



How Hurricane Harvey flooding potentially contaminated parks and impacted resident perceptions of environmental health

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Community Engagement Core
Texas A&M Superfund

Outline

- Flood risk in Houston – It wasn't just Harvey
- Implications of using green infrastructure for flood mitigation
- Bringing together
 - environmental sampling,
 - resident perceptions, and
 - community engagement to plan for and mitigate risk
- Relevance beyond Houston



Flooding and Flood Risk in Houston

- Tropical cyclone associated precipitation; surge
- Inland precipitation
- Sea-level rise
- Subsidence
- >impervious surfaces



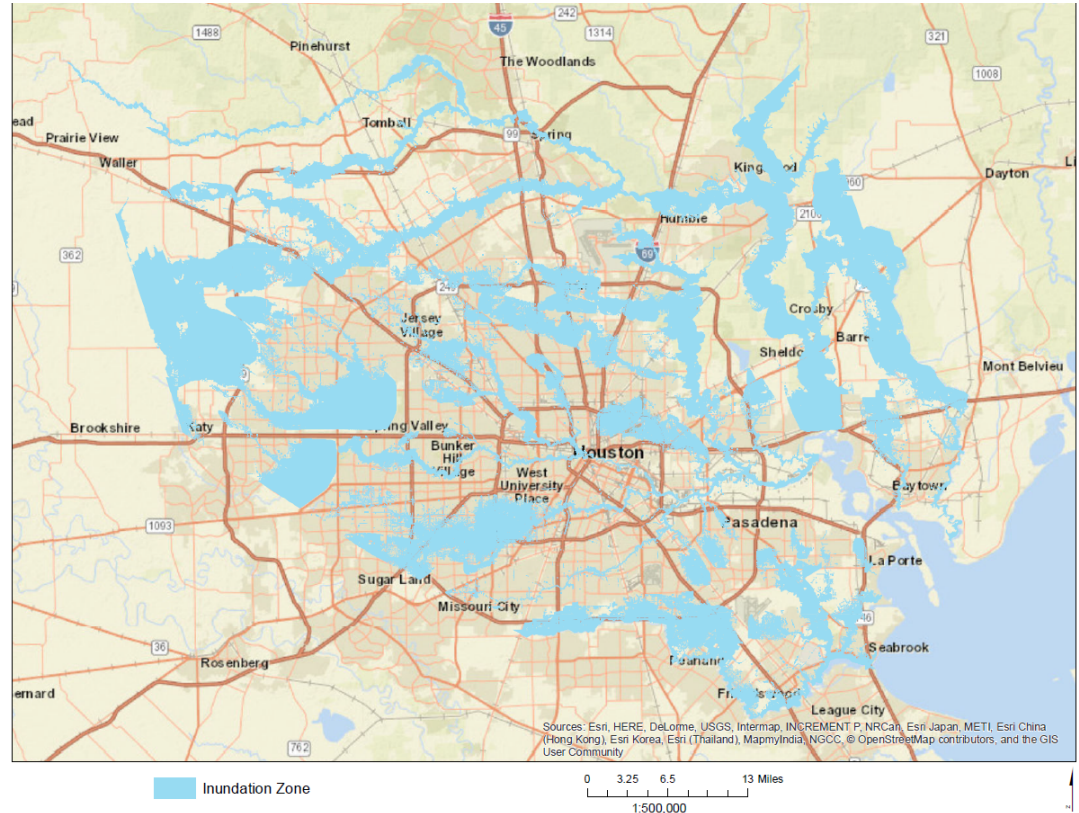
- Tropical Storm Alison (2001)
- Hurricanes Rita (2005) and Ike (2008)
- Memorial Day Floods (2015)
- Tax Day Floods (2016)
- Hurricane Harvey (2017)

Flooding and Flood Risk in Houston

According to NOAA, 56 inches of rain fell over Houston after Hurricane Harvey

70% of the City was inundated to a level of at least 18 inches

1,447 square kilometers of Harris County were flooded



Hurricane Harvey Inundation (Source: Harris County Flood Control District)

Green Infrastructure in Houston

- Greenways and flood management zones as part of the Bayou system provide multiple functions
 - Provide space for recreation activities including playgrounds, dog parks, hiking trails, picnic areas and flood mitigation

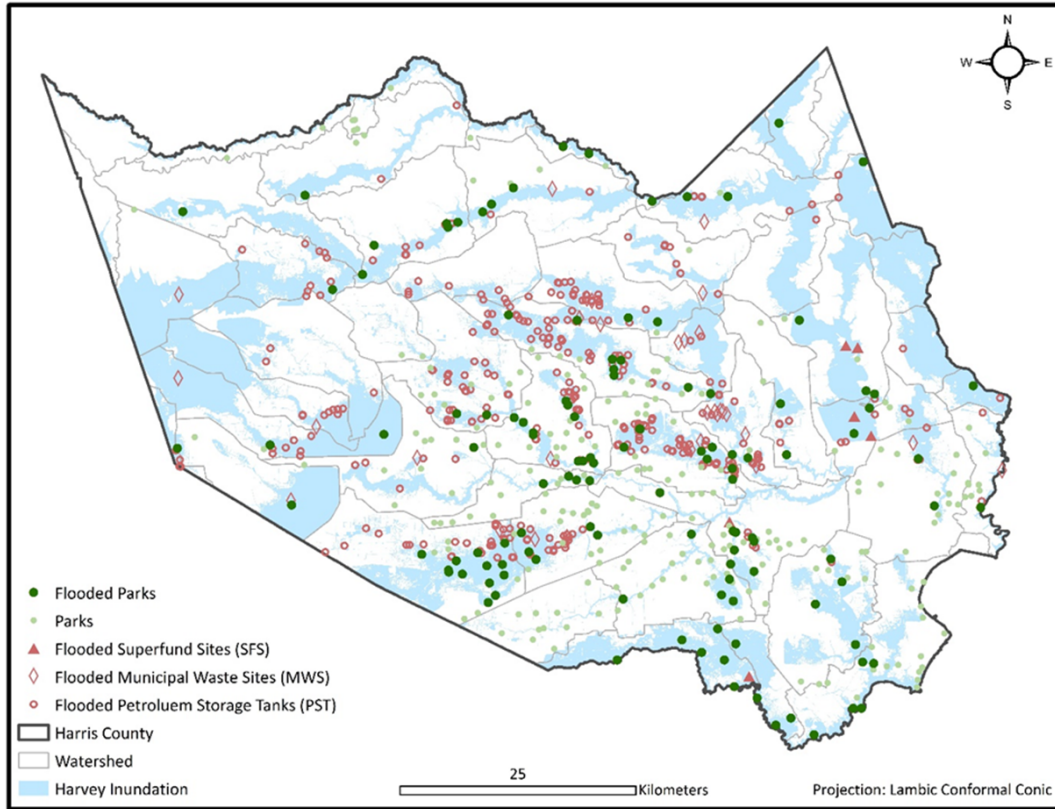


Green Infrastructure in Houston

- Proximity to industrial, petrochemical, and regulated waste sites
 - Over 1 million gallons spilled from petroleum storage tanks; 500,000 in the Houston Ship Channel
 - 14 Superfund sites flooded
 - 32 municipal solid waste sites flooded
- Of all Harris County parks, 121 of 349 (36.78%) were flooded by Hurricane Harvey
 - 102 of 121 (84.30%) flooded parks were located in sub-watersheds with at least one potential exposure site.



Green Infrastructure



Flooded parks concentrated in center and southern parts of Harris County

Potential exposure sites concentrated in center, north-central parts of Harris County

Houston Health Department concerned about potential recreational exposure after Hurricane Harvey

Little is known about the role parks play in post-disaster recovery

What are we doing to understand potential recreational exposure?







- In partnership with the Houston Health Department, collected soil samples in 6 parks 6, 12, and 18 weeks after Hurricane Harvey
 - Analyzed for heavy metals, pesticides, PCBs, PAHs
 - PAH profiles nearly identical immediately after Harvey, as time passed more heterogeneity



Polycyclic Aromatic Hydrocarbons in Houston Parks after Hurricane Harvey











- Low, homogenous concentrations of PAHs 1 week after Hurricane Harvey

AR-1	AR-2	BCP-1	BCP-2	CP-1	CP-2	MEP-1	MEP-2	MEP-3	MEP-4	MP-1	MP-2	MP-3	MP-4	MTP-1	MTP-2	MTP-3	MTP-4
1.7962	3.5016	6.4752	4.3607	0.6415	5.4643	0.5005	0.3462	0.5372	2.0327	6.9993	6.4053	5.4058	7.9595	5.2483	2.604	7.5446	8.5868
1.8208	3.7624	6.6357	5.0577	1.4283	6.513	0.6311	0.351	0.8018	2.3805	8.7373	8.8131	8.1388	11.1922	6.6612	3.6492	8.4173	11.344
2.192	4.258	10.242	6.6617	2.1678	8.1798	0.8475	0.5306	0.829	3.4455	12.242	11.1253	9.0213	13.8307	8.2314	3.956	15.4715	11.6437
2.8492	5.3468	23.368	30.334	7.928	21.95	0.856	0.734	1.0301	14.717	14.049	51.378	36.189	72.76	26.013	4.3733	30.583	30.173
12.758	35.1	71.534	45.661	8.915	60.128	3.707	1.88	5.07	21.607	83.423	75.572	59.795	95.616	61.708	30.545	88.26	101.024

 Benzo(a)pyrene	 Benzo(b)fluoranthene	 Dibenzo(a,h)anthracene	 Benzo(k,j)fluoranthene	 Indeno(1,2,3-c,d)pyrene	 Benz(a)anthracene
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- Increasing, and more heterogeneous, chemical profiles as time passed

BCP-1	BCP-2	CP-1	CP-2	CP-3	MEP-1	MEP-2	MEP-3	MEP-4	MP-1	MP-2	MP-3	MP-4	MTP-1	MTP-2	MTP-3	MTP-4	HMS
52.9	12.7	13.6	25.0	5.94	3.43	7.13	10.2	13.1	67.1	57.2	7.87	30.7	85.4	45.6	424	57.3	52.5
54.4	12.9	13.9	26.5	5.95	3.58	8.16	10.8	13.8	68.0	61.9	8.46	32.2	88.2	47.1	441	57.9	59.4
55.3	13.1	14.8	30.8	6.99	4.88	9.13	15.0	14.3	70.5	74.1	11.4	34.9	103	58.7	667	65.3	63.2
58.9	14.3	16.9	32.5	7.22	6.28	10.1	16.6	15.8	90.2	80.8	13.8	36.6	133.2	70.2	700	73.2	66.8
60.454	14.657	25.239	33.425	16.369	8.114	20.85	33.234	34.045	102.701	98.159	29.999	45.352	149.743	85.646	911.771	79.074	75.7

 Fluoranthene	 Naphthalene	 Pyrene	 Benzo(b)fluoranthene	 Indeno(1,2,3-c,d)pyrene	 Benzo(g,h,i)perylene
 Chrysene/Triphenylene	 Benzo(k,j)fluoranthene	 Benzo(a)pyrene	 Phenanthrene		



What are we doing to understand potential recreational exposure?

- In partnership with NIEHS P30 Center, compare recreation area soil analysis with surveys and in-depth interviews with those using parks post-Harvey



Improve Communication after a Natural Disaster

- Examining how people communicate after a natural disaster can help with:
 - Understanding reactions to the event that guide behavior
 - Identifying knowledge gaps that can be addressed by local aid organizations
 - Identifying strategies for best disseminating information
 - Identifying community leaders/groups that can best disseminate information



Runners, bikers, and dog walkers returning to Buffalo Bayou Parks in the wake of Hurricane Harvey are finding a vastly different landscape blanketed with untold tons of sandy sediment (Molly Glentzer, AP).

Data Collection

Survey Data

- Collected survey data in 6 parks in the Houston area in February 2018
 - Feelings of uncertainty
 - Emotional response
 - Community resilience

Interview Data

- Conducted qualitative interviews with park goers February-March 2018
 - What knowledge do park goers have about pollution in the parks after Harvey
 - What information do they want?
 - How do they want to receive that information?



Resident Certainty about Pollution

- Half (58 of 117, 49.6%) reported they felt certain or very certain that Hurricane Harvey caused environmental pollution in their community
 - Two-thirds reported a desire to be certain about both the pollution caused by Hurricane Harvey and its potential health effects



A barbed-wire fence encircles the Highlands Acid Pit that was flooded by water from the nearby San Jacinto River. Floodwater inundated at least five highly contaminated toxic waste sites near Houston, raising concerns that the pollution there might spread. (Jason Dearen, AP)

Emotional Response to Pollution

- When asked about their emotional response towards environmental pollution in their community
 - Two in five reported that the pollution made them feel angry (42 of 107, 39.3%)
 - One in five reported that the pollution made them feel afraid (19 of 89, 21.4%)
 - 60 of 101 (59.4%) respondents reported they did not feel “proud”



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Perceptions of Community Resilience

- Although they had little knowledge about potential environmental contamination, one-quarter to one-third of respondents strongly agree or agree that the community has:
 - Resource resilience: **25.5%**
 - Transformative potential: **29.9%**
 - Information and Communication resilience: **34.2%**

“It rained pretty much, so it cleaned off that contaminated water.” (Female, Hispanic, 45, 10 miles from park)

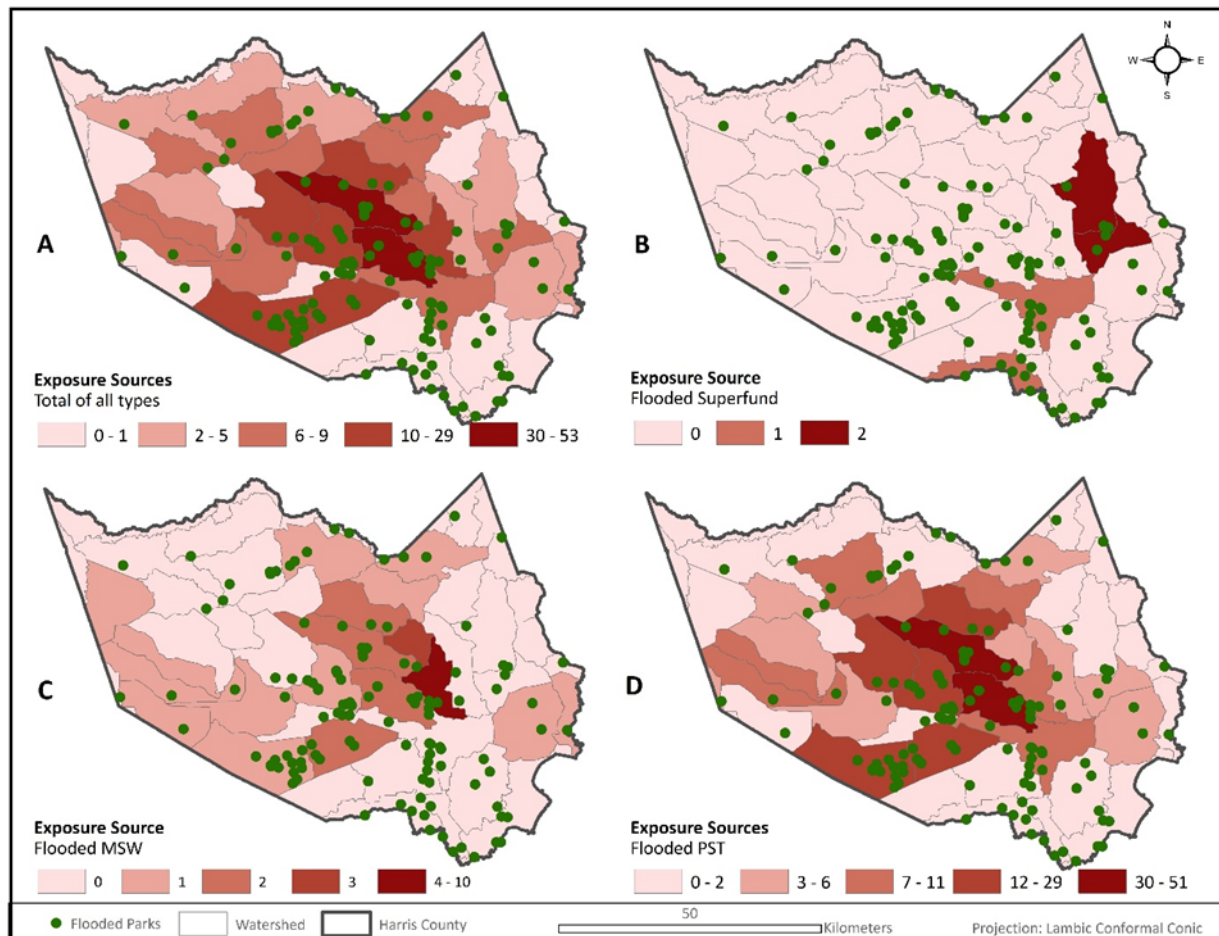
“How often is the water tested at the water treatment plant to make sure it’s actually okay for human consumption” (Male, African American, 33, 3 miles from park)

“Only pollution, of course, is all the debris” (Male, Caucasian, 61, 7 miles from park)

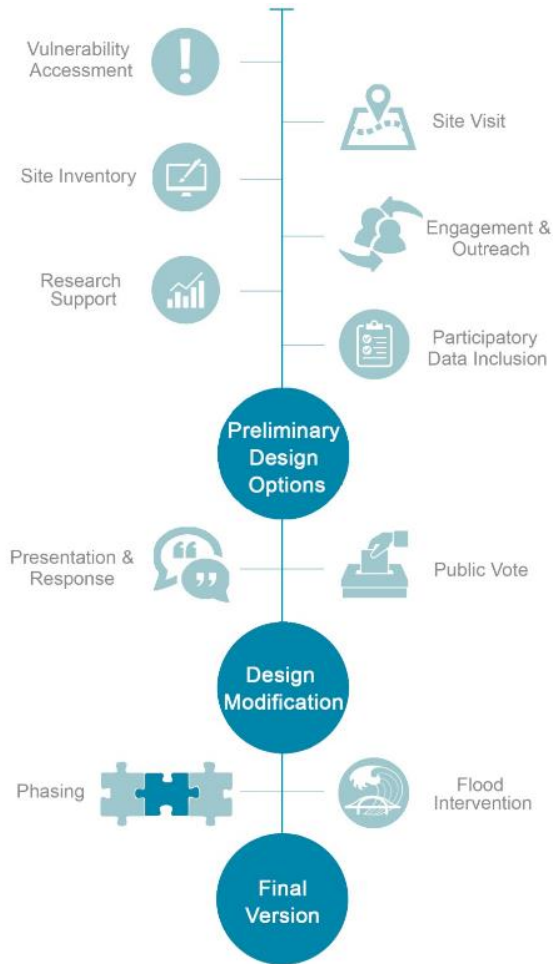


What are we doing to understand potential recreational exposure? Spatial analyses beyond samples

- Spatial analysis of potential recreational park exposure by sub-watershed and source type.



What are we doing to mitigate potential recreational exposure? Community engagement



Site Visits



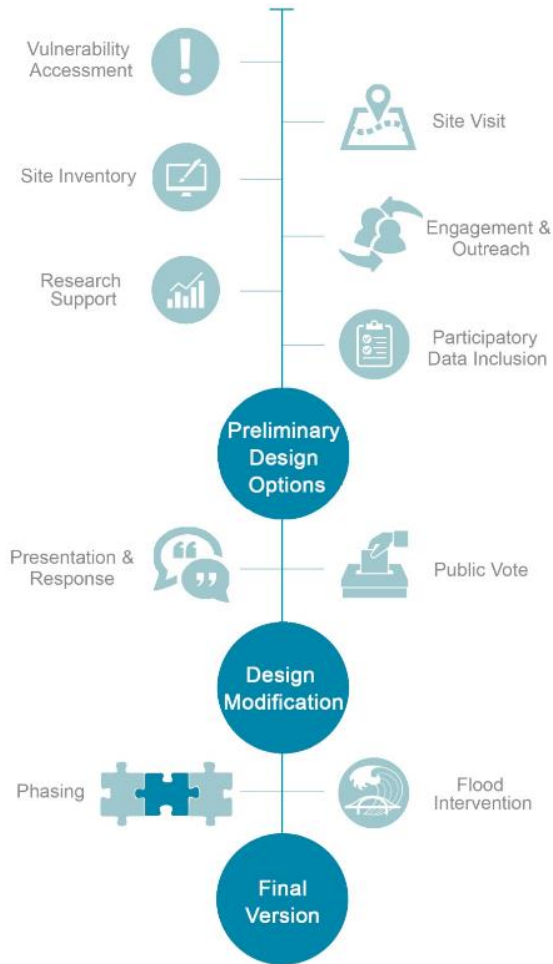
Infrastructure Assessment



Drone Footage



What are we doing to mitigate potential recreational exposure? Community engagement



Citizen Presentations



Media Outreach



Student Scenario Presentations



Final Outputs



What are we doing to mitigate potential recreational exposure? Low Impact Design



Low impact facilities were suggested in areas of extreme stormwater ponding or flow paths to asset with infrastructure issues.



These provisions were visualized and explained to community members. Many said provisions were used to regenerate vacant lots.

Relevance to other communities at risk

There are factors that make Houston unique...

However, this interdisciplinary approach is relevant to other communities:

- Environmental and climate justice
- Utilization of green infrastructure for mitigation
- Expansion of areas at risk from flooding



Questions?

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