Assessing Dynamic "100-year" Floodplain Risk for Residential Properties After Record Events



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<u>Why is flooding so bad in SE</u> <u>Texas!?</u>

• Function of:

- Precipitation rate/intensity (how hard did it rain?)
- Precipitation duration (how long did it rain?)
- Infiltration rate (how fast can water soak into soil?)
- Land use/land cover
- Size of stream channels
- Topography/slope
 - Change in land elevation over distance









Influence of Land Use/Land Cover



Rating Curve: River Stage vs. Discharge



Impact of "Record" Events



Probability:

100-year flood = 1/100 or 1% annual chance

500-year flood = 1/500 or 0.2% annual chance

Events can happen back-to-back!

So, let's say you live in a "100-year" floodplain... What are the odds that a 100-year flood will impact your house over the course of a 30-year mortgage?

 $= 1 - (1 - 1/RP)^{n}$ $1 - (1 - 1/100)^{30}$ $1 - (0.99)^{30}$ 1 - 0.74 $0.26 \text{ or } 26^{0}/_{0}$

 $= 1 - (1 - 1/RP)^{n}$

 $\frac{1-(1-1/50)^{30}}{1-(0.98)^{30}}$ $\frac{1-0.55}{0.45 \text{ or } 45\%}$

Study Background

- We know the "100-year" floodplain is not static
 - "Stationarity Is Dead" Milly et al., (2008)
- Flood maps are becoming outdated quickly as a result of:
 - Land use/land cover change
 - Shifting precipitation dynamics
- Risk is not accurately reflected in floodplain maps even for home buyers trying to be diligent; those that live in floodplains are seeing higher risk than when they bought

Question

In a rapidly-urbanizing area, how does incorporating a recordsetting storm (Harvey) impact flood maps? • Flood discharges

Flood stages (water surface elevations (WSELs))

- Residential property risk exposure
 - Pre- and post-Harvey

Study Area





Conroe and Woodlands area in 1984



Conroe and Woodlands area in 2016

Methods

• HEC-SSP

- Assess flood discharge changes
 - Pre-Harvey 100-year Q
 - Post-Harvey 100-year Q (USGS, 2017)

• FEMA FIS Study

- Transects from 2014
- Updated with 5-year rating curves (2014-2018) and post-Harvey expected WSELs percent changes at each gage
 - Interpolate between gages
- Build flood-depth grids from WSELs

• ArcGIS

- Building footprints (Microsoft, 2017)
- County parcel data (Montgomery Central Appraisal District, 2017)
- Missing footprints
 - Lots of Digitizing! (Thank you students!)
 - Filtered to areas >700 sq ft



USGS Gage ID	River	Near	n	Expected 100 yr Q (pre-2017)	USGS 100 yr Q (post- 2017)	% Change	100-y WSEL (pre-2017)	100-y WSEL (post- 2017) USGS Q	Diff in 1% EP WSEL (ft)	% Change
08067650	W F San Jacinto	Lake Conroe	45	39,504	97,700	147.32%	158.05	163.53	5.48	3.47%
08068000	W F San Jacinto	Conroe	63	86,080	111,000	28.95%	124.73	126.63	1.90	1.52%
08068090	W F San Jacinto	Lake Houston	33	136,154	196,000	43.95%	74.05	79.23	5.18	6.99%









Property Exposure

	2014 (Pre-Harvey)		2018	(Post-Harvey)	Change (Pre to Post)		
Damage by depth (ft)	Homes	Exposure	Homes	Exposure	Homes	Exposure	
0-0.99	92	\$10,787,800	97	\$15,141,830	5	\$4,354,030	
1-1.99	109	\$12,940,560	105	\$15,326,080	-4	\$2,385,520	
2-2.99	93	\$10,184,860	105	\$12,627,420	12	\$2,442,560	
3-3.99	65	\$7,222,530	110	\$11,510,130	45	\$4,287,600	
4-4.99	57	\$6,096,370	63	\$7,281,530	6	\$1,185,160	
5-5.99	59	\$6,051,215	57	\$5,889,480	-2	-\$161,735	
6-6.99	53	\$5,633,660	54	\$6,150,470	1	\$516,810	
7-7.99	47	\$4,727,910	55	\$5,748,525	8	\$1,020,615	
8-8.99	32	\$1,504,100	48	\$4,883,070	16	\$3,378,970	
9-9.99	10	\$181,820	36	\$1,994,960	26	\$1,813,140	
10+	10	\$467,010	40	\$2,275,120	30	\$1,808,110	
TOTAL	627	\$65,797,835	770	\$88,828,615	143	\$23,030,780	

Discussion

- Increase in property exposure
 - Some of the highest risk properties are in buyout process
 - \$8.8 million for ~400 properties in Montgomery County
 - Applied for \$12.9 million more
 - Even more homes qualify since thanks to TS Imelda and others
 - Buyouts offset by total increase in existing homes within floodplain
 - Not including all new structures in floodplain!

Residents still confused on if they're even in a floodplain: "Although the Harvey buyout program is focused on homes in the floodplain, Cooper said there is a lot of confusion from residents surrounding what the terms 100- and 500-year floodplains mean on the FEMA flood insurance map.

'[The FEMA flood insurance map] will not tell you whether you will or will not flood. I guarantee you we have flooding outside the flood line,' Cooper said." - Andy Li, Community Impact











\$32,650 (9.67%) 2 Full & 1 Half Bath(s) 2,643 Sqft. 4 Bedroom(s) 12,967 Lot Sqft Single-Family 116 Day(s) on Market

\$337,500





324 Coldwate	r Creek Court	For Sale Unde	For Sale Under Contract - P		
Conroe, TX 77304 Get [Directions	\$710,961	Est. Mortgage \$3,595/month		
Mew construction					
3 Bedroom(s)	3 Full & 1 Half Bath(s)	2,937 Sqft.			
8,310 Lot Sqft	Single-Family	35 Day(s) on Market			

Discussion

- All the analysis here is also just a snapshot in time
 - Does not include increased runoff from new developments
 - Need coupled hydrologic/hydraulic models
 - Does not include continued changes in precipitation

Complete Period(cfs)									
% Chance Excedence	Computed Curve	Expected Probability	0.05 Confidence Limit	0.95 Confidence Limit					
0.2	190,230.30	220,128.30	338,894.90	122,330.20					
0.5	137,384.70	153,437.30	232,542.00	91,645.10					
1	105,117.10	114,606.10	170,736.20	72,205.20					
Without Harvey									
% Chance Excedence	Computed Curve	Expected Probability	0.05 Confidence Limit	0.95 Confidence Limit					
0.2	130,455.00	147,034.30	220,563.60	87,259.50					
0.5	99,960.50	109,585.20	162,092.70	68,876.90					
1	80,016.20	86,080.00	125,389.30	56,479.70					

Final Thoughts

- We don't have enough resources to calibrate and validate new hydraulic models every time a record event occurs across the U.S.
- Can geographers help communicate risk more effectively through use of geospatial tools?
 - Won't be perfect either, but better than maps that show no changes
- Best way forward
 - Real estate agents
 - What do they know?
 - New home buyers and home owners
 - Developers
 - Cities and Counties
 - Community partnerships

Questions?

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- @SHSUGeo (Twitter/X)

