Is flooding getting worse? Historical analysis of flood flow frequencies in the Passaic Basin and New Jersey

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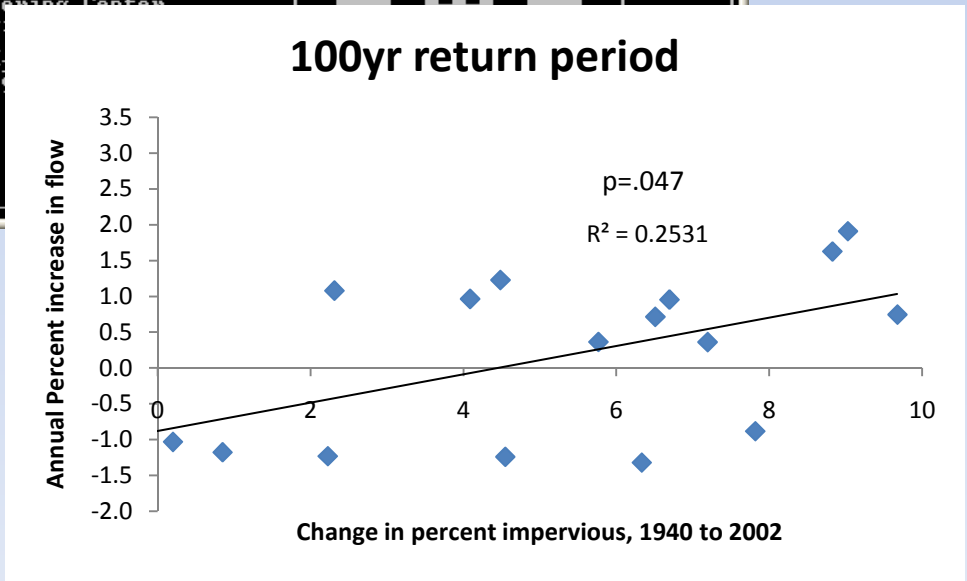
Road map for today's talk

- Flood hazards
- HEC FFA
- Results

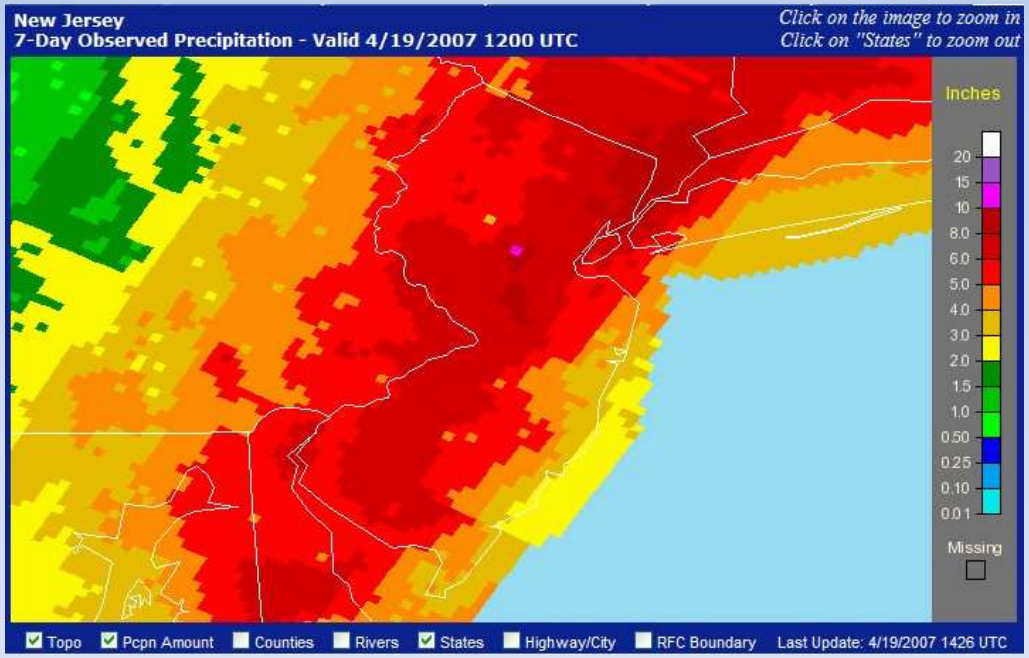


Flood hazards

http://nj.usgs.gov/special/flood0407/

Perception of increased flooding

- Flooding April 2007



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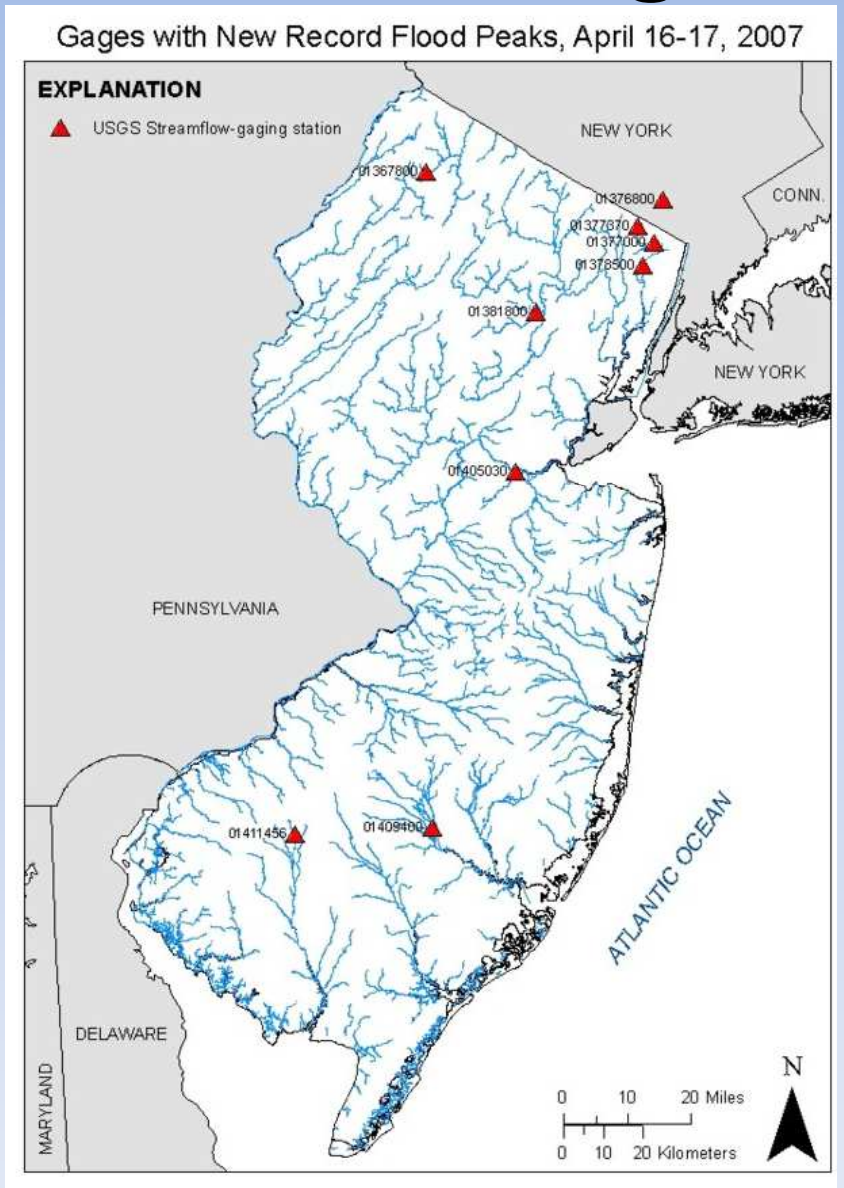


Perception of increased flooding

- Large floods on the Delaware River in September 2004, April 2005, June 2006

- "We used to hear about a 100-year flood plain. Well, there's clearly no 100-year flood plain anymore." Pennsylvania Governor Ed Rendell, 7/9/2006

Is flooding getting worse?

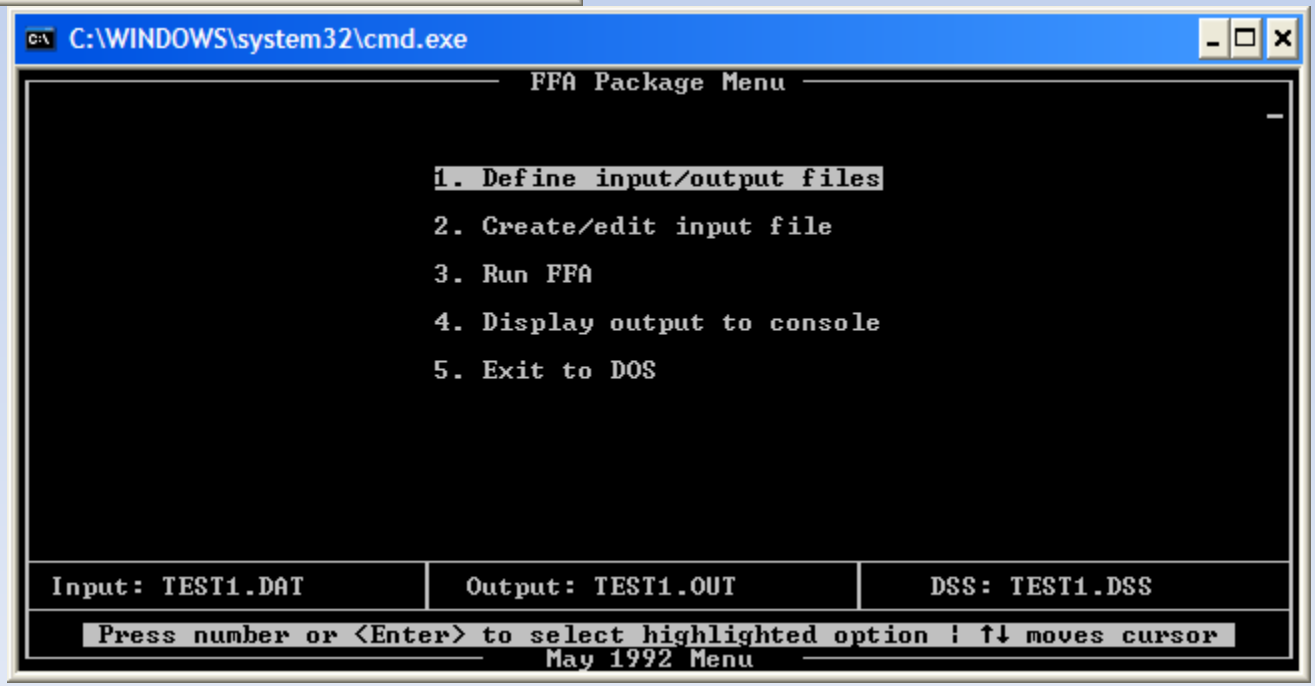
- Use HEC FFA program to analyze USGS gage data
- Analyzed 30 year blocks of data to determine changes
- Used multiple USGS gages

What is a 2 year flood?

Recurrence interval, years (aka a "…year flood")	Probability of occurrence in any given year	% chance of occurrence in any given year
100	1 in 100	1%
50	1 in 50	2%
20	1 in 20	5%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

Methods: HEC FFA

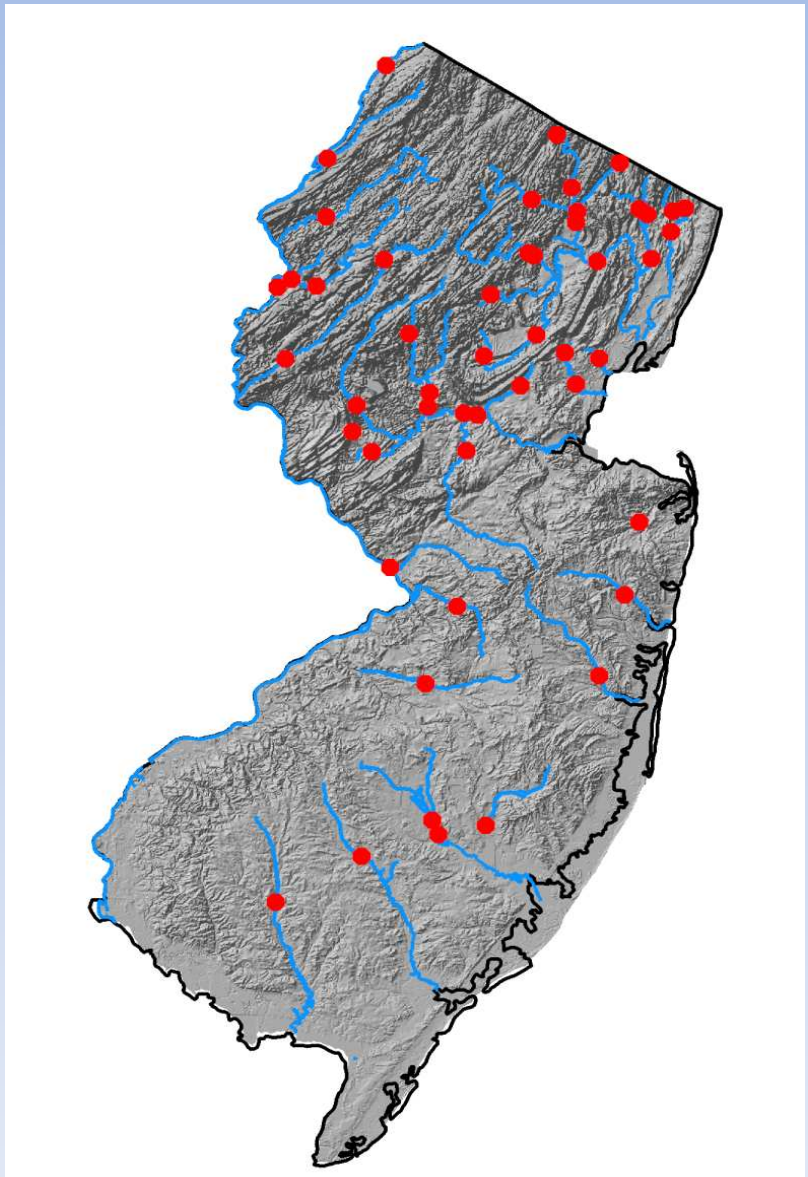
- Hydraulic Engineering Center Flood Frequency Analysis



Input data: USGS gage selection

1. More than 50 years of peak annual flow data
2. Within New Jersey

53 gages

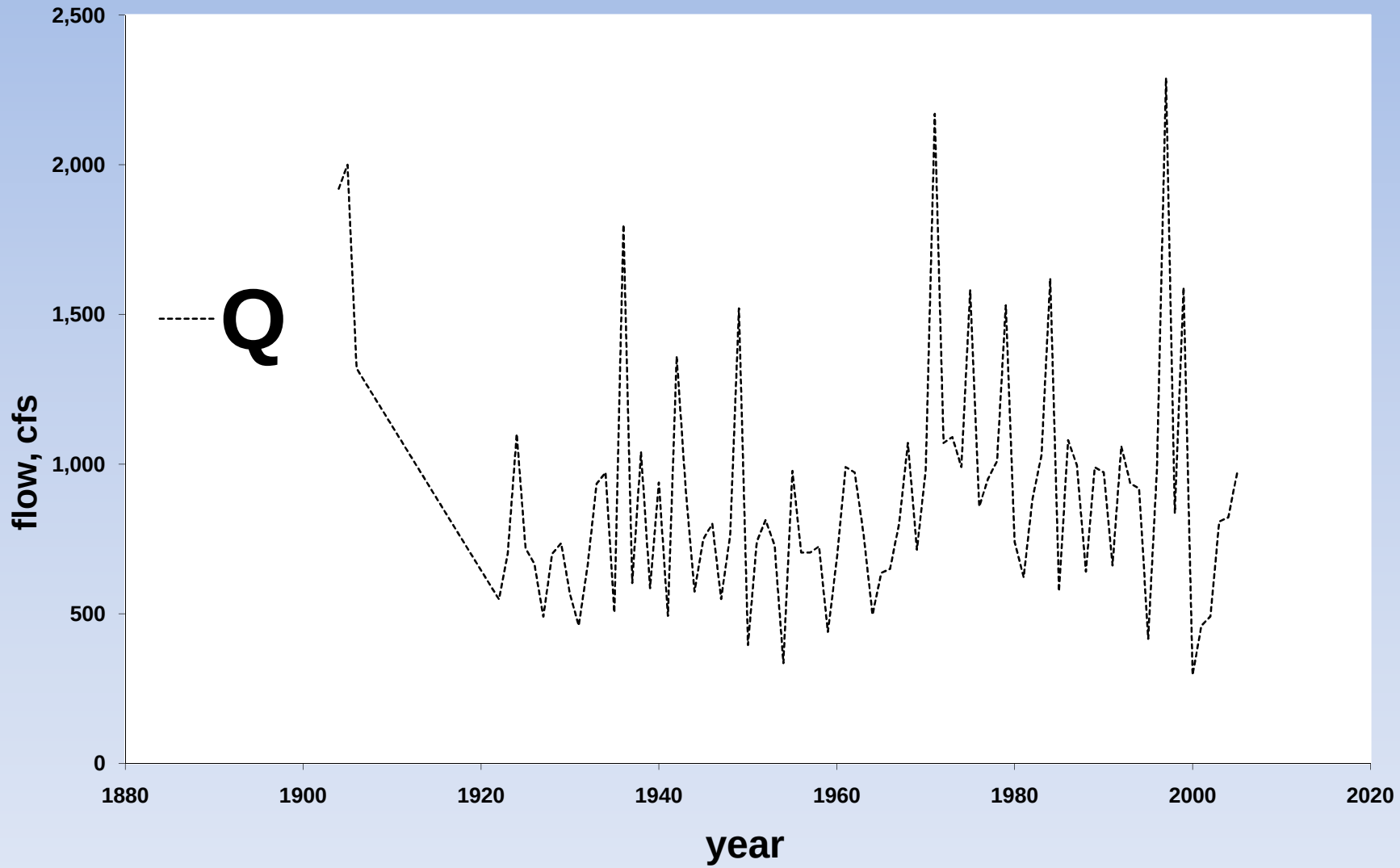


Input files

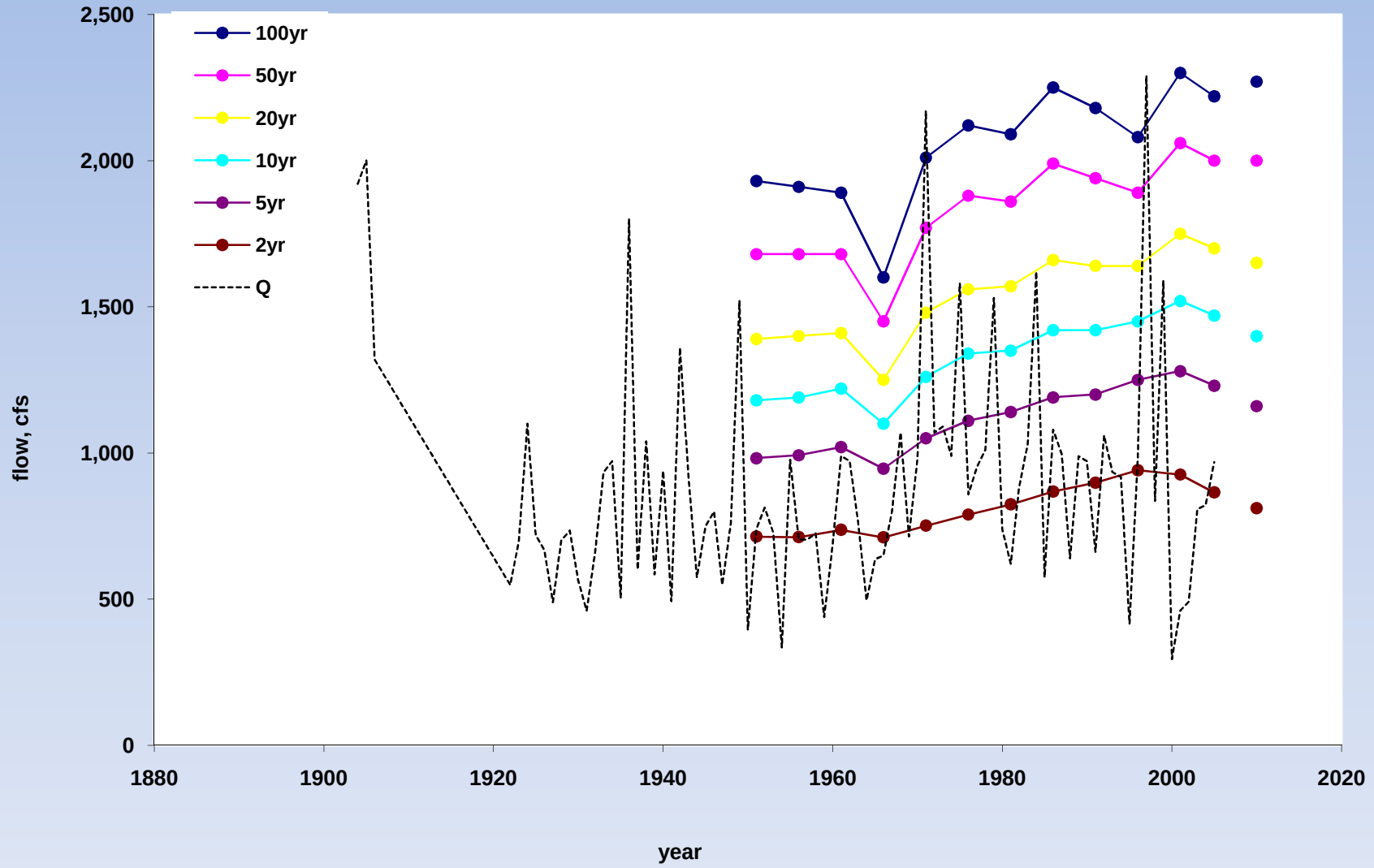
- Used 30 years blocks of data, moving in 5 year increments
- Peak annual flows recorded at each gage
  - HEC FFA then calculates a flood magnitude equal to a 2-, 5-, 10-, 20-, 50-, 100-year flow for those 30 years

Start Year	End year
1927	1956
1932	1961
1937	1966
1942	1971
1947	1976
1952	1981
1957	1986
1962	1991
1967	1996
1972	2001
1976	2005

Passaic River near Millington, NJ

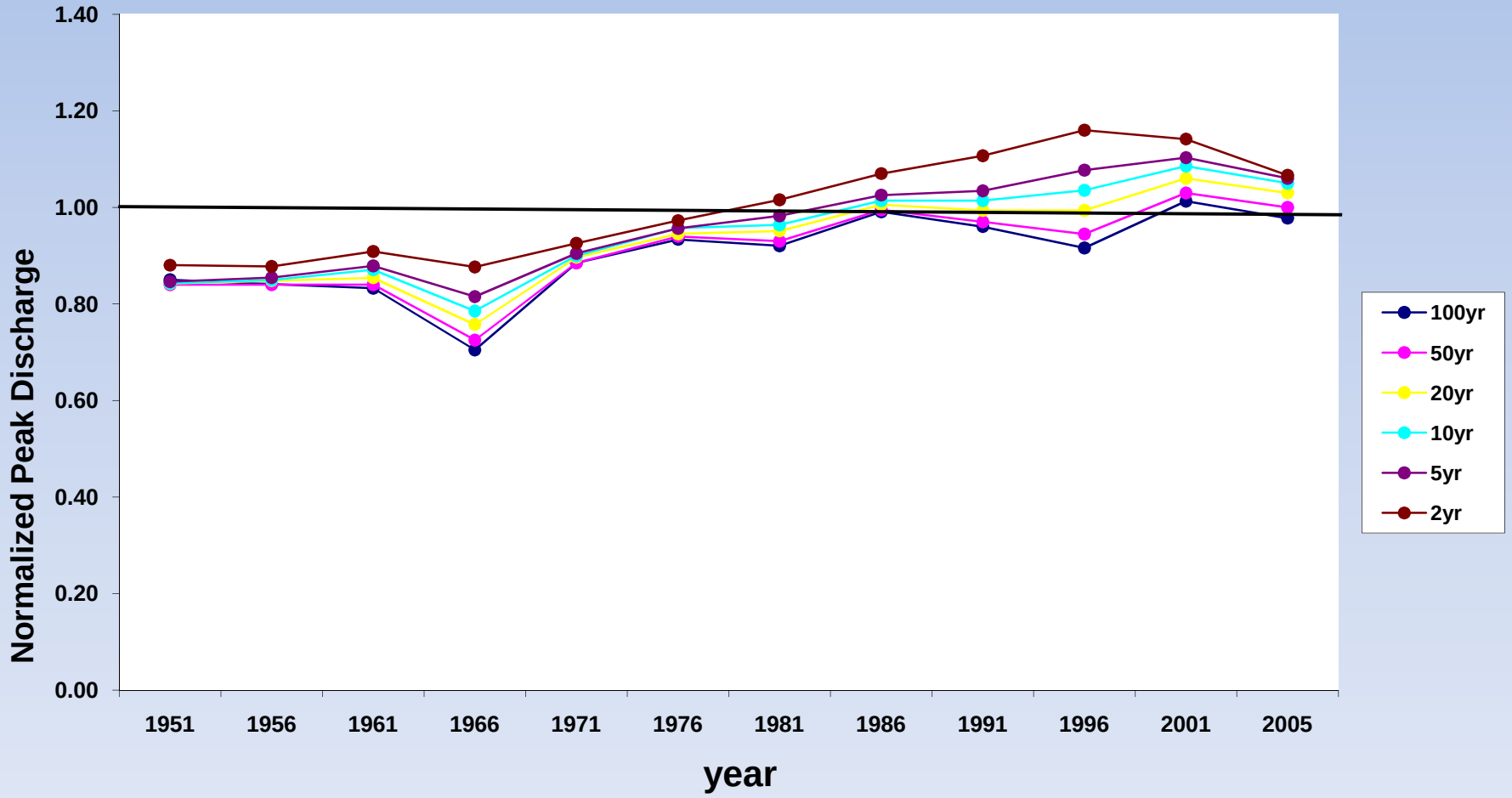


Passaic River near Millington, NJ

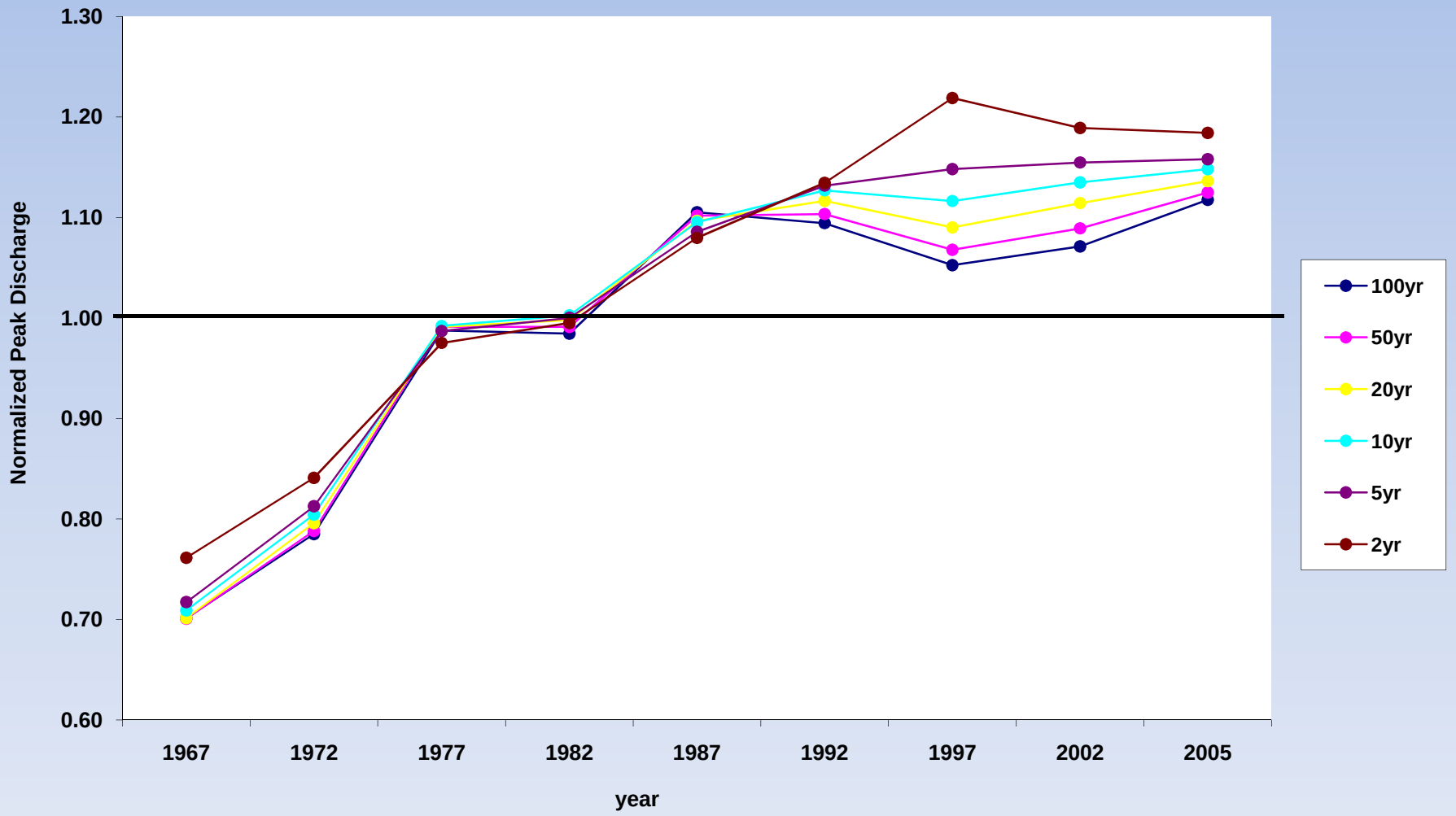


Passaic River near Millington, NJ

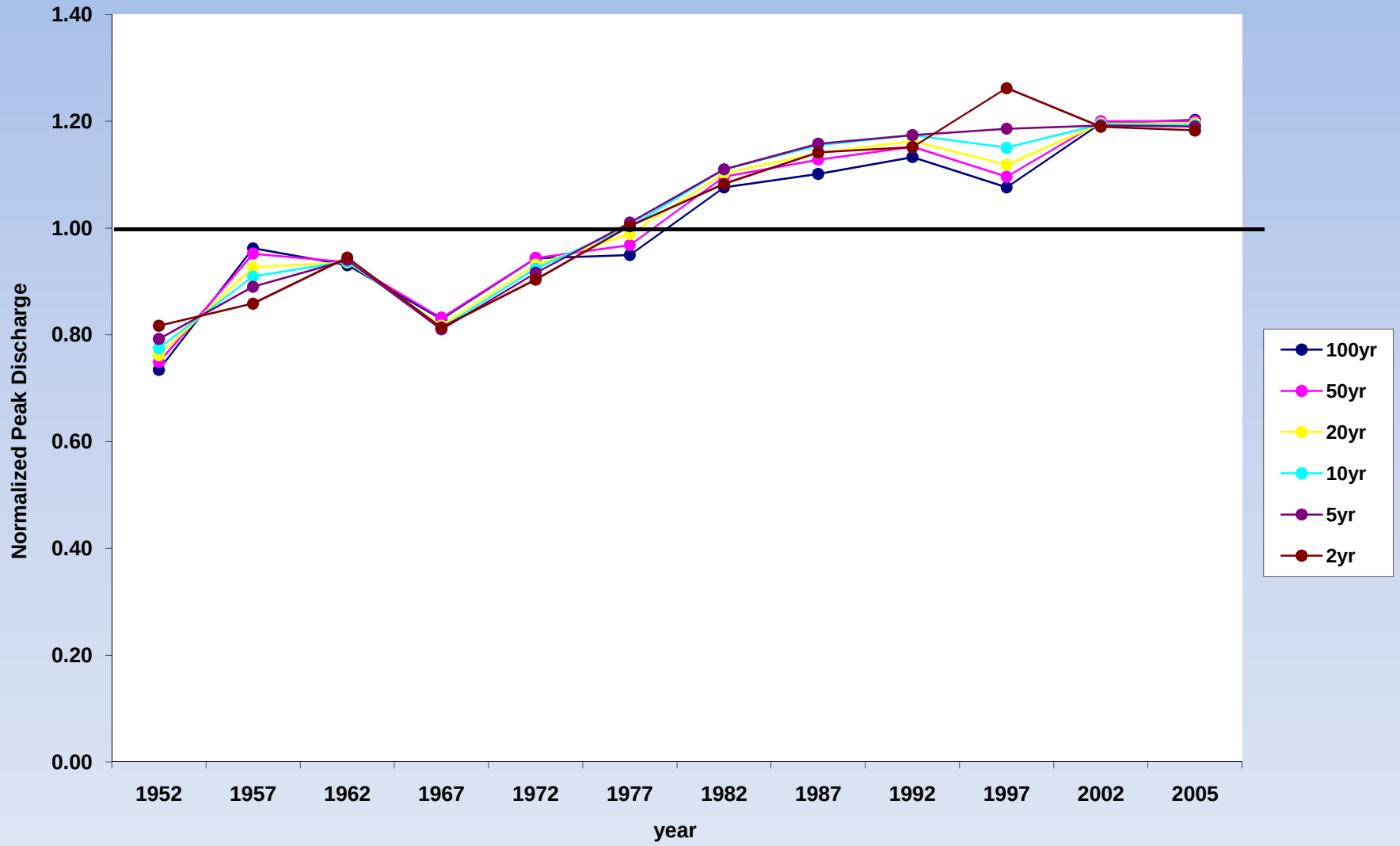
- Normalized for the entire record: 1 = no change



Rockaway River above reservoir at Boonton



Ramapo River near Mahwah



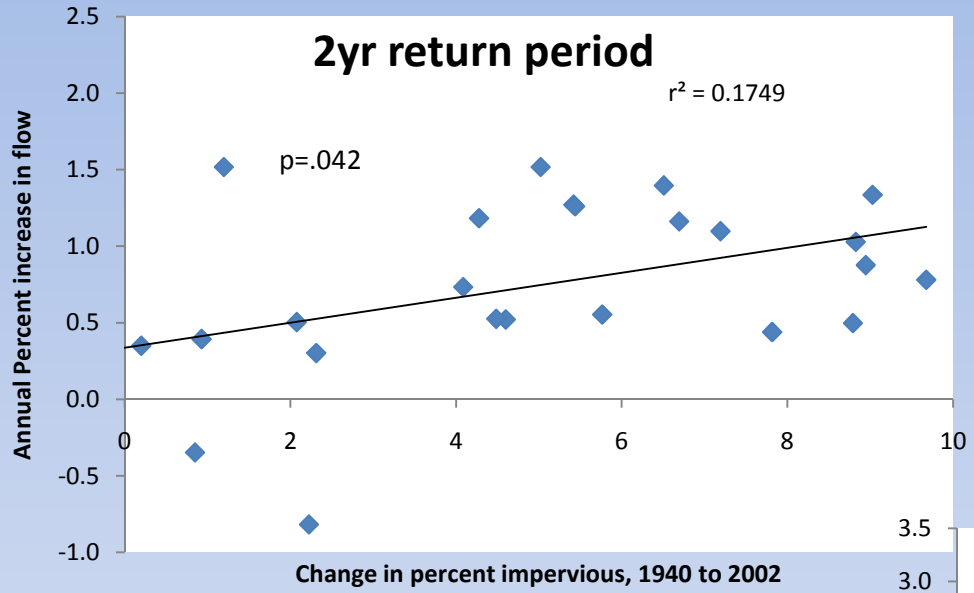
Rate of change (%) per year for statistically significant flows for Passaic-Hackensack

Site Name	Drainage Area (Sq. Mi.)	Start Year	End Year	100yr Flow	50yr Flow	20yr Flow	10yr Flow	5yr Flow	2yr Flow
HACKENSACK R AT NEW MILFORD NJ	113	1922	2005	2.9%	2.7%	2.3%	1.9%	1.5%	0.6%
HACKENSACK R AT RVALE NJ	58	1942	2005	1.9%	1.9%	1.9%	1.9%	1.8%	1.3%
HOHOKUS BROOK AT HO-HO-KUS NJ	16.4	1954	2006		1.0%	1.1%	1.2%	1.2%	1.2%
PASCACK BROOK AT WESTWOOD NJ	29.6	1935	2005	1.6%	1.5%	1.3%	1.1%	1.0%	1.0%
PASSAIC R NEAR CHATHAM NJ	100	1904	2005						0.5%
PASSAIC R AT LITTLE FALLS NJ	762	1882	2005						
PASSAIC R NEAR MILLINGTON NJ	55.4	1904	2005	0.4%	0.4%	0.5%	0.5%	0.5%	0.6%
PEQUANNOCK R AT MACOPIN DAM	63.7	1904	2005						1.5%
POMPTON R AT POMPTON PLAINS NJ	335	1904	2005			0.6%	0.7%	0.9%	1.3%
RAMAPO R NEAR MAHWAH NJ	120	1904	2005	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%
RAMAPO R AT POMPTON LAKES NJ	160	1882	2005			0.3%	0.3%	0.4%	0.4%
ROCKAWAY R ABOVE RES. AT BOONTON	116	1938	2005	1.0%	1.0%	1.0%	1.1%	1.1%	1.2%
ROCKAWAY R BELOW RES. AT BOONTON	119	1904	2005	0.7%	0.8%	1.0%	1.1%	1.2%	1.4%
SADDLE R AT LODI NJ	54.6	1924	2005	0.7%	0.8%	1.0%	1.2%	1.4%	1.9%
SADDLE R AT RIDGEWOOD NJ	21.6	1945	2005						
WANAQUE R AT AWOSTING NJ	27.1	1919	2006						
WANAQUE R AT WANAQUE NJ	90.4	1913	2005			0.9%	0.8%	0.6%	
WHIPPANY R AT MORRISTOWN NJ	29.4	1922	2005		0.3%	0.4%	0.5%	0.6%	0.9%

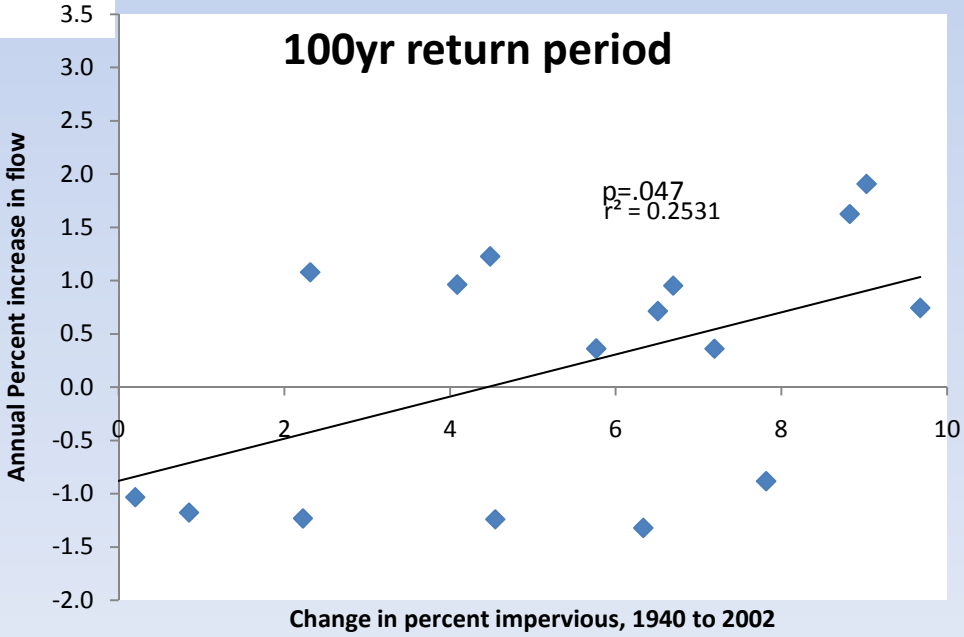
Rate of change for all 53 gages: statistically significant changes

	2	5	10	20	50	100
TOTAL	44	39	34	35	29	26
Positive #	38	32	30	30	23	20
Negative #	6	7	4	5	6	6
% Positive	72	60	57	57	43	38
% Negative	11	13	8	9	11	11
% Not significant	17	26	36	34	45	51
Maximum	1.89%	1.76%	1.93%	2.29%	2.67%	2.92%
Median	0.66%	0.72%	0.73%	0.71%	0.81%	0.74%
Average	0.70%	0.68%	0.77%	0.72%	0.69%	0.64%
Minimum	-0.82%	-0.98%	-1.07%	-1.11%	-1.19%	-1.32%

Causes?



- Impervious surfaces
- Climate change?



Summary

1. Significant changes in flood magnitudes for all flow magnitudes:
   - Many more positive than negative (4-6x)
2. More small flows (2 year) affected than larger flows (100 year)
   - Analysis method?
3. Broad implications for flood hazards, floodplain delineation, emergency managers, flood insurance…