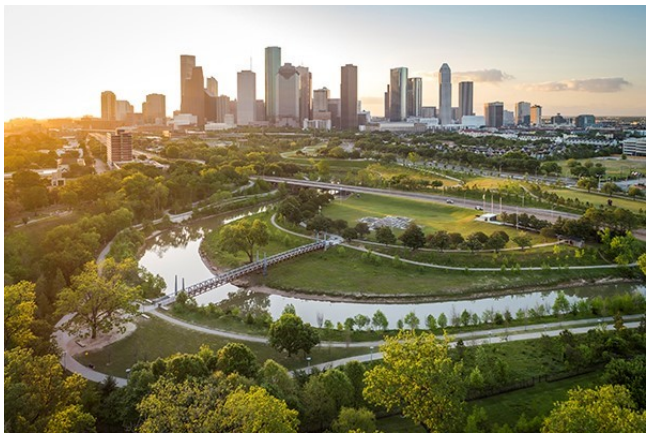
There are several successful examples of this strategy throughout Texas. For instance, Exploration Green Nature Park in Clear Lake City which is considered one of the largest urban wetlands in Texas, has transformed an out-of-use golf course into a 200-acre natural park and stormwater detention facility. During Hurricane Harvey, the detention area, which was only about 80 percent complete, could hold 100 million gallons of water, protecting 3,000 homes that used to habitually flood. In addition, Exploration Green provides a walking trail, lake, and various other recreational amenities.

A second example is the revitalization of the Buffalo Bayou Park in Downtown Houston. Part of Buffalo Bayou was transformed into functioning green infrastructure and a thriving waterfront that is capable of protecting the bayou and its residents from major flash flooding. Furthermore, Buffalo Bayou Park serves as a 23-acre promenade with extensive native landscaping, hike and bike trails, public art, 12 street-park entryways, and a pedestrian bridge. During Hurricane Harvey, the park worked as designed, storing and releasing floodwater gradually (McCormick 2018).

Despite the documentation of these various benefits, urban parks have not been adequately incorporated into urban governance and planning for hazard mitigation. For example, in the City of Houston's Hazard Mitigation Action Plan, updated in 2018, urban parks were mainly considered as a victim of flooding rather than a potential measure for mitigating flooding.



Exploration Green Nature Park, Clear Lake City
Credit: Joe Bibby



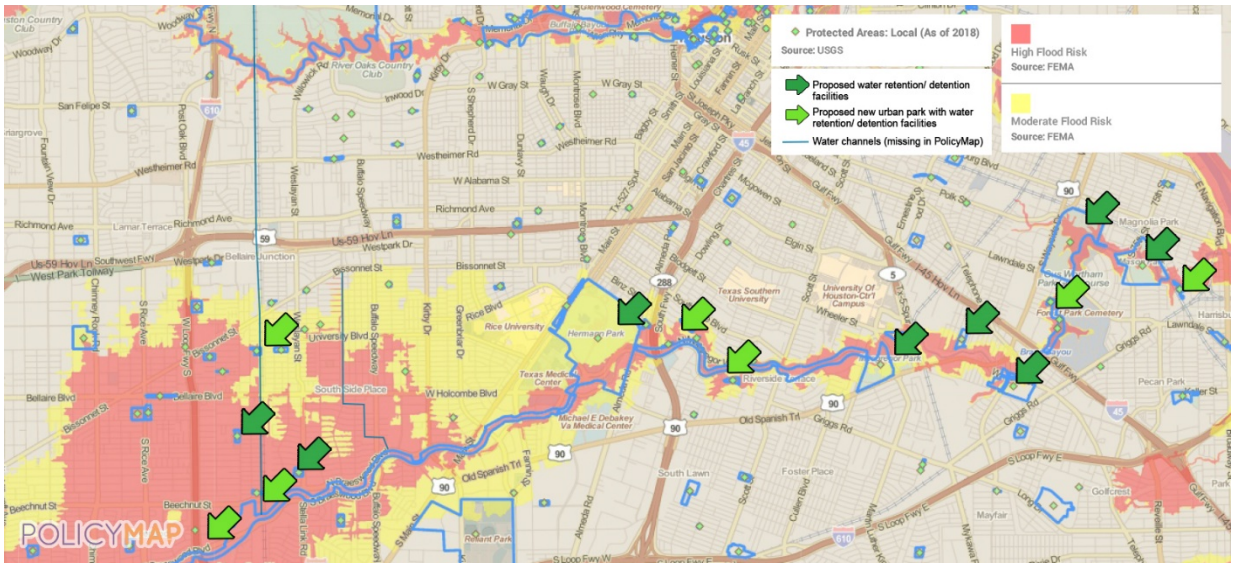
Buffalo Bayou Park
Credit: Jonnu Singleton/SWA Group

Buffalo Bayou Park, before and after Hurrican Harvey
Credit: Geoffrey Lyon/SWA Group

Possible Solution

Step 1: Choosing urban parks where flood mitigation measures are appropriate and needed

An important consideration in identifying urban parks where floodwater retention/detention may be successful is where flooding is a current and future issue, or where to provide an opportunity to capture floodwater effectively, but also where such flood mitigation measures are most needed. Accordingly, these parks should be located in (1) low-lying areas, either in proximity to the main watercourse or to areas with high and moderate flood risk, and (2) highly developed areas with dense impervious surfaces, especially the residential areas that are likely to face more damage and loss in the case of an extreme weather event. Other criteria for site selection are based on the availability of land, the water holding capacity of the soil, the cost of construction, and other impacts on the environment, such as the ability to create a natural habitat for local wildlife. Establishing new urban parks or enlarging or connecting several existing parks may require land acquisition and the purchase of houses and properties in high flood-risk neighborhoods. Thus, it is equally important to find areas where the conversion of an urban park would dislocate the fewest residents.



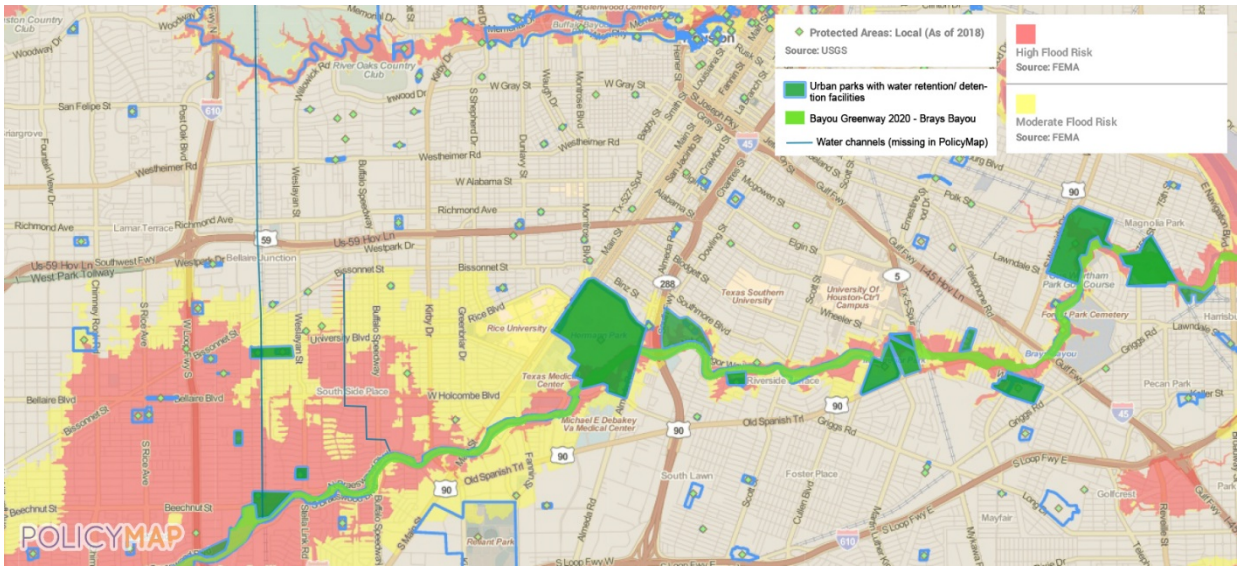
Map: The proposed locations of new water retention/detention facilities that could be introduced in either existing or new urban parks. Site selection is based on the proximity of urban parks to the bayous and their water channels, the availability of land, and the degree of flood-risk on local residents. Credit: The Place Database and Author.

Step 2: Completing physical interventions to transform urban parks into floodwater detention/retention facilities

Turning an urban park into a floodwater detention/retention facility might involve (1) digging out the detention/retention basin based on calculated volume of floodwater, (2) creating a canal to the nearest bayou or to the receiving channel in combination with piping and pumping system if needed, and (3) redeveloping the riparian zones inside the retention/detention ponds with native vegetation.

Step 3: Creating a system of urban parks to serve as green infrastructure

Of course, a single park cannot control and mitigate flooding across the whole Houston area. Therefore, it is important to develop a park system that creates an interconnected network of urban parks and green spaces throughout the city. With such green infrastructure, the goal is to make the city more attractive and livable while expanding the city's capacity to absorb floodwater. Compared to conventional approaches, green infrastructure is much cheaper and more cost-effective. Moreover, the system of urban parks with water retention/detention facilities will connect to the Bayou Greenway 2020 projects that aim to provide drainage, transportation, and recreation opportunities along eight Houston bayous.



Map: A proposed system of urban parks with water retention/detention facilities along the Brays Bayou in Houston. The proposed system will directly contribute to the Bayou Greenways 2020 project which will connect Houston's bayous and parks to its neighborhoods. Credit: The Place Database and Author.

Step 4: Changing building regulations and developing a floodwater detention/retention index

Flooding issues can also be addressed through building regulations. Along with a ban on building new structures in highly flood-prone areas, developers could make use of a floodwater retention/detention index that defines potential areas with the capacity to capture floodwater. It would be a voluntary incentive program which encourages developers to construct or reintroduce floodwater retention/detention measures on their land. Based on the index, there may be a discount on flood insurance rates or other incentives for developers reflecting the amount of floodwater their land can capture. The index provides a useful tool to inform policy in light of increasing natural disasters, urban development, and landscape degradation across Houston.

There are risks that must be considered in the implementation of these plans. Because the introduction of new water features in urban parks can provide more recreational activities, create opportunities for community engagement, and improve well-being, residents have expressed concerns that an increase in adjacent property values may lead to the gentrification of presently diverse neighborhoods. In addition, residents may not be aware of the possible dangers of a water retention/detention basin, especially during the time of flooding. Thus, flood mitigation planning must involve the public as a fundamental player in every phase of its development rather than as the final recipient of a decision.

Photo: Construction site in Houston downtown district. Credit: Getty Images/typhoonski.

Conclusion

These maps were created with the goal of highlighting a potential approach for cities or regions to deal with the impact of future flooding. The story these maps introduced can be described as a longitudinal framework for choosing geographic locations of urban parks for the purpose of flood mitigation, with a focus on how to appropriately design a vision and what the city should do to implement it through the planning process. Finally, the maps not only tell a story of Houston but also suggest possible applications for other flood-vulnerable cities across the nation.

Photo: Houston skyline and Buffalo Bayou Park. Credit: Getty Images/Davel5957.

Sources

City of Houston. 2018. “Hazard Mitigation Plan Update 2018: Maintaining a Safe, Secure, and Sustainable Community.” https://s3-us-west-2.amazonaws.com/uasi-jtti/wp-content/uploads/sites/29/2018/05/16202024/City-of-Houston-HMAP-Update-3.13.18-3.12.23-PUBLIC-COPY_compressed.pdf

Exploration Green Conservancy. 2013. “CLCWA Detention Facilities and Associated Open Space and Park Plan.” https://www.explorationgreen.org/the-plan

Harris County Flood Control District. 2019. “Stormwater Detention: How it Works.” https://www.hcfcd.org/flooding-floodplains/stormwater-detention-how-it-works/

Houston Parks Board (Cartographer). 2019. “Bayou Greenways 2020.” http://www.arcgis.com/apps/webappviewer/index.html?id=5532d390fb234779b0b9286744d85a2f&extent=-10634866.1535,3472820.2219,-10573716.5308,3500605.0817,102100

Matthews, T., A. Y. Lo, and J. A. Byrne. 2015. “Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners.” *Landscape and Urban Planning, 138*, 155-163.

McCormick, K. 2018. “Houston Surveys Post-Harvey Policy Landscape: The ‘Bayou City’ Considers Land Use Rules Changes.” *Lincoln Institute of Land Policy.*

Ozdil, T., S. Modi, and D. Stewart. 2013. “2013 LAF’s CSI Program Landscape Performance Series: The University of Texas at Dallas Campus Identity & Landscape Framework Plan Methodology.” *The University of Texas at Arlington. Arlington, Texas*. https://www.landscapeperformance.org/case-study-briefs/buffalo-bayou-promenade

Schwab, J. 2014. “Planning for post-disaster recovery: Next generation.” *American Planning Association*.