Evaluating the Effectiveness of Weighted Site Selection Method for Green Infrastructures to Mitigate Flood Risks of Hunting Bayou Watershed, Harris County

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Background

In the wake of Hurricane Harvey's catastrophic impact on Houston and its surrounding areas in 2017, the urgent need for resilient flood management strategies in Harris County became glaringly apparent. This devastating storm, which inundated neighborhoods, overwhelmed infrastructure, and inflicted immense economic and emotional tolls, served as a stark reminder of the vulnerabilities inherent in urban environments facing increasing climate-related risks.

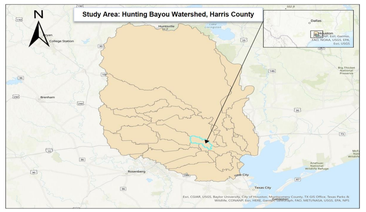
Among one of the most heavily affected regions was the Hunting Bayou Watershed, an expansive urban landscape within Harris County characterized by a complex network of waterways and diverse land uses. Hurricane Harvey's unprecedented rainfall inundated the watershed, exacerbating existing flood vulnerabilities and underscoring the pressing need for proactive flood risk mitigation measures. In response to this imperative, green infrastructures (GI) emerged as a promising solution. Unlike traditional "gray" infrastructure, GI leverages natural systems to manage stormwater, offering a suite of benefits including flood mitigation, improved water quality, and enhanced ecosystem services. However, the successful implementation of GI hinges upon strategic site selection, considering factors such as hydrological characteristics, environmental sensitivity, and community vulnerability.

Research Questions

1. **What are the important factors to consider in a site suitability analysis for placement of green infrastructure ?**
2. **What are the most suitable sites to purse for the placement of green infrastructure in Hunting Bayou watershed?**

Study Area

Study Area: **Hunting Bayou Watershed** , Harris County, Texas, USA.



Research Objectives

The purpose of this project is to identify locations within the Hunting Bayou Watershed that are suitable for installation of stormwater collecting green infrastructure. This project will continue to further the City's objectives as a leader in sustainable urban development and planning, and meet specific goals identified by the Harris county flood control district Action Plan. To investigate the effectiveness of weighted site selection approach to reduce flood risks and can improve water quality in Hunting Bayou, compared to traditional approaches.

Data Used

Sl. No.	Data	Source
1	DEM	USGS Global Visualization Viewer (GloVis)
2	Watershed Boundary	Koordinates – Earth's Data Platform
3	Soil Data	Soil Survey Geographic Database (SSURGO)
4	Land Cover Map (2019)	National Land Cover Database (NLCD)
5	Imperviousness (2019)	National Land Cover Database (NLCD)
6	Water Quality Data (Historical)	USGS National Water Information System (Nwis)
7	100 Year Flood Plain Shape File (FEMA)	City of Houston Geographic Information System (COHGIS)
8	Parcel Information	Houston Public Works Open Data

Methods

We used a Weighted Overlay site selection method in ArcGIS to identify suitable sites.

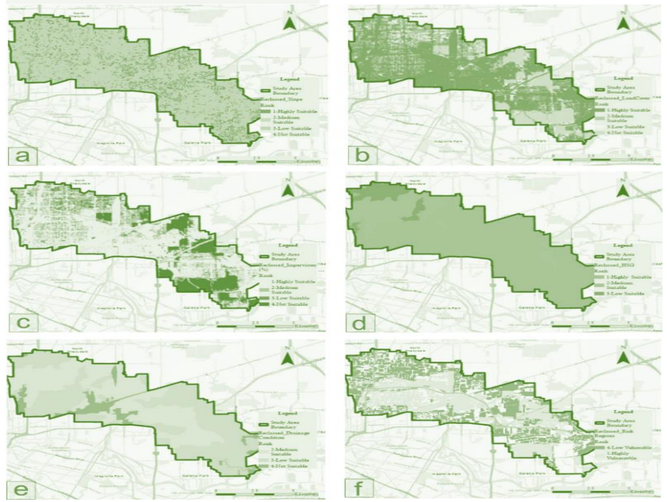
- First, we consulted existing studies to identify common variables used in a GIS site suitability analysis for green infrastructure, and identified the following variables: slope, land use types, public/private ownership, hydrologic soil types, and impervious surface types.
- Next, after the variable layers were all converted into raster layers and ready to perform analysis, we ran the weighted overlay tool using four different weight models.
- Finally, we used the Majority Filter Tool to simplify the resulting raster and identify more unified areas.

The summary figure and table identifies each variable used in this analysis, its ideal conditions for green infrastructure, the flow of data processing, and the respective weights given to each variable in a series of Weighted Overlay models.

Research Methodology Workflow

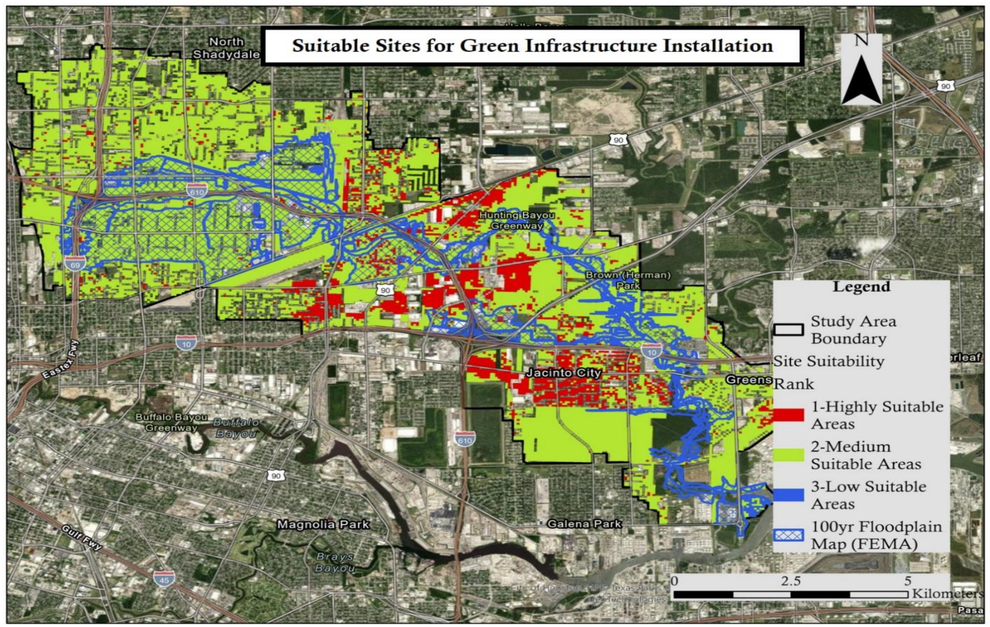
Geoprocessing: Proposed Weighted Overlay

Raster	Renamed Raster	%(Weighted)
Hydrologic Soil Data (HSG)	Hsg_reclass	20
Landuse	Landuse_reclass	10
Imperviousness	Reclass_imperv_final	20
Slope	Reclassed_slope	20
Location within/near the 100-year Floodplain Boundary	Reclass_areas	10
Natural Drainage Class	Reclassified_drainge_condition	20



Reclassified Raster data based on their Suitability (a) Slope, (b) Land use, (c)Imperviousness, (d) Hydrologic Soil Group (HSG), (e) Natural Drainage Class, and (f) Proximity to 100-year Floodplain Boundary

Results



Conclusion

With projected population growth in the Huston region, urban infill and development will likely increase within the Hunting Bayou Watershed and lead to a higher ratio of impervious landcover and higher risks of flooding and water quality. Implementing a system of green infrastructure for stormwater management is a sustainable and effective approach to mange these current and future challenges. While there were limitations to our study including time constraints and lack of certain data (notably, an existing green infrastructure inventory, and a complete spatial database of the sewer network within the watershed), our analysis provides a starting point for the Hunting Bayou Watershed.

References

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