Relationship between Urbanization and Baseflow in New Jersey: A Historical, Empirical Analysis

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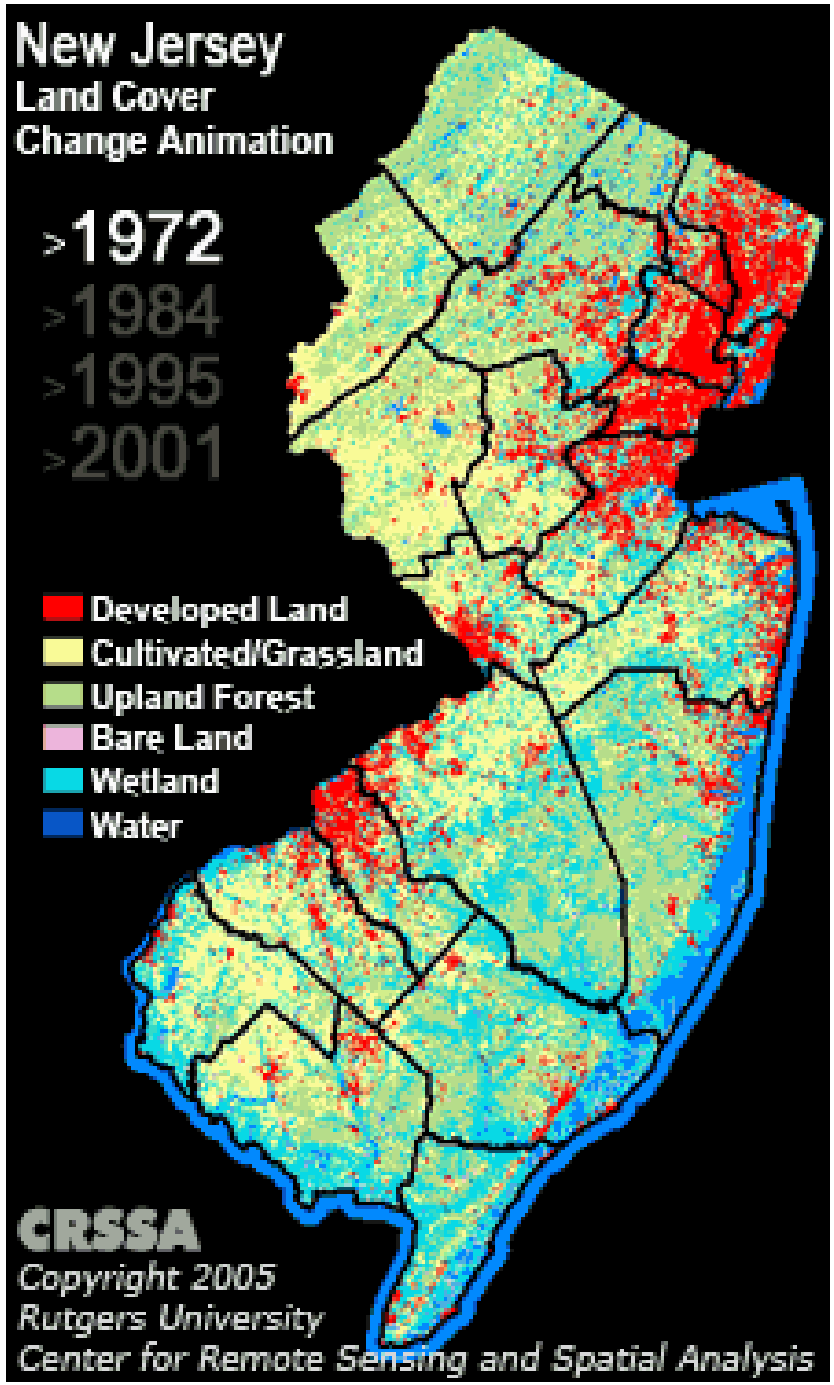
Motivation

- Much of NJ depends on surface water for potable waters
- Droughts are common; perhaps to become more common and/or severe
- Streams and reservoirs rely on baseflow during drought
- Historically rural, water supply reservoirs are urbanizing
- Urbanization reduces infiltration, theoretically reducing baseflow
- Urbanization could pose an important threat to surface water supply (and stream ecology)
- Several confounders to the theoretical relationship


New Jersey
Land Cover
Change Animation
>1972
>1984
>1995
>2001
Developed Land
Cultivated/Grassland
Upland Forest
Bare Land
Wetland
Water
CRSSA
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Is the theoretical relationship borne out by historical data?

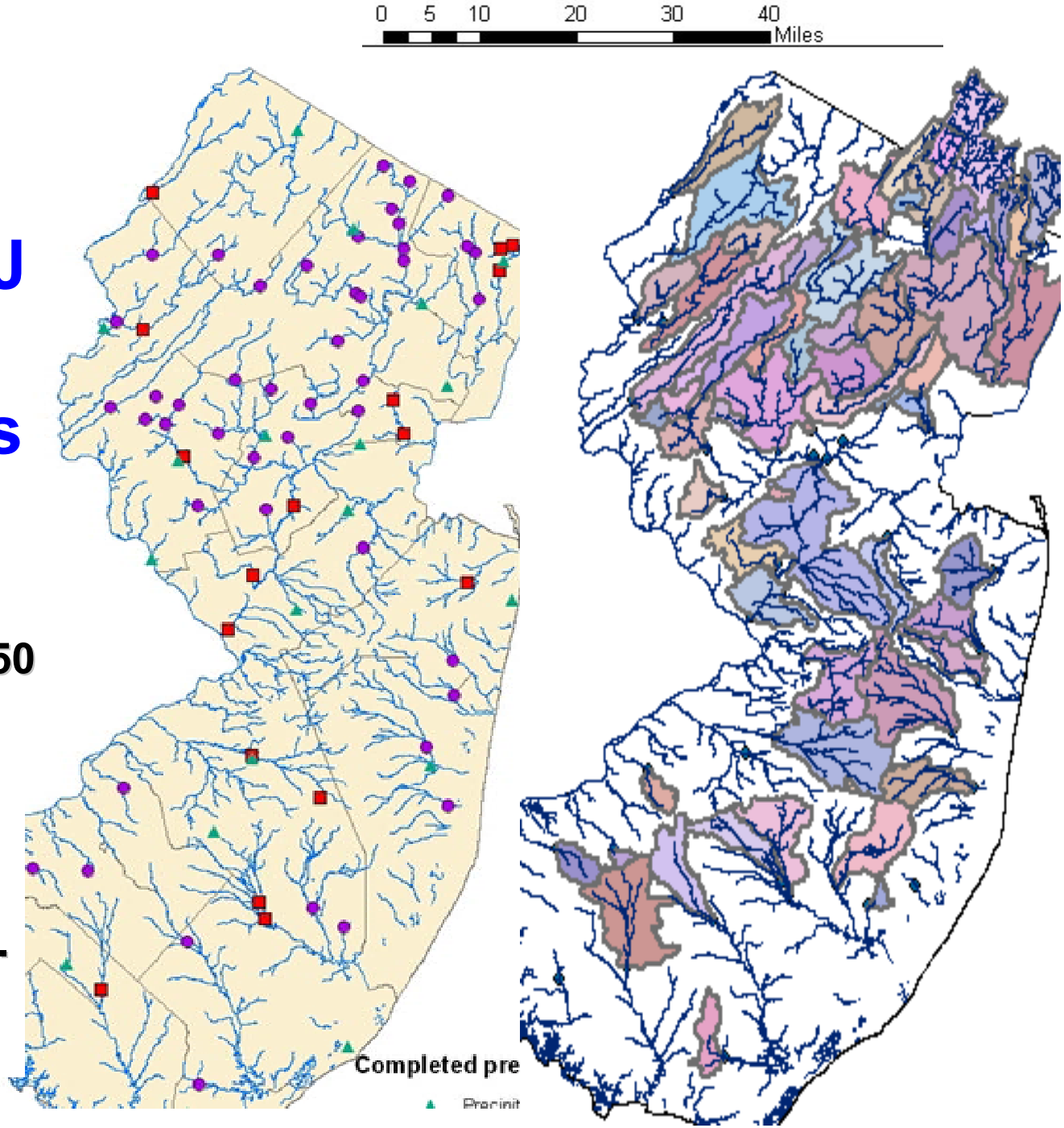
- straight-forward empirical analysis and correlation
- use daily average flow measured by USGS stream gages
- separate stream flow into base flow and storm flow (WHAT–web implementation of the Eckhardt digital)
- aggregate annually;
- normalize by watershed area
- normalize by annual precipitation
- analyze for baseflow trends
- estimate historic imperviousness by correlation with population
- analyze for correlation with imperviousness

Long-term stream gages in NJ and their watersheds

Criteria

- >= 25 years of record
- drainage area <=350 sq mi
- 64 stream gages

▲ Precip gauge.
■ Stream gage already analyzed.
● Stream gage to be analyzed



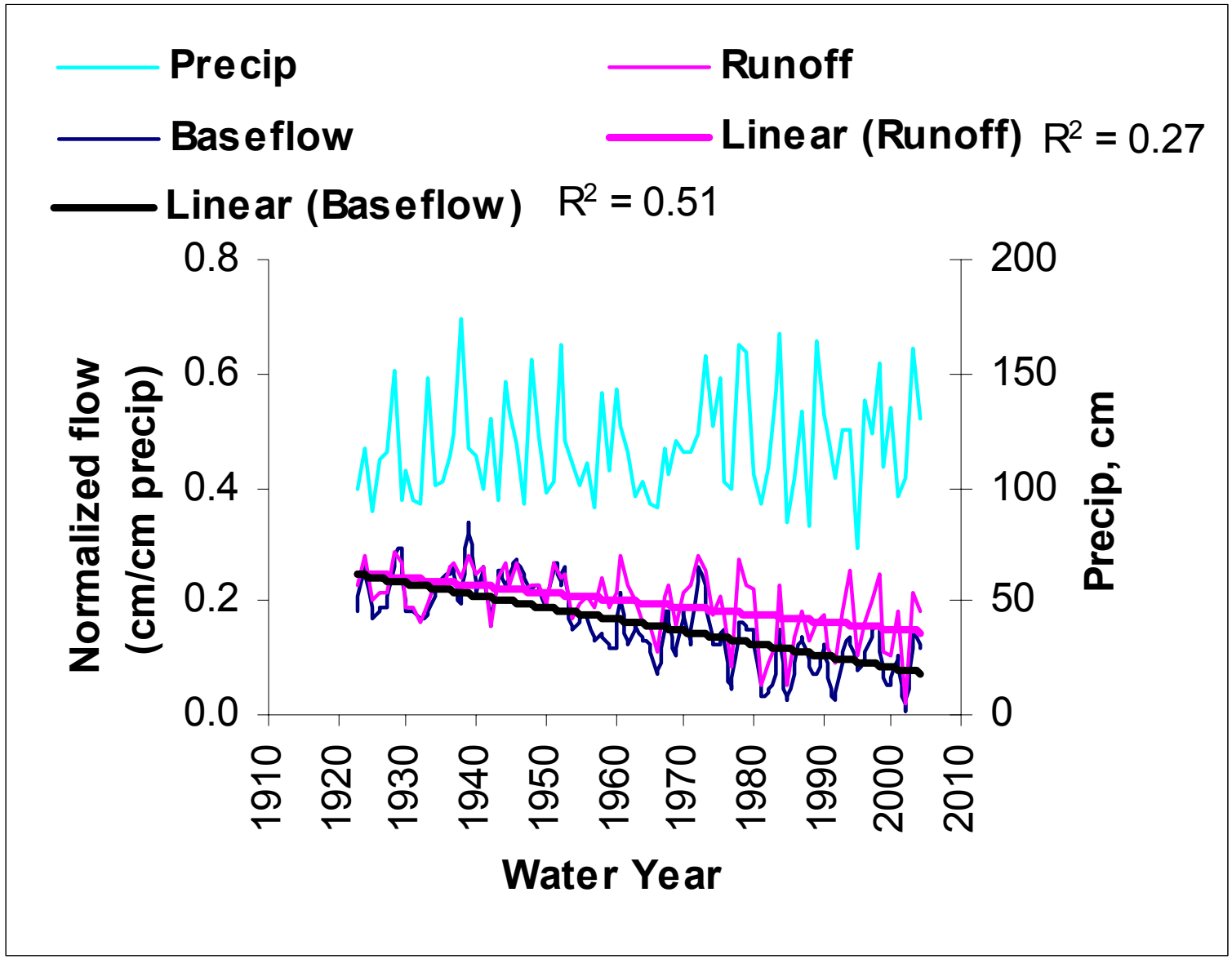
Preliminary Results for 15 Gages

(basin sizes, sq mi: min:2.4 avg:74 max:235)

(all with >50yrs of record)

	Annual non-normalized flow (cm)						Annual normalized flow (cm/cm precip)				
			R^2 vs. Precip			R^2 vs. Year			R^2 vs. Year		
	Avg	Max	Min	Median	Max	Max	Avg	Max	#>.3	#>.4	#>.5
Baseflow	27.2	83.1	0.23	0.47	0.68	0.35	0.24	0.63	2	2	1
Storm flow	19.7	70.0	0.50	0.64	0.80	0.20	0.17	0.53	1	0	0
Total flow	47.0	113.5	0.41	0.59	0.59	0.25	0.40	0.91	2	1	0

Swimming River, Monmouth County, NJ (49 sq mi, 81 years)



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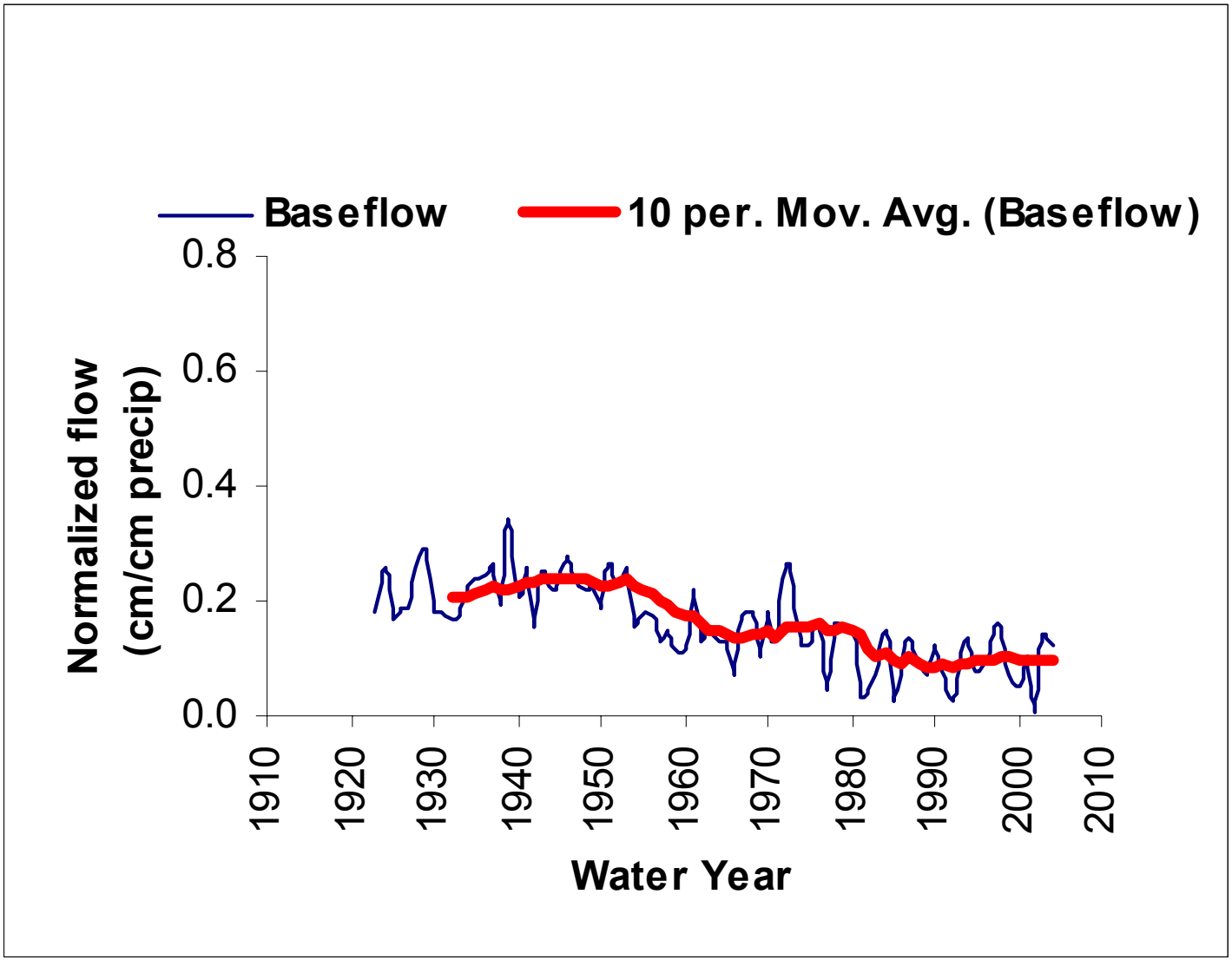


Preliminary Conclusions

- For most of the 15 gages, baseflow correlation with precip is not strong

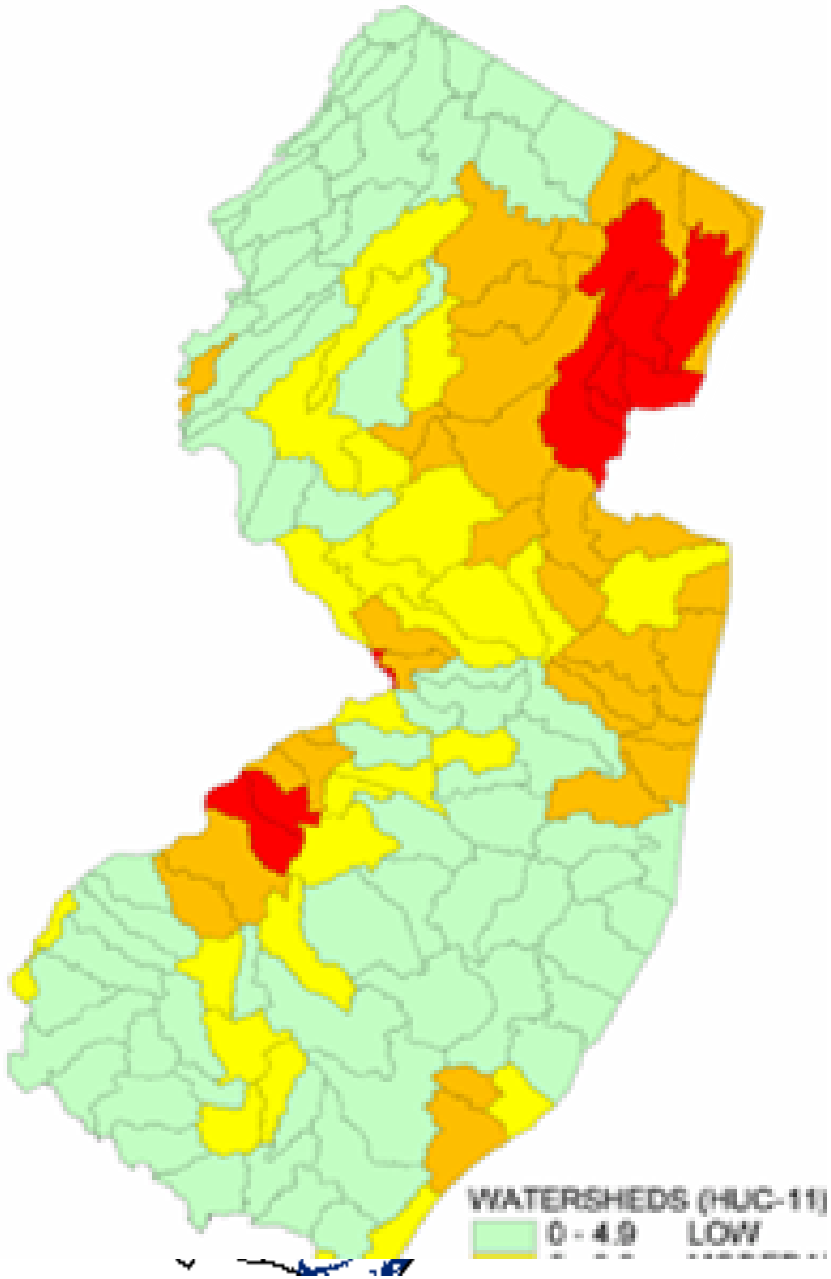
- Trend analysis
  - poor correlation between annual BF(cm) and time for all gages
  - For precip-normalized BF, only 1 gage of 15 showed moderate correlation with time
  - For that 1 gage, a trend was not clear

Left To Do

- analyze other 49 gages
- baseflow trend analysis via Mann Kendall test
- develop imperviousness time series for each gaged watershed
- correlate imperviousness with baseflow for basins with trends
- compare BF in basins with different %I, but are otherwise similar
- analyze only last 20-40 years
- compare always urbanized vs. never urbanized

Percent Imperviousness by HUC 11, 1995

CRSSA, Rutgers U



Left To Do (2)

- segregate by geology/soils
- segregate by watershed size
- remove “confounded” gages (eg, below reservoirs)
- different baseflow separation method (HYSEP \= WHAT)
- look at other low flow measures – 7Q10, annual min
- monthly (rather than annual) analyis
- try to identify other factors that explain differences/variations (or lack thereof) in baseflow