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What Makes A Big Flood In the Northeast?

It's not just about heavy rainfall...

David R. Vallee
Hydrologist-in-Charge
NOAA/NWS Northeast River Forecast Center
weather.gov/nerfc



Record flooding on Pawtuxet River, West Warwick, RI
– March 31st, 2010. Source: D. Vallee/NWS



Record flooding in Dolgeville, NY on West Canada
Creek, November 1st, 2019. Source: D. McGee



Flash Flooding on the Long Island Expressway from 11
inches of rain in ~ 3 hours! August 13th, 2014.

Overview

- The ingredients necessary for significant floods
- The types of storm systems capable of producing significant floods
- Antecedent conditions are key!
- Can happen anytime of year in the region



Record flooding along the Shawsheen River during the Mother's Day Floods, Lawrence, MA – May 16th, 2006. Source: Eagle Tribune



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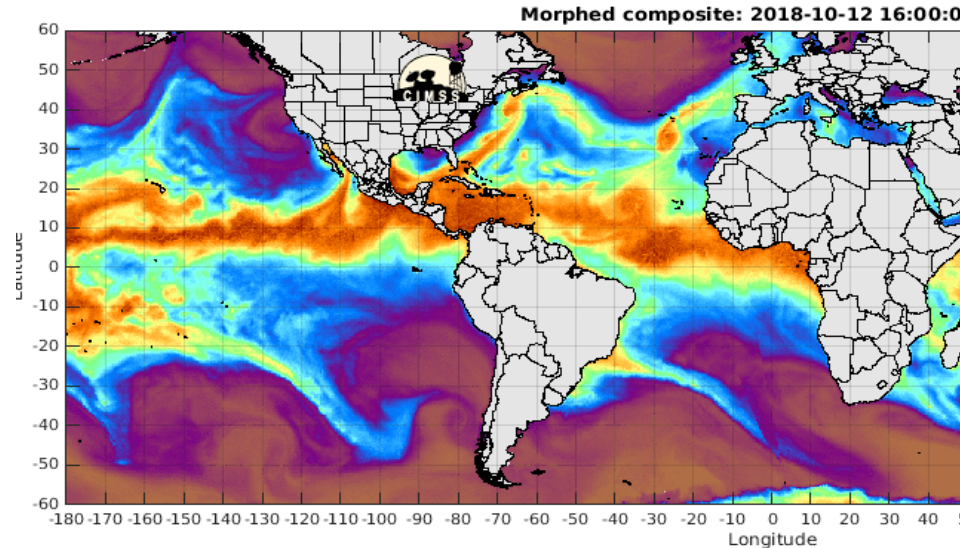
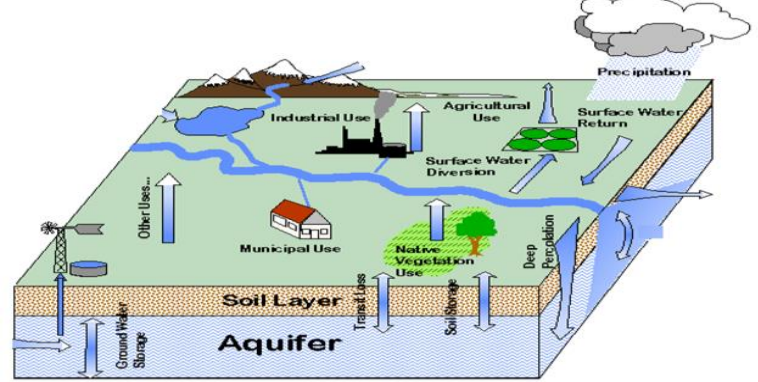
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Key Ingredients

- Antecedent conditions:
 - Soil moisture and streamflow
 - Snow water in the snowpack
- The theme of the pattern
 - An active weather pattern
 - Anomalous moisture content for the given time of year
 - Tropical connections!
 - Slow moving fronts/storms
 - One behemoth storm or multiple storms in a row
 - Is it driven by thunderstorms



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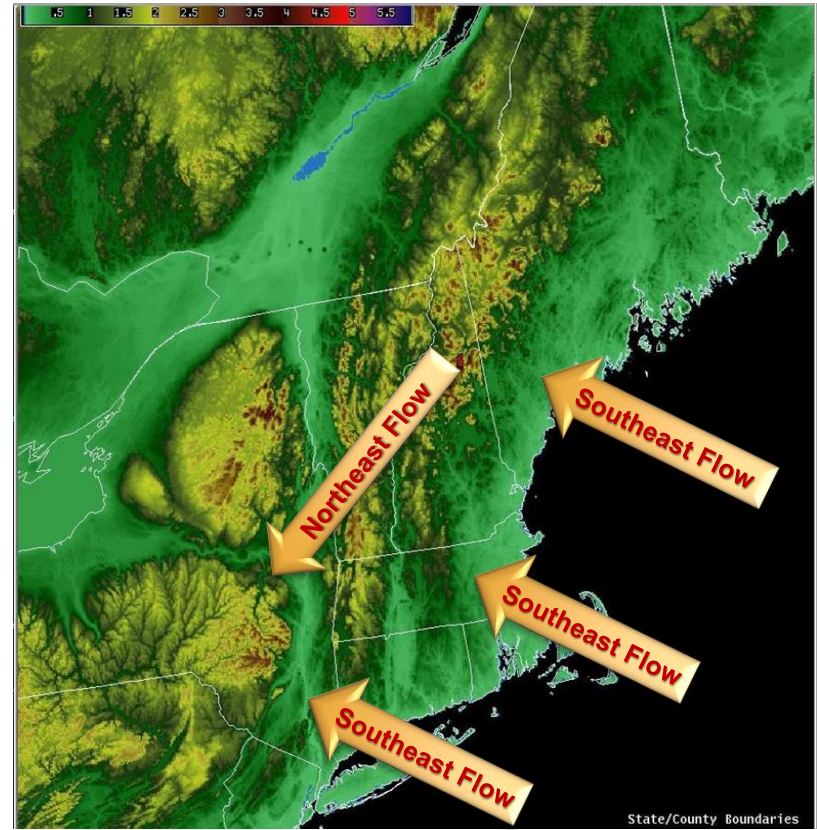
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Don't forget the “Givens”

- The significance of the terrain
 - Upslope and add a lot of vigor to rainfall production
- The urban corridors
 - Too much impervious surface and / or an aging & under-designed stormwater infrastructure
 - Too much encroachment into the floodplain



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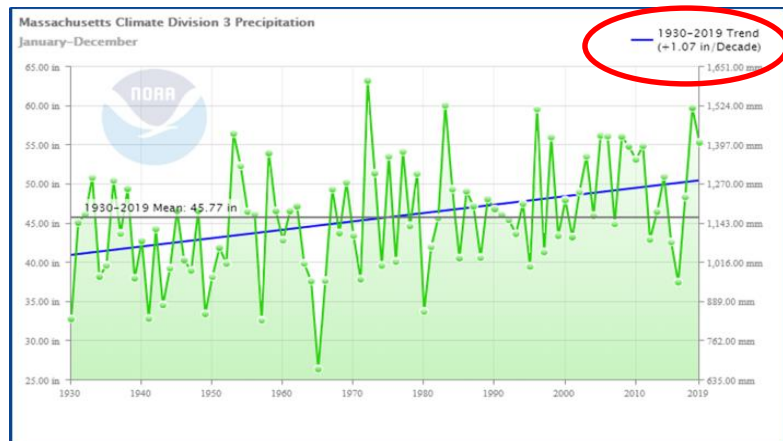
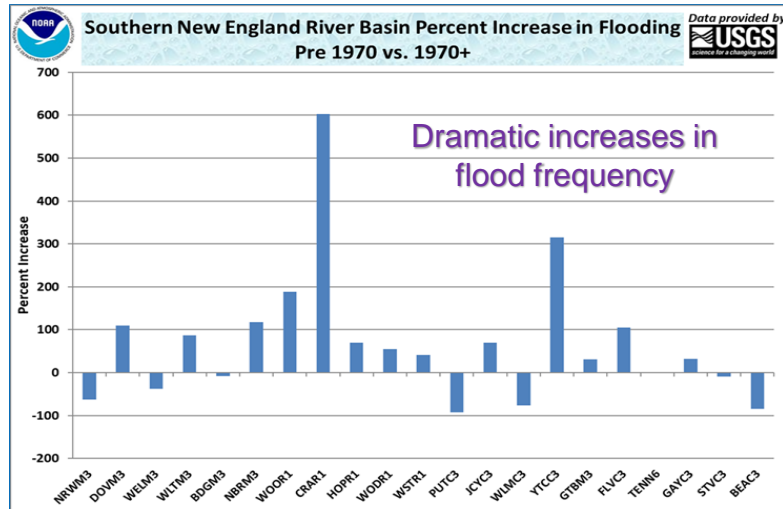
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Our Changing Climate!

- Common themes across New England:
 - Increasing annual precipitation
 - Increasing frequency of heavy rains
 - Warming annual temperatures
 - Wildly varying seasonal snowfall
- Shift in precipitation frequency (50, 100 yr – 24 hr rain)
- For smaller (<800 sq mi) basins:
 - Trend toward increased flood magnitude and/or frequency
 - Most pronounced where significant land use change and/or urbanization has occurred



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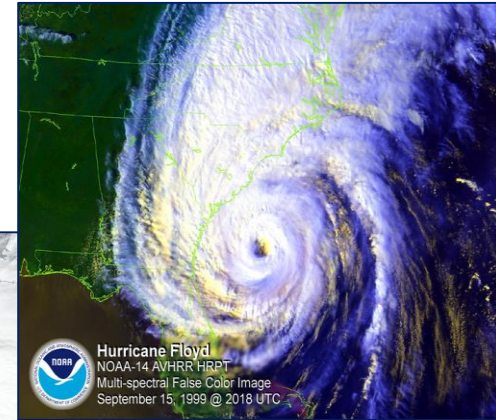
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Types of Storm Systems

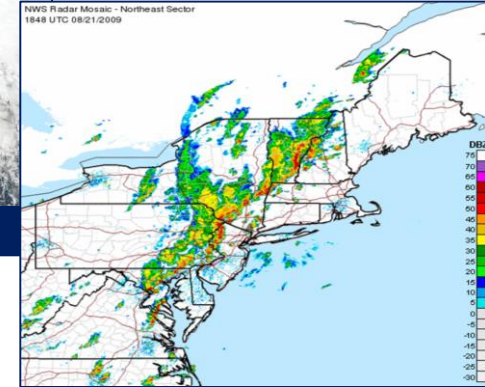
- Large scale storms
 - Nor'easters accompanied by significant warm up, rapidly melting snows, and heavy rainfall
 - Tropical Cyclones – historically the most devastating of all events!
 - Southern Gales – large intense storm moving through the Great Lakes driving wind and rain through the region
- Stalled out fronts where thunderstorms erupt
 - Summertime occurrence
 - Typically isolated to small areas of impact
 - Hard to predict accurately in advance



The Blizzard of January 2018



Hurricane Floyd
NOAA-14 AVHRR HRPT
Multi-spectral False Color Image
September 15, 1999 @ 2018 UTC



Training thunderstorms producing
Flash Flooding – August 2009



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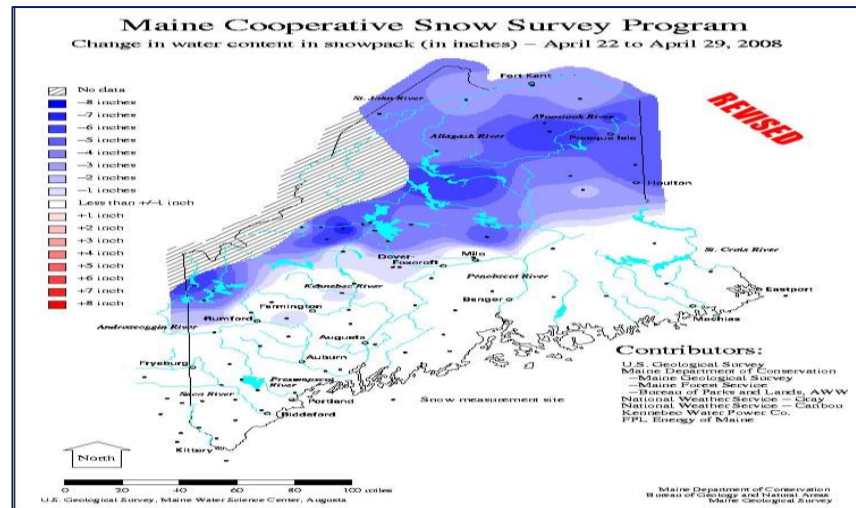
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Exhibit A: April 2008

Snowmelt & back to back rains!

- Deep and wet snowpack
 - Water content of 6 to 14 inches on April 22nd
 - 4 to 8 inches lost just between April 22nd and 29th
- Active weather pattern
 - Produce back to back significant rainfall events
 - Total precipitation for the week of April 22-29 was 4-8 inches
- The result: Record Flooding



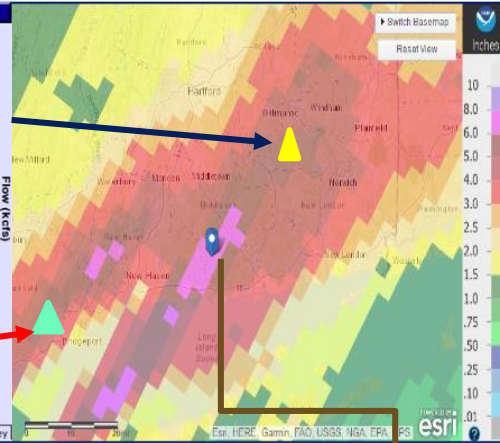
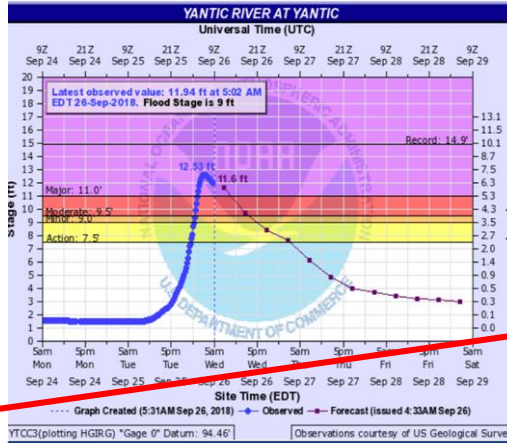
Record flooding along Fish and Saint John Rivers in northern Maine, April 29th, 2008. Source: USGS



Exhibit B: Flash Flooding in Connecticut

Slow moving front with training thunderstorms, Sept 2018

- Slow moving cold front and very tropical air produced training thunderstorms & 5-8 inches of rain
 - Moving over the same locations over a 3-6 hour period
- The result: Water Rescues



Killingsworth, CT received 6.78 inches in < 12 hours
3hr ~ 50 yr event and the 6-12 hr ~ 75-100 yr event

Duration	Obs	Approx ARI	1	2	5	10	25	50	100
1h	1.56	~5-yr	0.993	1.2	1.53	1.81	2.19	2.49	2.78
2h	2.95	~25-yr	1.31	1.58	2.01	2.37	2.86	3.24	3.63
3h	3.74	~50-yr	1.53	1.83	2.34	2.75	3.32	3.76	4.21
6h	4.95	>50-yr	1.95	2.34	2.98	3.51	4.24	4.8	5.36
12h	6.21	>50-yr	2.42	2.91	3.71	4.38	5.29	6	6.7
24h	6.78	>25-yr	2.84	3.44	4.43	5.25	6.38	7.25	8.13

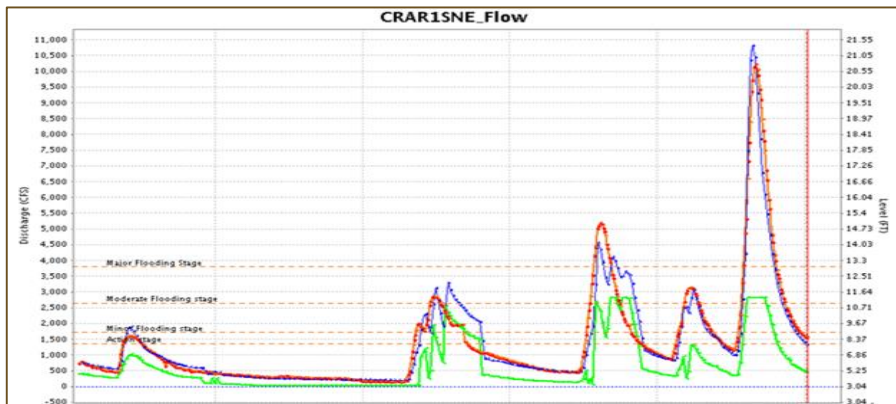


Westport firefighters rescued two adults and two children from vehicles that were swept off the road by floodwaters. Crews had to break a window to extricate one victim, but no injuries were reported.
Photo credit: Town of Westport Fire Department

Exhibit C: March 2010

Back-to-back-to-back heavy rains

- Active weather pattern
 - 4 major rain events in 5 weeks
 - 20 inches of rain in 30 days
 - 3 of the events in 2.5 weeks
- The result: Record Flooding



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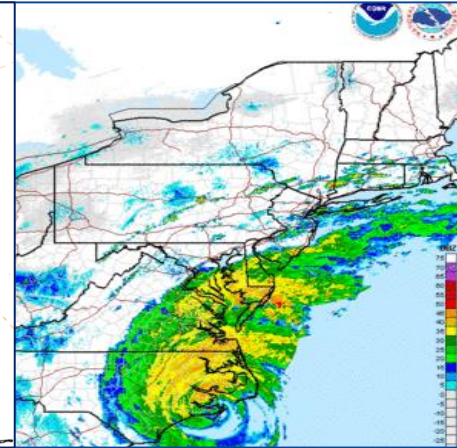
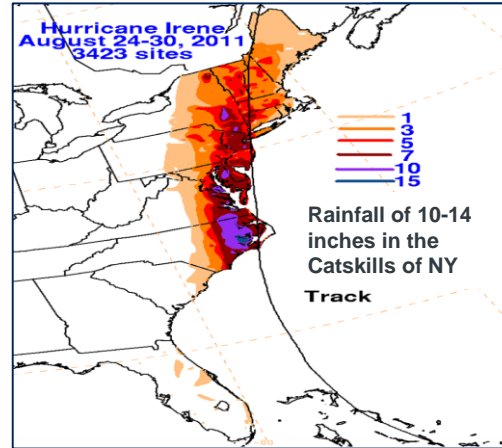
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Exhibit D: Tropical Storm Irene

Heavy rainfall west of track

- Classic New England Tropical Cyclone
 - Wind/surge to the east & torrential rains to the west
- Slower moving and feeding off a rich tropical air mass
- Preceded by a wet spring and summer
- The result: Catastrophic Flooding from 10-14 inches of rainfall in a 9-15 hour period!



Record Flooding – Buckland, MA



Catastrophic Flooding - Prattsville, NY



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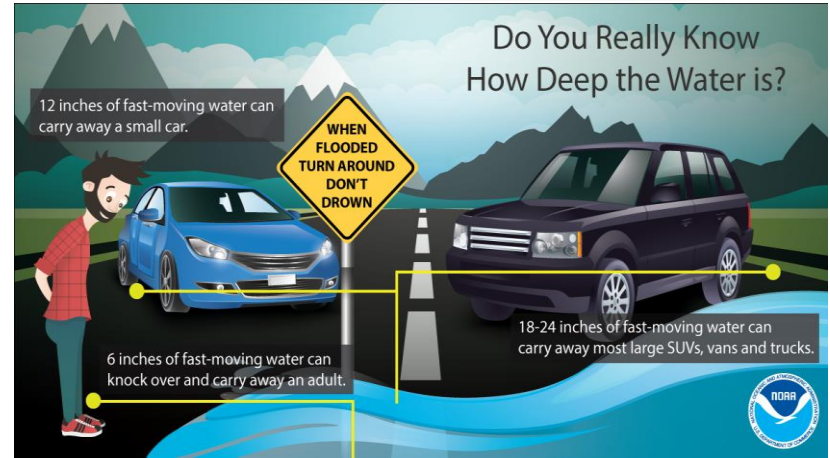
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Summary

- Floods can occur at any point in the year
 - They come in a variety of shapes and sizes
- The alignment of key atmospheric and hydrologic ingredients can lead to widespread major flooding
- Topography can influence severity
- Impacts are compounded by land use changes combined with our changing climate





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QUESTIONS?

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