



Nebraska  
Department of Natural Resources

## NEBRASKA'S WATER MANAGEMENT RESOURCE

Providing the sound science and support for  
managing Nebraska's most precious resource.

### **Evaluating the Role of Precipitation Pattern on the Temporal Changes in Streamflow and Baseflow**

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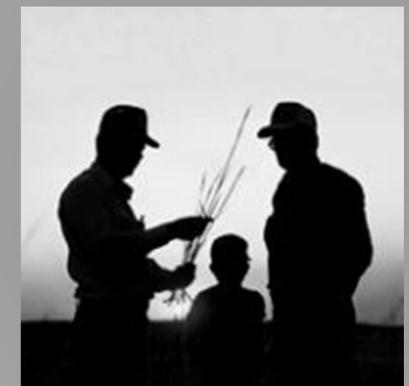
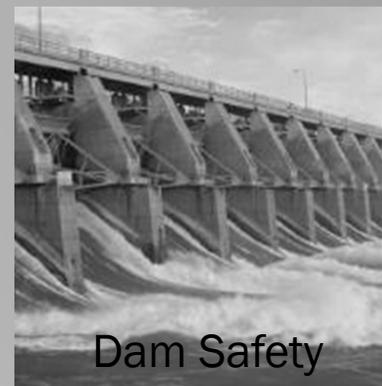
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**WATER TODAY. WATER TOMORROW.**

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IMPLEMENTATION

Water Management  
Projects

Strategic Planning Actions

PLANNING  
AND PUBLIC  
PARTICIPATION

Goals and Objectives  
for Water Planning

Stakeholder Involvement

Water Availability and Water  
Shortages

Water Supplies and Water Uses

SCIENCE

Hydrologic Models, Data, and Analyses

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# Changes in Precipitation Pattern

- Evaluating the presence of precipitation pattern changes
  - Period
  - Quantity
  - Type
  - Intensity
- Precipitation pattern changes can impact:
  - Infiltration (runoff, groundwater, and baseflow)
  - Recharge (groundwater, baseflow)
  - Surface runoff (streamflow)

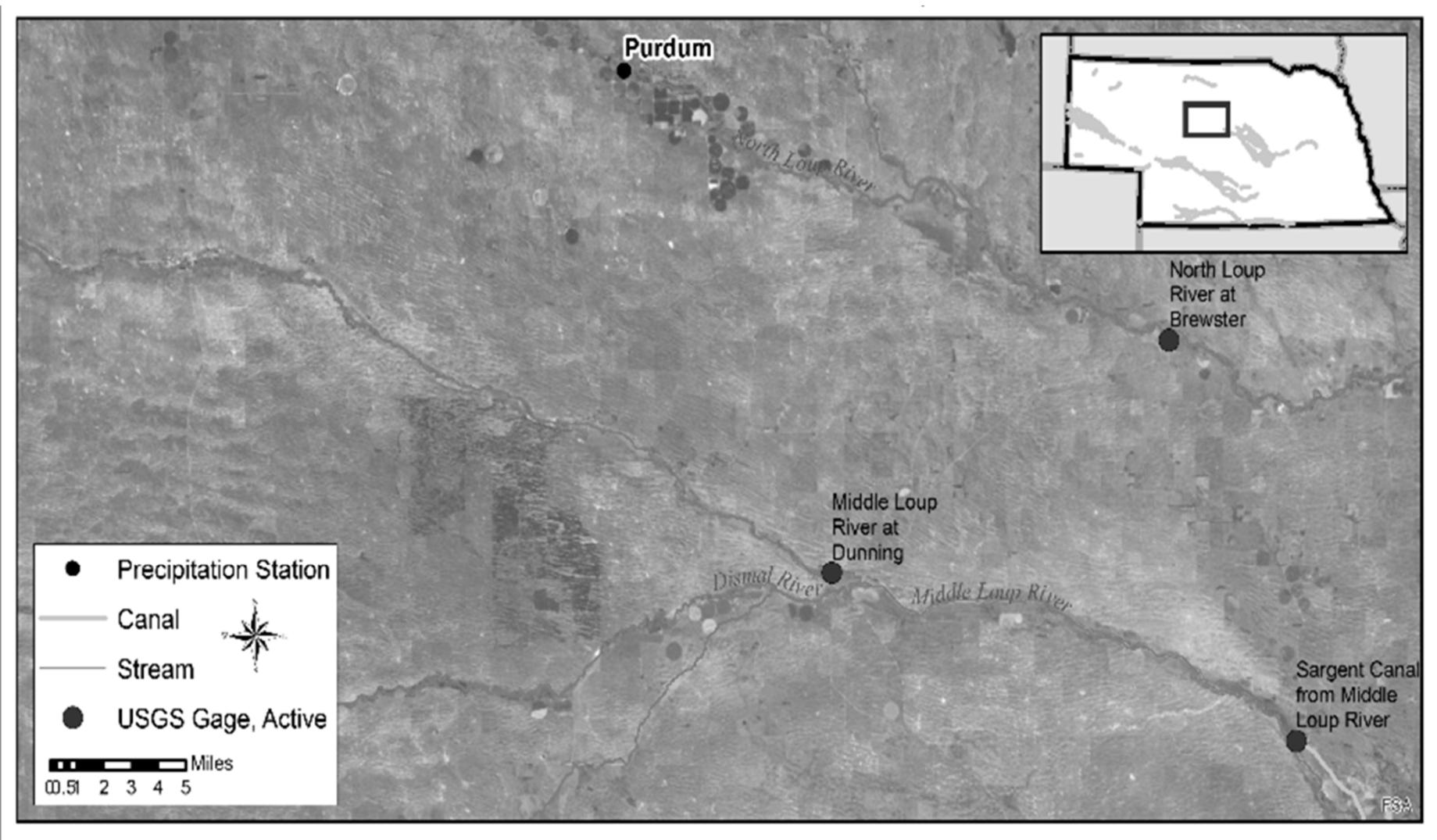
# Objective

- Are there any long term temporal trends
  - Total streamflow
  - Baseflow
  - Runoff
- Do the changes in precipitation pattern contribute to these trends?

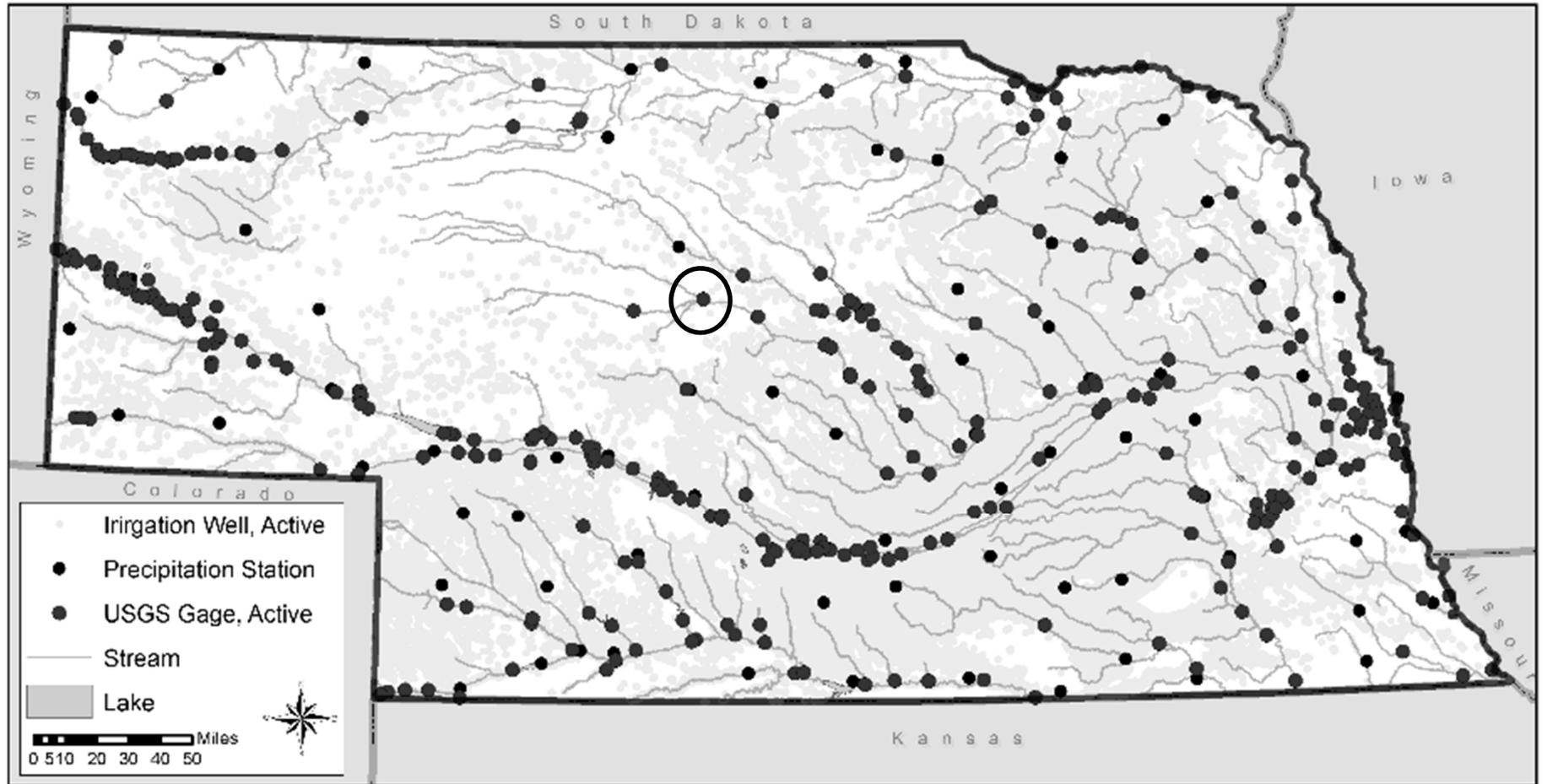
# Background

- Nebraska legally recognized hydrological connection
- The statute tasks:
  - DNR administer surface water
  - Natural Resources Districts administer groundwater
  - Integrated management to protect water users
- The DNR evaluates:
  - Streamflow trends
  - Trends in components impacting streamflow

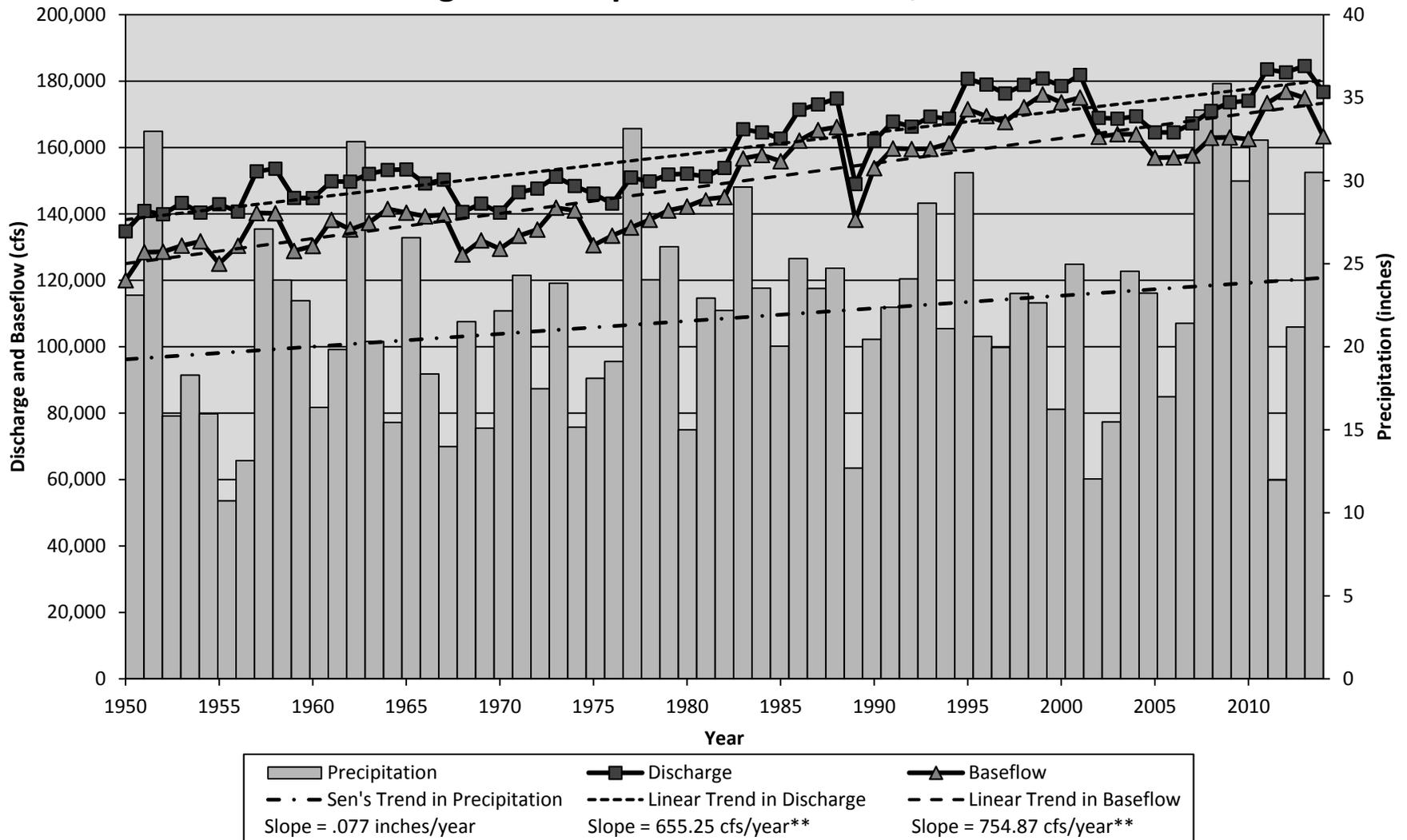




# Nebraska Active Irrigation Wells

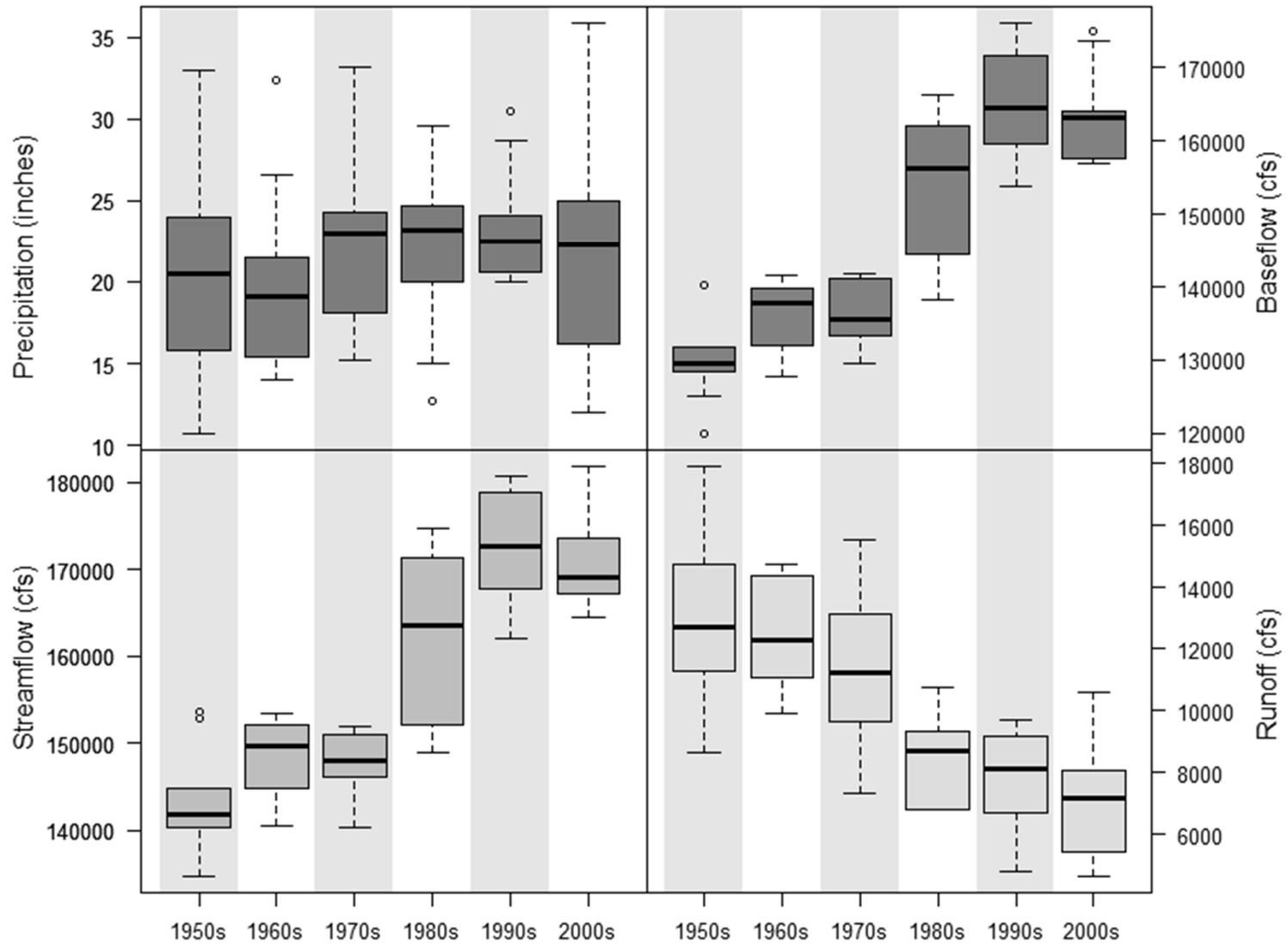


## Annual Total Discharge and Baseflow of the Middle Loup River at Dunning and Precipitation at Purdum, Nebraska

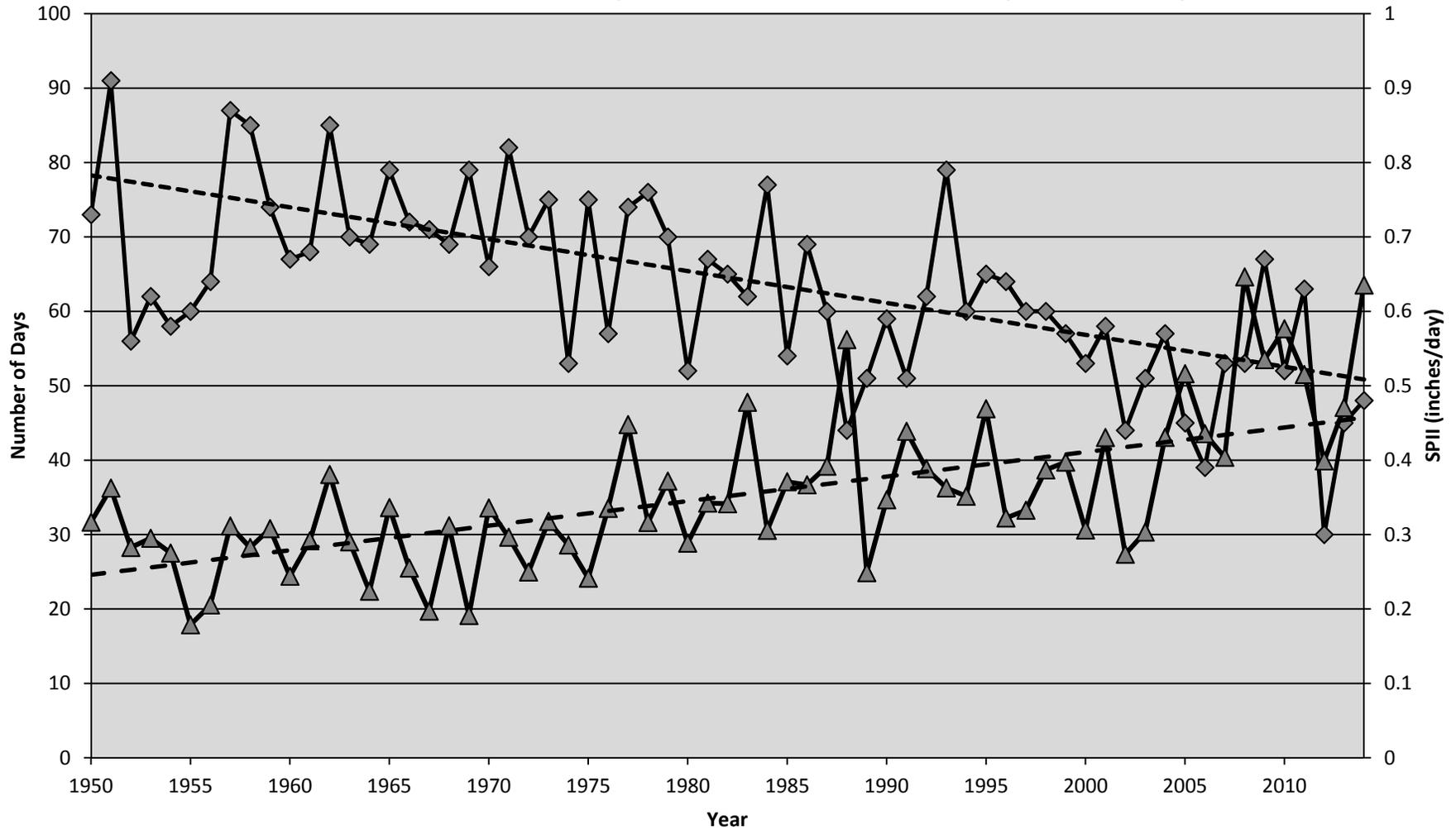


\*\*Statistically significant at 95% confidence

### Decadal Distribution of Streamflow and Runoff of Middle Loup River at Dunning and Precipitation at Purdum



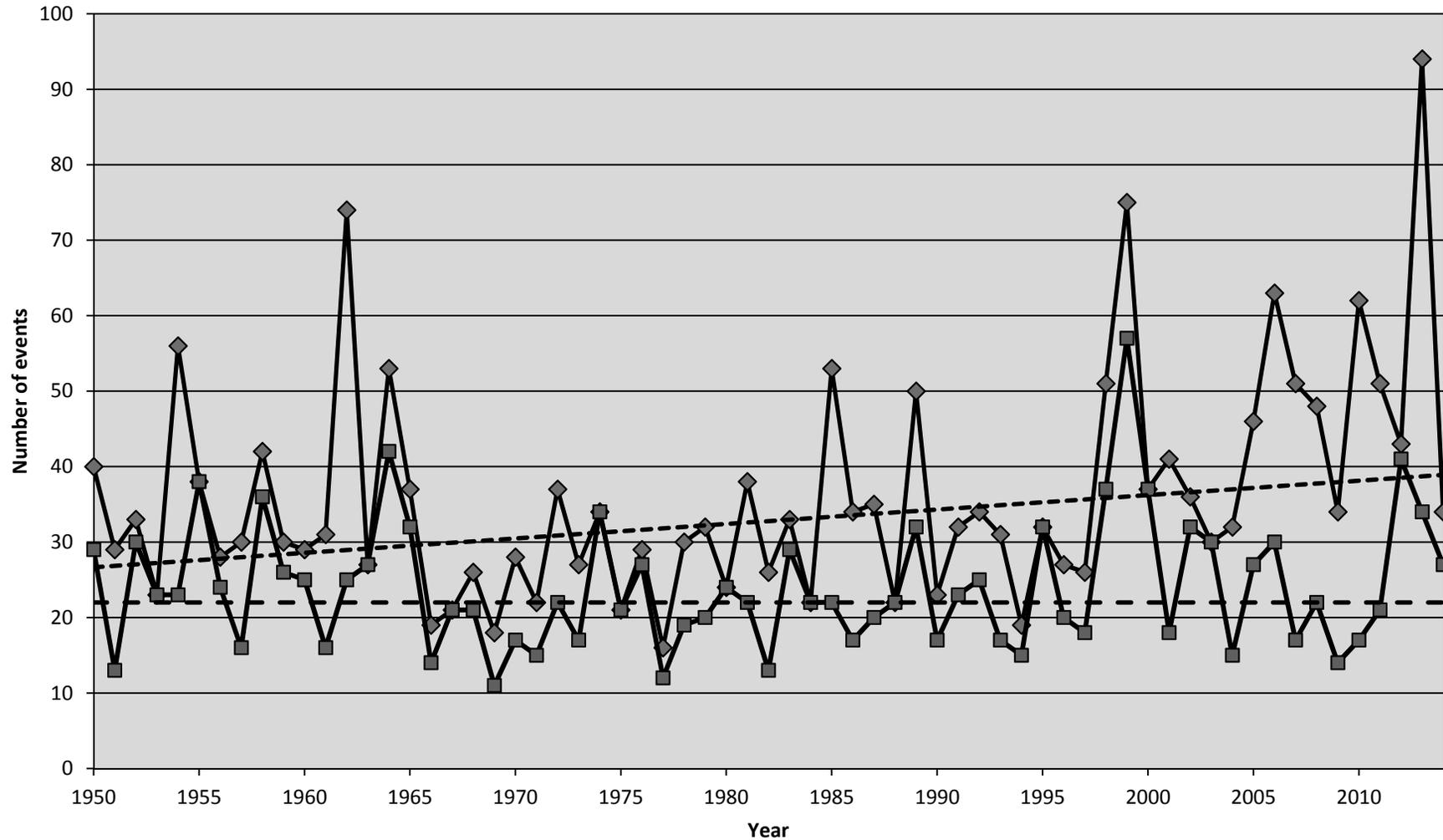
## Annual Number of Days with Precipitation and the Simplified Precipitation Index (Annual Total Precipitation/Number of Precipitation Days)



Number of Wet Days	Sen's Trend in Number of Wet Days	Slope = -0.43 days/year**
Annual SPII	Sen's Trend in Annual SPII	Slope = 0.0033 inches per day/year**

\*\*Statistically significant at 95% confidence

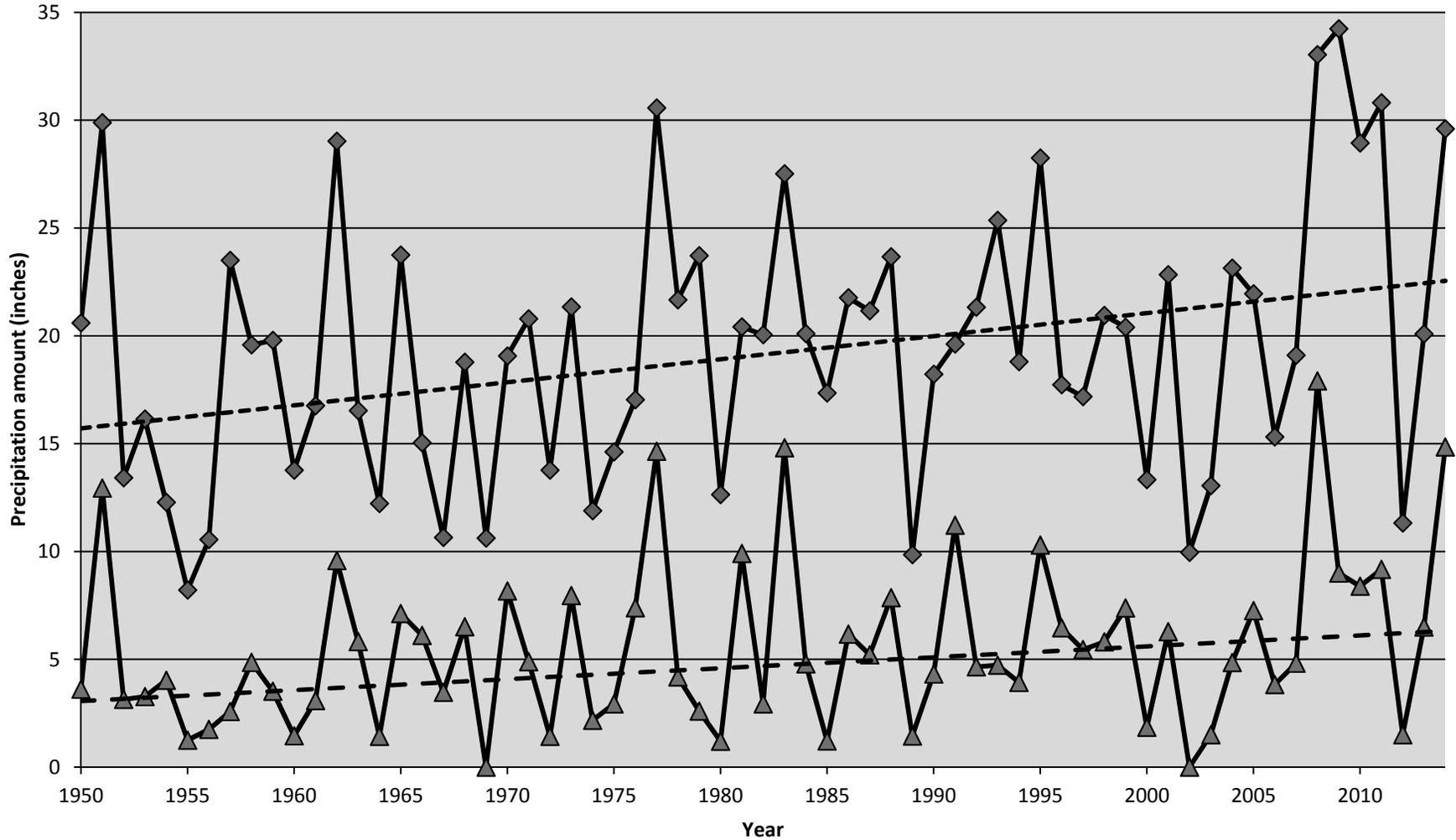
## Annual and Wet Season Maximum Lengths of Consecutive Days without Precipitation



◆ AnnDry  
 ■ SeaDry  
 - - - Sen's Trend AnnCDD  
 - - - Sen's Trend WetSeaCDD  
 Slope = 0.19 days/year\*\*  
 Slope = 0.00 days/year

\*\*Statistically significant at 95% confidence

## Annual Total Precipitation Amounts from Events in the Greatest 50<sup>th</sup> and 95<sup>th</sup> Percentiles



Annual precipitation from 50th percentile (0.2 inches)
  Annual precipitation from 95th percentile (1.2 inches)

Sen's Trend in 50th percentile total precipitation
  Sen's Trend in 95th percentile total precipitation

Slope = 0.11 inches/year\*\*
 Slope = 0.051 inches/year\*\*

\*\*Statistically significant at 95% confidence

# Summary

- Slight increasing trend in annual precipitation
- Declining precipitation events per year
  - Precipitation decrease in the dry season
- Increasing total streamflow and baseflow
- Decreasing trend in runoff

# Conclusions

- Possible explanations for increased streamflow and baseflow
  - Increasing intensity of rainfall may result in greater recharge rates
  - Greater recharge rates can elevate groundwater table and baseflow
  - Increased baseflow can surge total streamflow
  
- Possible explanations to decreased runoff
  - Decreased events in the dry season (dry soils) reduces runoff
  - Rainfall interception by a manmade forest (Halsey National Forest)
  - Changes to snowfall and snowmelt timing
  - Distance between weather station and gage

# Acknowledgments

- Kari Burgert
- Rick Vollertsen
- Elise Jared



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# THANK YOU

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<b>Correlation Coefficients</b>	<b>Stream flow</b>	<b>Base flow</b>	<b>Runoff</b>	<b>Total Prcp</b>	<b>Total Prcp ≥ 0.2 in/day</b>	<b>Total Prcp ≥ 1.2 in/day</b>	<b>Annual Max Wet Spell</b>	<b>Annual Max Dry Spell</b>	<b>Wet Season Max Wet Spell</b>	<b>Wet Season Max Dry Spell</b>
<b>Streamflow</b>	1	0.99	-0.60	0.29	0.35	0.26	0.04	0.34	0.02	0.19
<b>Baseflow</b>	0.99	1	-0.72	0.23	0.30	0.22	0.00	0.33	-0.03	0.20
<b>Runoff</b>	-0.60	-0.72	1	0.11	0.07	0.04	0.22	-0.17	0.23	-0.15
<b>Total Prcp</b>	0.29	0.23	0.11	1	0.99	0.79	0.28	0.08	0.27	-0.34
<b>Total Prcp ≥ 0.2 in</b>	0.35	0.30	0.07	0.99	1	0.80	0.27	0.12	0.26	-0.31
<b>Total Prcp ≥ 1.2 in</b>	0.26	0.22	0.04	0.79	0.80	1	0.10	0.09	0.10	-0.16
<b>Annual Max Wet Spell</b>	0.04	0.00	0.22	0.28	0.27	0.10	1	0.10	0.98	-0.08
<b>Annual Max Dry Spell</b>	0.34	0.33	-0.17	0.08	0.12	0.09	0.10	1	0.10	0.52
<b>Wet Season Max Wet Spell</b>	0.02	-0.03	0.23	0.27	0.26	0.10	0.98	0.10	1	-0.06
<b>Wet Season Max Dry Spell</b>	0.19	0.20	-0.15	-0.34	-0.31	-0.16	-0.08	0.52	-0.06	1

# Baseflow Extraction

## ➤ Sens test

- A non-parametric test
- Similar to Mann-Kendal test or Kendal Tau
- Appropriate when the data contains cycles or seasonality
- It models how the “median” changes with time rather than the “mean”
- Much less sensitive to outliers

## ➤ Baseflow extraction – USGS and USBR program

- Calculate 5-day minimas
- Find turning points in these 5-day minimas
- Connect the turning points to obtain the baseflow hydrograph
- The graph is contained to equal the observed data
- Baseflow Index is the baseflow percent of the total streamflow

