
Source: Cal FIRE

The Year of Extremes: Lessons from the Catastrophes of 2017

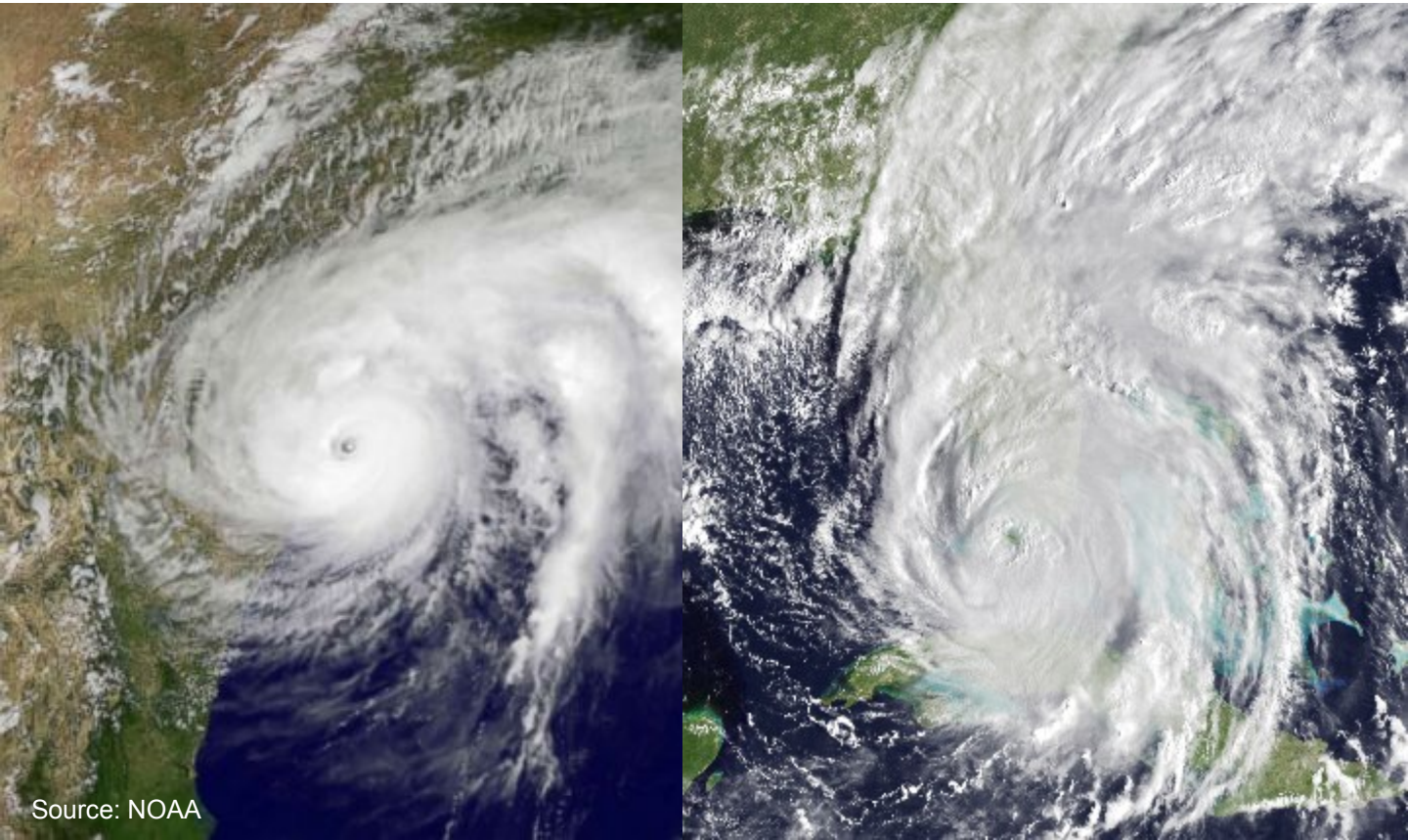
Mark C. Bove, CPCU, ARe
CARe Seminar on Reinsurance
4 June 2018

Munich RE

Agenda

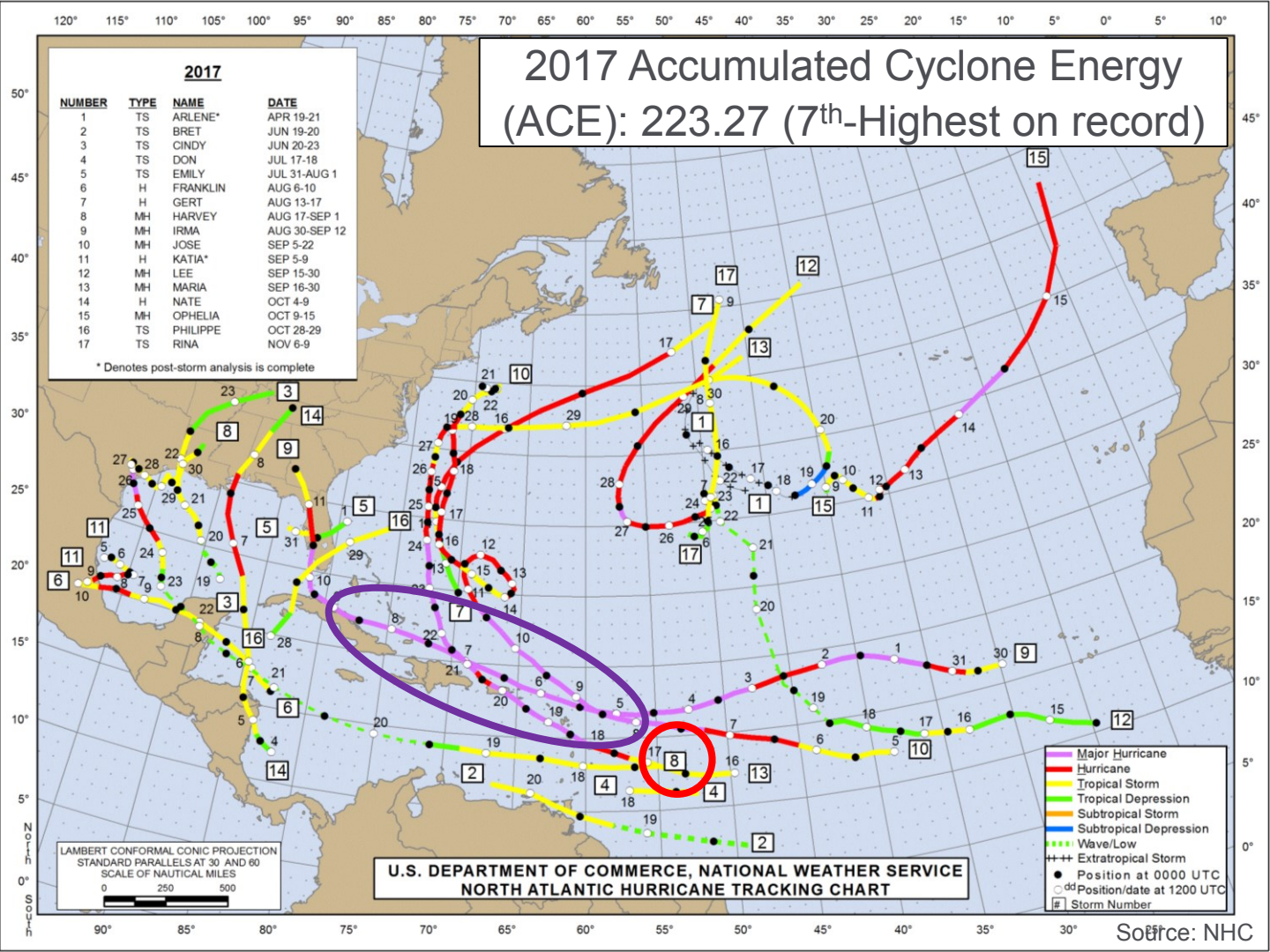
- The Great Flood & The Close Call: Hurricanes Harvey & Irma
- Gray Swans: The 2017 California Wildfires
- The Big Picture: What does 2017 tell us about the future?

The Great Flood & The Close Call: Hurricanes Harvey & Irma



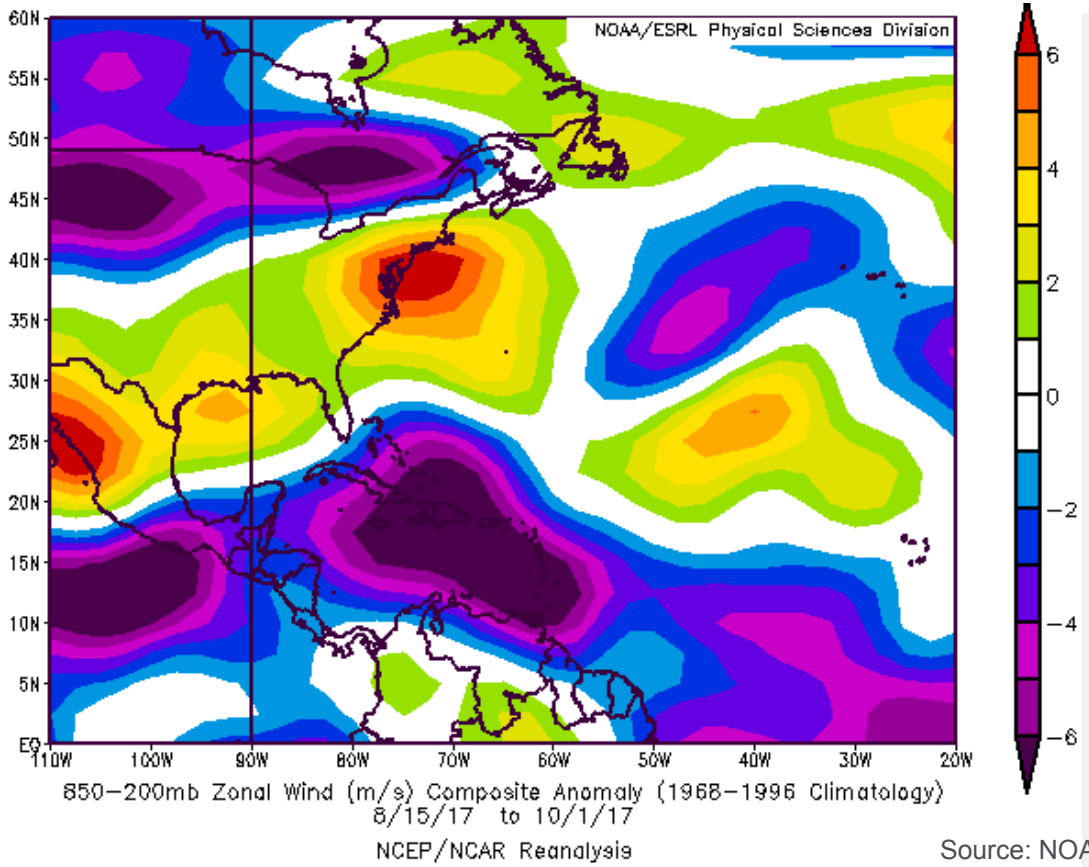
Source: NOAA

2017 Accumulated Cyclone Energy (ACE): 223.27 (7th-Highest on record)



Source: NHC

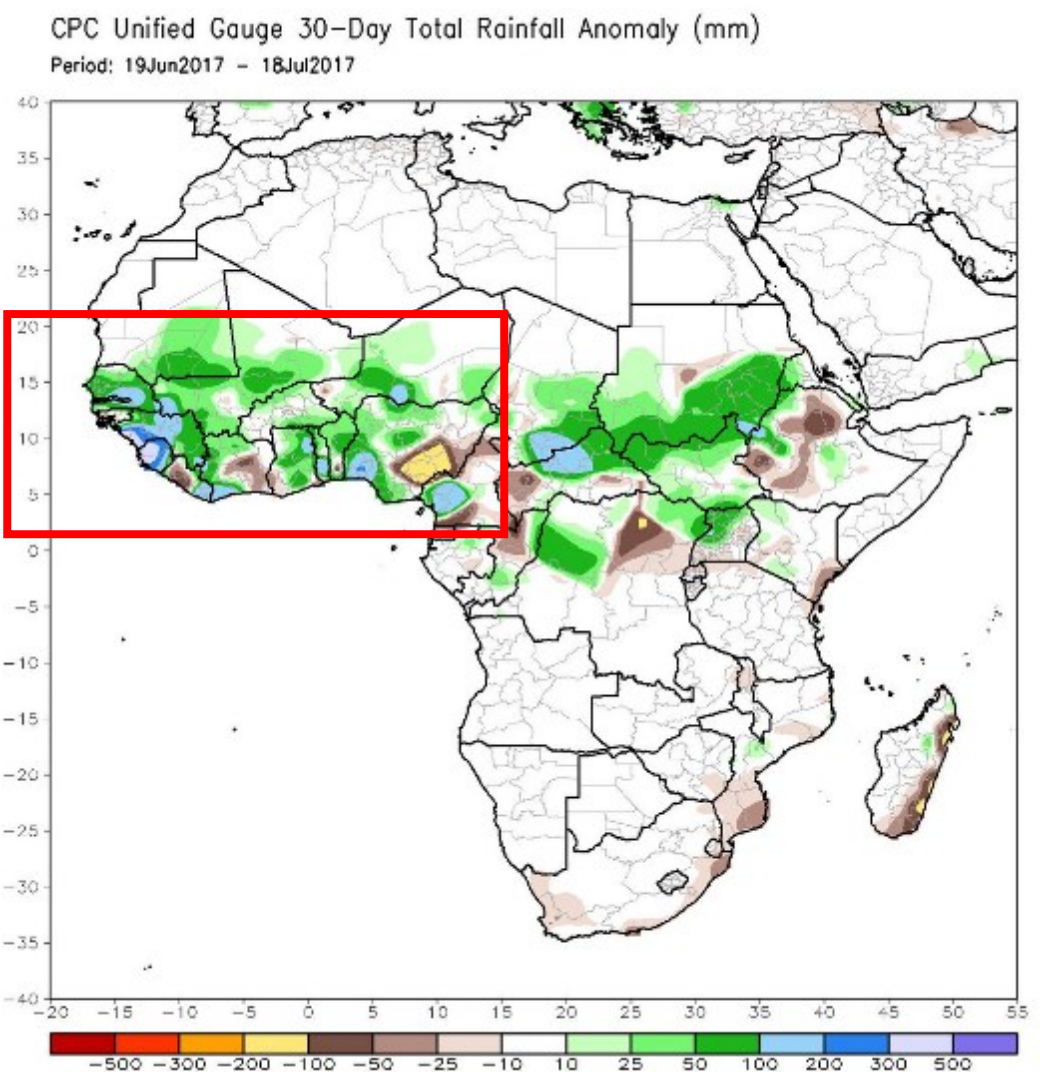
August – September 2017 Conditions in the Northern Caribbean Region



Source: NOAA / ESRL

June – July African Rainfall Anomalies

Above average rainfall is an indicator of more vigorous tropical waves. Rainfall also increases moisture available to subsequent systems.



Source: Dr. Ryan Maue

Tale of the Barometer / Anemometer: Harvey vs. Irma's Florida Landfalls

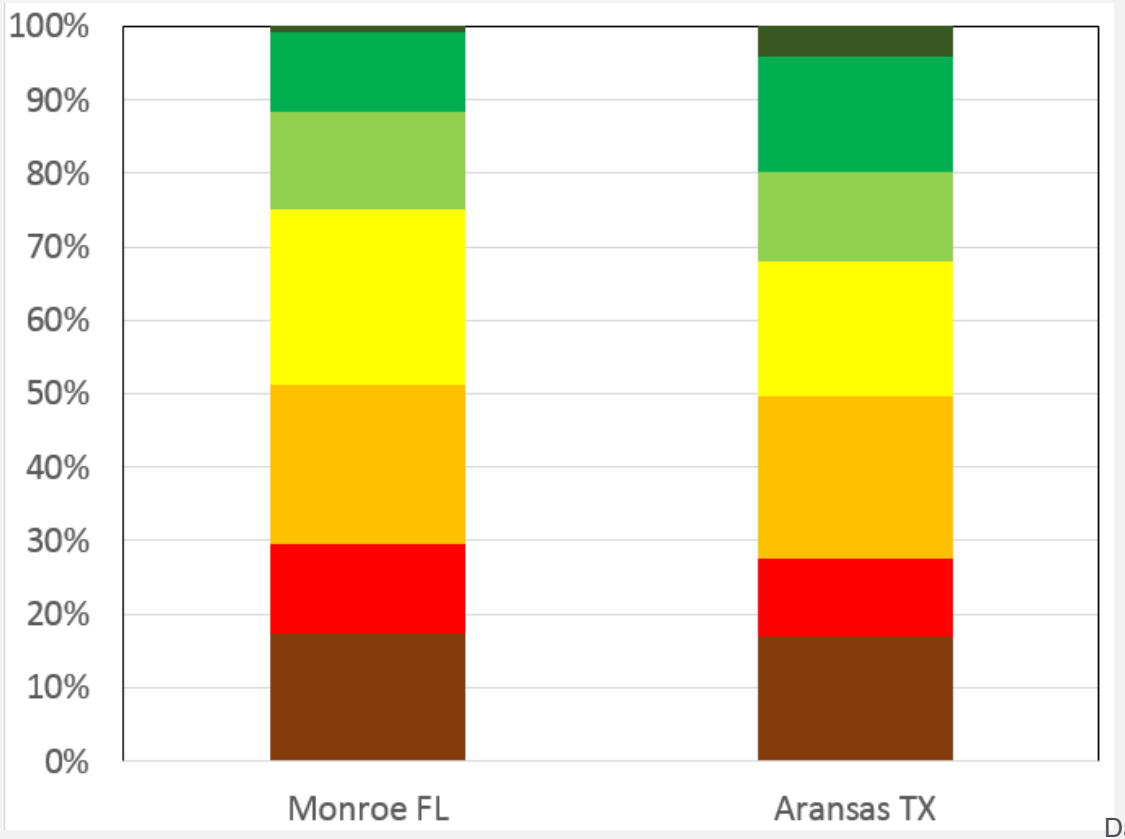
	Harvey	Irma
Central Pressure	938 hPa	929 hPa (Keys) 940 hPa (Marco Island)
Sustained winds (1-minute avg.)	130 mph	130 mph (Keys) 115 mph (Marco Island)
Rate of Forward Motion	7 mph	8 mph (Keys) 12 mph (Marco Island)

IBHS Building Code Ratings by State

2015 and 2012 STATE SCORES

State	2015 New Score	2012 Original Report Score
VIRGINIA	95	95
FLORIDA	94	95
SOUTH CAROLINA	92	84
NEW JERSEY	89	93
CONNECTICUT	88	81
RHODE ISLAND	87	78
NORTH CAROLINA	84	81
LOUISIANA	82	73
MASSACHUSETTS	79	87
MARYLAND	78	73
GEORGIA	69	66
NEW YORK	56	60
MAINE	55	64
NEW HAMPSHIRE	48	49
TEXAS	36	18
MISSISSIPPI	28	4
ALABAMA	26	18
DELAWARE	17	17

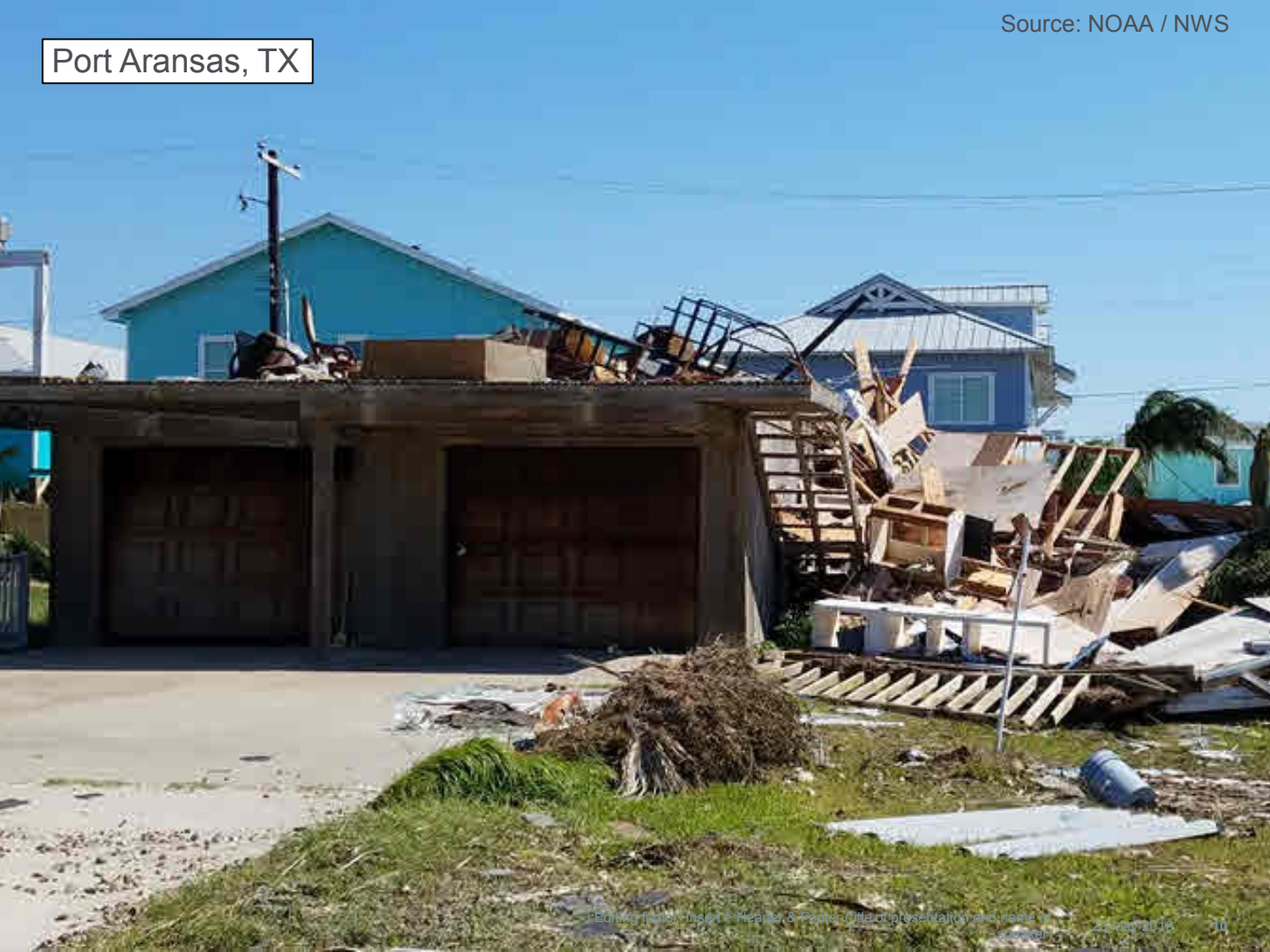
% of Housing Units by Decade Built



Data: U.S. Census Bureau

Source: NOAA / NWS

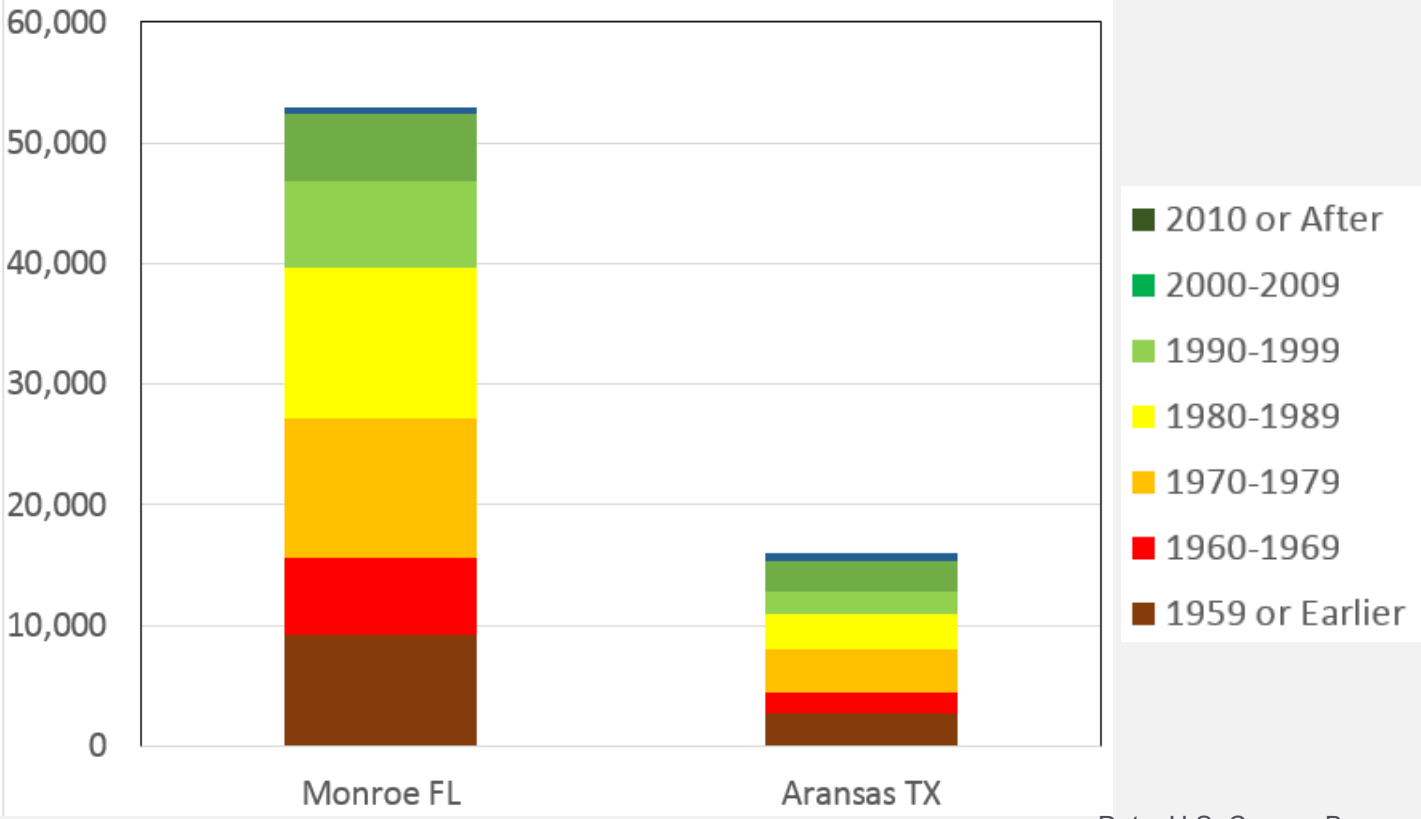
Port Aransas, TX



Little Torch Key, FL

Source: Munich Re (US)

of Housing Units by Decade Built



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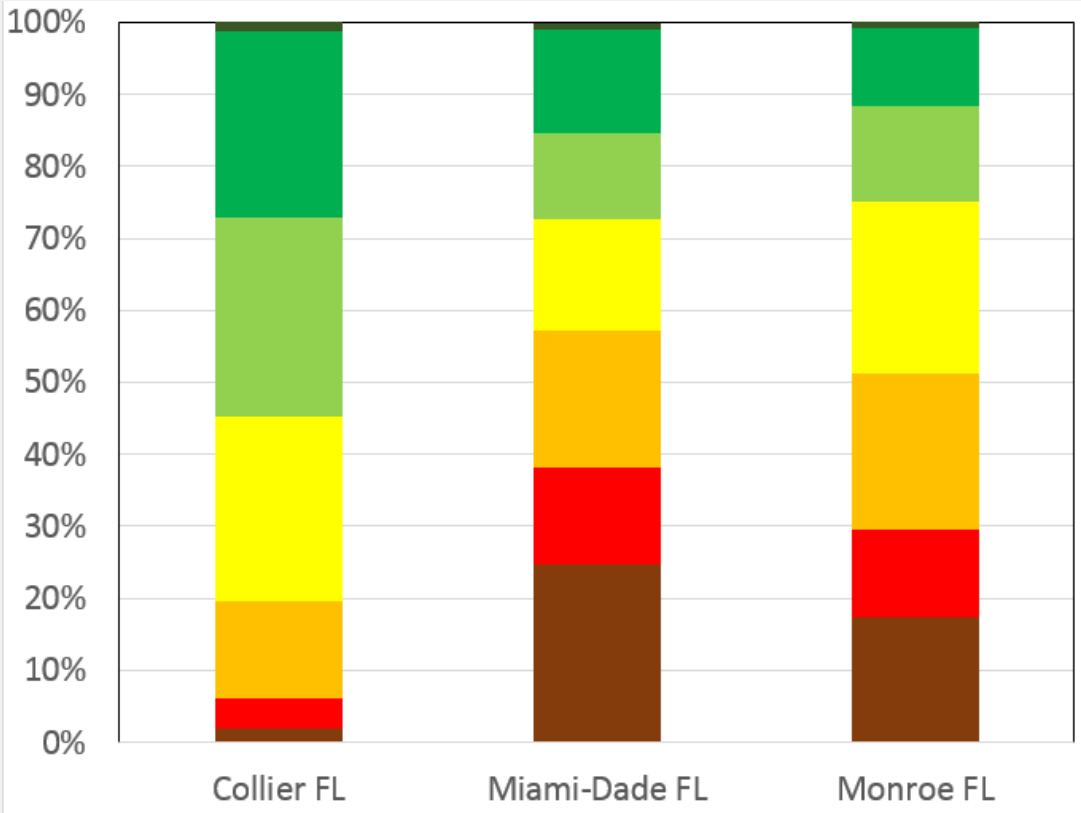
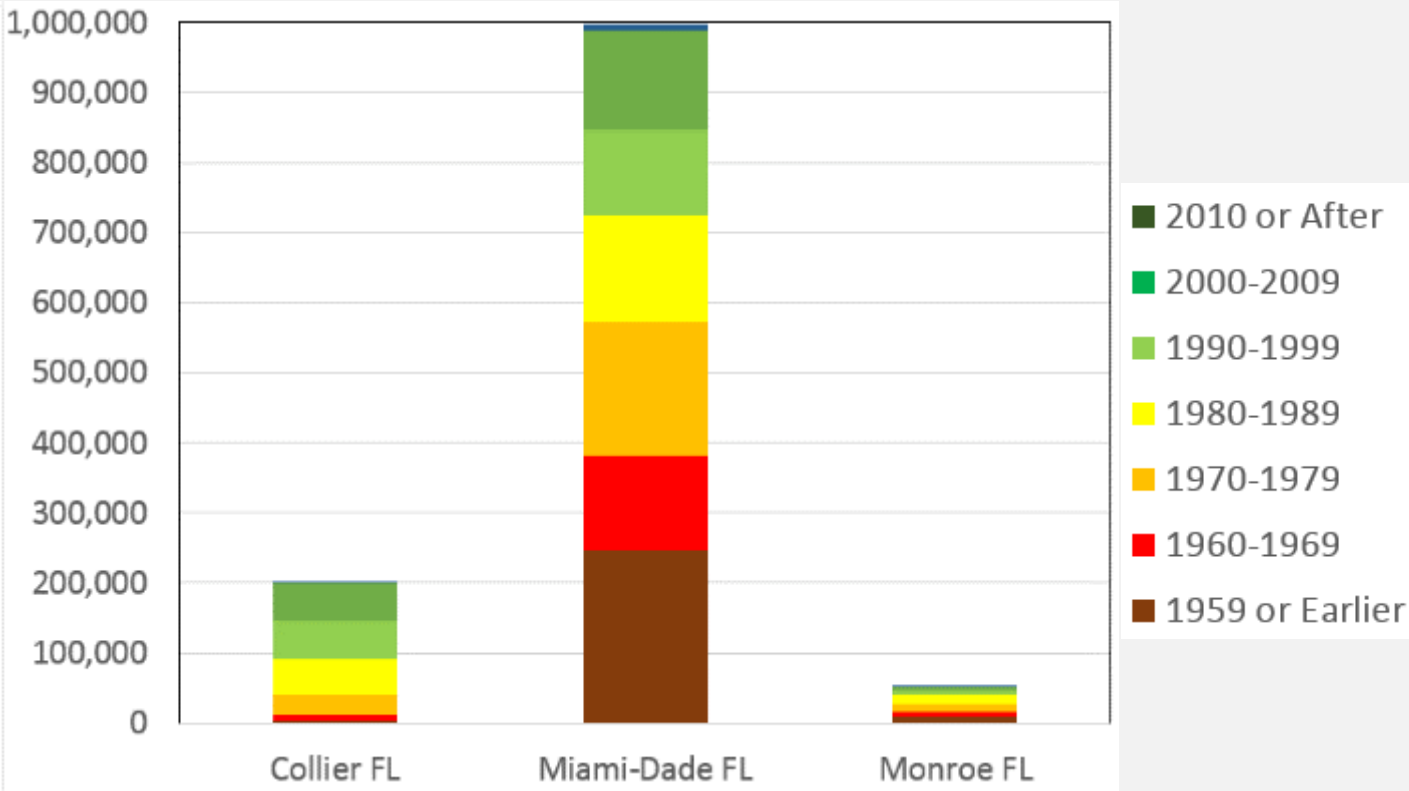


Data: U.S. Census Bureau


Marco Island, FL
Hurricane Irma
Source: Munich Re (US)


Marco Island, FL
Hurricane Wilma (2005)
Source: Munich Re (US)

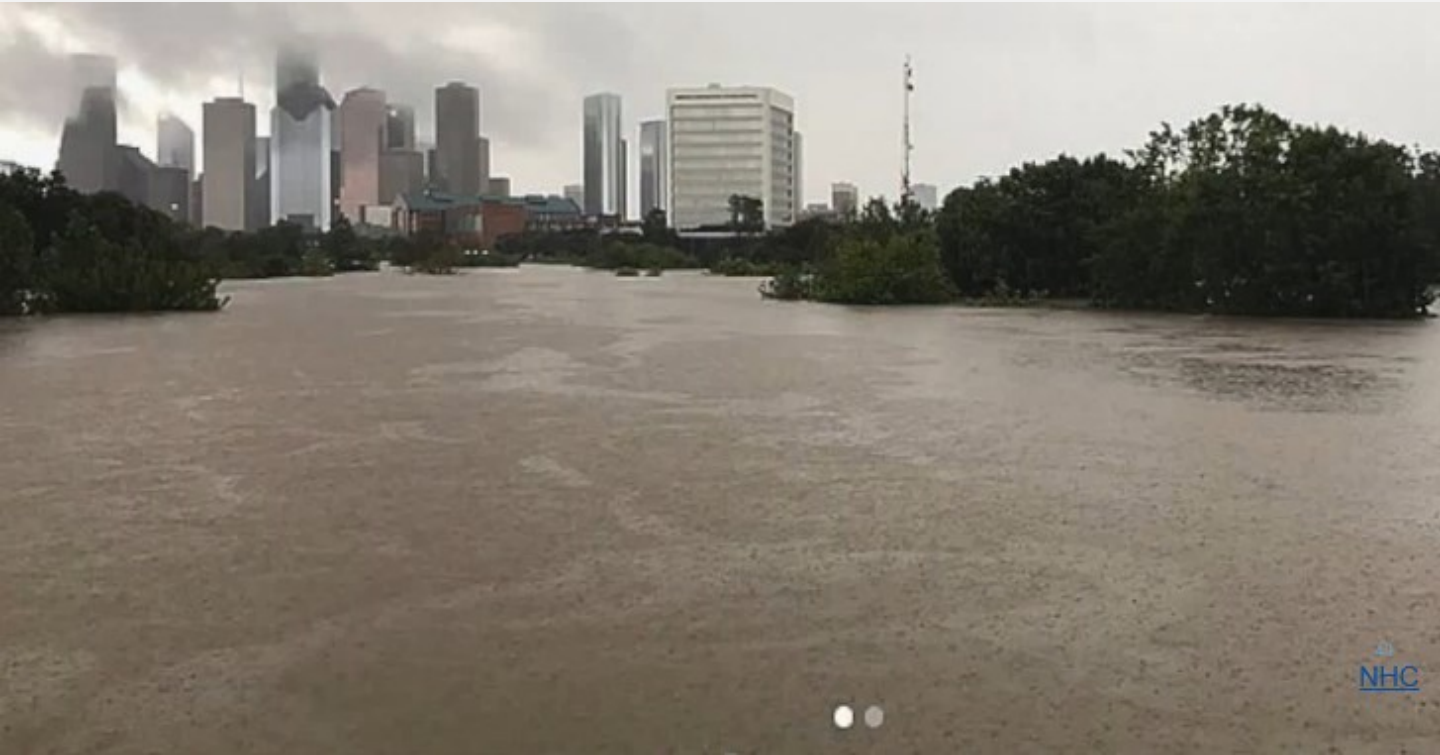
of Housing Units by Decade Built



Data: U.S. Census Bureau

Buffalo Bayou, Houston, TX, during Harvey

Over 60” (1,524 mm) of rain in 5 days – a U.S. record!



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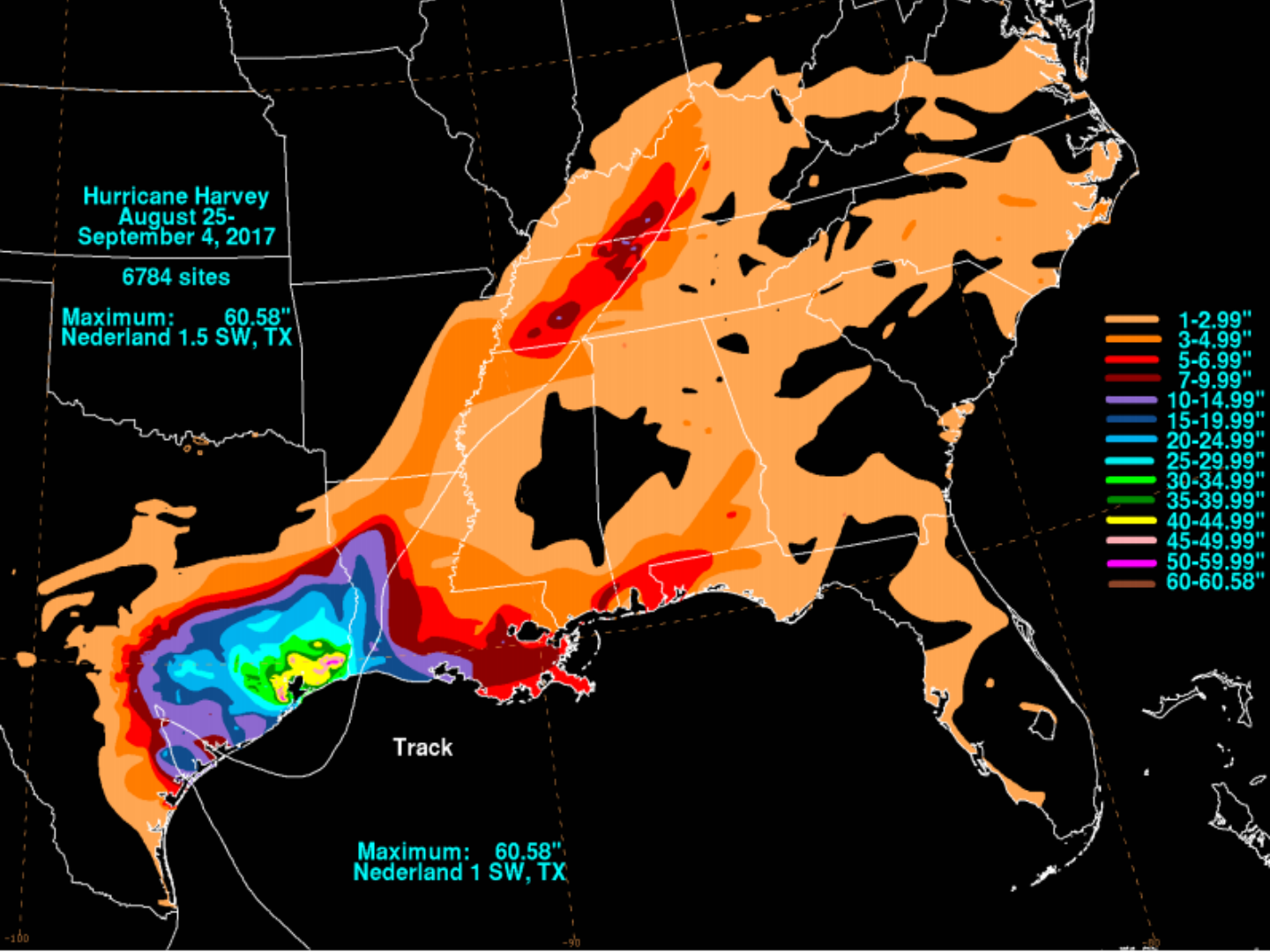
NHC

NHC

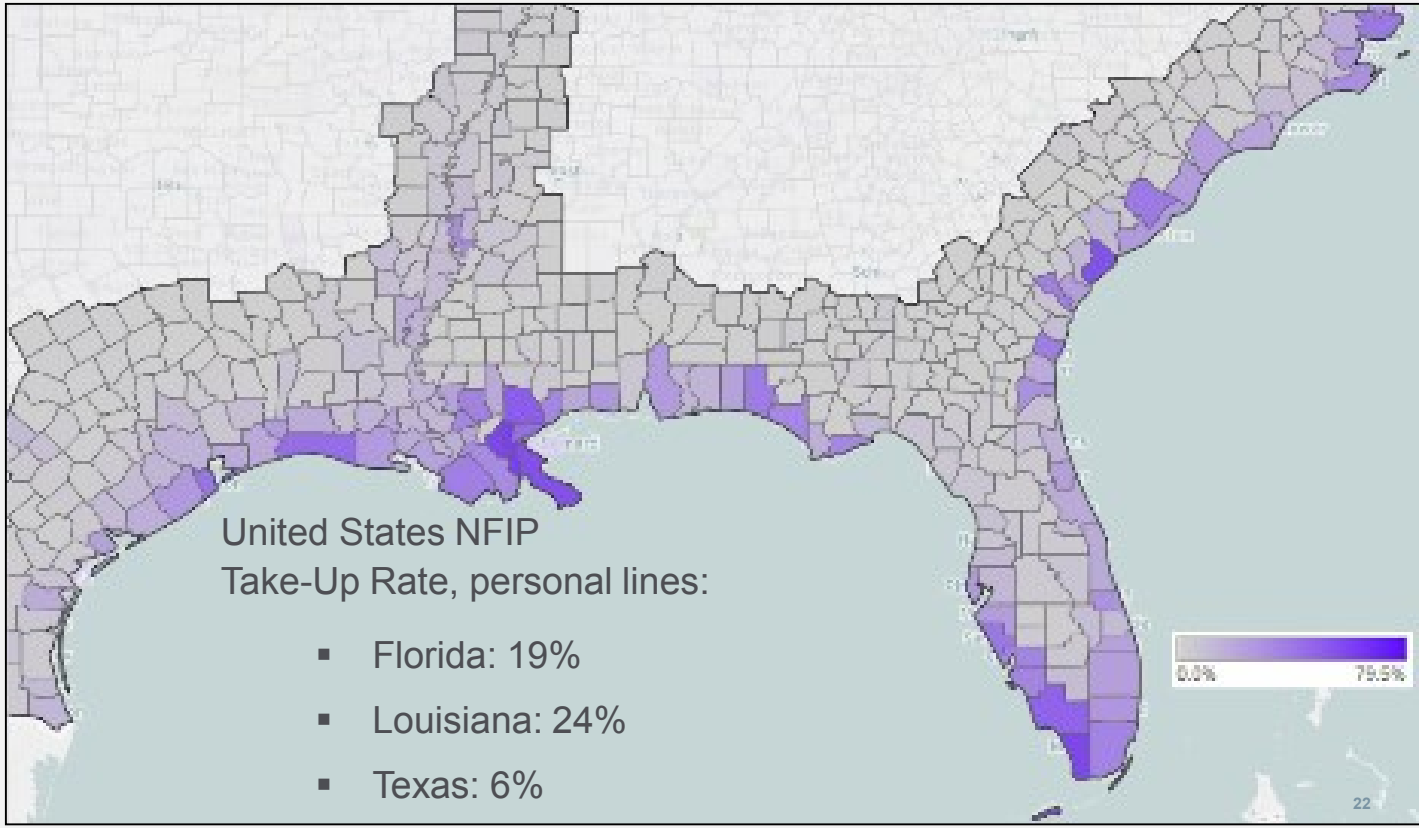

Hurricane Harvey
August 25-
September 4, 2017
6784 sites
Maximum: 60.58"
Nederland 1.5 SW, TX
1-2.99"
3-4.99"
5-6.99"
7-9.99"
10-14.99"
15-19.99"
20-24.99"
25-29.99"
30-34.99"
35-39.99"
40-44.99"
45-49.99"
50-59.99"
60-60.58"
Track
Maximum: 60.58"
Nederland 1 SW, TX

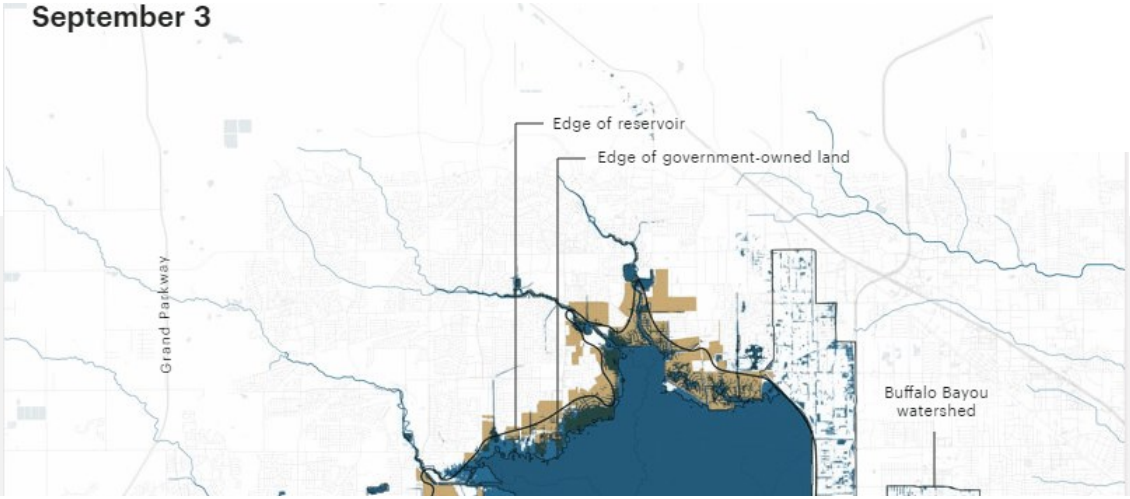
Hurricane Harvey
Inland Flooding, Port Arthur, TX

Source: US Army

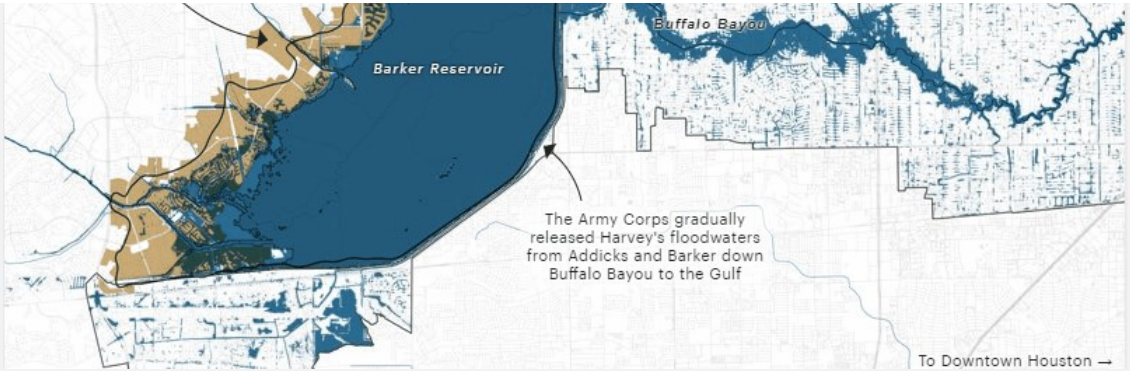
Hurricane Harvey
Inland Flooding & the Insurance Gap

Munich RE

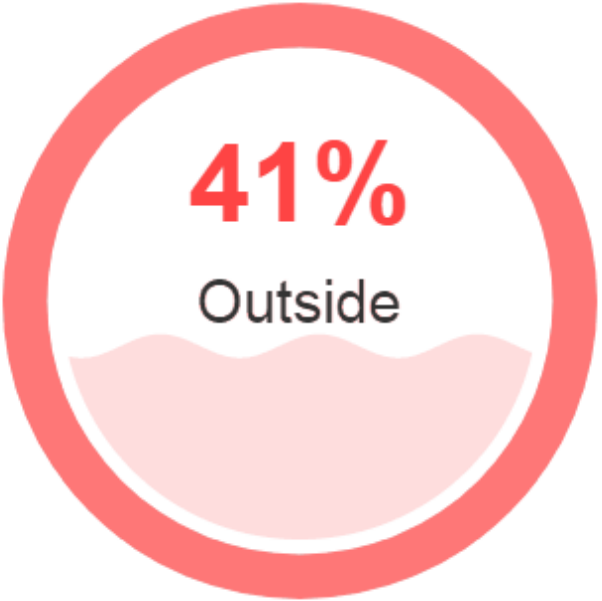


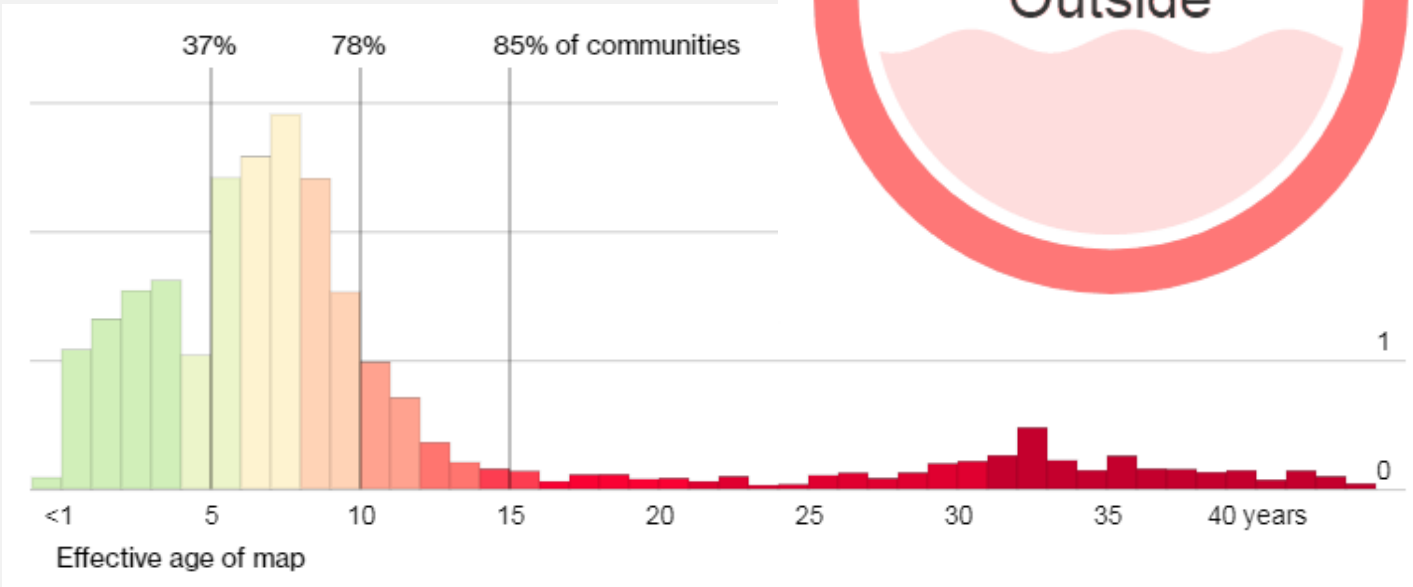


- Houston reservoir animation can be viewed at: https://projects.propublica.org/graphics/harvey-maps?utm_campaign=sprout&utm_medium=social&utm_source=twitter&utm_content=1515006687

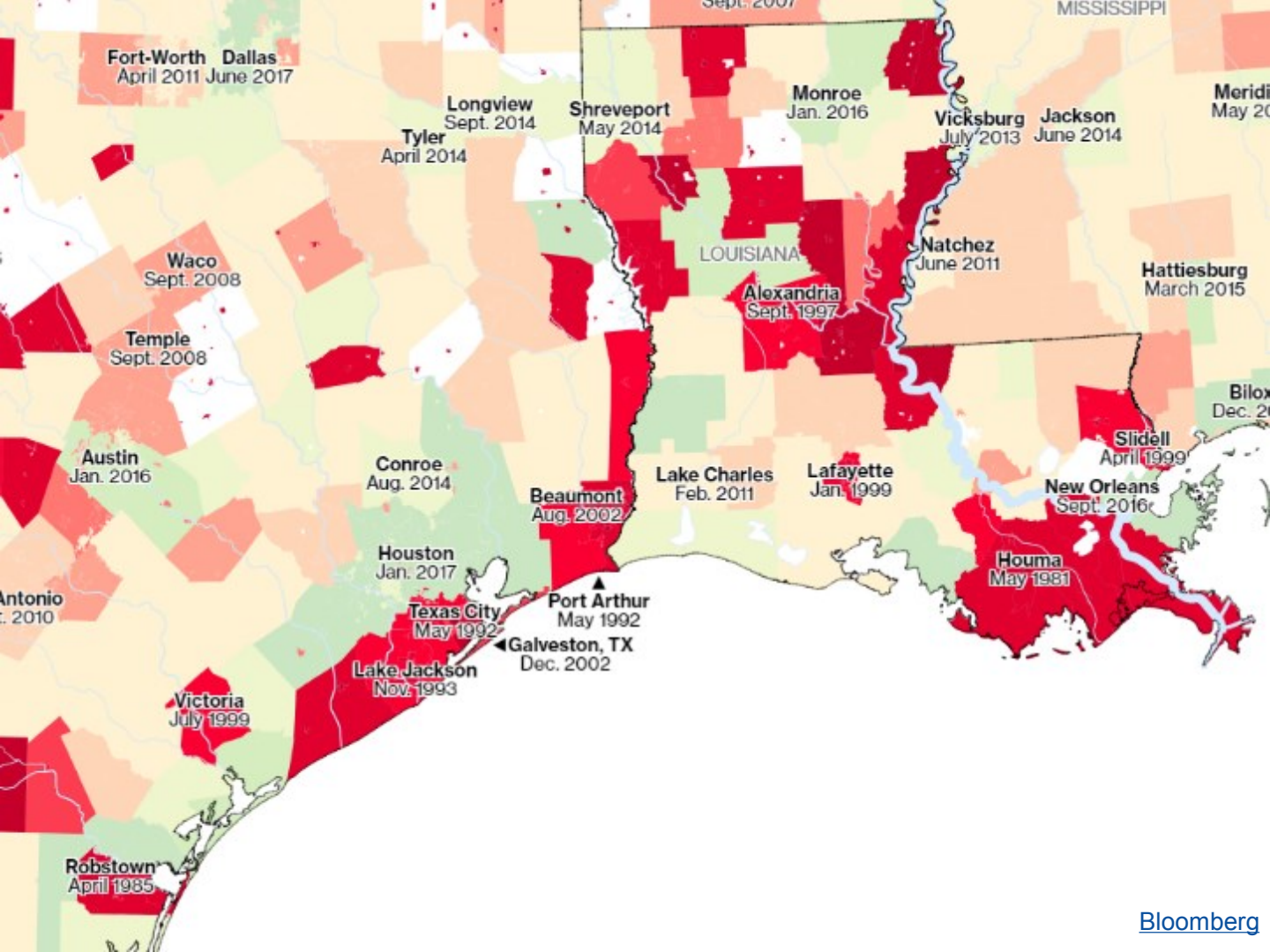


ProPublica





Bloomberg, Rice University


Fort-Worth Dallas
April 2011 June 2017
Longview
Sept. 2014
Tyler
April 2014
Shreveport
May 2014
Monroe
Jan. 2016
Vicksburg
July 2013
Jackson
June 2014
MISSISSIPPI
Waco
Sept. 2008
LOUISIANA
Natchez
June 2011
Hattiesburg
March 2015
Alexandria
Sept. 1997
Temple
Sept. 2008
Austin
Jan. 2016
Conroe
Aug. 2014
Beaumont
Aug. 2002
Lake Charles
Feb. 2011
Lafayette
Jan. 1999
Slidell
April 1999
New Orleans
Sept. 2016
Houma
May 1981
Houston
Jan. 2017
Port Arthur
May 1992
Texas City
May 1992
Galveston, TX
Dec. 2002
Lake Jackson
Nov. 1993
Victoria
July 1999
Robstown
April 1985

Bloomberg

Hurricane Harvey
Inland Flooding, Houston, TX

Texas World Speedway after Harvey being used to store flooded cars. Photo credit Brazos Drones.

Source: NOAA

Hurricane Harvey
Inland Flooding, Houston, TX

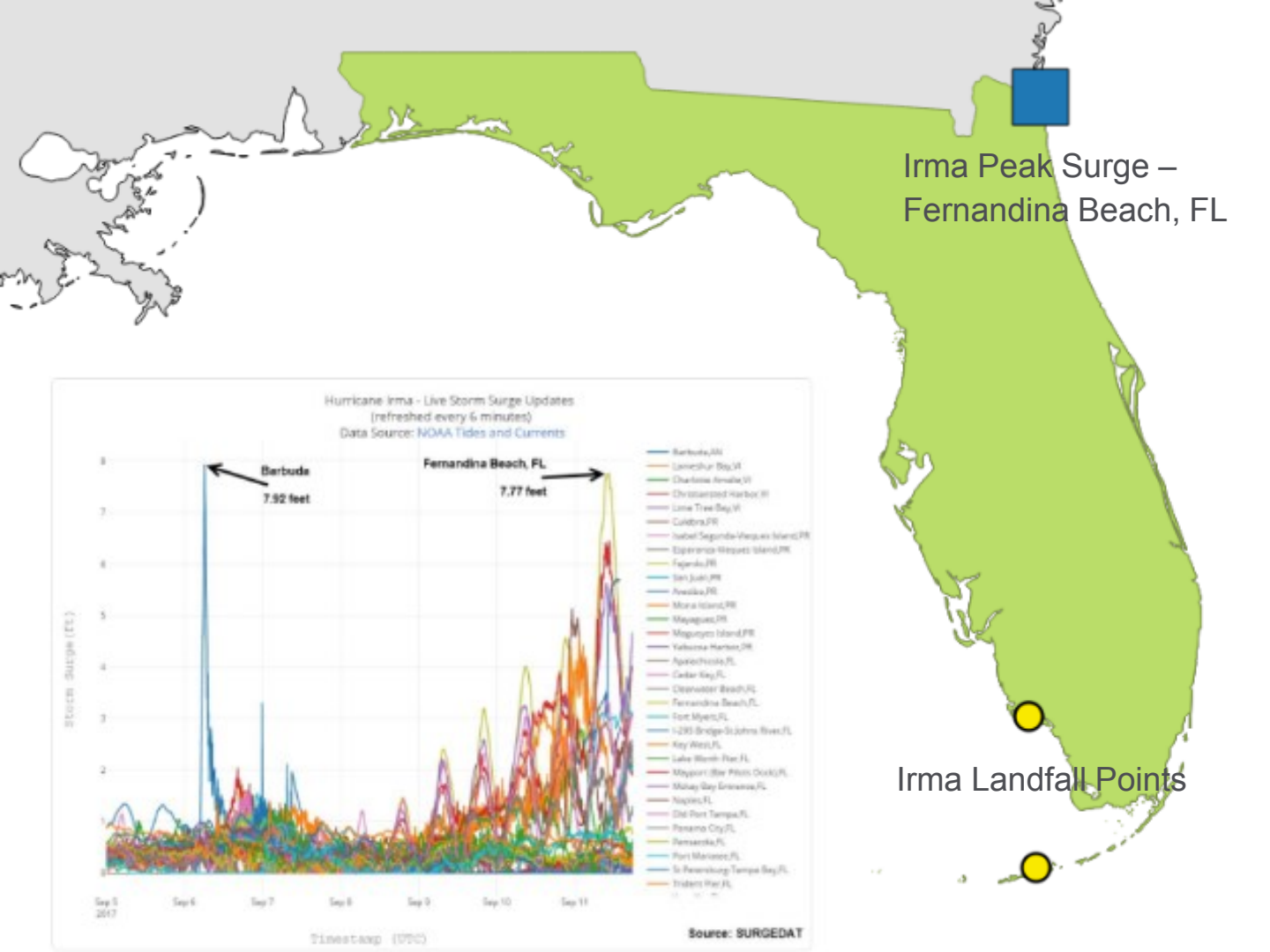
Source: New Republic

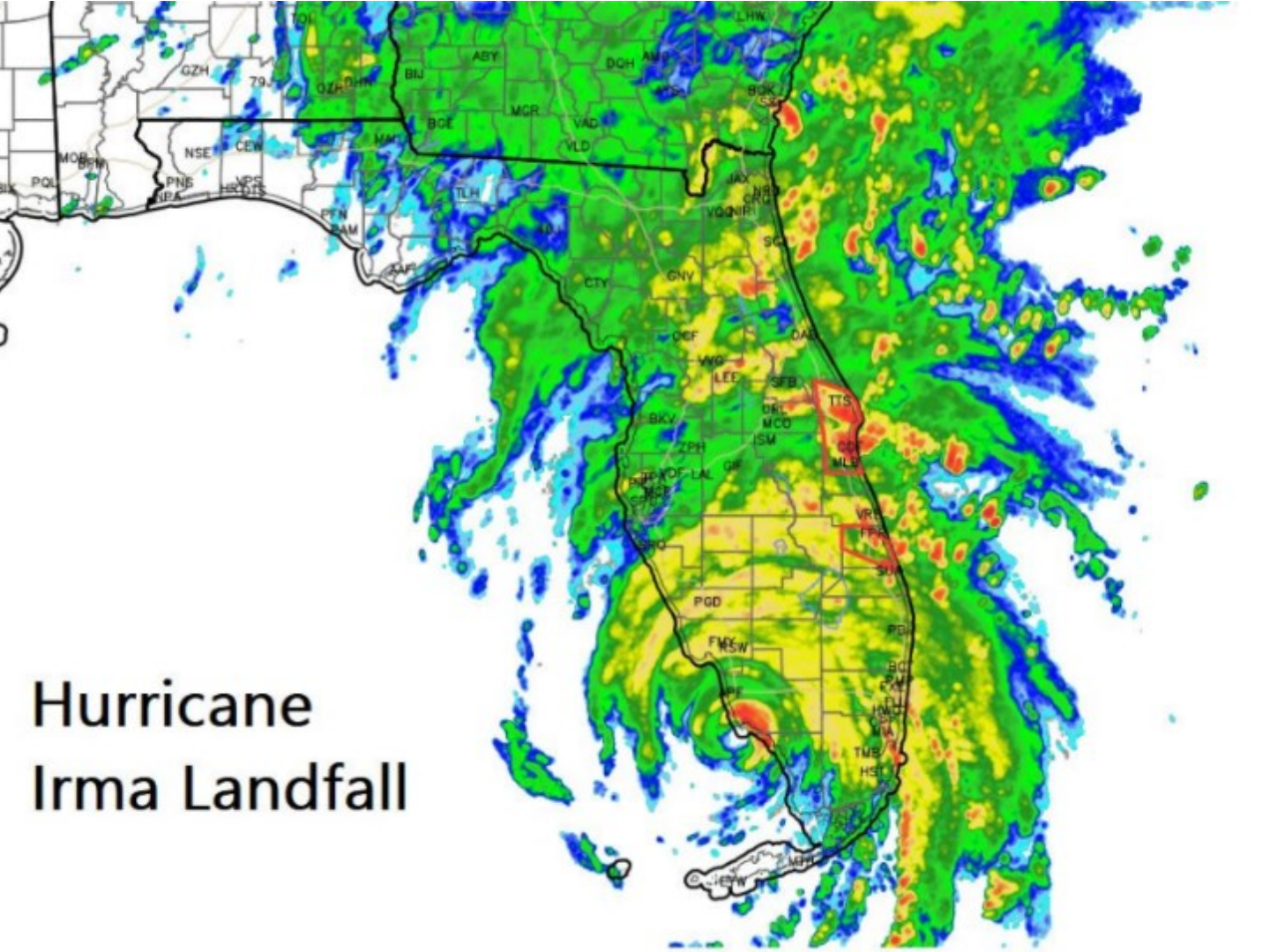
Lessons from Harvey: Location of Contents

- The location of contents within an insured location is critical when assessing flood loss potential, particularly for commercial and industrial risks.
- Examples:
  - Hospitals (MRIs, CAT Scan Machines, Radiology equipment)
  - Office Buildings (Electrical and IT equipment, etc.)
- Catastrophe Risk Models tend to spread out contents value over the number of stories within a building. This could lead to an underestimation of the amount of contents at risk to flood losses.
- Heavy Industry (Oil & natural gas refining, storage, and distribution) also heavily affected, damage to equipment, potential for health & environmental liability from leaking chemicals.

Lessons from Harvey: Other Items of Note

- Personal Lines – Wind
  - Homes built to meet 2006 International Building Code performed very well in Harvey's high winds. Proper construction and resiliency work!
  - However, lack of statewide building codes mean many older homes in TX not built with any wind hazard considerations – poorer risks, and debris from these homes can damage even well-built structures. Community / state action critical for resiliency of entire community!
- Personal Lines - Flood
  - Don't build communities inside of reservoirs!
  - Elevating homes significantly above local elevation critical in reducing loss!
  - Cost to build to code may be significant.
  - Flood maps can be outdated – much of the flood loss was outside of 100-year flood zone!


Irma Peak Surge –
Fernandina Beach, FL
Irma Landfall Points
Hurricane Irma - Live Storm Surge Updates
(refreshed every 6 minutes)
Data Source: NOAA Tides and Currents
Barbuda
7.92 feet
Fernandina Beach, FL
7.77 feet
Storm Surge (ft)
Timestamp (UTC)
Source: SURGEDAT


Hurricane
Irma Landfall

Gray Swans:
The 2017 California Wildfires

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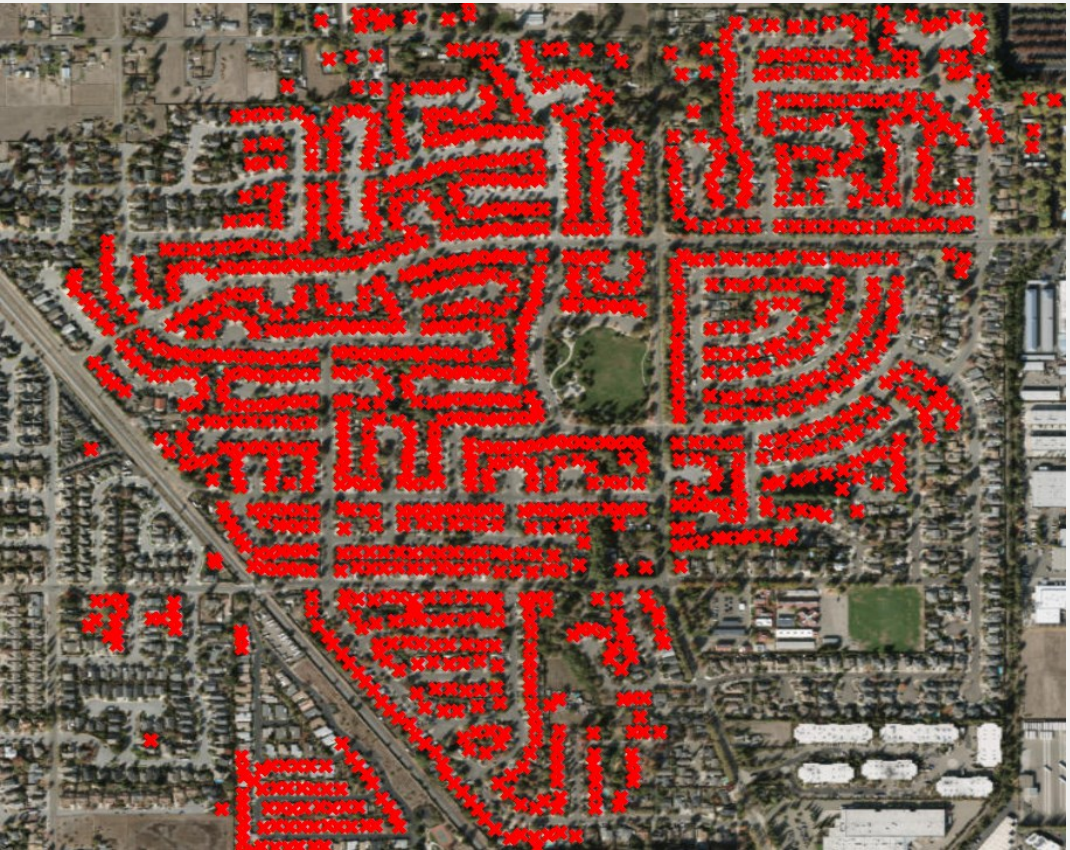
2017 California Wildfires

California 2017:

- >10k structures lost
- >$13 bn insured loss (aggregate)
- Previous largest wildfire loss:

  Oakland Hills Fire (1991); $3 billion loss (2017 US$)

2017 California Wildfires



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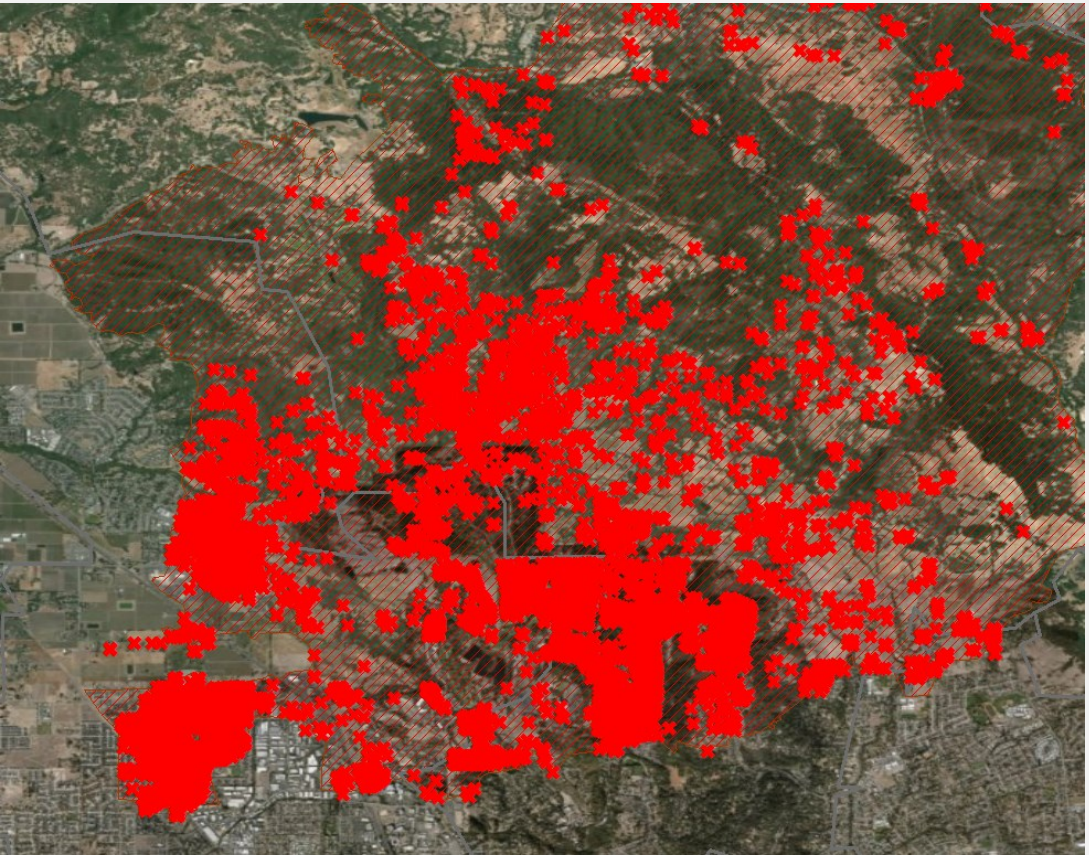

California 2017:

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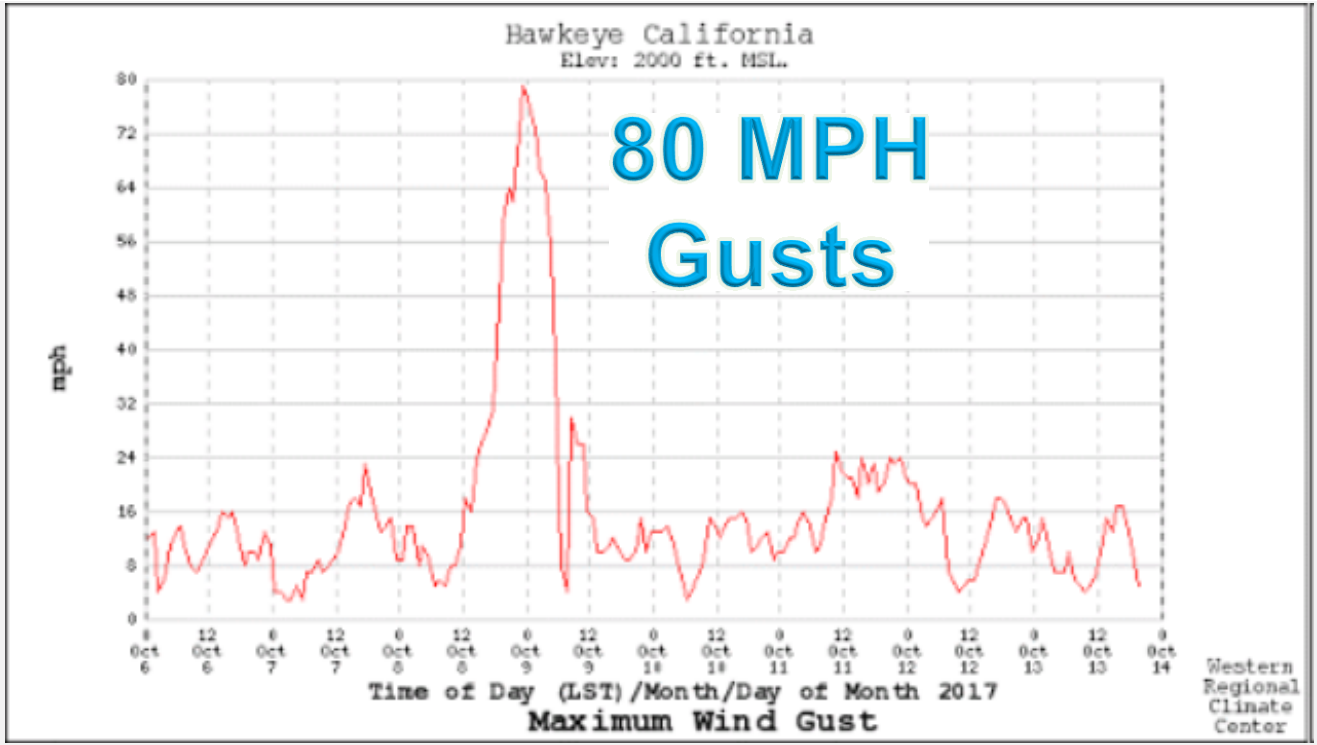
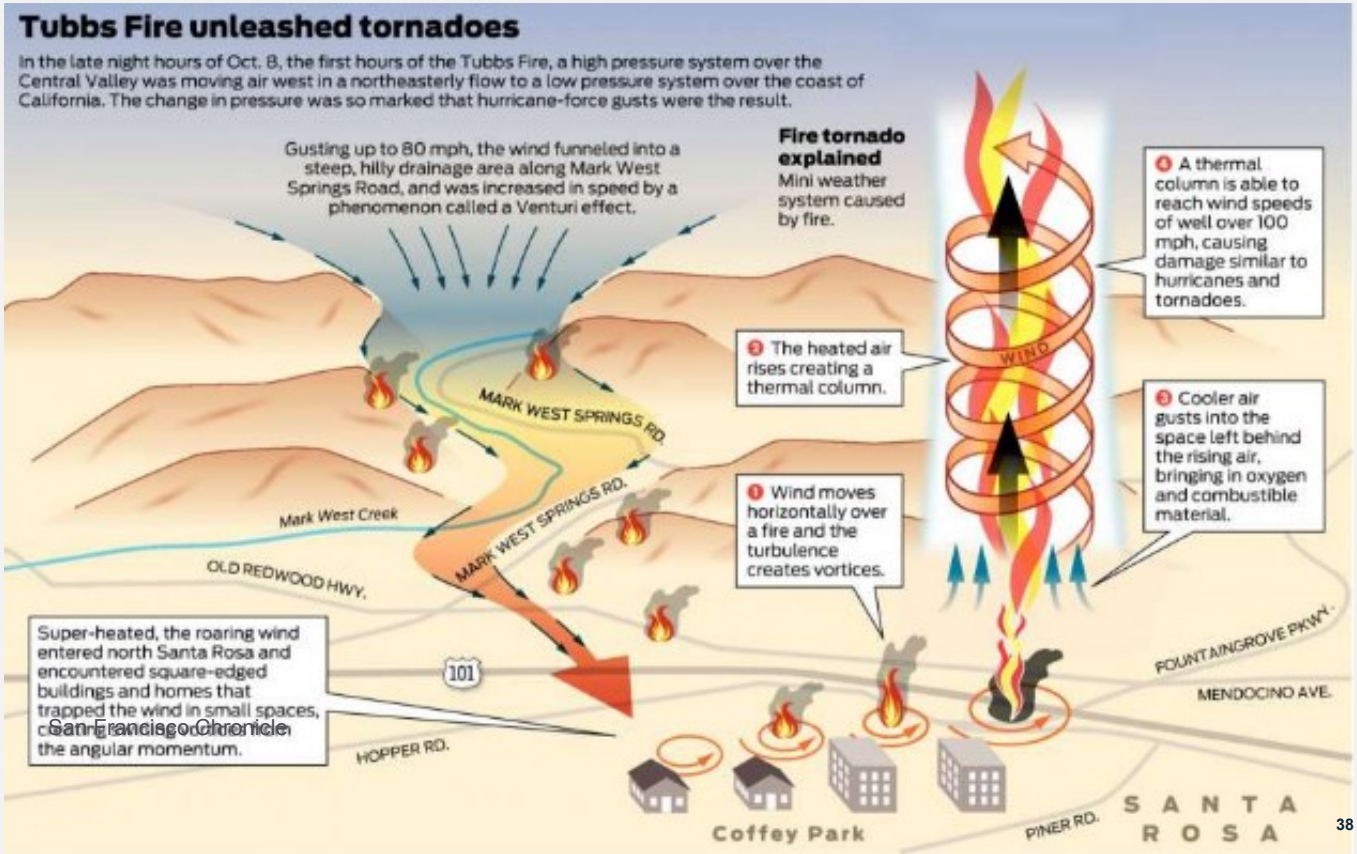
Why was the Tubbs Fire so Destructive?



Source: Kim Roberts / Used with Permission

Tubbs Fire – Sonoma County
Interaction of wind & topography



Tubbs Fire – Santa Rosa
Coffey Park Neighborhood

Source: Kim Roberts / Used with Permission

Tubbs Fire – Santa Rosa

Source: Kim Roberts / Used with Permission

Thomas Wildfire - Downtown Ventura

Source: Kim Roberts / Used with Permission

Montecito Mudslides

Source: Kim Roberts / Used with Permission

Montecito Mudslides

Source: Kim Roberts / Used with Permission

The Big Picture:
What Does 2017 Tell Us About The Future?

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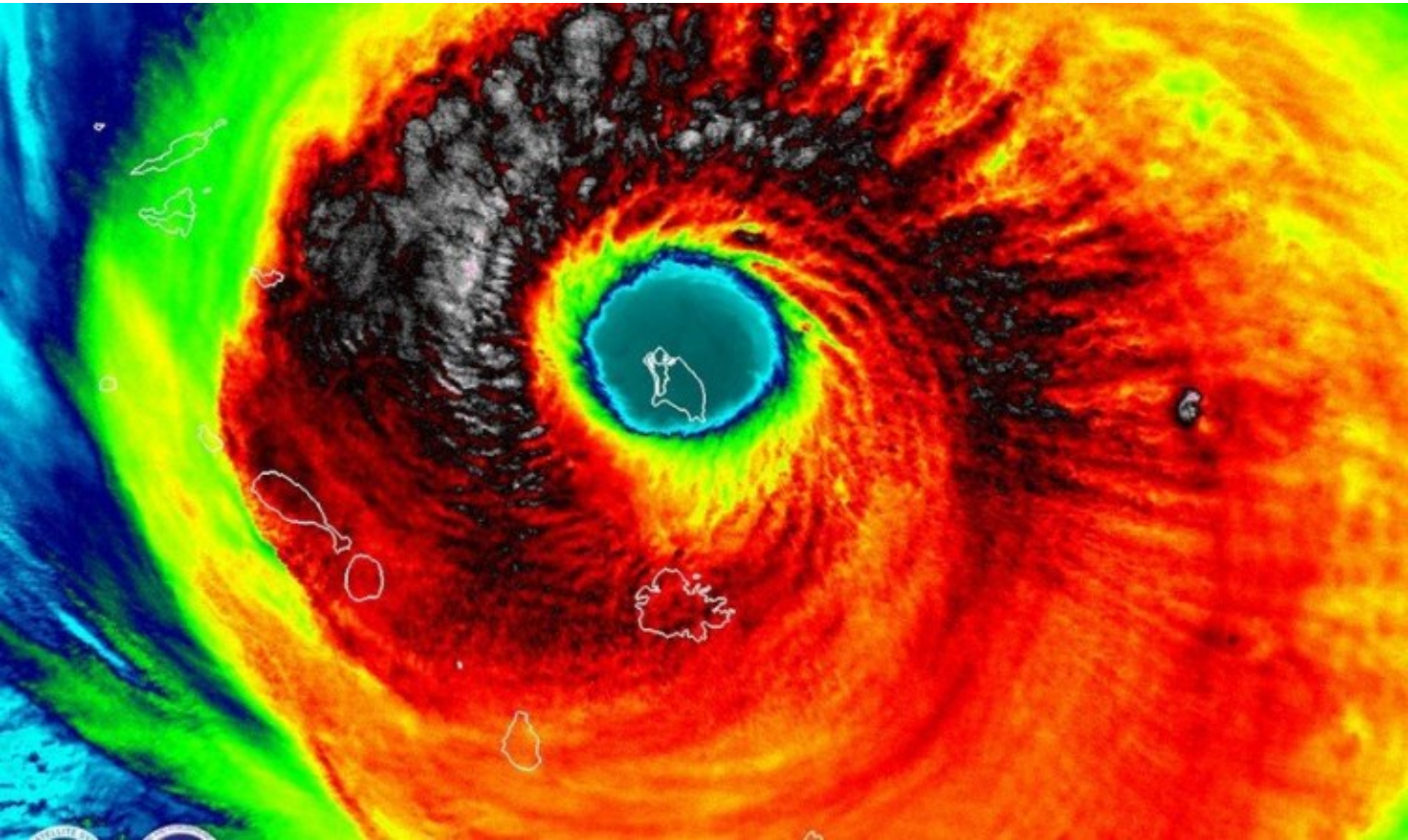
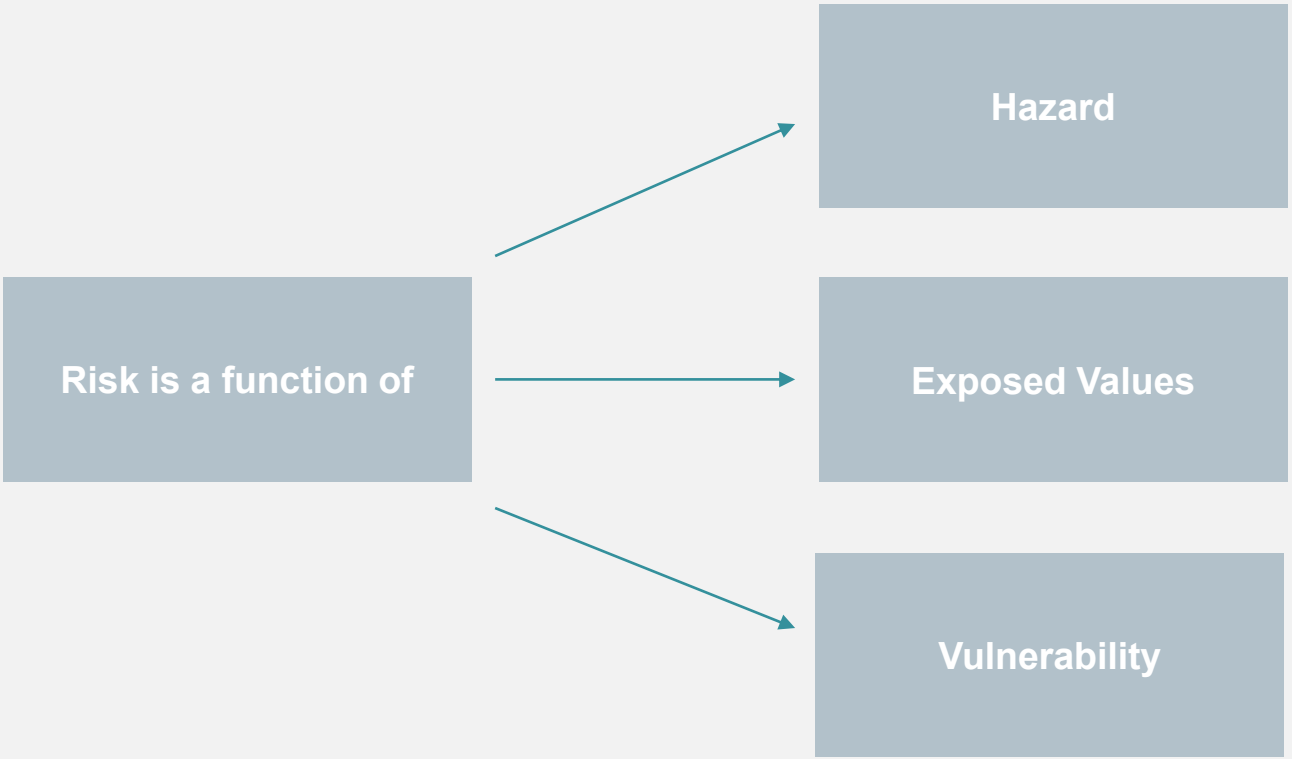


Factors Influencing Natural Catastrophe Risk



Climate Change and U.S. Meteorological Perils: General Predictions

The more large-scale the phenomena, the more confident one can be with predicted likelihood and impacts.

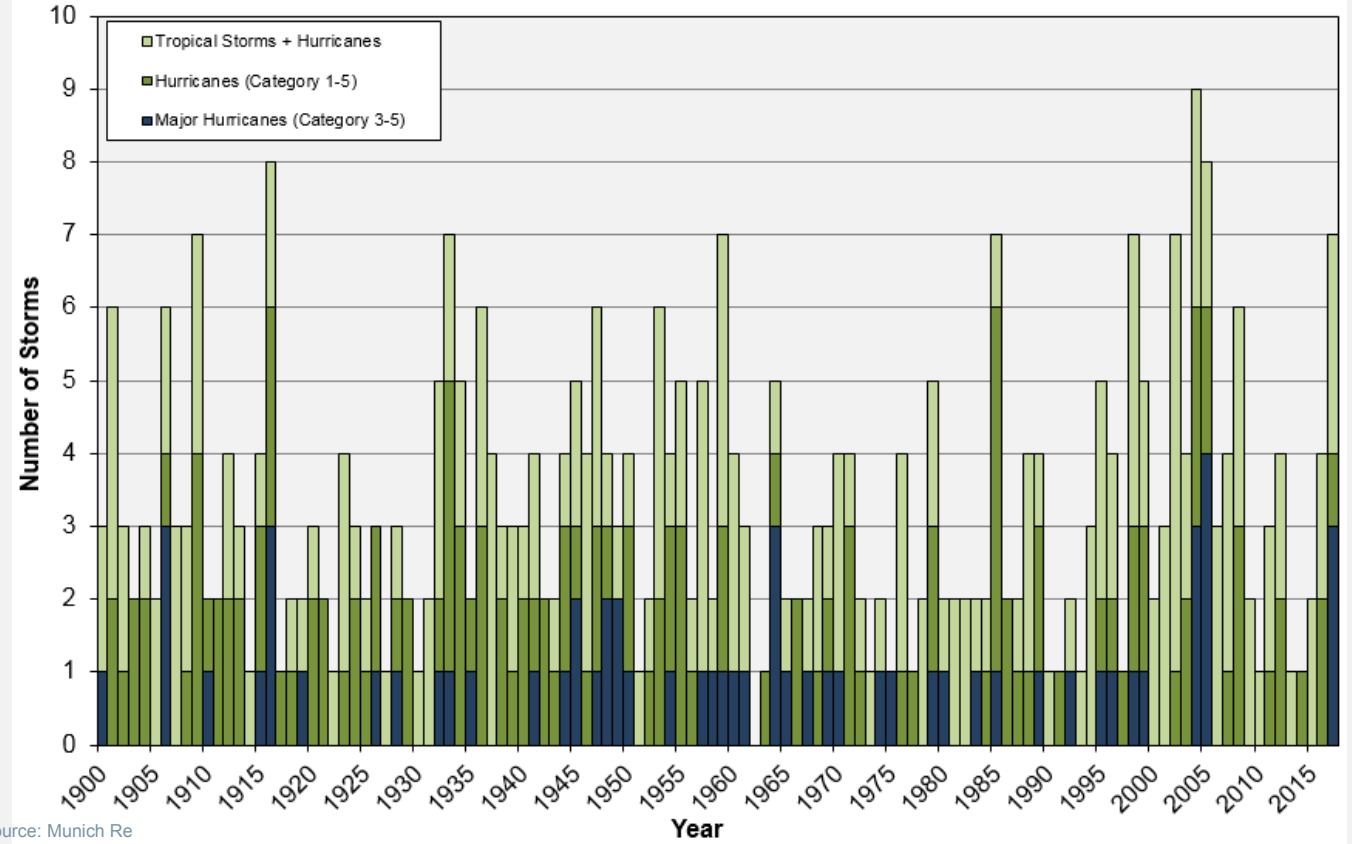
Most confidence
Changes in Hydrological Cycle

- Arid regions will tend to become drier (Southern California, Intermountain West and Desert Southwest)
- Wet regions will tend to become wetter (Pacific Northwest, Northern Plains, Midwest, Eastern Seaboard)

Less confidence
Changes in frequency and severity of

- Winter Storms
- Thunderstorms
- Tropical Cyclones

Annual Number of U.S. Landfalling Tropical Cyclones (TCs), 1900 – 2017



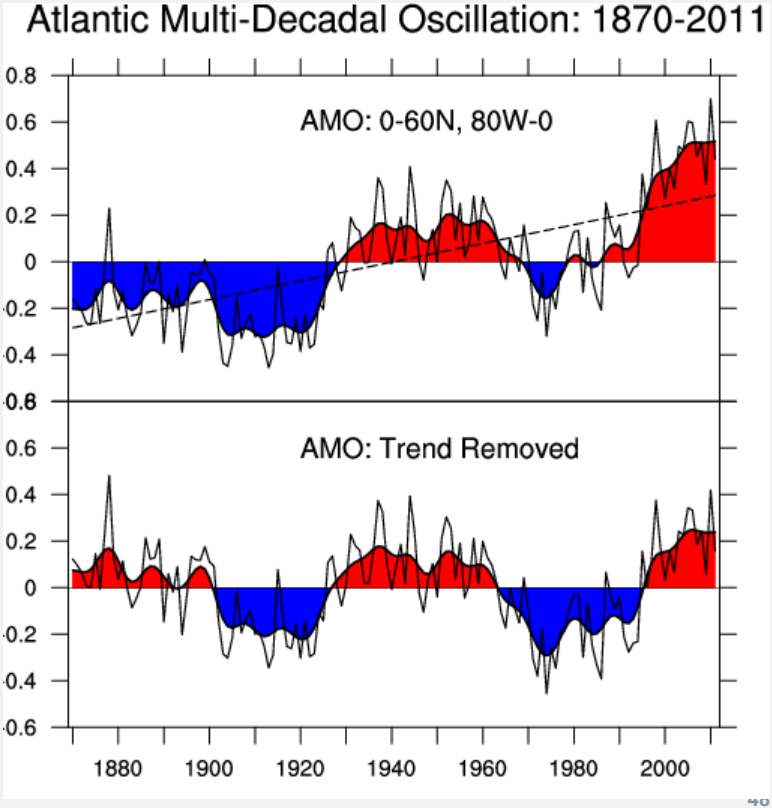
Source: Munich Re

Impact of Oceanic Heat Increase on Atlantic Hurricane Climate

Munich RE

Ocean warming has led to an apparent linear increasing trend in the decadal-scale AMO cycle.

Increased oceanic heat content can provide more “fuel” for hurricanes and allow them to become more intense – but only if other atmospheric conditions are conducive for Intensification.



Source: NOAA

Climate change & Harvey rainfall:

Early climate attribution research shows that Harvey's rains were:

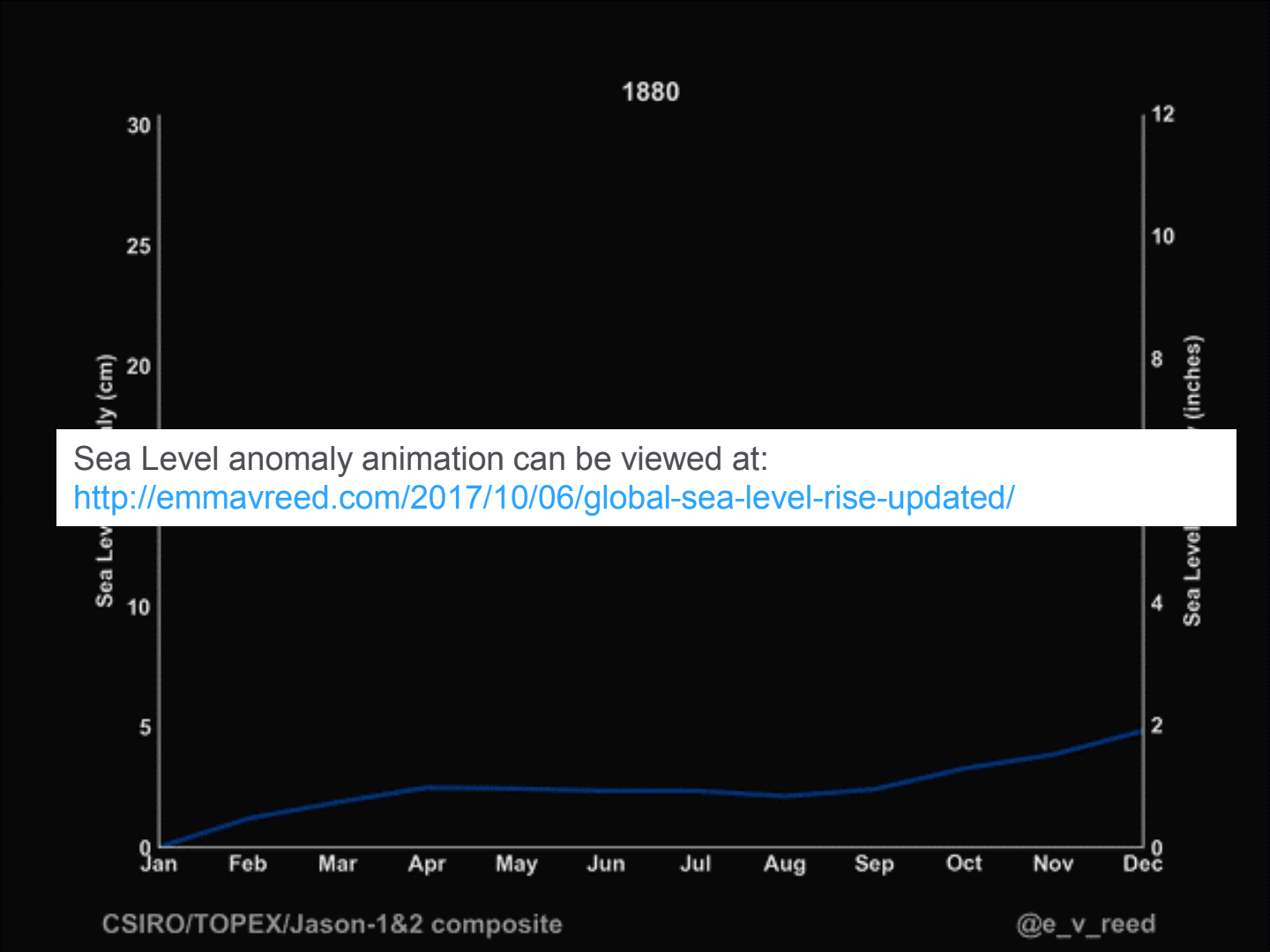
15% more intense

OR

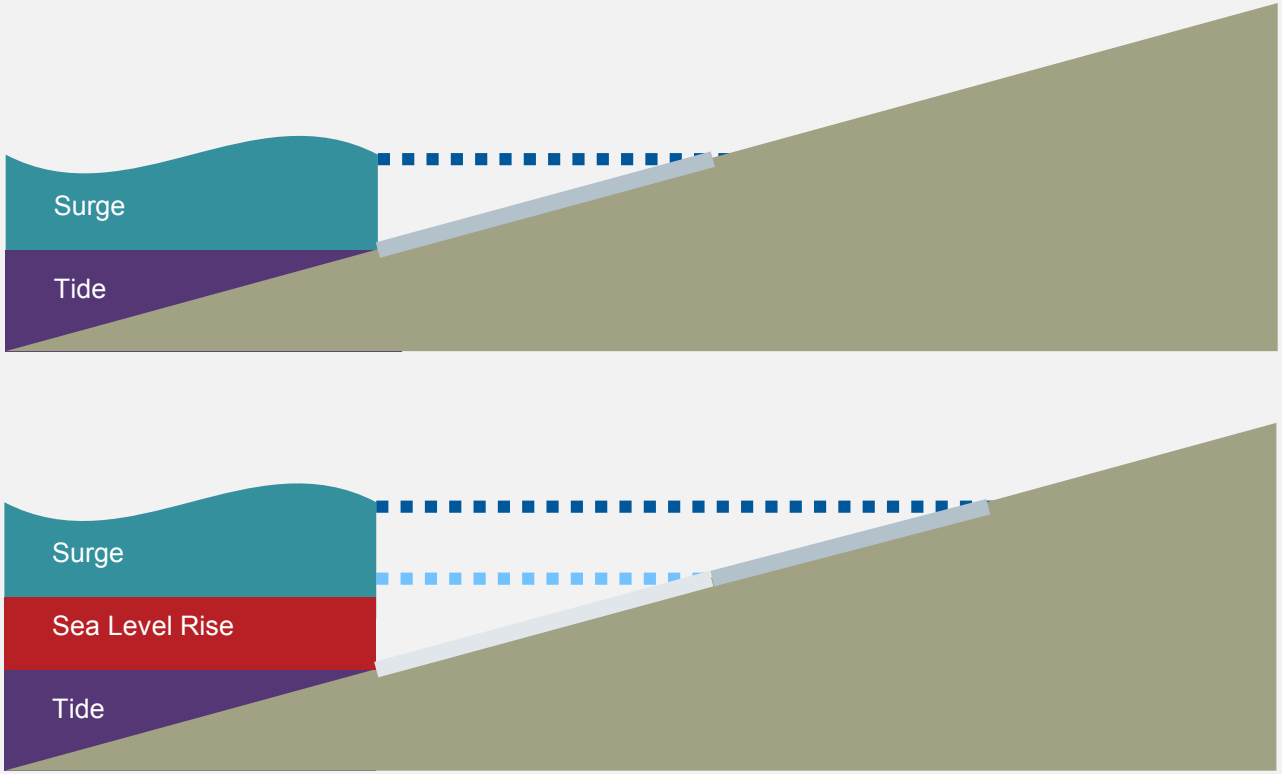
3x more likely.

However, 15% less rain from Harvey would of still caused substantial flooding!

Infrastructure / urban sprawl also played a massive role in this event.

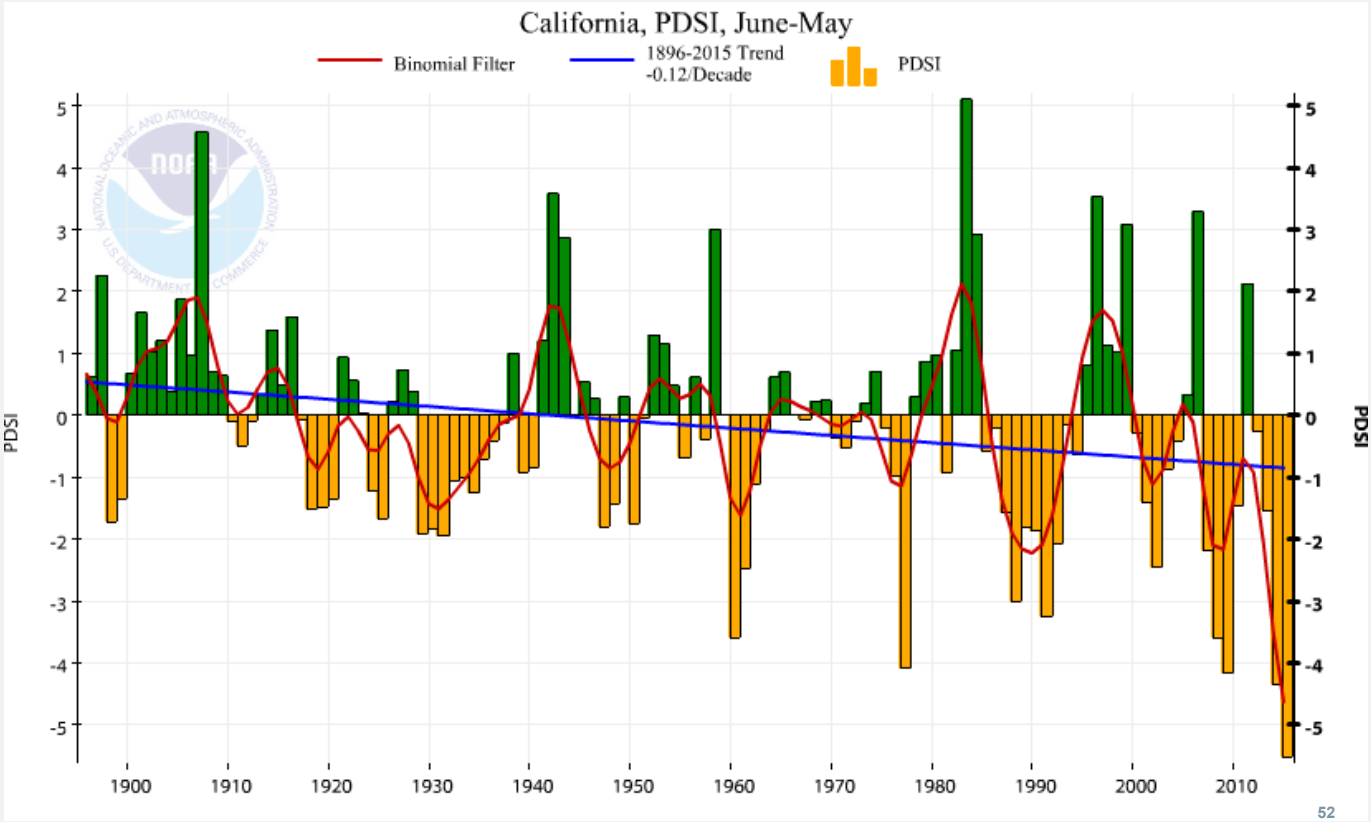

1880
30
25
20
10
5
0
12
10
8
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Sea Level anomaly animation can be viewed at:
http://emmavreed.com/2017/10/06/global-sea-level-rise-updated/
CSIRO/TOPEX/Jason-1&2 composite
@e_v_reed

Impact of Sea Level Rise on Storm Surge

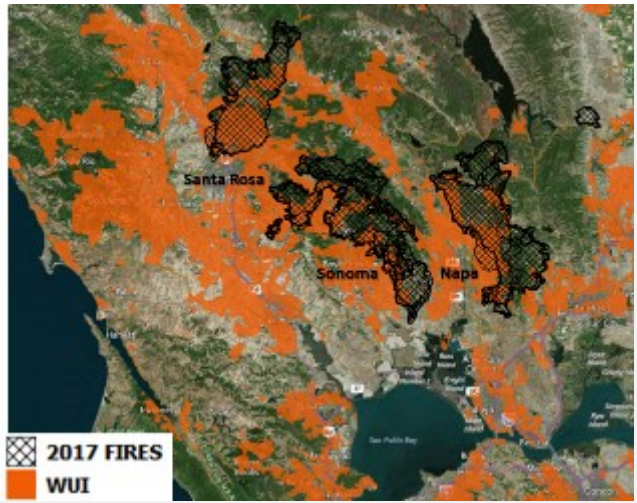


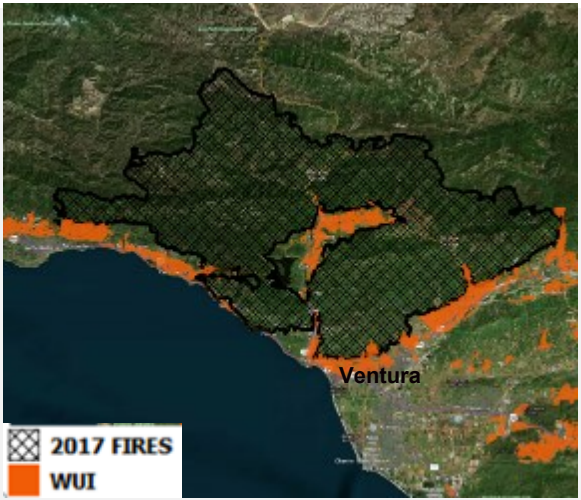
Source: Kelly Hereid/ Used with Permission

Wildfire & Climate:
California Palmer Drought Severity Index (PDSI)



The Future of Wildfire Risk





720% POPULATION INCREASE IN WUI AREAS SINCE 1960: 25M TO 140M PEOPLE

Source: Kim Roberts / Used with Permission

Acknowledgements

- Thanks to Dr. Kelly Hereid, Chubb; Dr. Steve Bowen, Aon; & Kim Roberts, JLT Re, in the development of the presentation this one is derived from. Any materials provided by them are noted as such and are used with permission.

Thank you for your attention!

Mark C. Bove, CPCU, ARe
mbove@munichreamerica.com
@MarkCBove

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