HYDROLOGIC ANALYSIS OF THE ILLINOIS RIVER BASIN IN ARKANSAS AND OKLAHOMA

Public Release
April 11, 2023

U.S. ARMY

US Army Corps of Engineers®

STUDY PARTNERS AND FEDERAL AUTHORITY

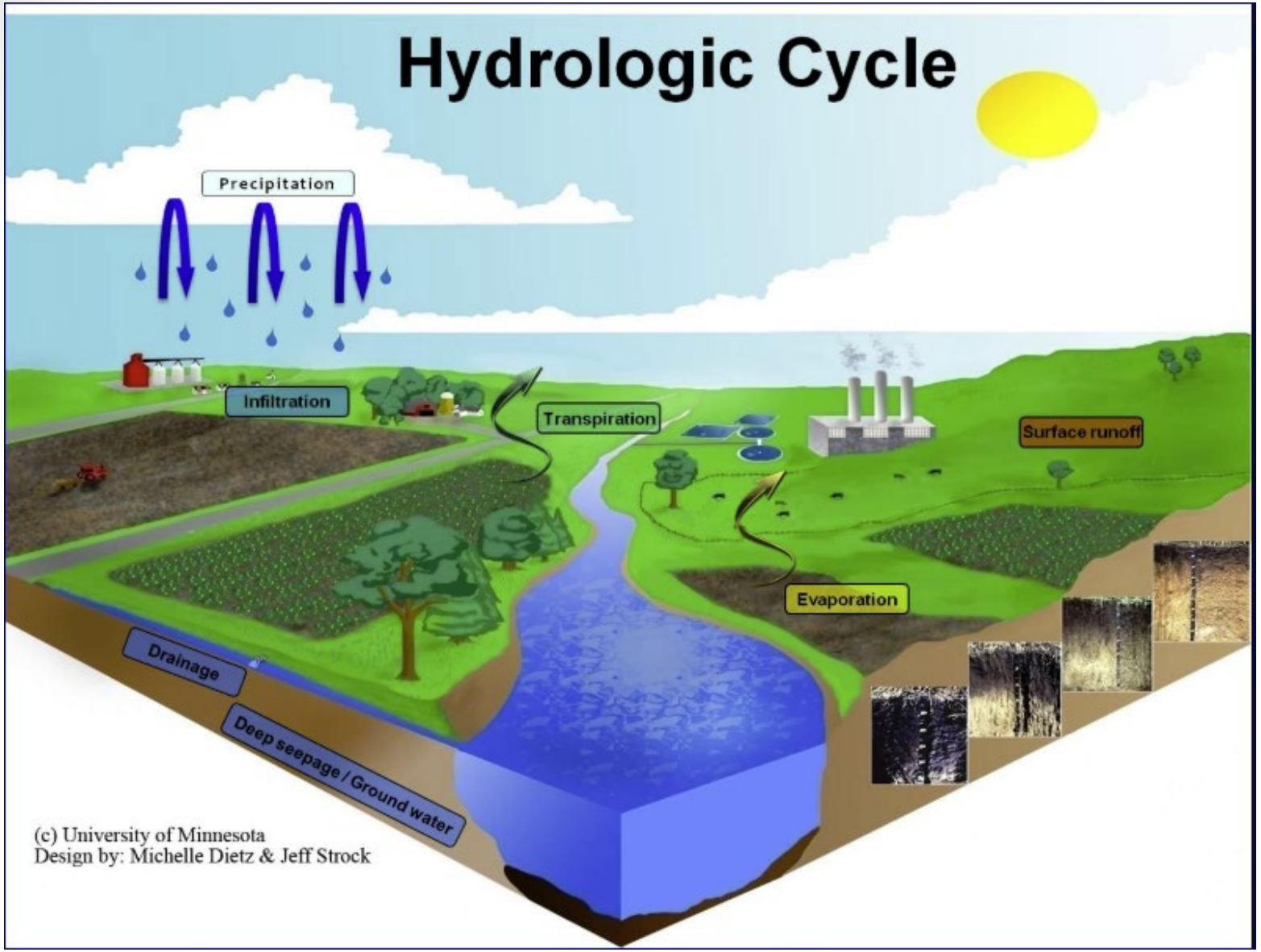
- U.S. Army Corps of Engineers functions as a technical arm of Congress
- Everything the U.S. Army Corps of Engineers does is authorized and appropriated through legislation
- Recurring authorizations exist to partner with local tribes, communities, municipalities to provide Federal assistance.
- Partnership with the Cherokee Nation through the recurring “Planning Assistance to State” authority to:
  - Identify the major contributing factors to increased water levels in the Illinois River Basin
  - Evaluate suggestions to decrease the frequency and magnitude of flooding
  - Supply data, models, information to assist in the communication of and understanding of flood risk for more localized planning entities to leverage.
  - The study focuses on investigating data looking to the future and NOT full forensics on the past (circa 1990 to present)
  - The study was conducted at a broad watershed level (not individual parcels) to provide a deeper understanding of conditions and to generate consistent datasets for use in planning by local level authorities.
  - **Corps of Engineers is NOT building dams or anything in the Illinois River Watershed.**

BLUF

- Not trying to unravel the past but trying to understand how to plan for the future
- This information will be used for planning purposes- information to better understand flood risk so that local planners can divide and conquer in their area
- Scenarios were simulated to understand the some best management practices at a 30,000 ft view, at a watershed scale
- There is localized impact of flooding from urbanization, however we looked at it from a watershed scale, not a really small, local scale

- **Increase in precipitation, increase in urbanization in NW AR and land-use change along the River in OK – All contributions to flooding with the largest being the <u>increase in precipitation</u>**

HYDROLOGY VS HYDRAULICS

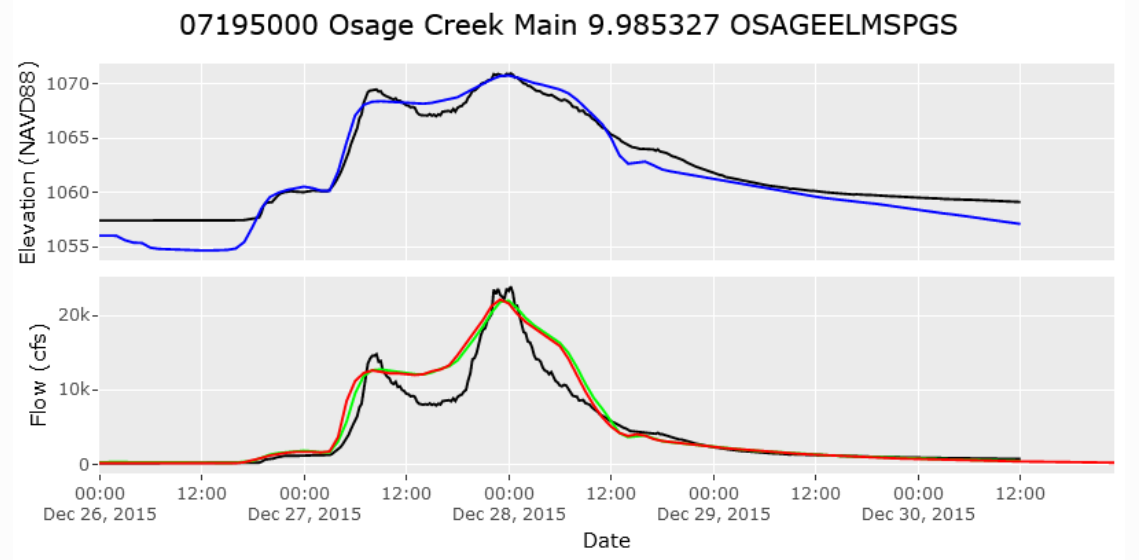


HYDROLOGY is translating **precipitation** to **streamflow**

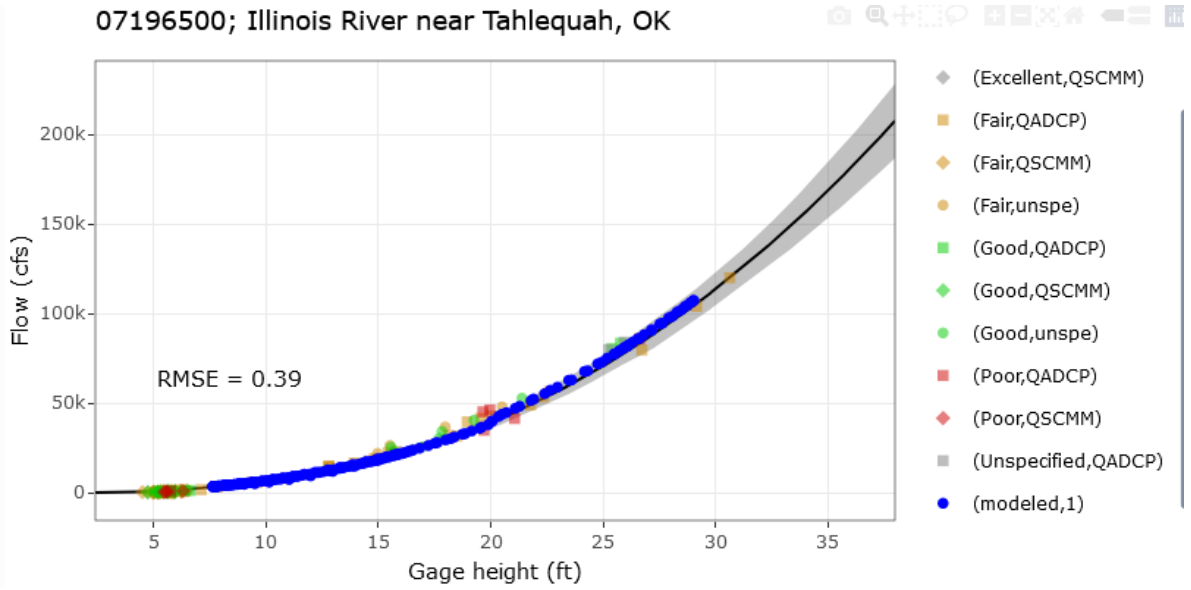
HYDRAULICS is translating **streamflow** to **elevation**

DATA & MODELS

Land-Use Data
Precipitation Data
Streamgage Data
Elevation Data



Statistical Models
Land-Use Model
Hydrologic Model
Hydraulic Model



OUTLINE

Precipitation Trends
Land-Use Trends
Streamflow Trends
Scenarios
- Precipitation
  - NOAA Atlas 14 Frequency Events
- Land use
  - NLCD Historical
  - Future
- Detention basins
- Riparian Buffers

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GAGE LOCATIONS

PRECIPITATION TRENDS

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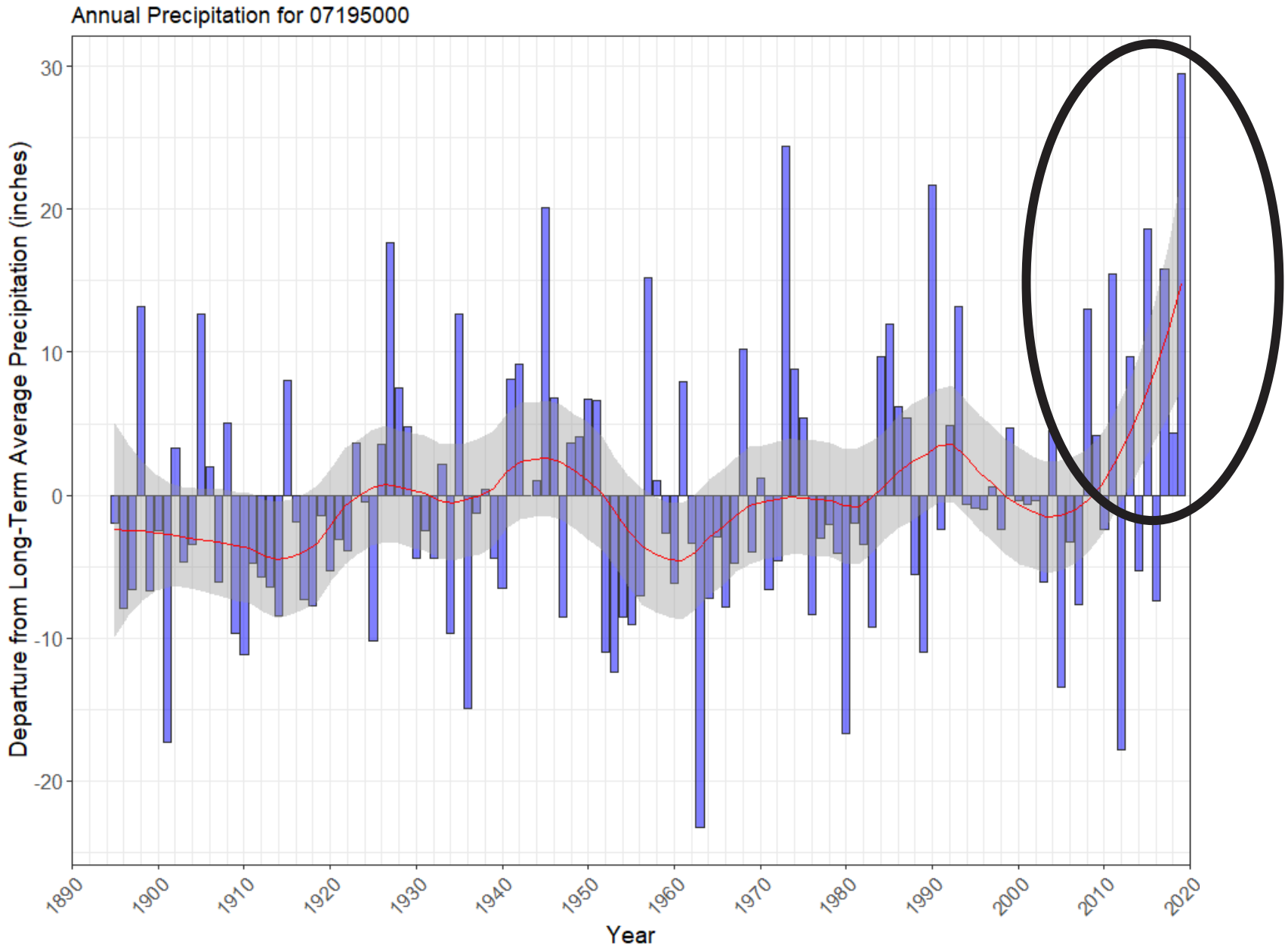
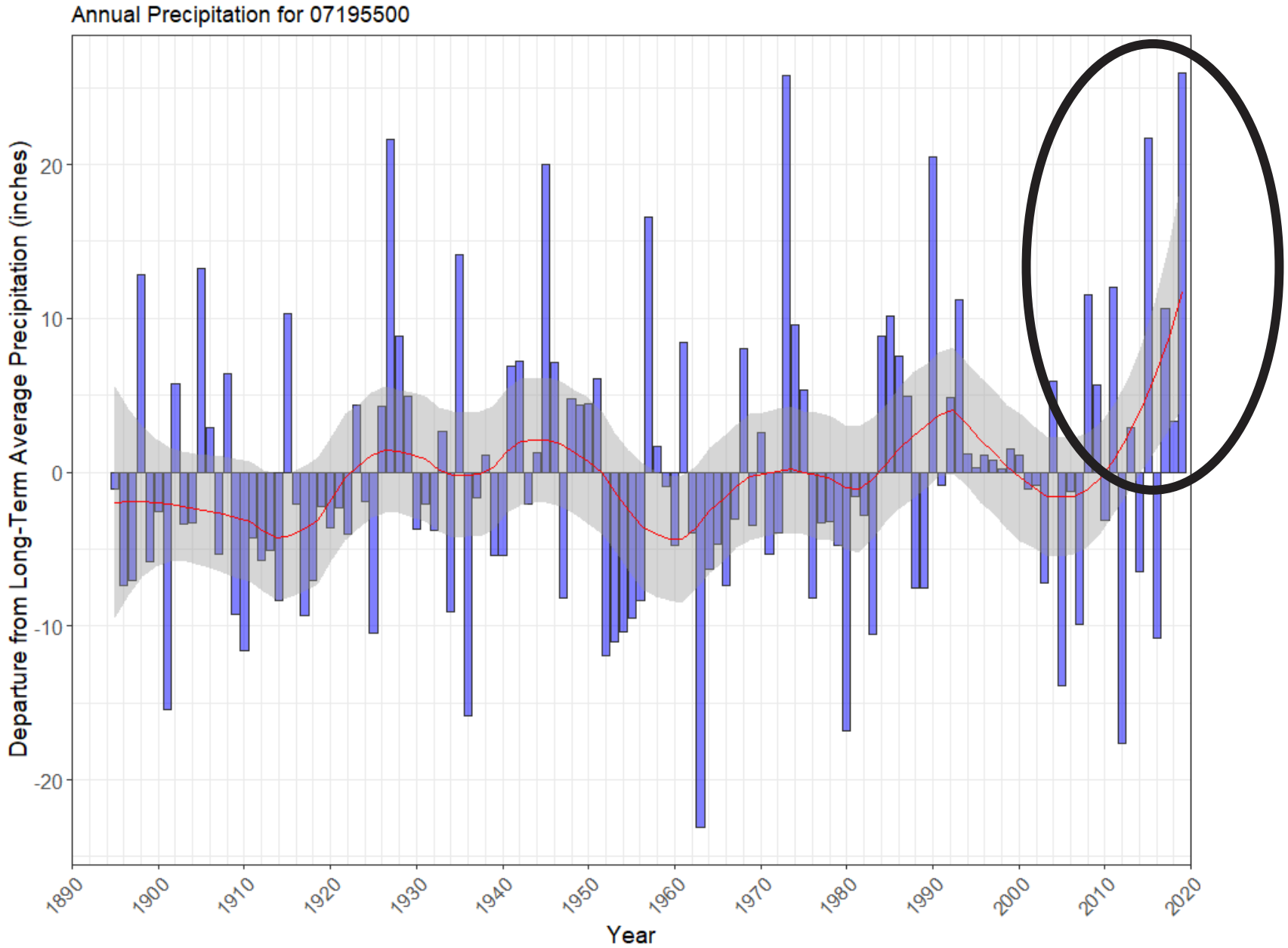
OSAGE CREEK NEAR ELM SPRINGS, AR



PRISM Climate Group

ILLINOIS RIVER NEAR WATTS. OK



PRISM Climate Group

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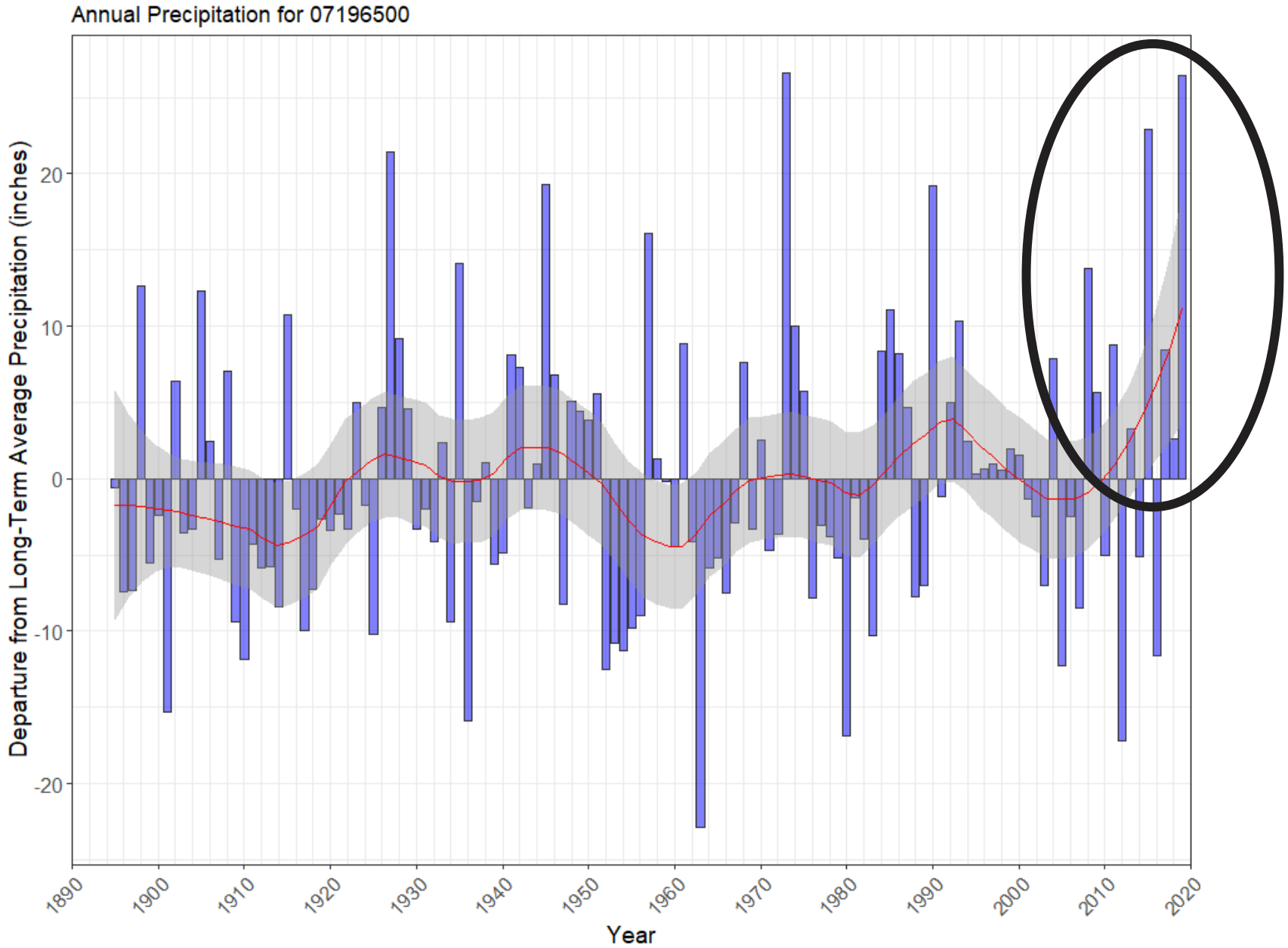
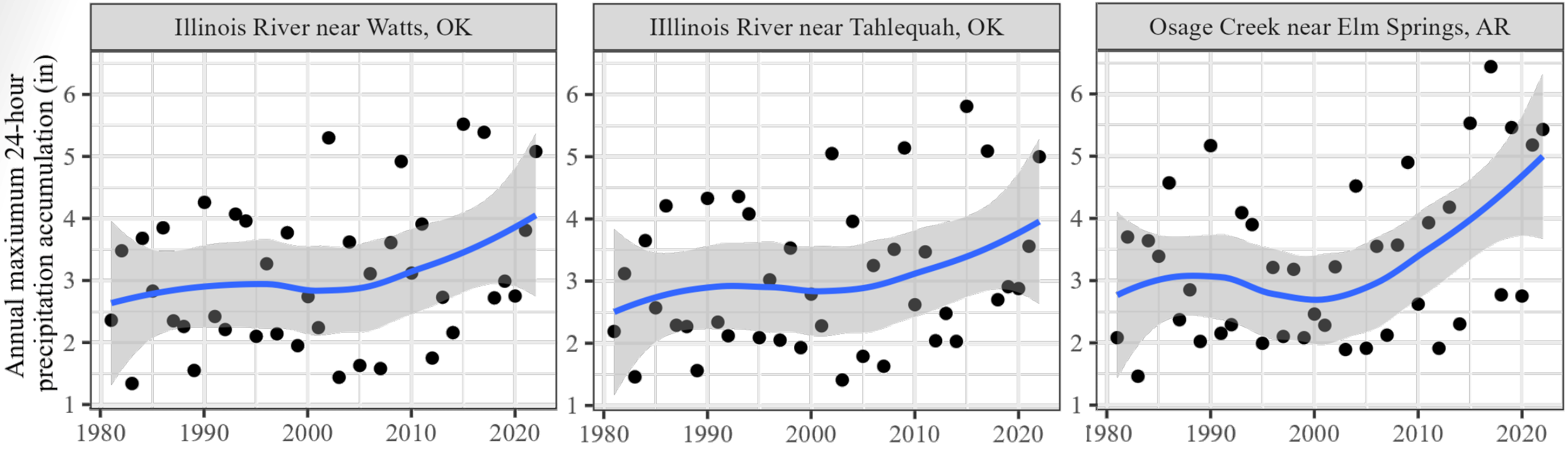
ILLINOIS RIVER NEAR TAHLEQUAH. OK



PRISM Climate Group

PRECIPITATION MAGNITUDE – 24-HOUR



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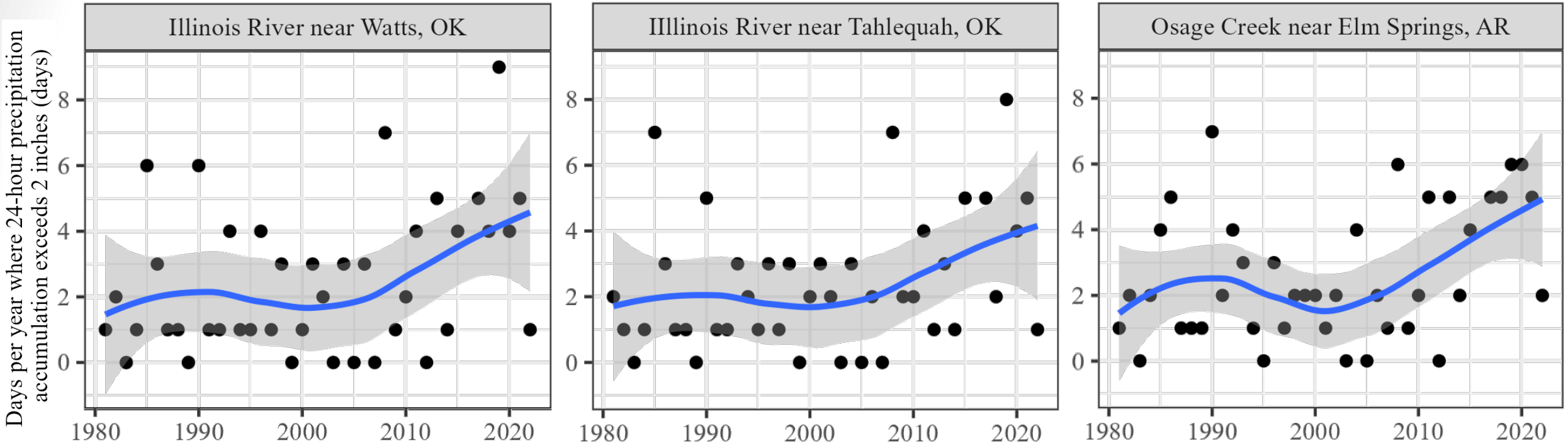
PRECIPITATION INTENSITY– 24-HOUR



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LAND-USE TRENDS

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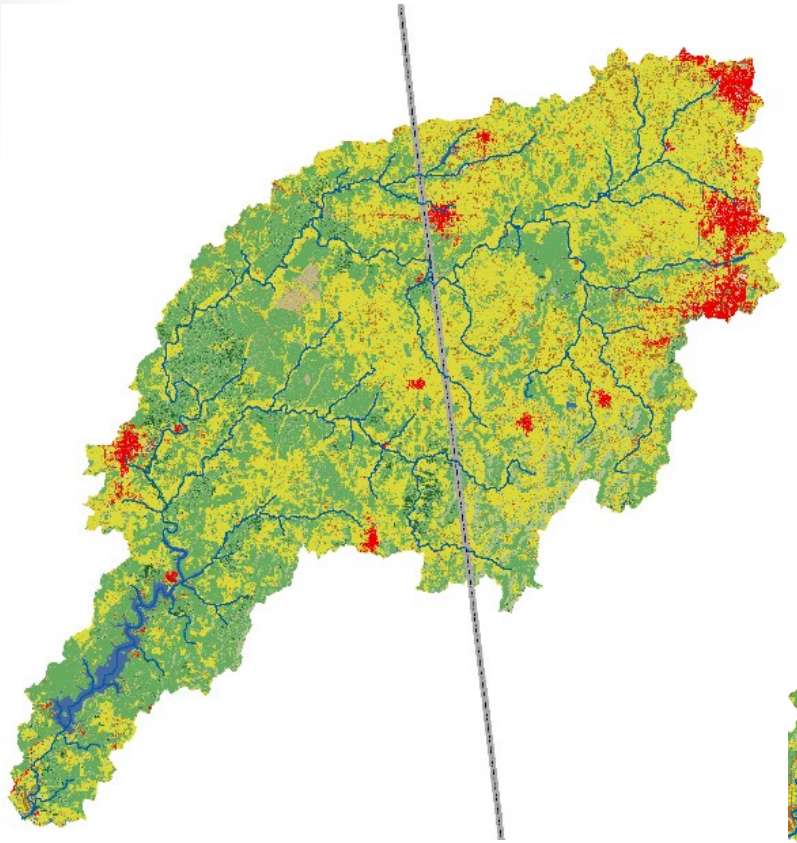
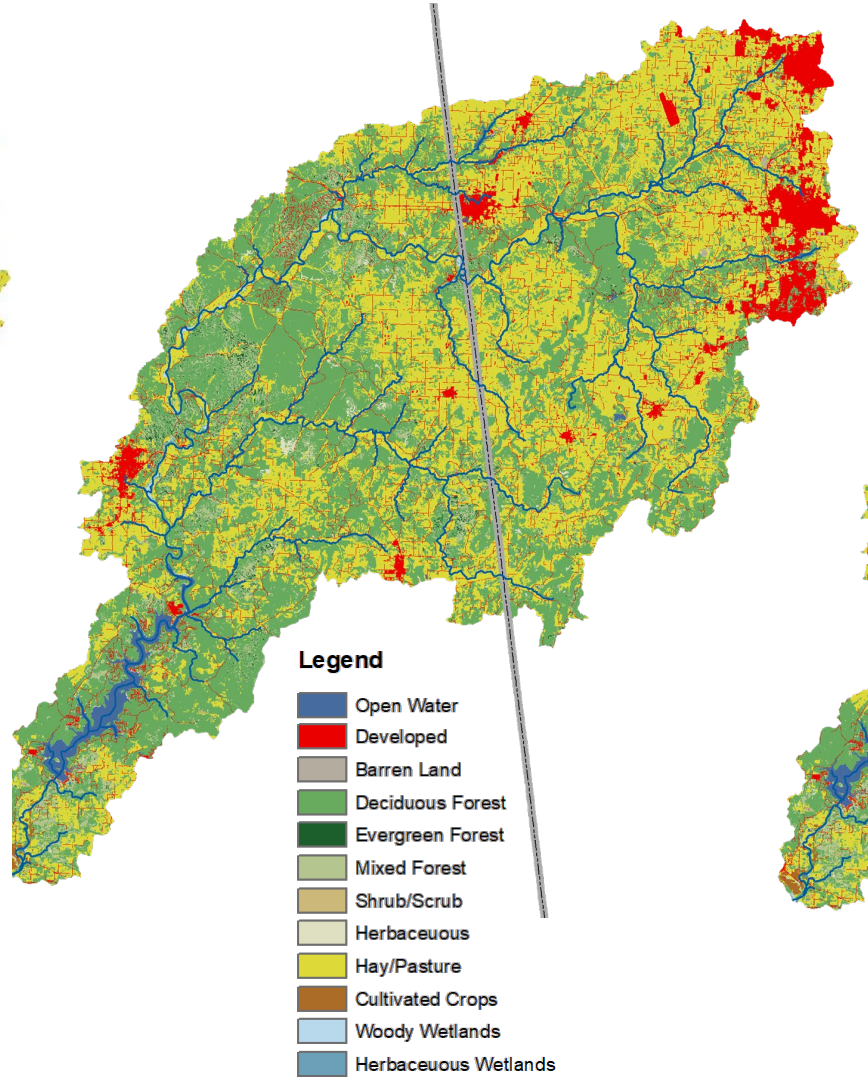
LAND-USE TRENDS

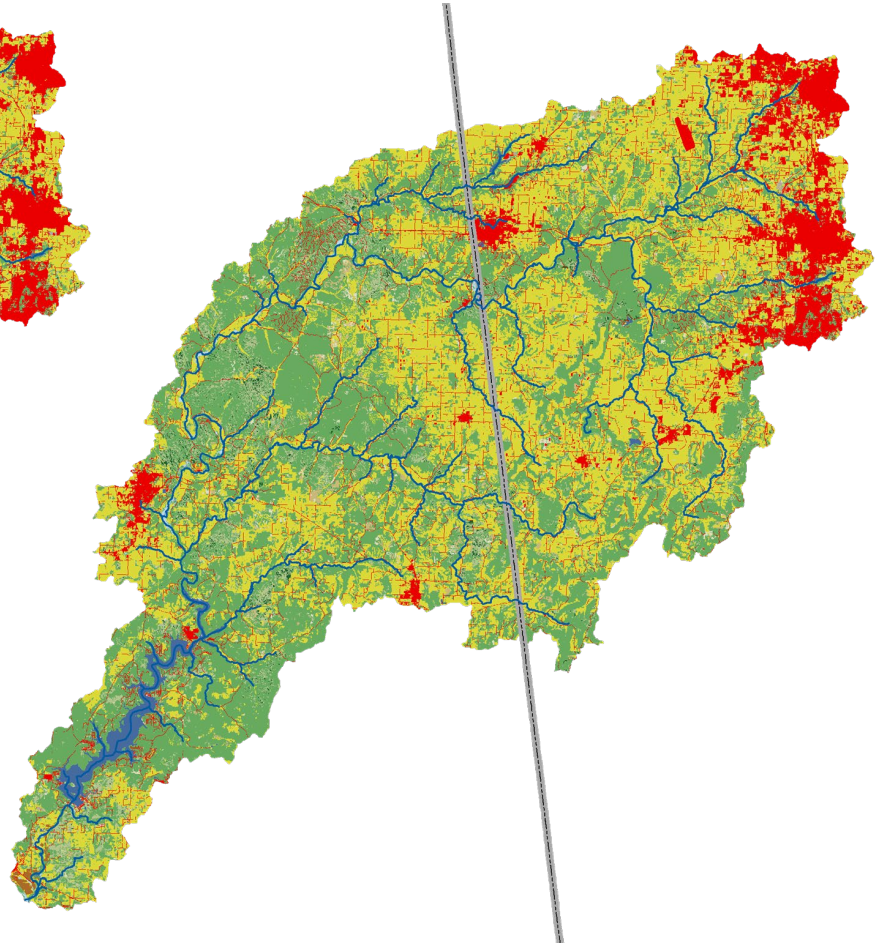
1992 Land use land cover



2001 Land use land cover



2016 Land use land cover



National Land Cover Database (NLCD)

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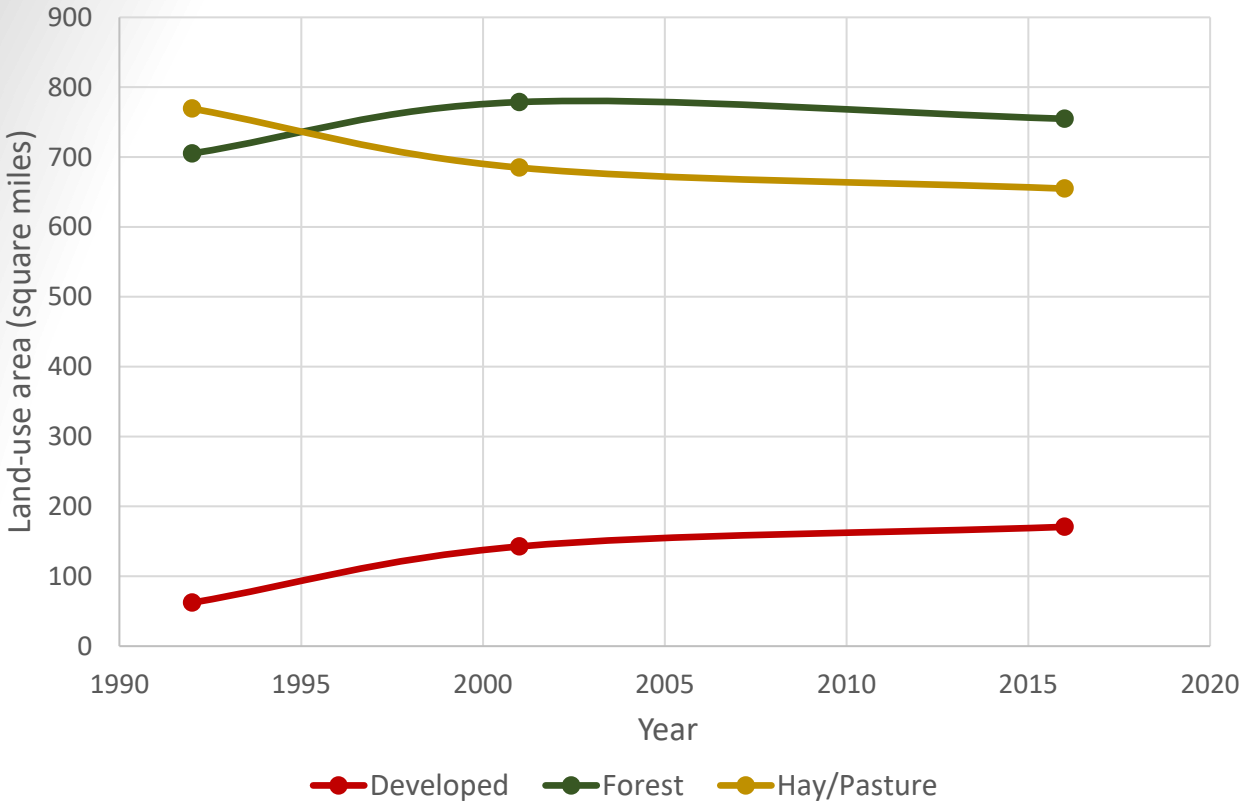
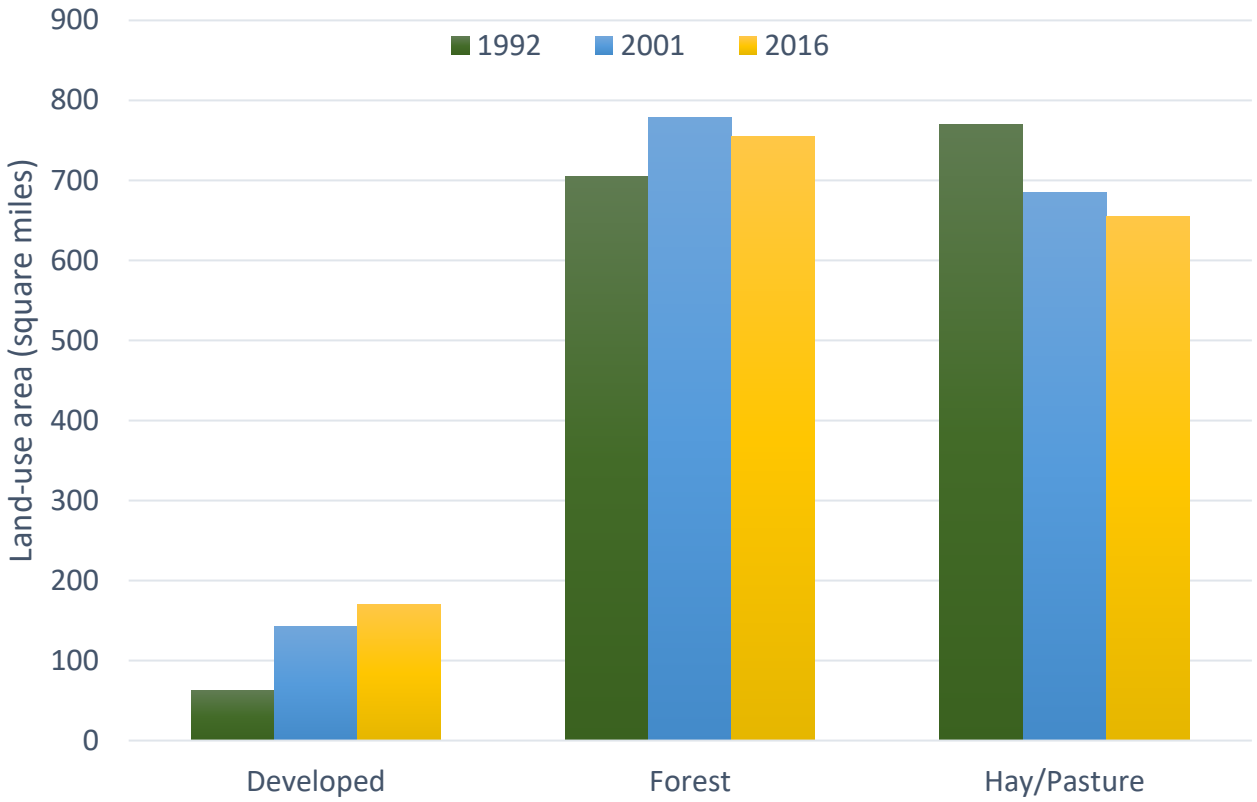
LAND-USE TRENDS





1992 = 62.2 mi^2

2001 = 142.6 mi^2 = 129.3% increase

2016 = 170.7 mi^2 = 19.7% increase

STREAMFLOW TRENDS

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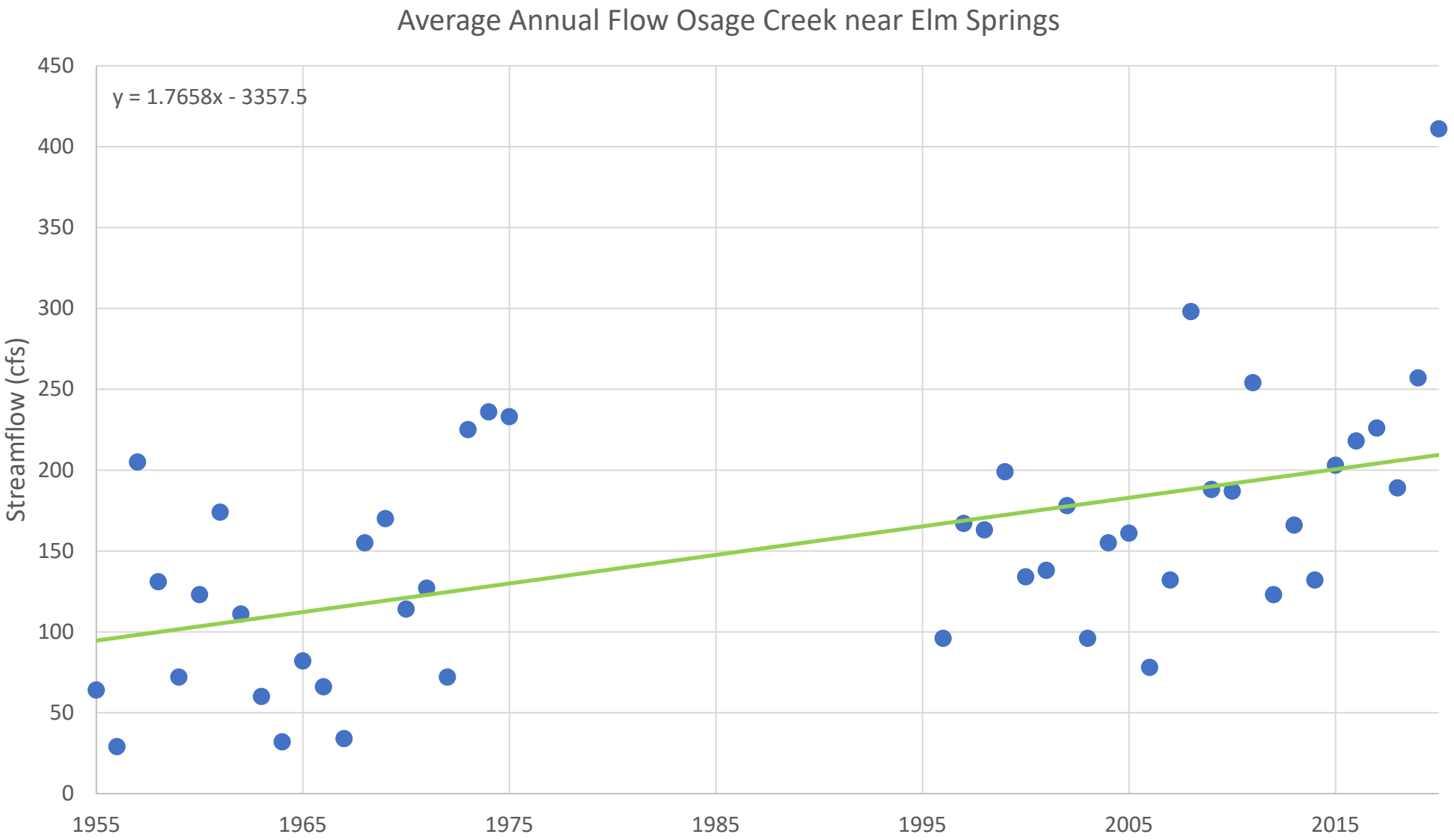
STREAMFLOW TRENDS



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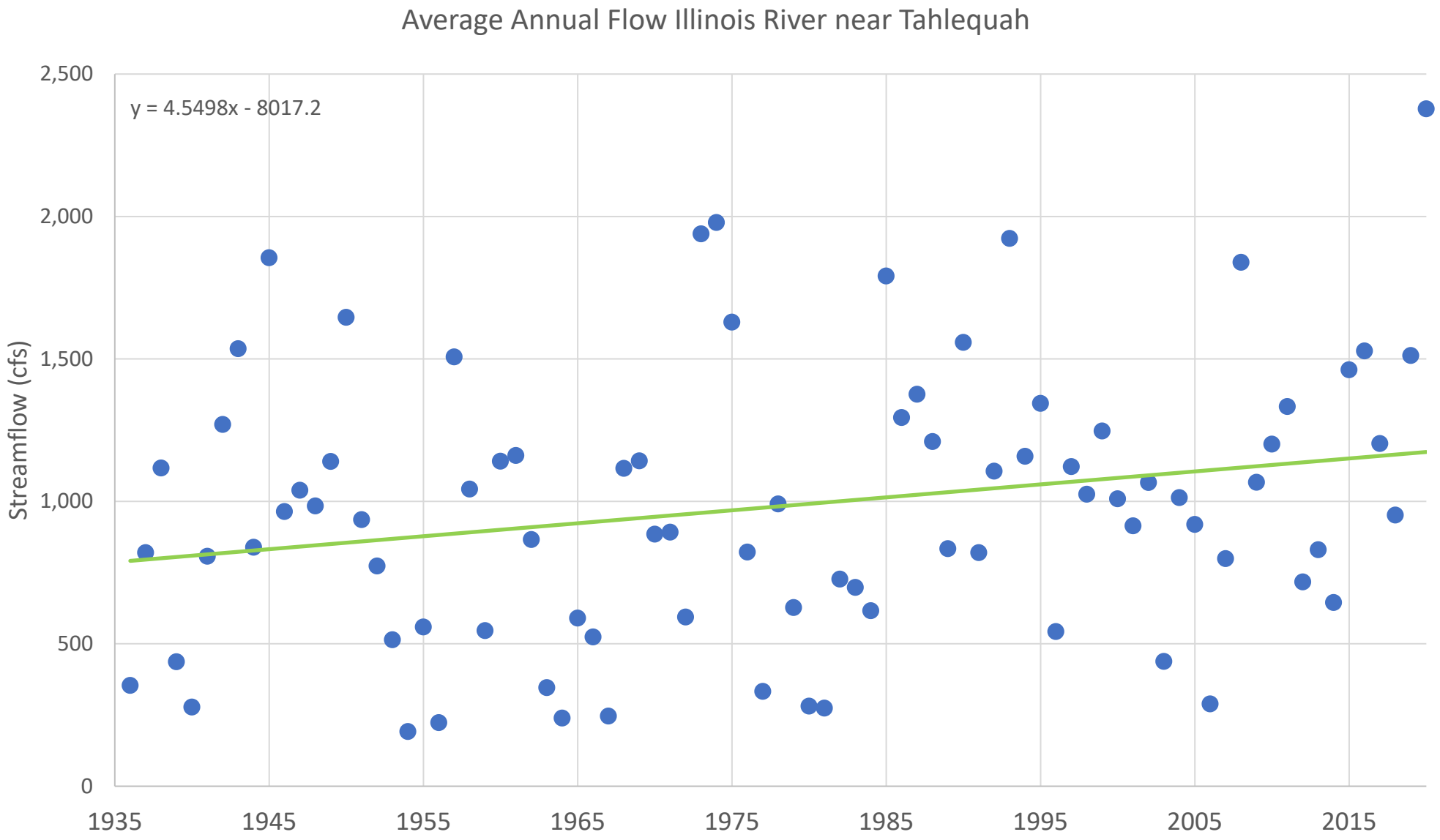
STREAMFLOW TRENDS



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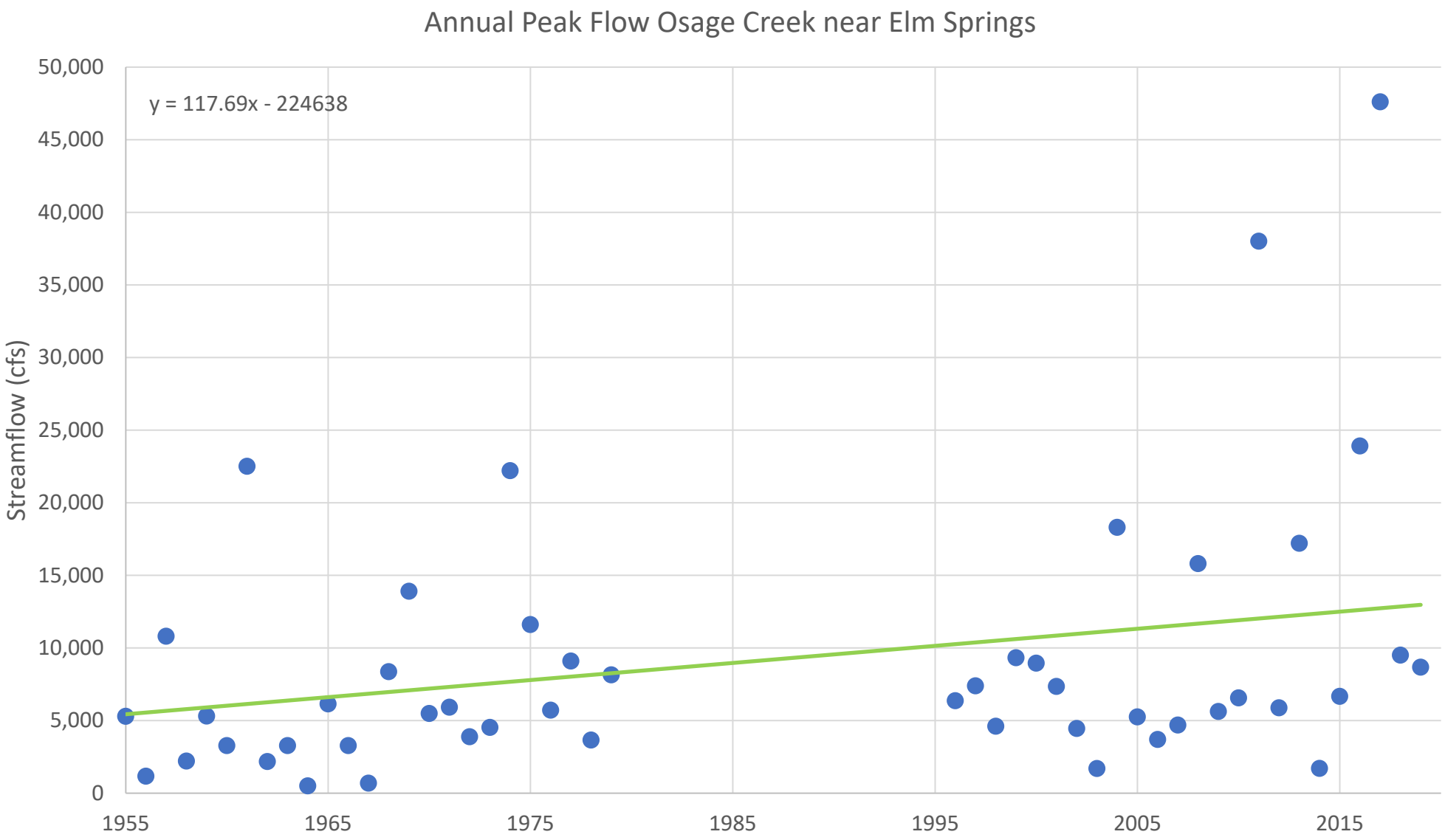
STREAMFLOW TRENDS



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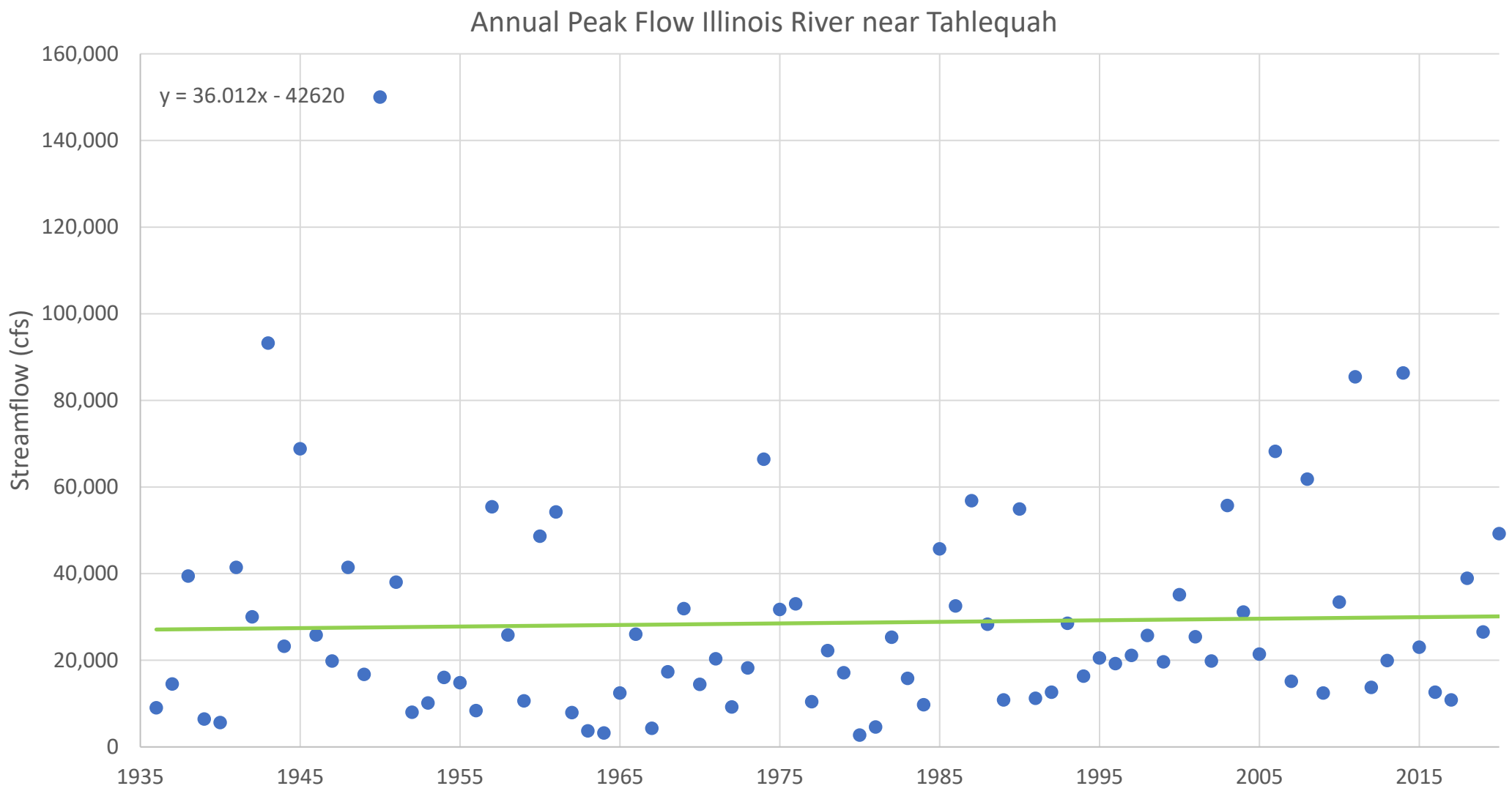
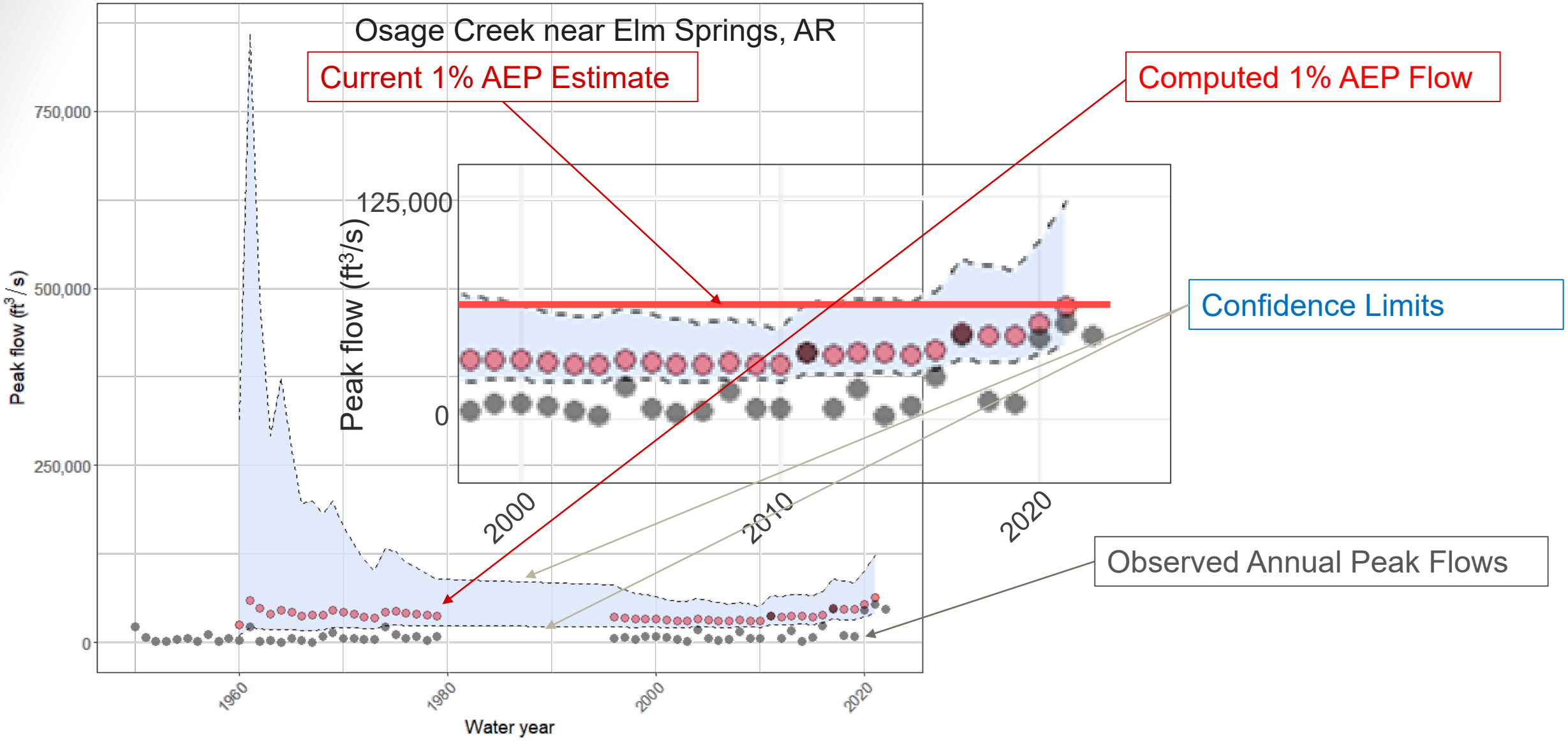
STREAMFLOW TRENDS



1% AEP(100-YEAR) FLOW CHANGE OVER TIME



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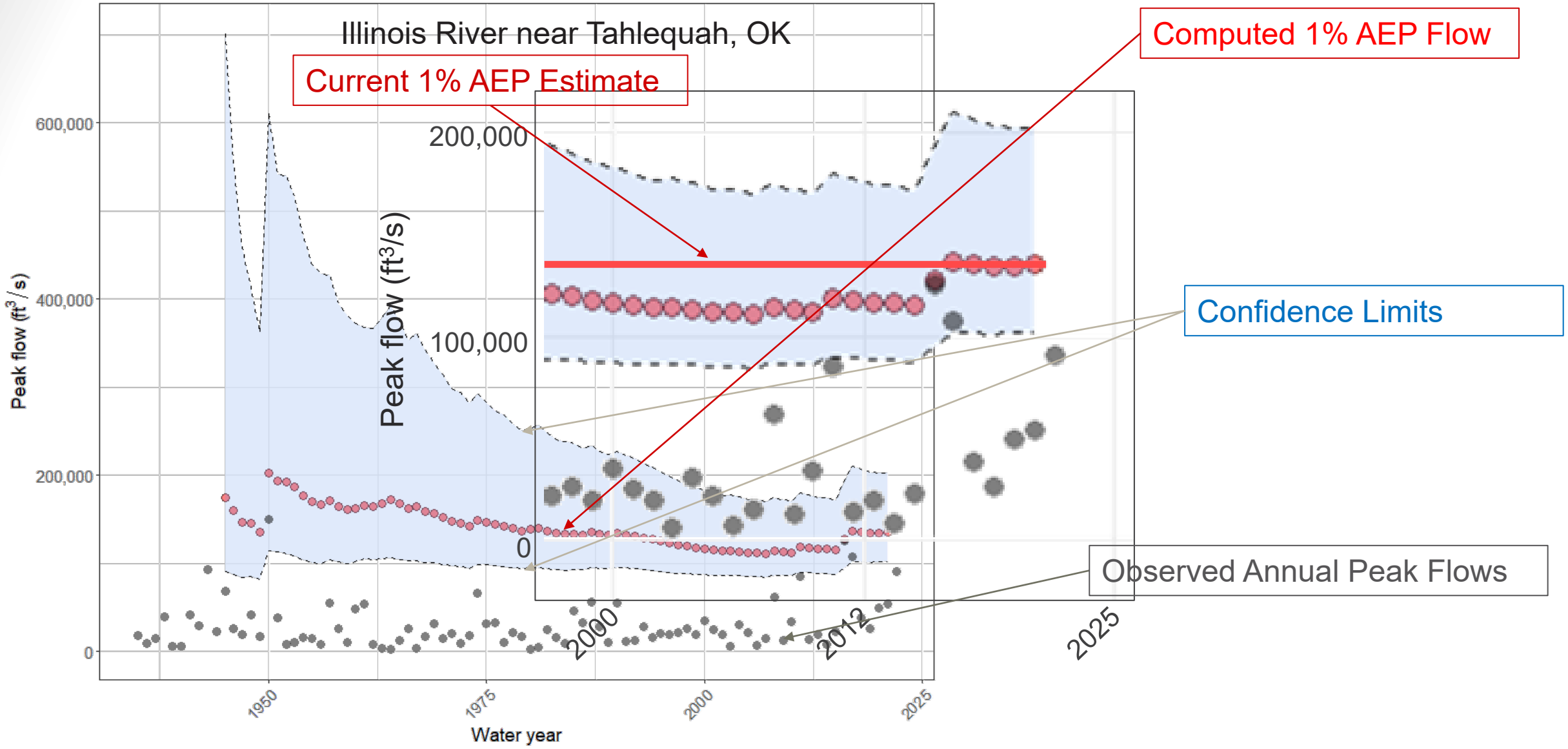
1% AEP(100-YEAR) FLOW CHANGE OVER TIME



SCENARIOS

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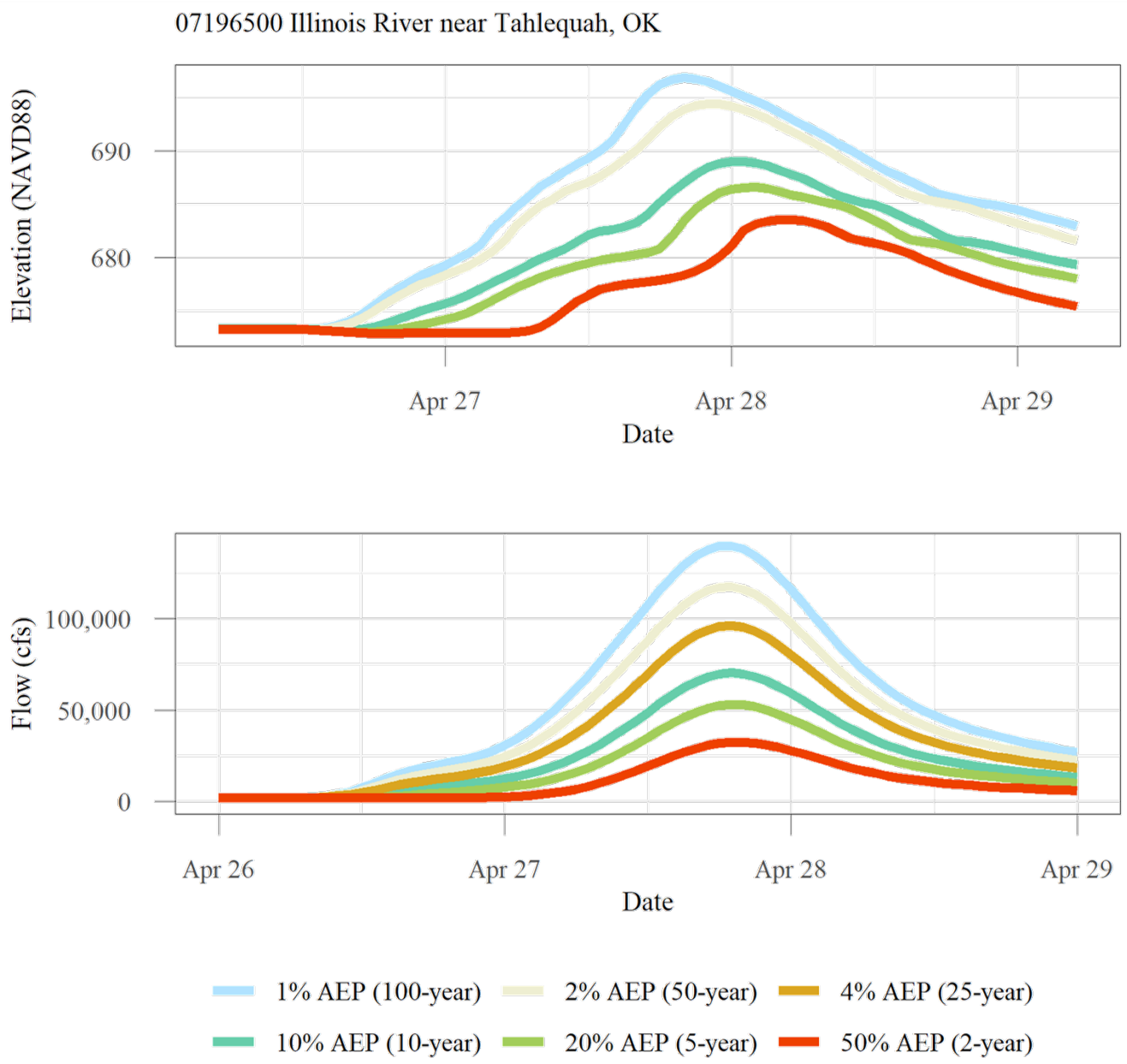
PRECIPITATION SCENARIOS

Event	24-Hour Precipitation Amount (inches)
50%AEP (2-year)	3.76
20%AEP (5-year)	4.71
10%AEP (10-year)	5.48
4% AEP (25-year)	6.57
2% AEP (50-year)	7.45
1% AEP (100-year)	8.37

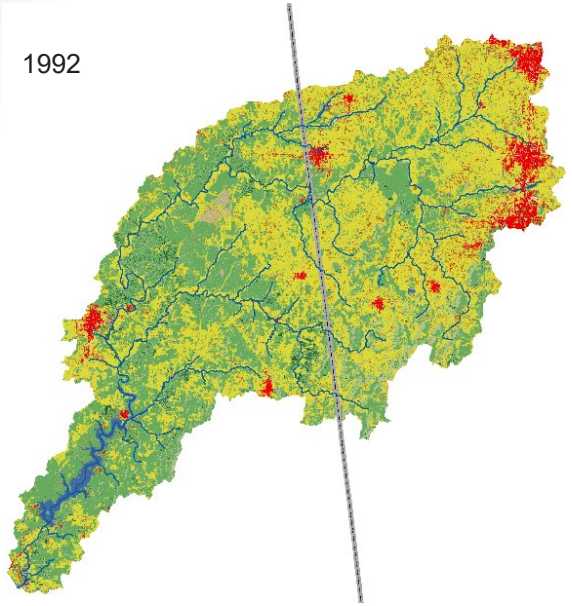
NOAA Atlas 14 Point Precipitation Frequency Estimates

2017



LAND-USE SCENARIOS

1992



2001

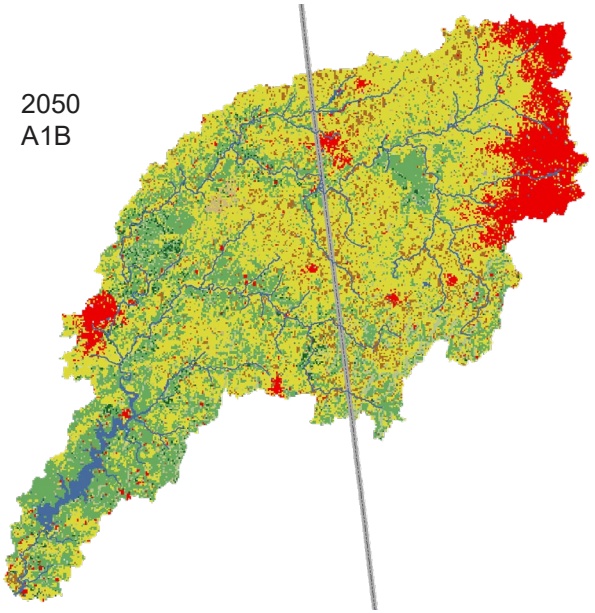
2050
B2

2016

Legend

- Open Water
- Developed
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Herbaceuous
- Hay/Pasture
- Cultivated Crops
- Woody Wetlands
- Herbaceuous Wetlands

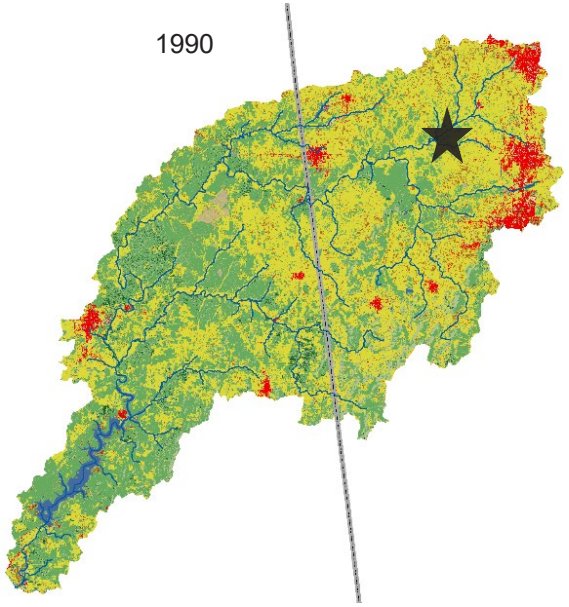
2050
A1B

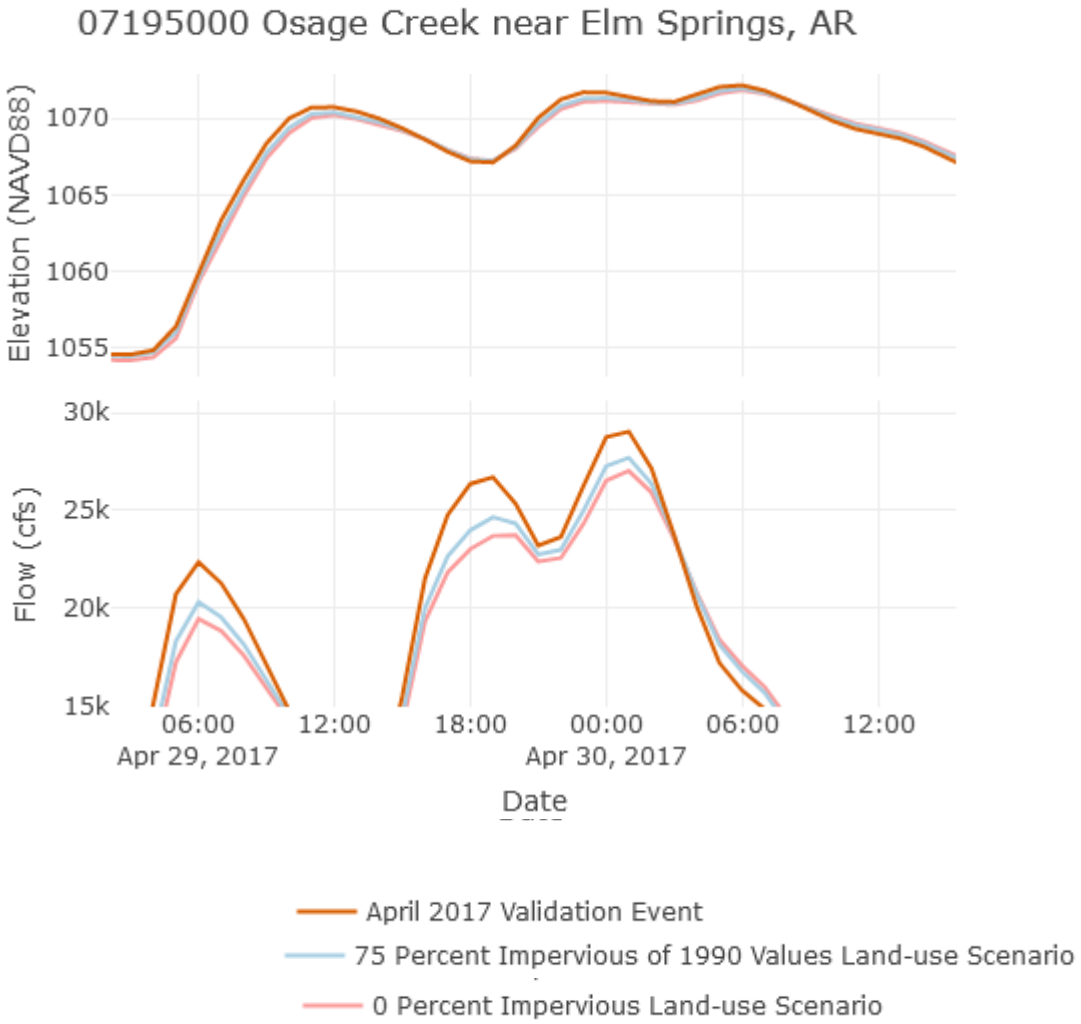


National Land Cover Database – USGS Earth Resources Observation and Science (EROS) Center

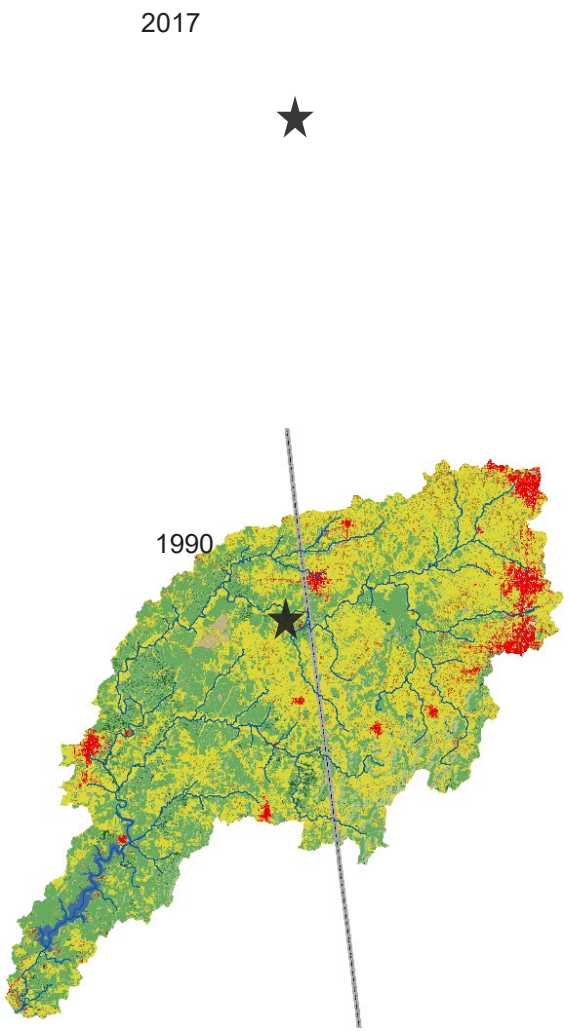
HISTORICAL LAND-USE

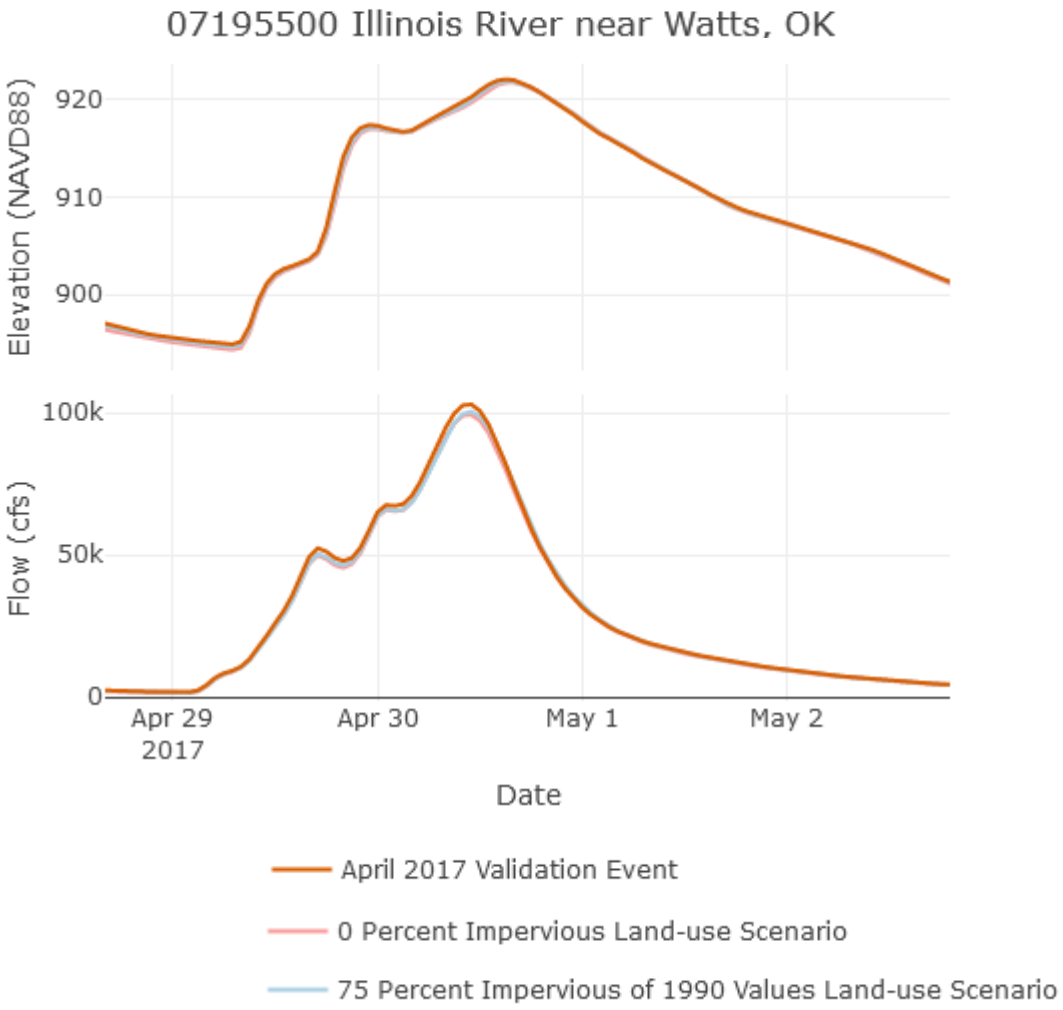
2017





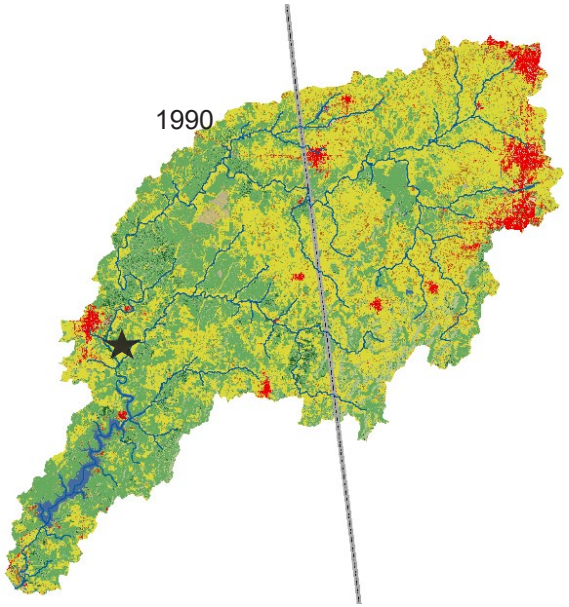
HISTORICAL LAND-USE

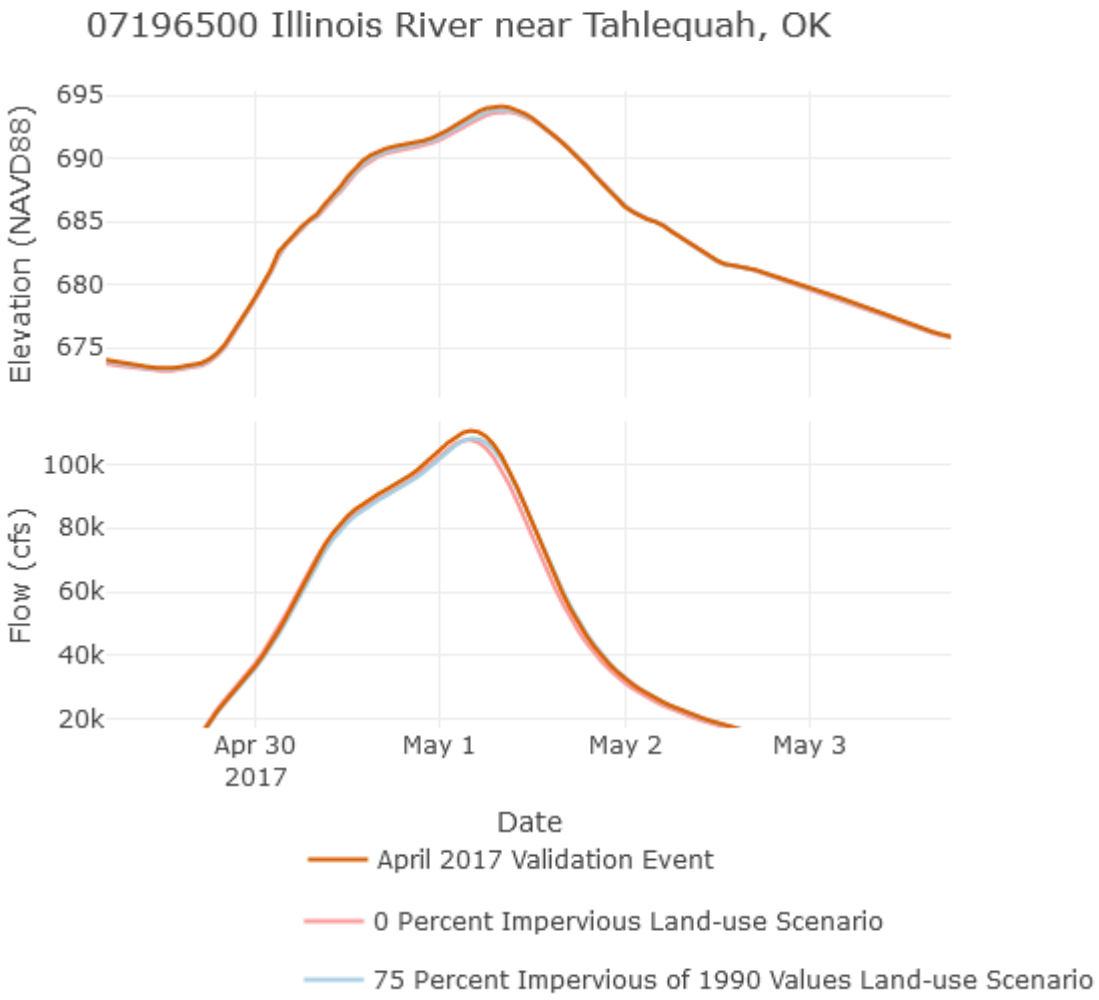




HISTORICAL LAND-USE

2017



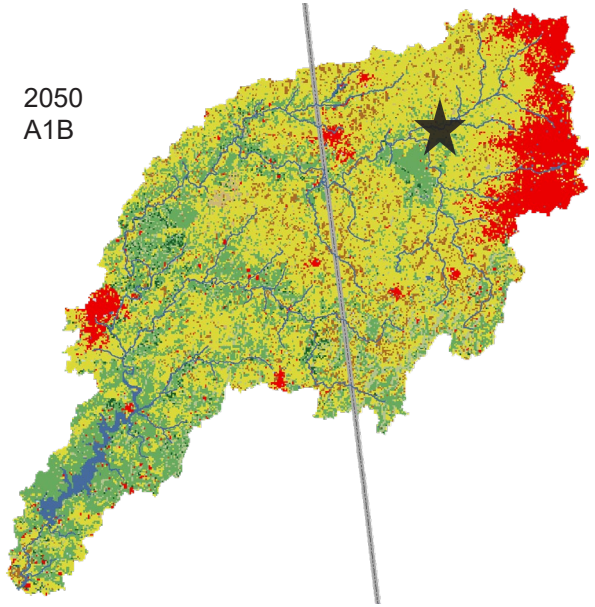


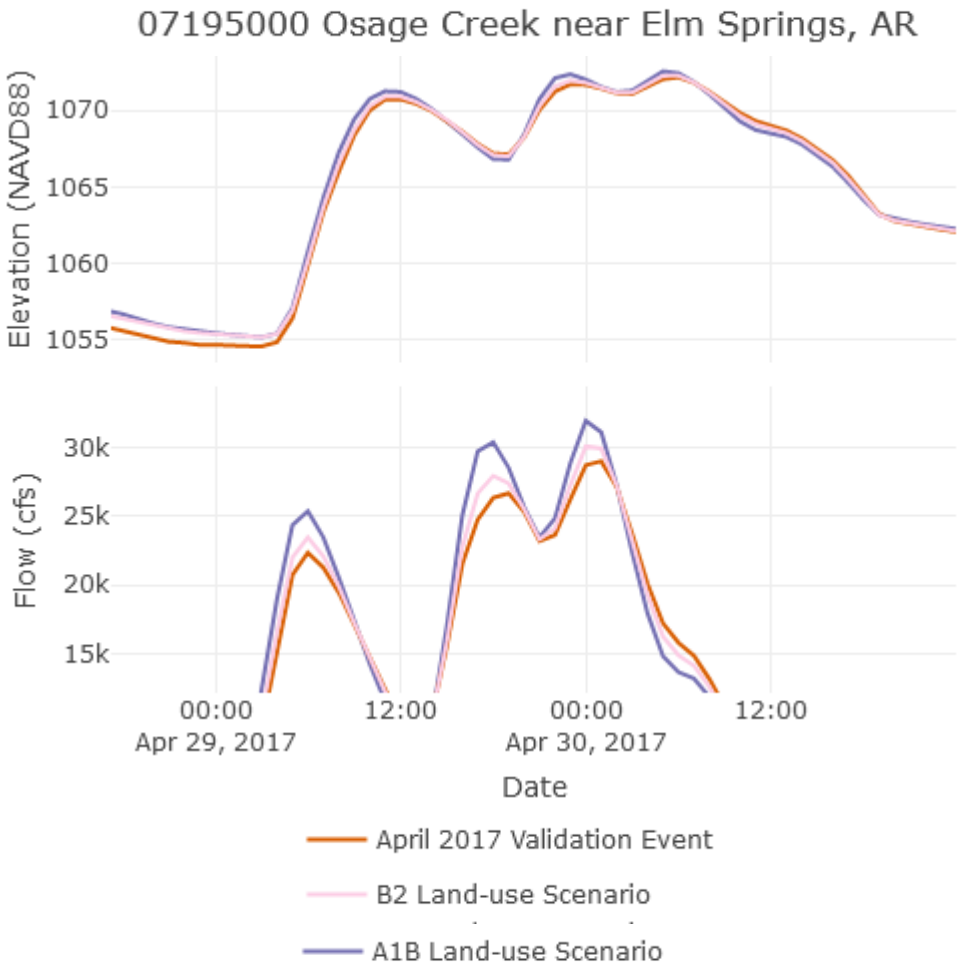
FUTURE LAND-USE PROJECTIONS – NO STORMWATER MANAGEMENT CONSIDERED

2017

2050 B2

2050
A1B



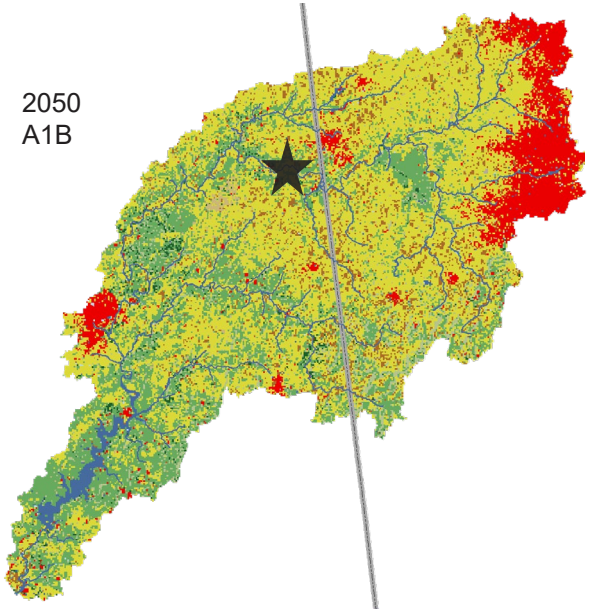


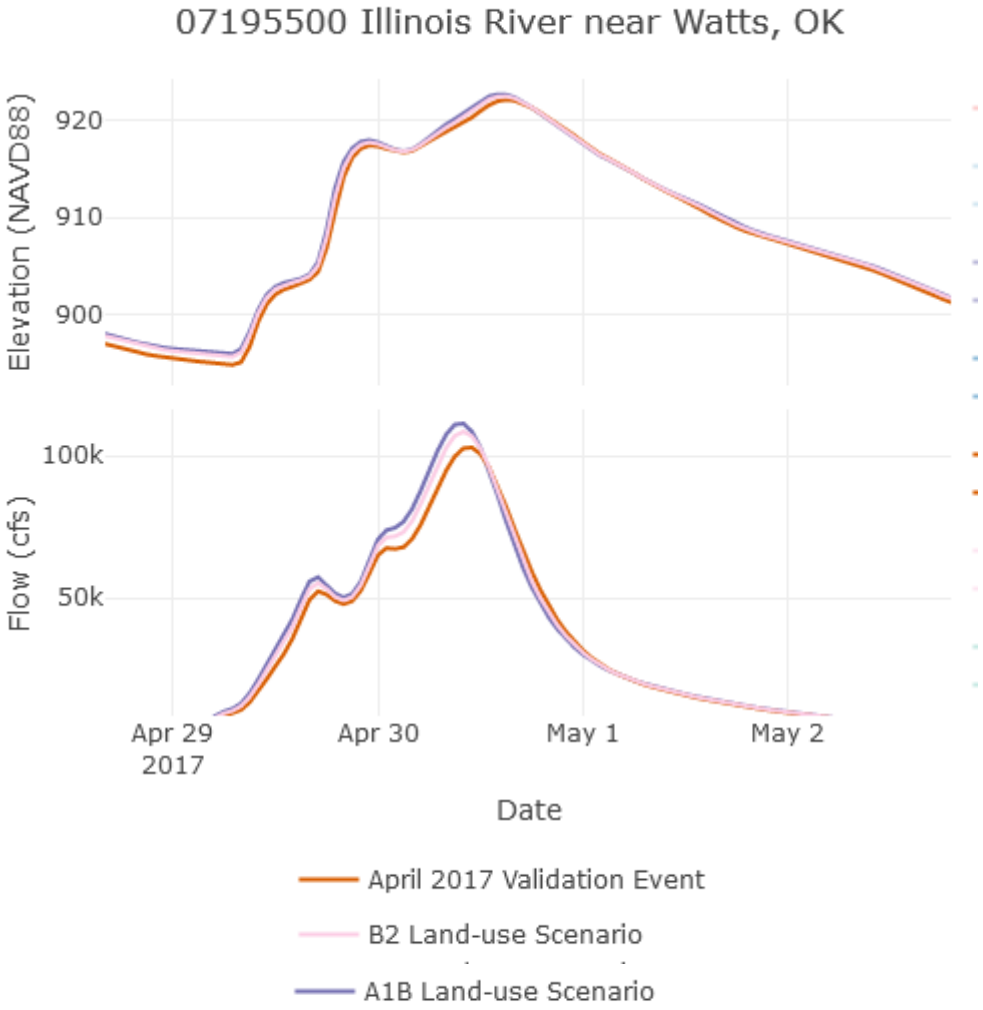
FUTURE LAND-USE PROJECTIONS – NO STORMWATER MANAGEMENT CONSIDERED

2017

2050
B2

2050
A1B



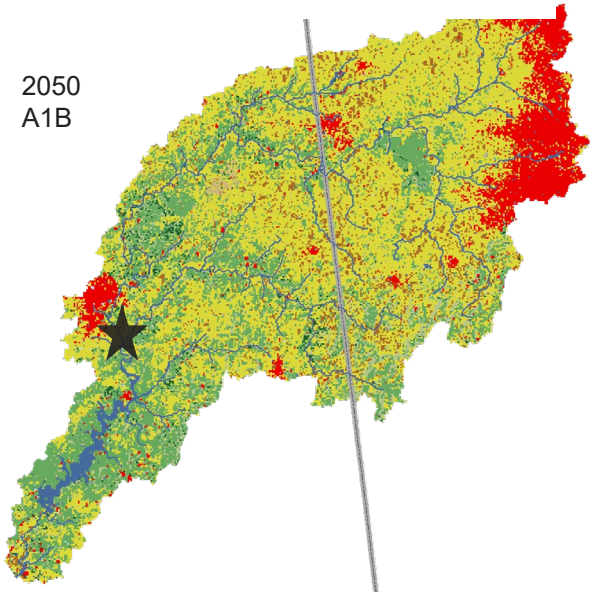


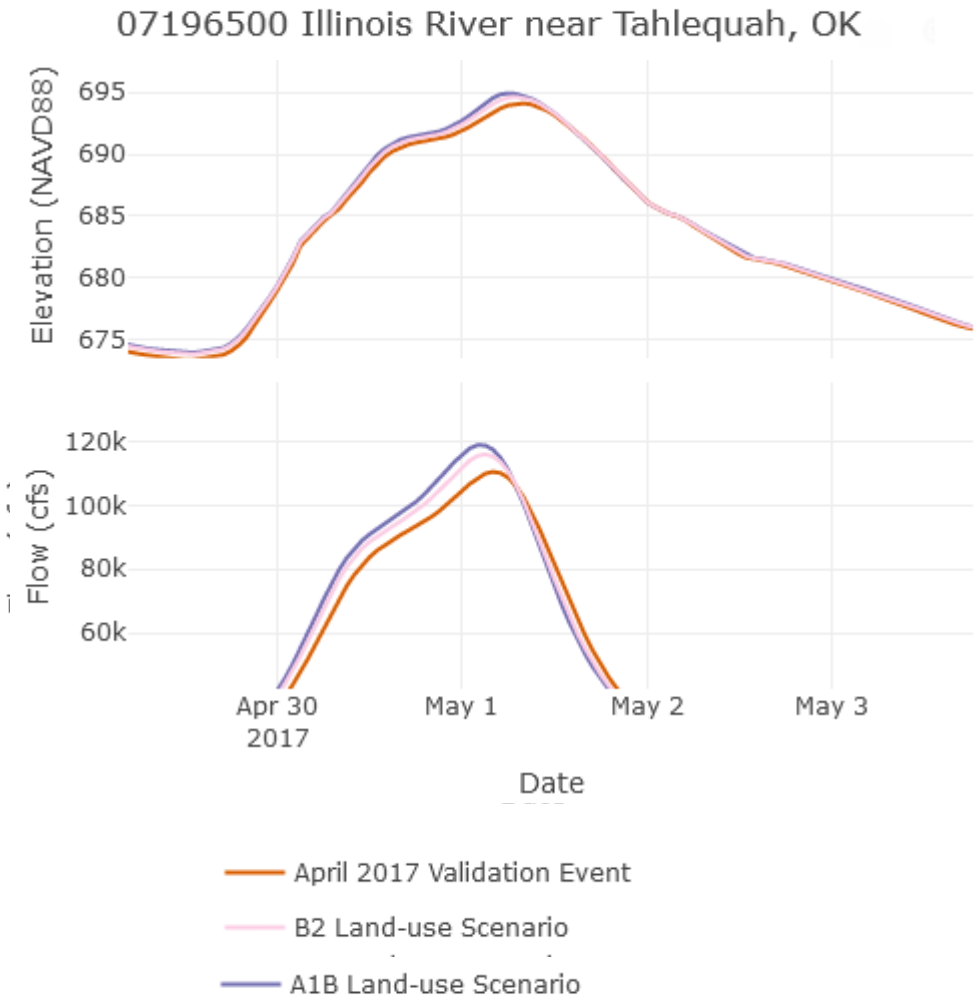
FUTURE LAND-USE PROJECTIONS – NO STORMWATER MANAGEMENT CONSIDERED

2017

2050
B2

2050
A1B



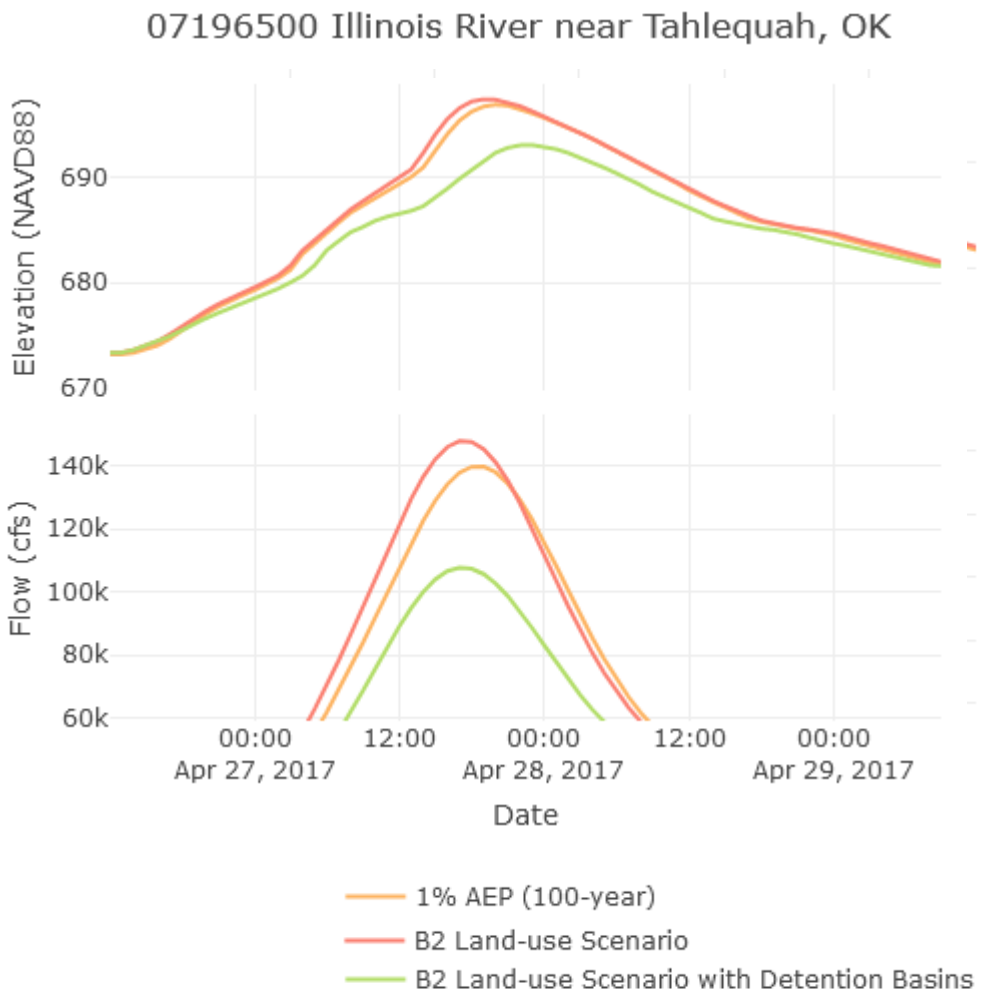


DETENTION BASINS – NOT RECOMMENDED

2017

2050 B2

2050 A1B

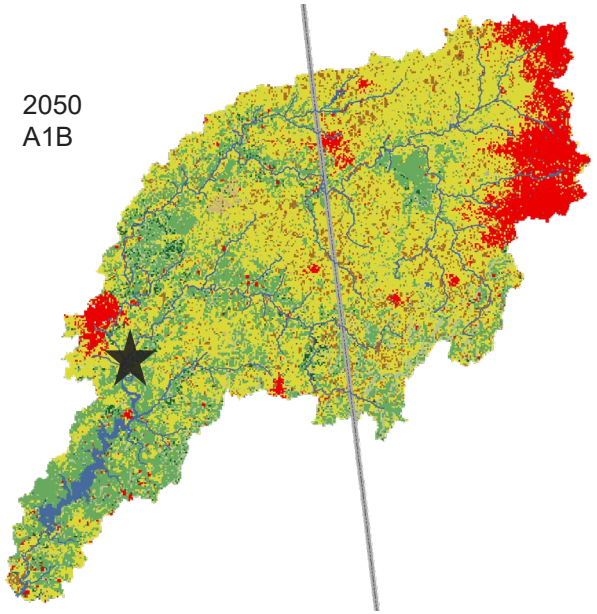


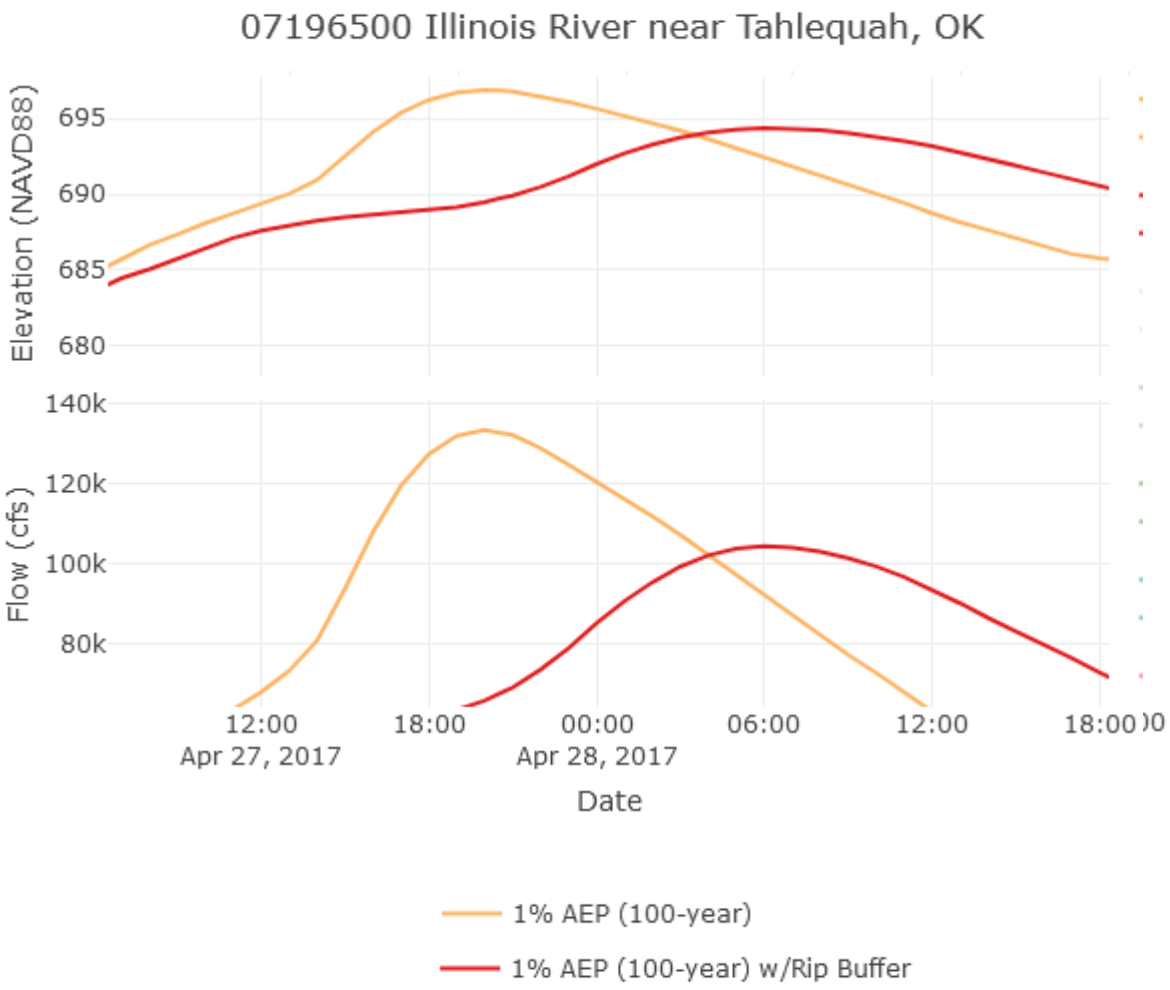
RIPARIAN BUFFERS – 1%AEP (100-YEAR)

2017

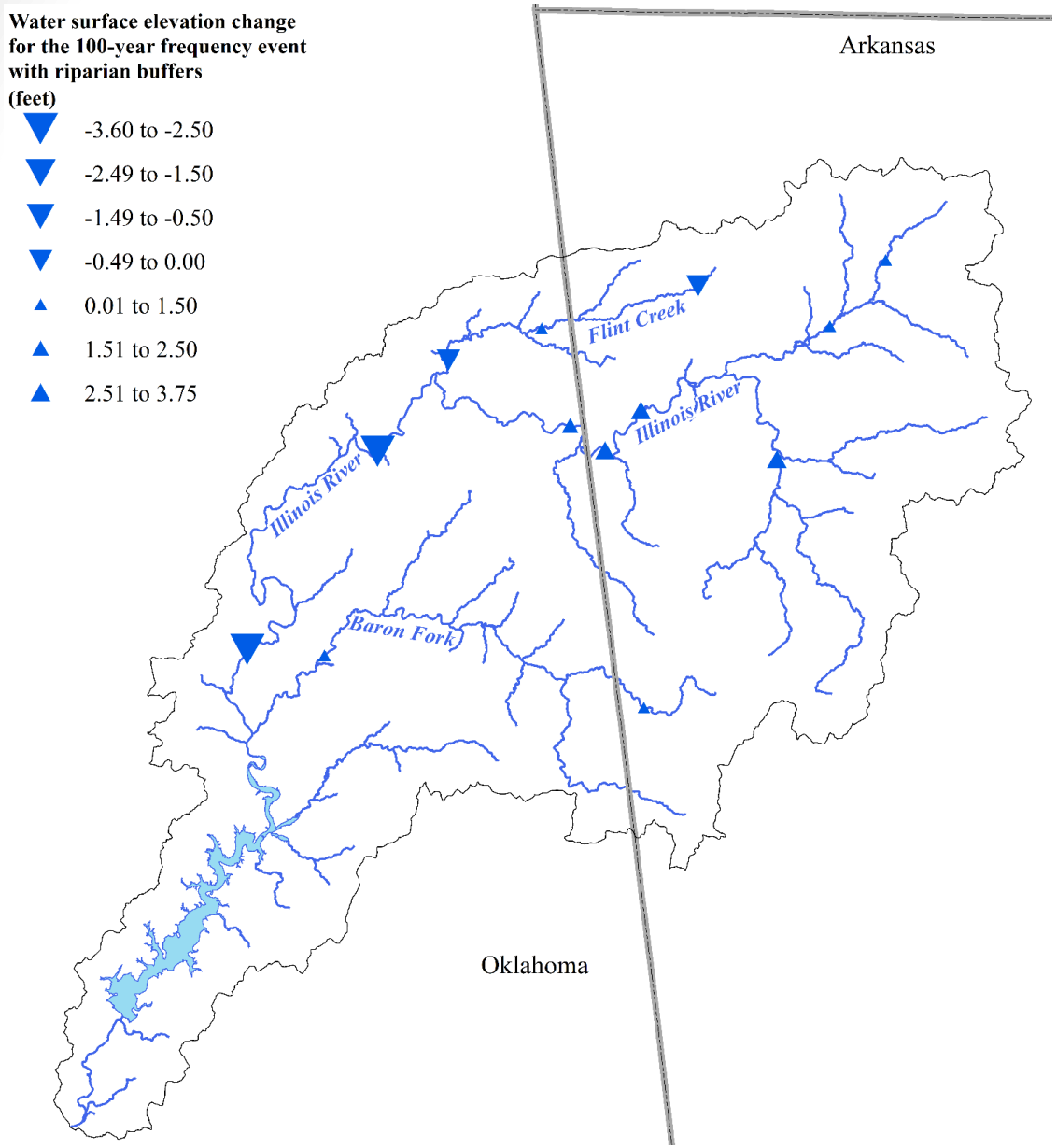
2050
B2

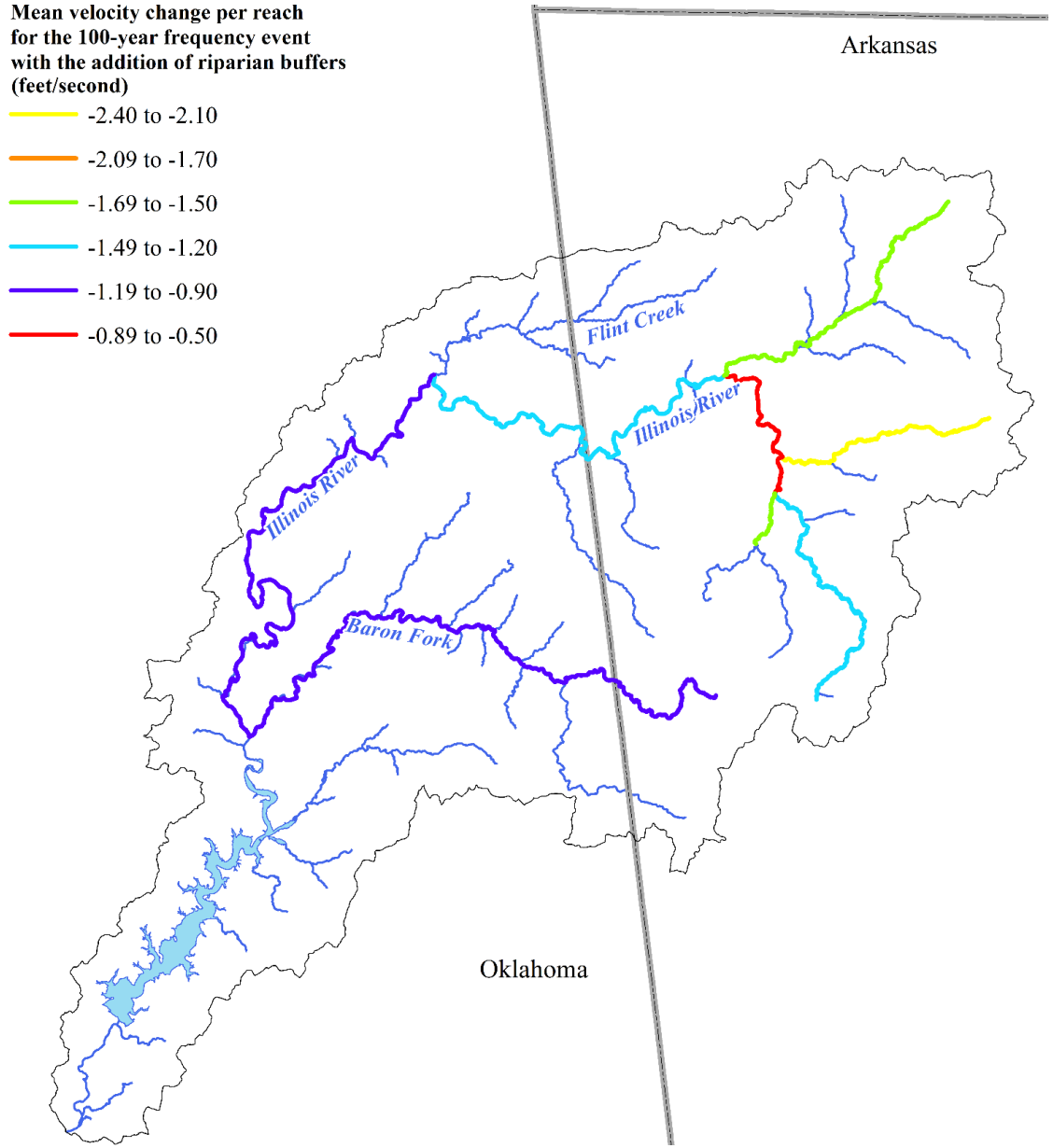
2050
A1B





RIPARIAN BUFFERS – 1%AEP (100-YEAR)





TAKE-HOMES

- Not trying to unravel the past but trying to understand how to plan for the future
- This information will be used for planning purposes- information to better understand flood risk so that local planners can divide and conquer in their area
- Scenarios were simulated to understand the some best management practices at a 30,000 ft view, at a watershed scale
- There is localized impact of flooding from urbanization, however we looked at it from a watershed scale, not a really small, local scale

- **Increase in precipitation, increase in urbanization in NW AR and land-use change along the River in OK – All contributions to flooding with the largest being the <u>increase in precipitation</u>**

Breakout

PEAK COMPARISONS (ILLINOIS RIVER NEAR TAHLEQUAH)

Scenario/Event	Land Use	Precipitation	Peak Streamflow (cubic feet per second)	Peak Stage (elevation in feet)
2-year Frequency Event	2016 NLCD	2-year Frequency Event	32,439.3	683.5
2-year Frequency Event w/Riparian Buffers	2016 NLCD	2-year Frequency Event	27,293.6	682.7
5-year Frequency Event	2016 NLCD	5-year Frequency Event	53,079.0	686.5
5-year Frequency Event w/Riparian Buffers	2016 NLCD	5-year Frequency Event	41,235.3	685.4
10-year Frequency Event	2016 NLCD	10-year Frequency Event	70,324.1	689.0
10-year Frequency Event w/Riparian Buffers	2016 NLCD	10-year Frequency Event	53,547.5	687.5
25-year Frequency Event	2016NLCD	25-year Frequency Event	96,216.7	692.1
25-year Frequency Event w/Riparian Buffers	2016 NLCD	25-year Frequency Event	71,897.6	690.3
50-year Frequency Event	2016 NLCD	50-year Frequency Event	117,495.3	694.4
50-year Frequency Event w/Riparian Buffers	2016 NLCD	50-year Frequency Event	87,617.2	692.4
100-year Frequency Event	2016 NLCD	100-year Frequency Event	139,794.5	696.9

PEAK COMPARISONS (ILLINOIS RIVER NEAR TAHLEQUAH)

Scenario/Event	Land Use	Precipitation	Peak Streamflow (cubic feet per second)	Peak Stage (elevation in feet)
100-year Frequency Event w/Riparian Buffers	2016 NLCD	100-year Frequency Event	104,545.8	694.3
100-year Frequency Event w/B2 Land-use Scenario	2050 SRES B2	100-year Frequency Event	147,911.8	697.4
100-year Frequency Event w/B2 Land-use Scenario and Detention Basins	2050 SRES B2 w/Detention Basins	100-year Frequency Event	107,826.7	693.1
100-year Frequency Event w/A1B Land-use Scenario	2050 SRES A1B	100-year Frequency Event	153,017.8	697.7
100-year Frequency Event w/A1B Land-use Scenario and Detention Basins	2050 SRES A1B w/Detention Basins	100-year Frequency Event	112,189.3	693.4
April 2017 Validation Event	2016 NLCD	April 2017 Event	110,557.7	694.1
0 Percent Less Developed	0% Impervious Values	April 2017 Event	107,678.7	693.7
75 Percent Less Developed	75% 1990 Impervious Values	April 2017 Event	108,113.9	693.9
B2 Land-use Scenario	2050 SRES B2	April 2017 Event	116,030.2	694.6
B2 Land-use Scenario w/Detention Basins	2050 SRES B2 w/Detention Basins	April 2017 Event	89,476.5	691.5
A1B Land-use Scenario	2050 SRES A1B	April 2017 Event	118,933.1	694.9
A1B Land-use Scenario w/Detention Basins	2050 SRES A1B w/Detention Basins	April 2017 Event	92,237.7	691.8

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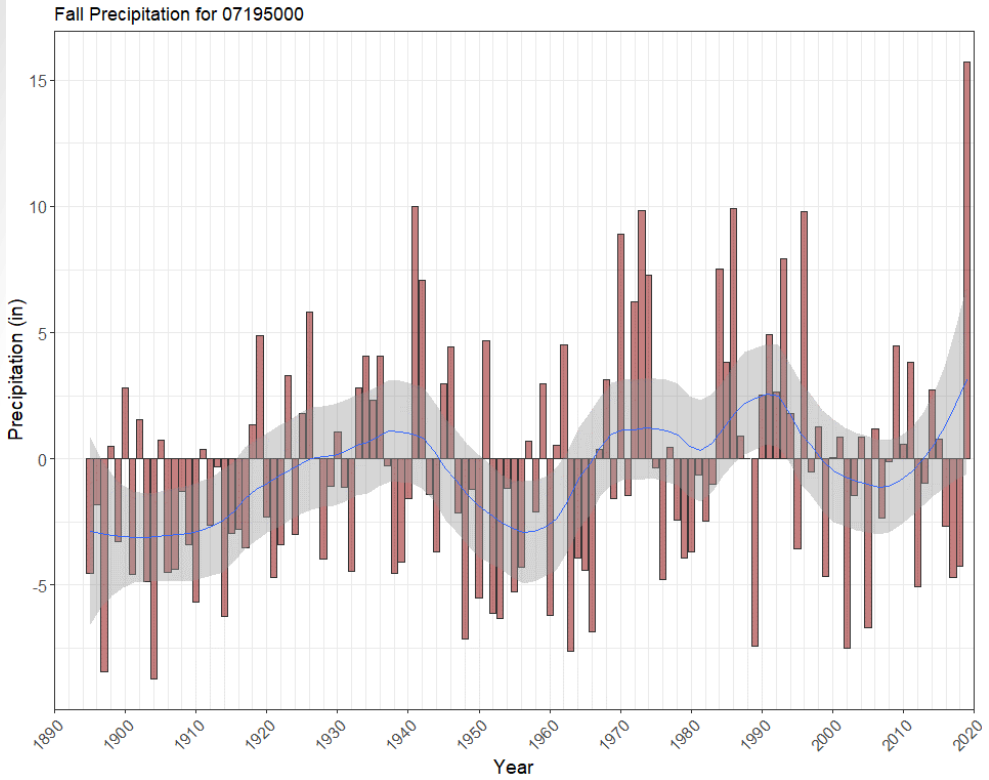
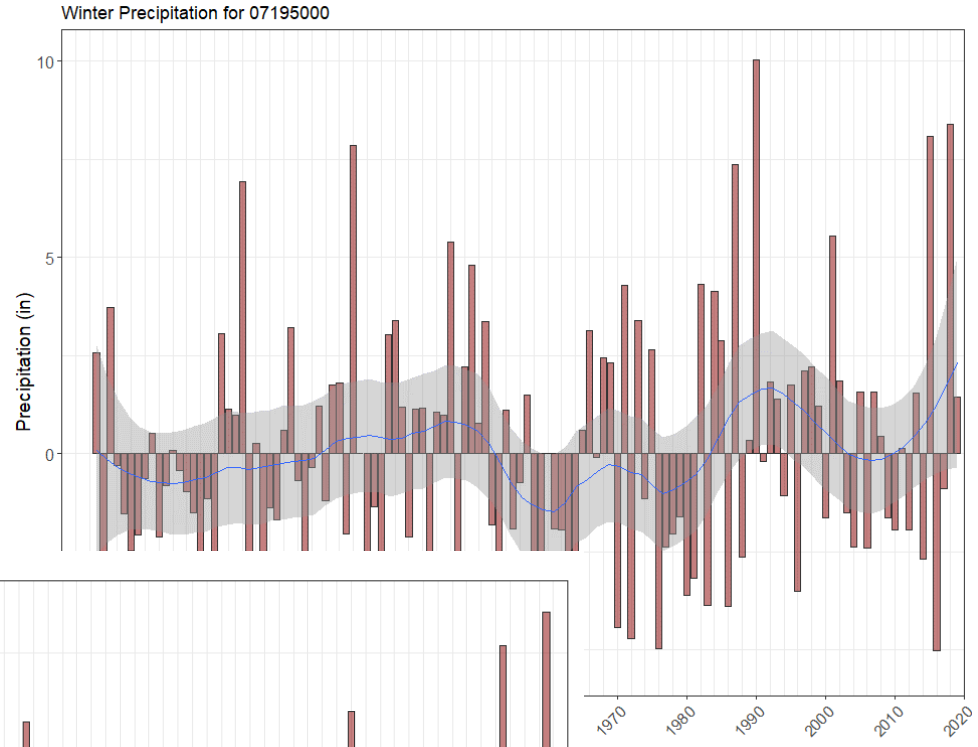
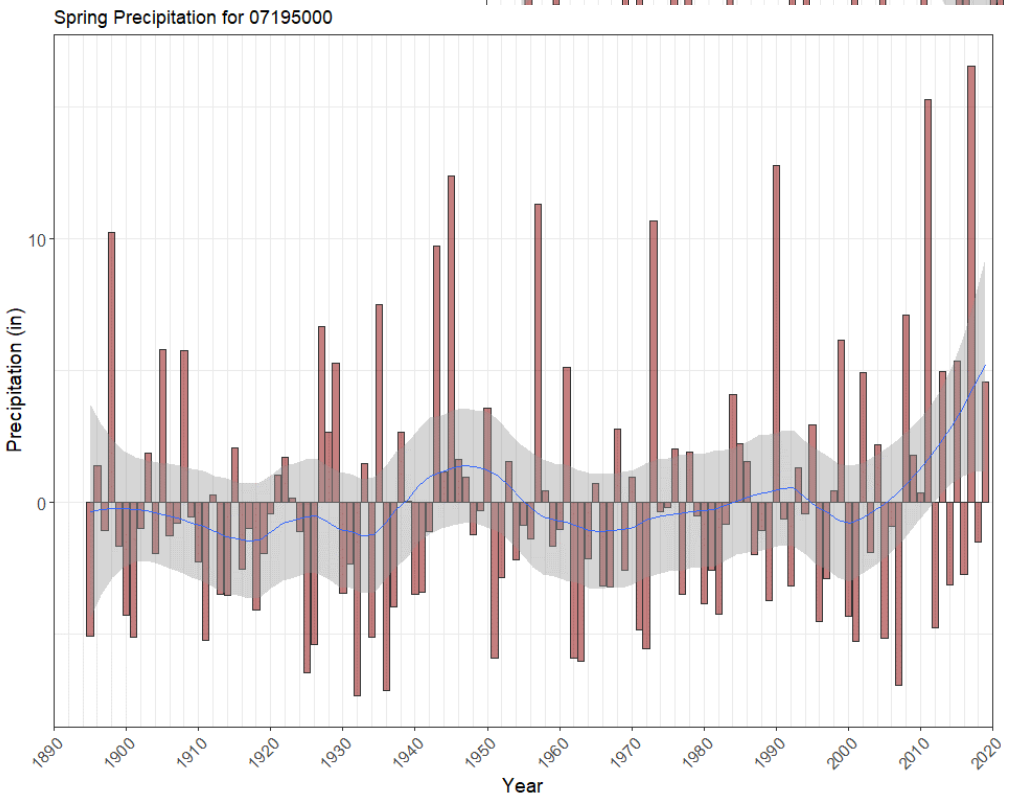
OSAGE CREEK NEAR ELM SPRINGS, AR







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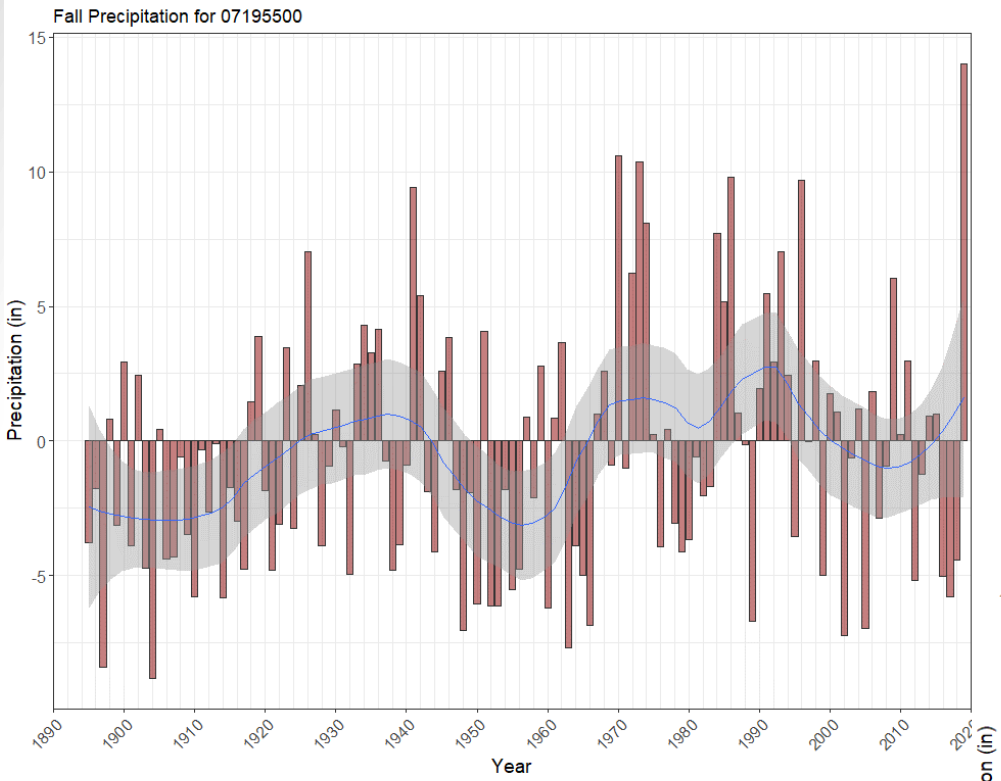
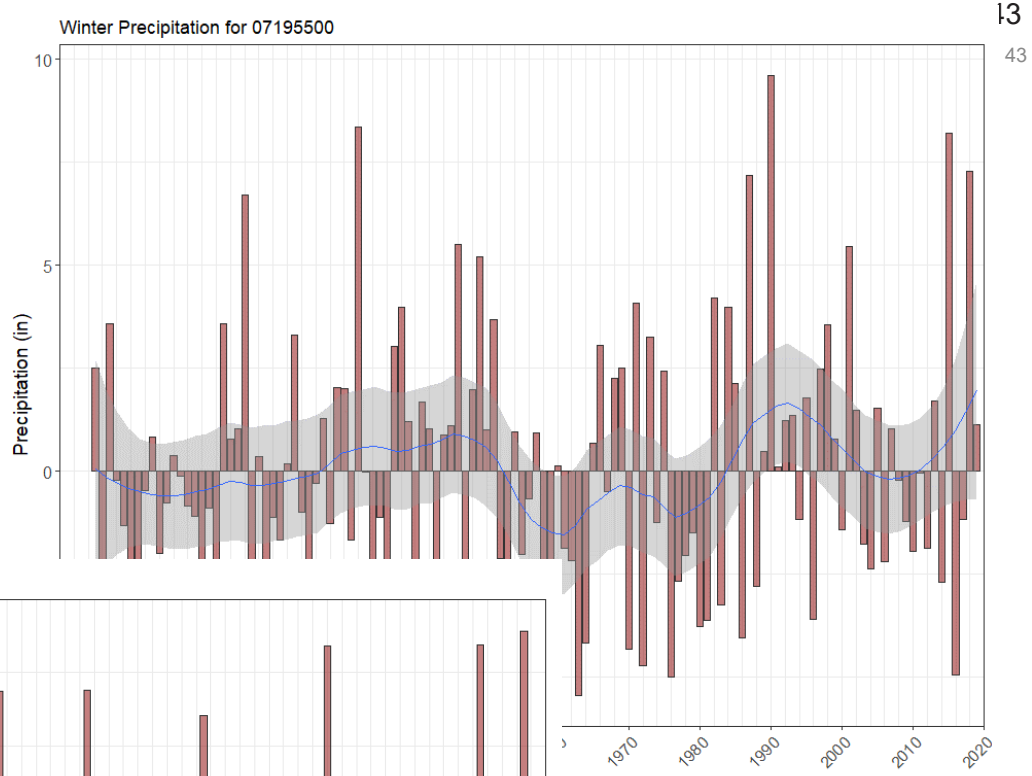
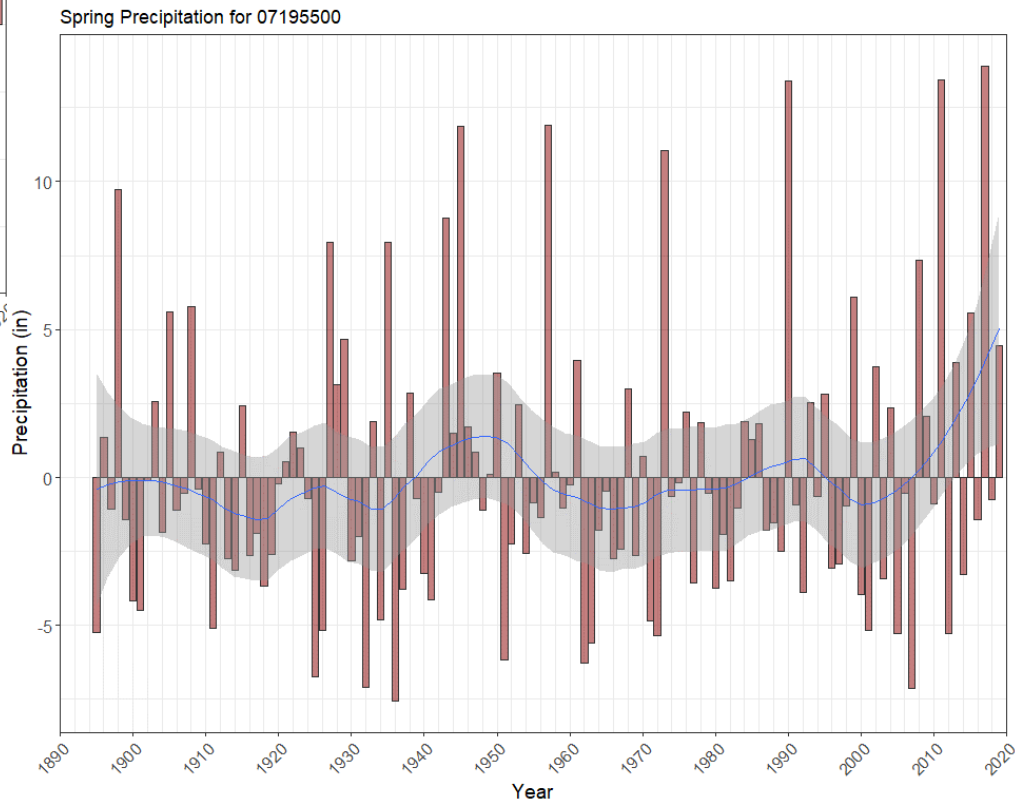
ILLINOIS RIVER NEAR WATTS, OK







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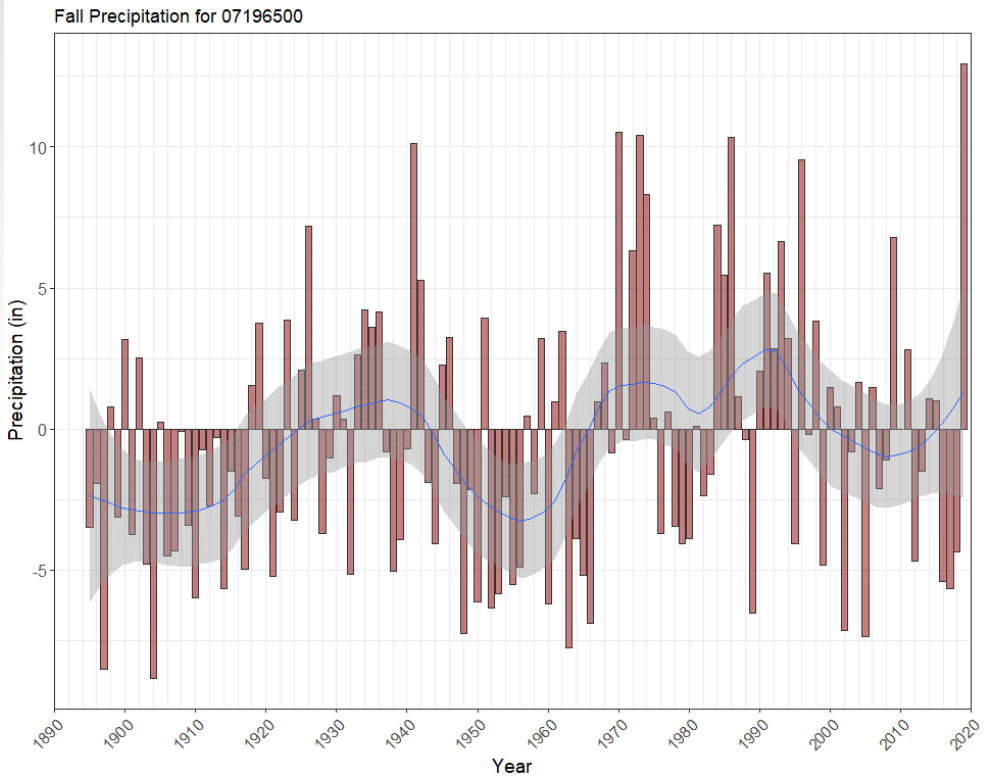
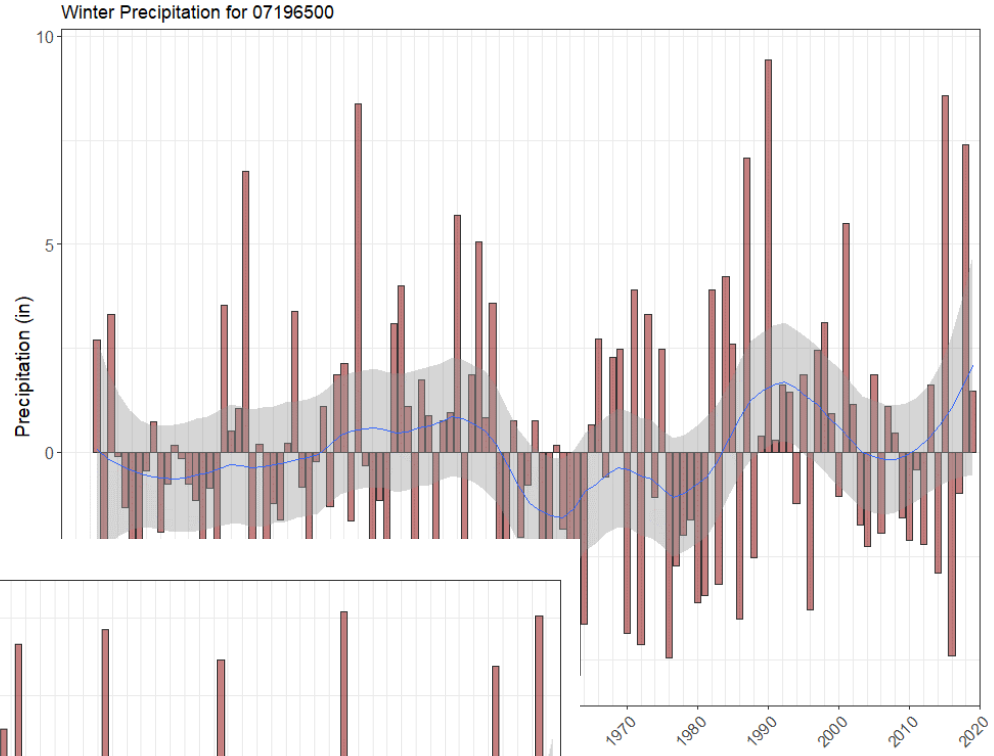
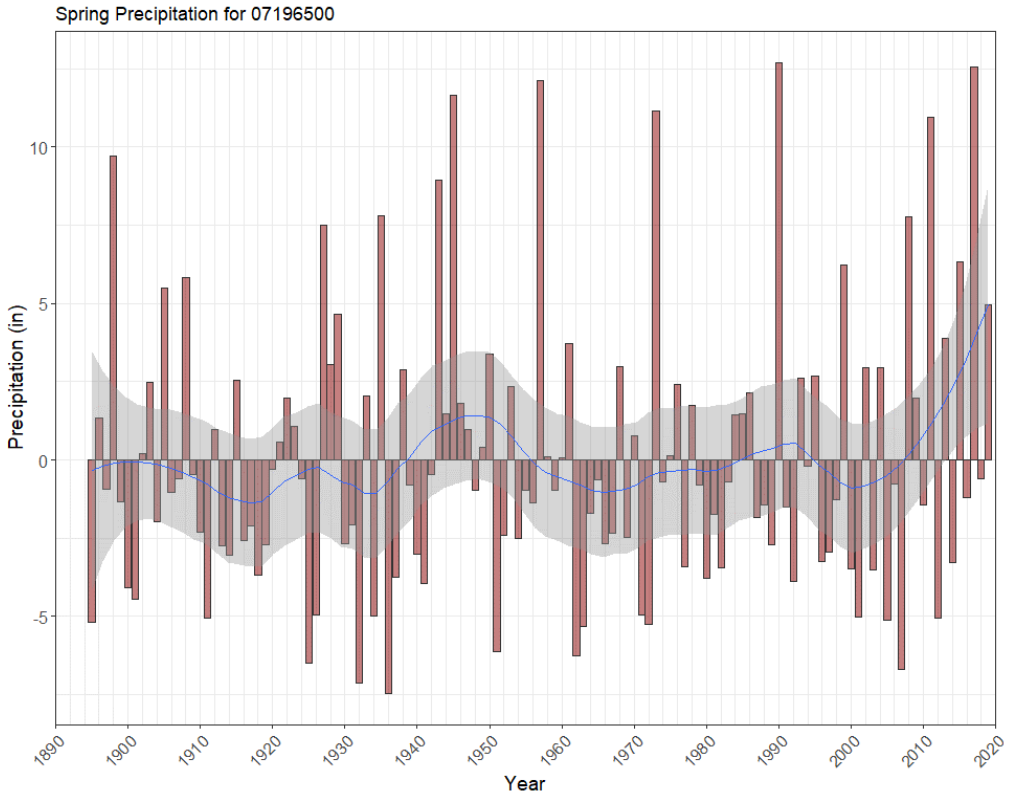
ILLINOIS RIVER NEAR TAHLEQUAH, OK







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