APRIL 13 2019 MEDIA WORKSHOP

Hydrology Topics

SUMMARY

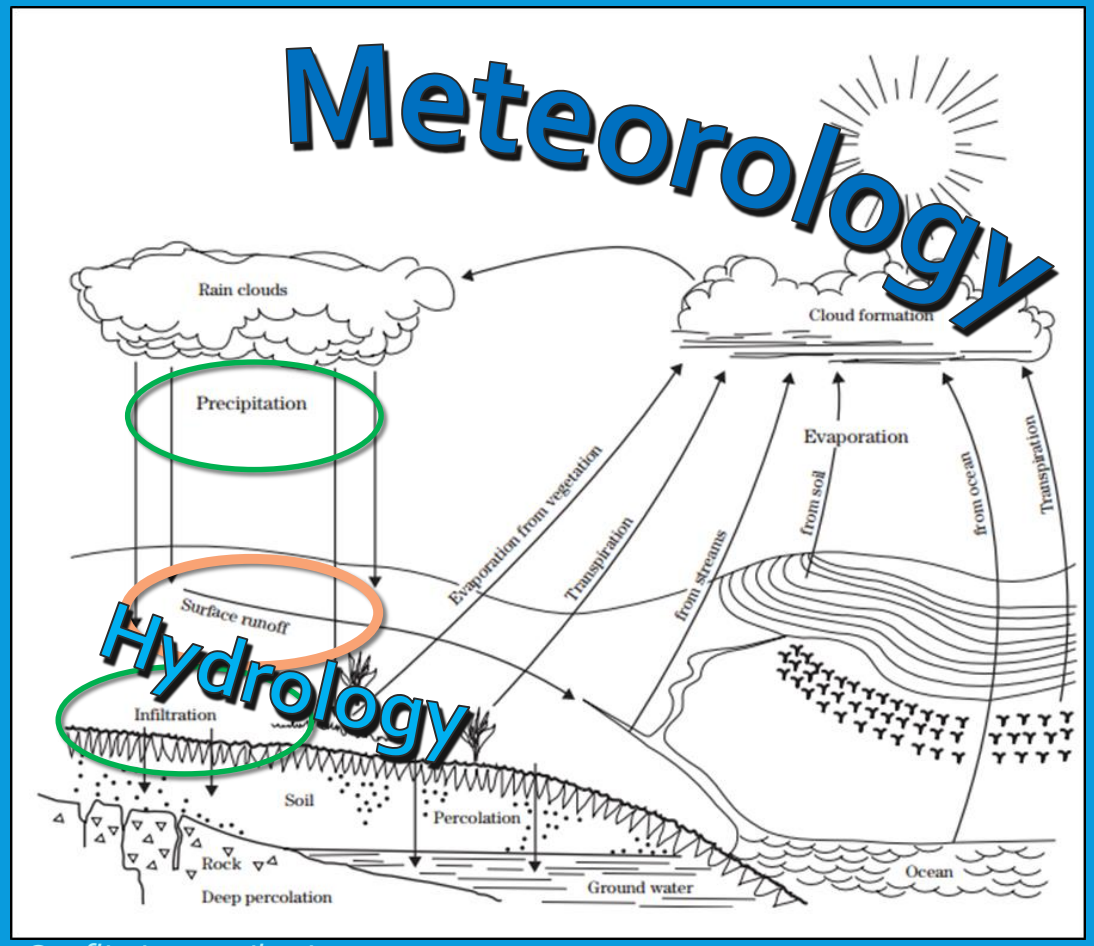
- Quick refresher/overview of how the NWS provides river forecast services
- Meteorology/hydrology factors of fall 2018 and spring 2019 flooding
- Trends in rainfall and streamflow across NE Illinois over the last several decades

NWS RIVER FORECAST SERVICES

An Overview

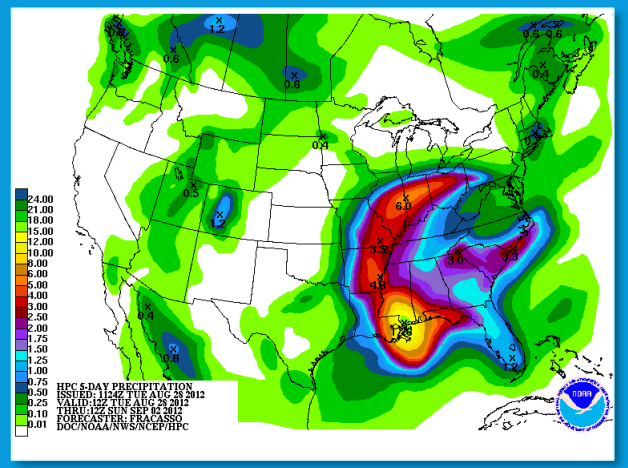
MAKING RIVER FORECASTS

- Hydrologists focus on water at the earth's surface
- Hydrologists at the National Weather Service use computer models to help determine **runoff**, the amount of rain water which heads directly to streams.
- Based upon expected river levels and impacts, the NWS issues watches, warnings, or advisories.



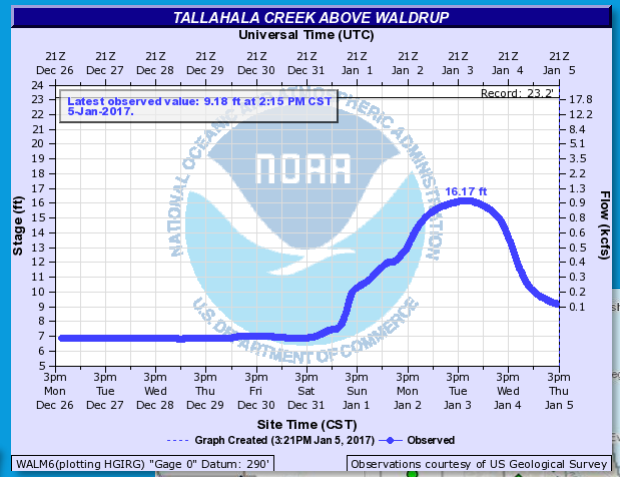
Conflicting attributions

MAKING RIVER FORECASTS

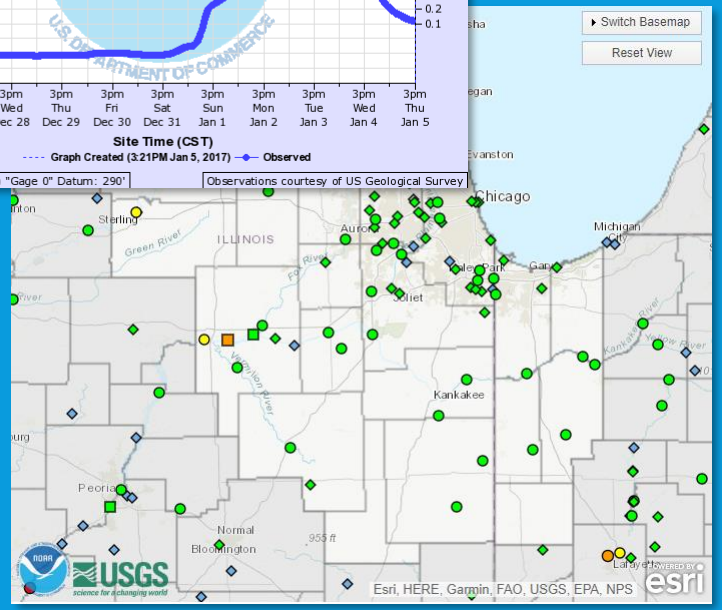


How much precipitation has fallen + will fall?

Where is it going to fall?



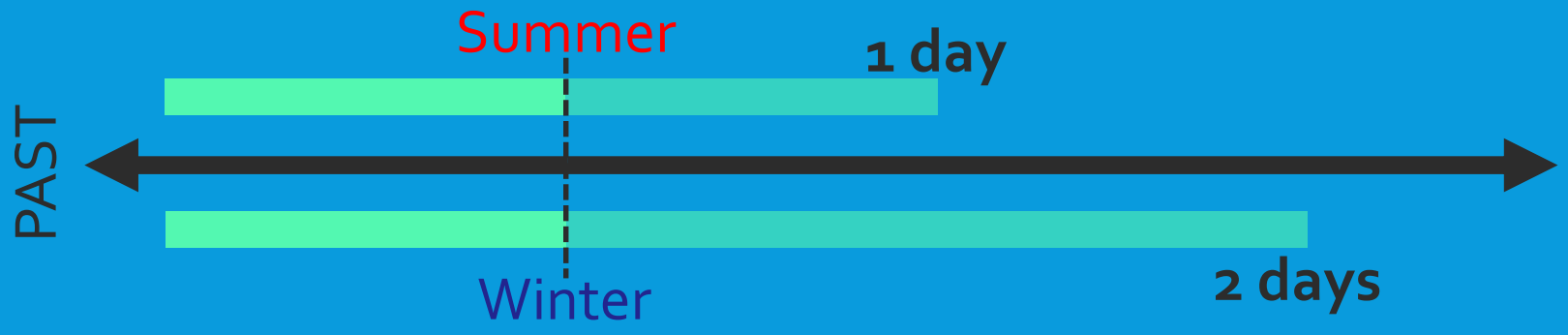
How quickly will runoff reach the rivers?



MAKING RIVER FORECASTS

River forecasts are based upon another forecast…

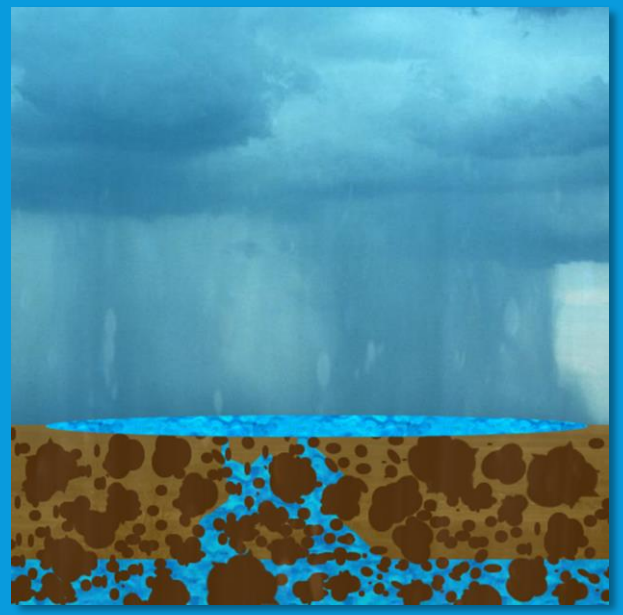
- River forecasts highly dependent on weather forecasts
- Small shifts in rainfall can move water into a different river basin entirely
- River forecasts use 24 hours of future rainfall in the summer, 48 hours in the winter (Oct 1 – Mar 31)



MAKING RIVER FORECASTS

River forecasts are complicated…

How saturated is the soil?



Will any precipitation be blocked or evaporated by vegetation?

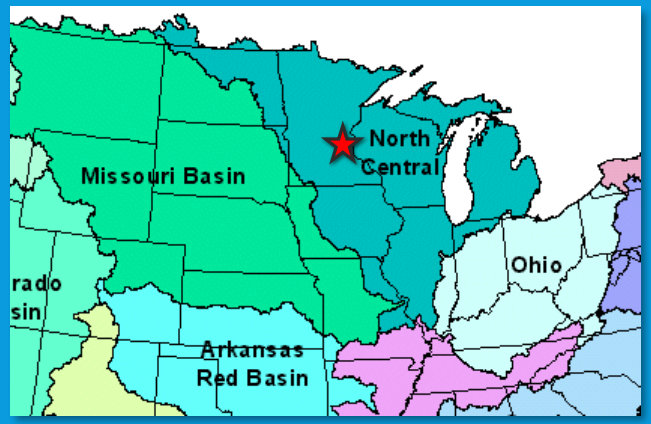
Is there snow cover?

MAKING RIVER FORECASTS

River Forecast Centers

Hydrology Forecasters:

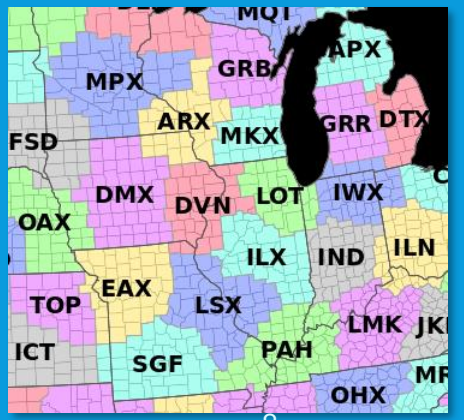
- Provide river forecast guidance to local weather forecast offices
- Develop and calibrate hydrology models



Local Weather Forecast Offices

Hydrology Program Managers:

- Document the impacts from flooding
- Work with local communities to determine water levels of concern
- Coordinate flood watches, warnings, and advisories based upon forecasts from river forecast centers



MAKING RIVER FORECASTS

How can I help improve river forecasts?

Report flooding to local NWS office!

- *Is water in a place it isn't normally during heavy rainfall?*
- *How deep? Is it moving?*
- *Is it in any structures?*
- *Are roadways closed?*
- *Anyone injured?*

Brad Smalley

MAKING RIVER FORECASTS

How can I help improve river forecasts?

Become a volunteer precipitation observer
cocorahs.org

Report severe weather via mPING app
mping.nssl.noaa.gov

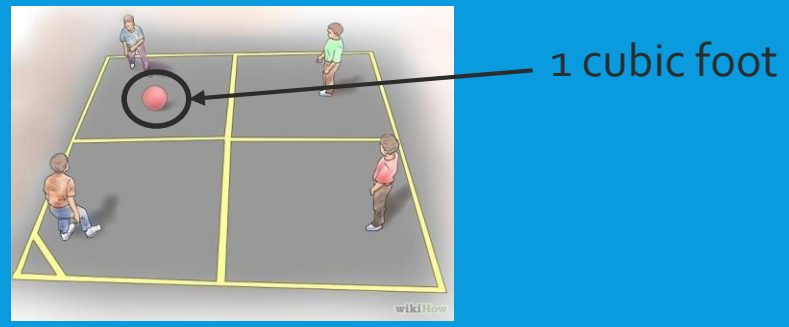
Report ice jams
Contact our NWS office

RELEVANT TERMS USED BY THE NWS TO DESCRIBE FLOODING

MEASURING RIVER LEVELS

How do we measure river levels?

- Stage
  Height of water above a reference elevation at a location.
- Discharge
  Rate of water moving past a location.
  Cubic feet per second = 1 very large playground ball.



MEASURING RIVER LEVELS

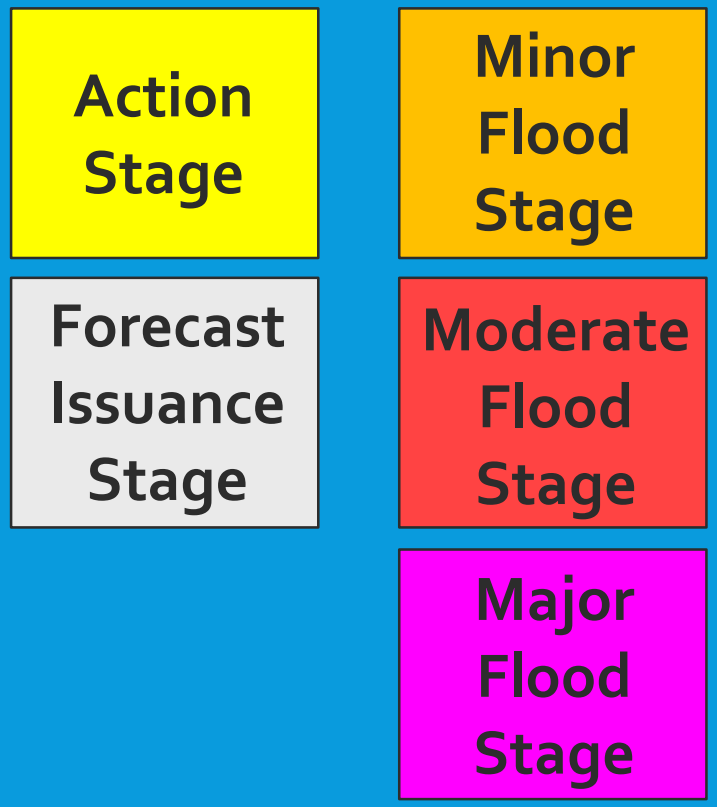
Each gauge represents a section of river

- Each river gauge is tied to a section of river called a "reach"
- River flood impacts along each section of river are tied to a stage on the river gauge

NWS FLOODING TERMS: IMPACT CATEGORIES

Action Stage	An established gage height where action is taken in preparation for possible significant hydrologic activity.
Forecast Issuance Stage	The stage where the National Weather Service begins issuing forecasts. By default, this stage is set the same as action stage.
Minor Flood Stage	Minimal property damage, but possibly some public threat. This may include inundation of roads.
Moderate Flood Stage	Some inundation of structures and roads. Evacuations of people and/or transfer of property to higher elevations.
Major Flood Stage	Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

NWS FLOODING TERMS: IMPACT CATEGORIES



Flood Impact Categories and Other Thresholds

- Are set based upon actual impacts due to river flooding
- Are set based upon the entire stretch of river covered by a gauge
- Are **NOT** meant to apply to any specific person or neighborhood

NWS FLOODING TERMS: IMPACT CATEGORIES

Action Stage	An established gage height where action is taken in preparation for possible significant hydrologic activity.

Flood Advisories are issued by the NWS when water levels are expected to reach this level.

- increased river monitoring by a community
- river restrictions
- moving property away from the river
- staffing of emergency operations centers
- often near bankfull level

NWS FLOODING TERMS: IMPACT CATEGORIES

Minor Flood Stage	Minimal property damage, but possibly some public threat. This may include inundation of roads.

*NOTE: Some flooding may already be occurring **BELOW** this level, but would generally be confined to areas away from people and property that can be damaged by water. Examples include forest land, low-lying sections of parks away from maintained trails.*

Flood Warnings are issued by the NWS when water levels are expected to reach this level.

- Roads impacted
- Heavily-used trails impacted
- Athletic fields impacted
- Water covering property near structures
- Utility sheds, boathouses impacted

NWS FLOODING TERMS: IMPACT CATEGORIES

Moderate Flood Stage	Some inundation of structures and roads. Evacuations of people and/or transfer of property to higher elevations.

- Major roads impacted
- Residences with water inundation at ground level (not basements)
- Major park structures impacted
- Commercial facilities near water impacted

NWS FLOODING TERMS: IMPACT CATEGORIES

Major Flood Stage	Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

- Expressways or interstates impacted
- Numerous residences impacted
- Hospitals, police, fire, or utilities impacted

NWS FLOODING TERMS: IMPACT CATEGORIES

- Are **NOT** meant to apply to any specific person or neighborhood. Think big, like comparing river to river, or region to region.
- Local community action plans may use similar language and terms, but they have different purposes.
- Don't base your actions on a flood impact category – know the elevation and river stage where you see flood impacts!

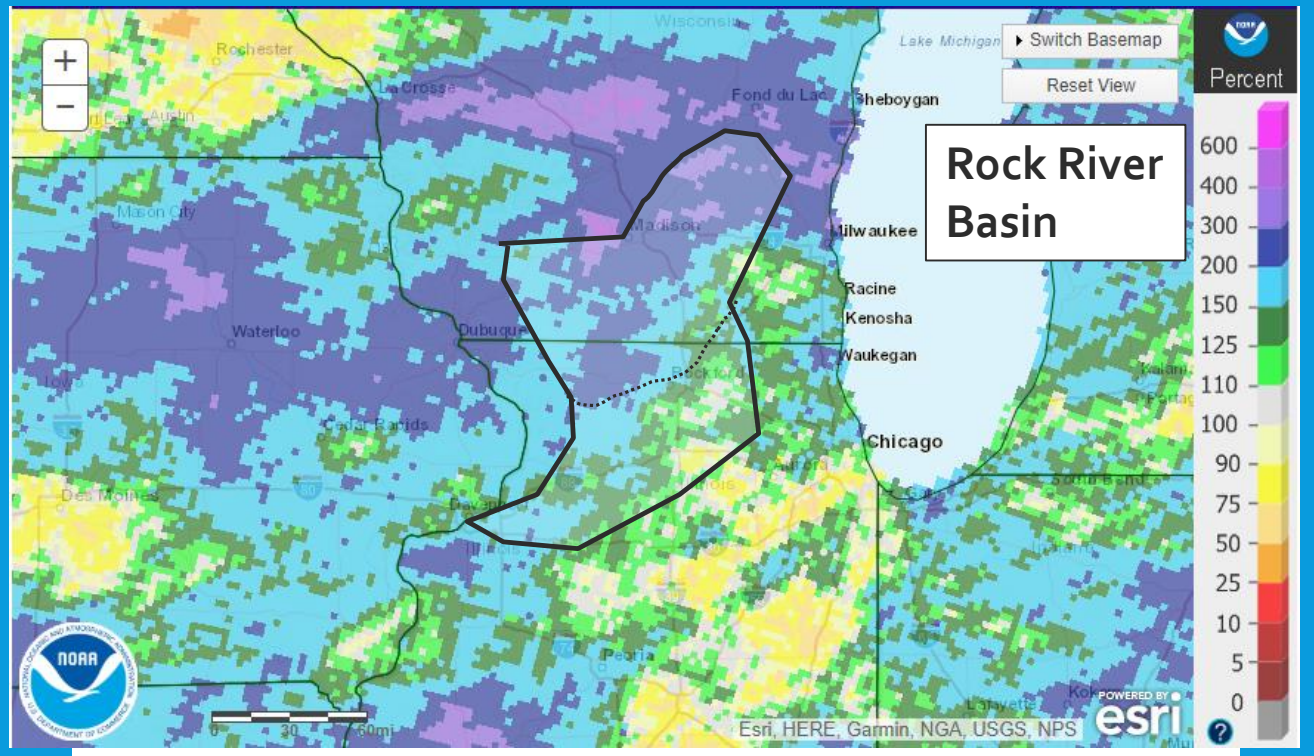
2018 AND 2019 RIVER FLOODING

The Meteorology and Hydrology Factors

2018 ROCK RIVER FLOODING

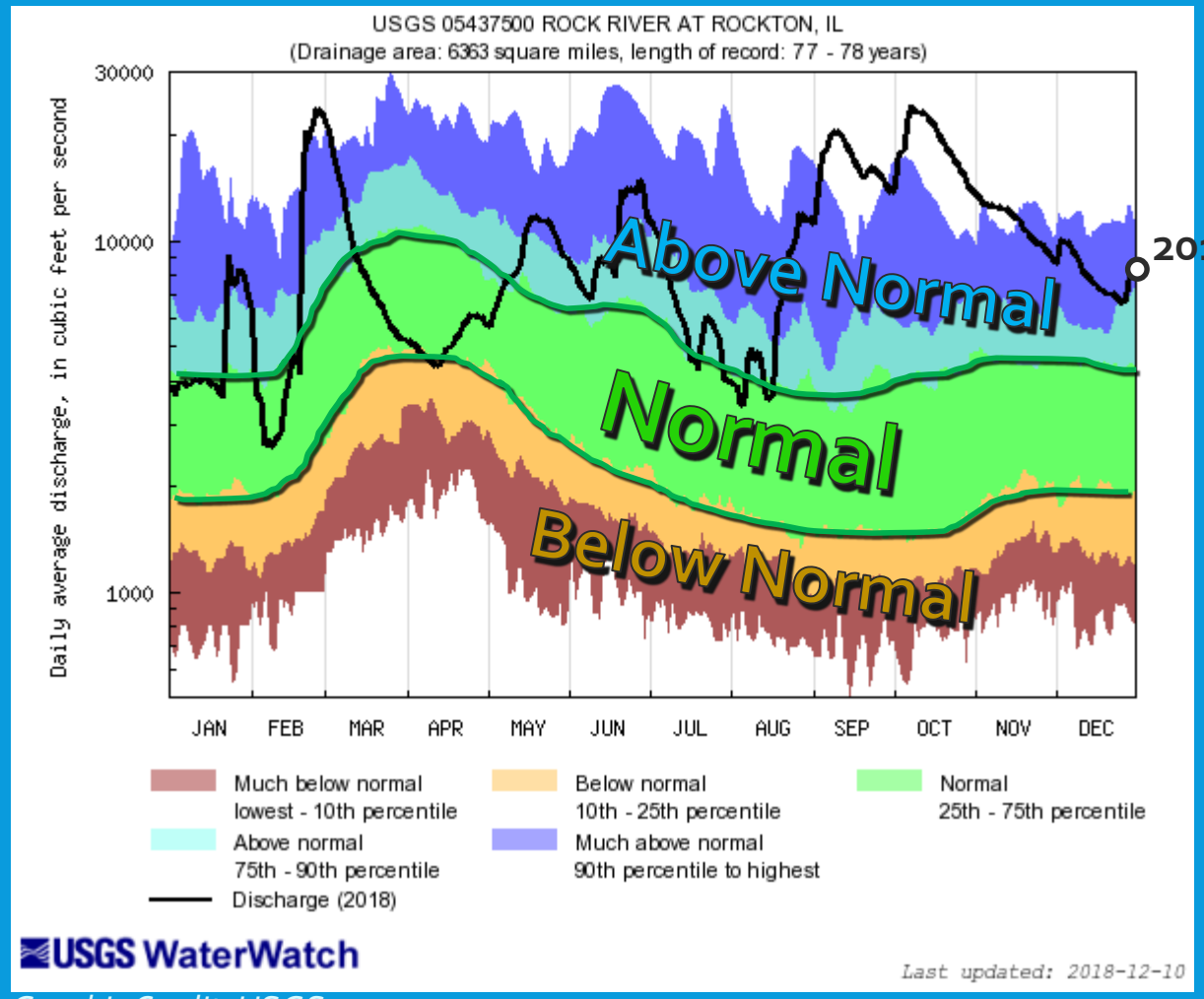
Many Factors Contributed to High Water in Fall 2018

- River levels elevated as early as spring 2018.
- Frequent rainfall kept soil moisture very high into late summer.
- Another heavy rainfall month in August… 150-400% of average.



Graphic Credits: NOAA Climate Prediction Center, NOAA AHPS

2018 ROCK RIVER FLOODING



Graphic Credit: USGS

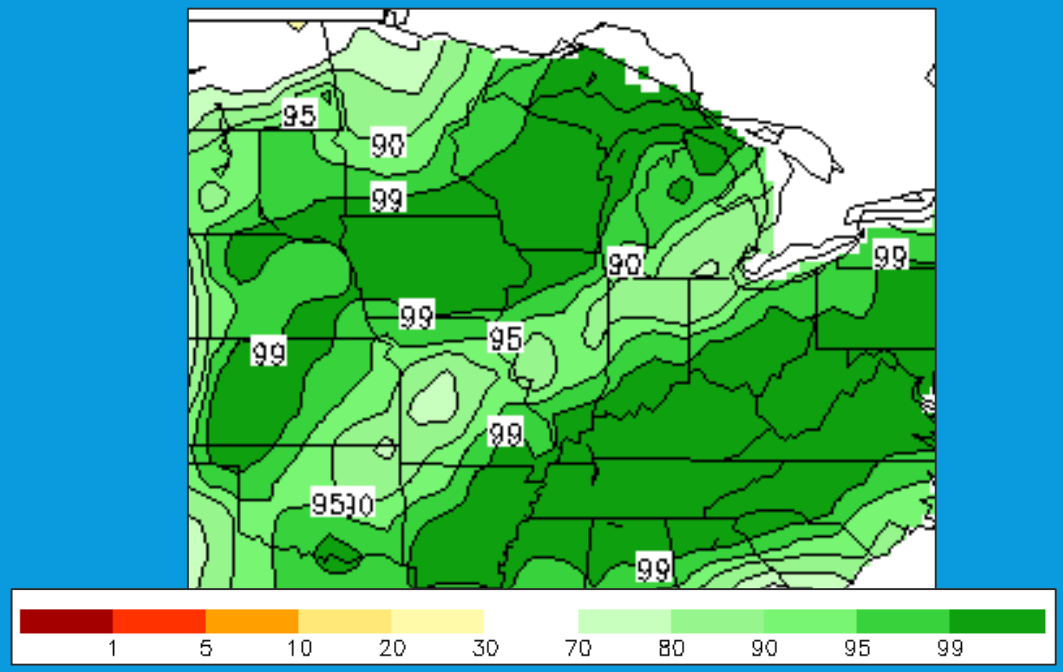
Streamflow/River Levels

- Streamflow values at Rockton gauge above average for most of the year
- Record highest streamflow values observed for most of September and October

2019 ROCK RIVER FLOODING

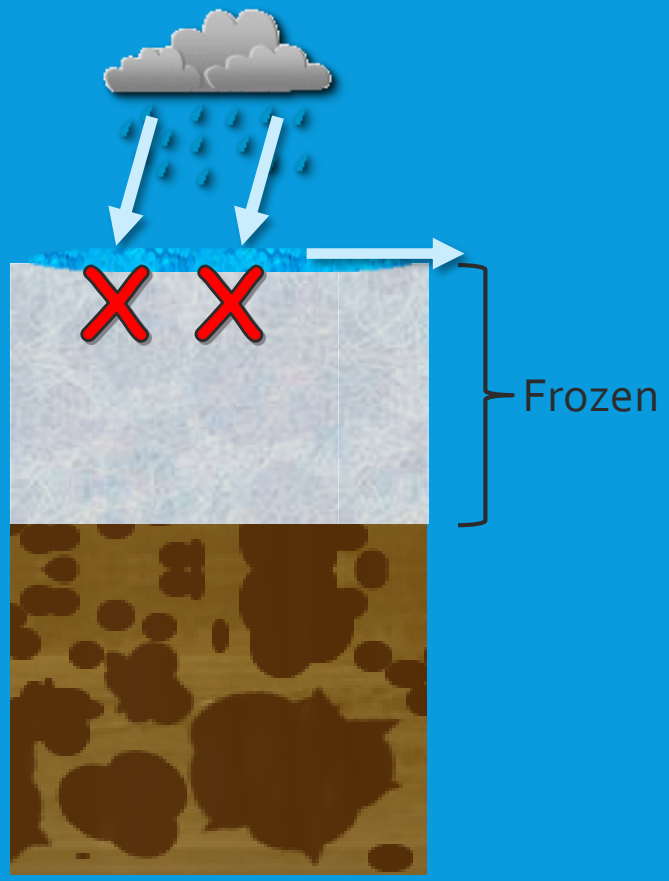
High Soil Moisture worsens…

- Fall 2018 flood left elevated soil moisture and elevated river levels late into the year
- Very little evaporation or transpiration during winter. Soil moisture stayed high.
- Soil moisture **wetter than than 99%** of previous March values



Graphic Credit: NOAA CPC

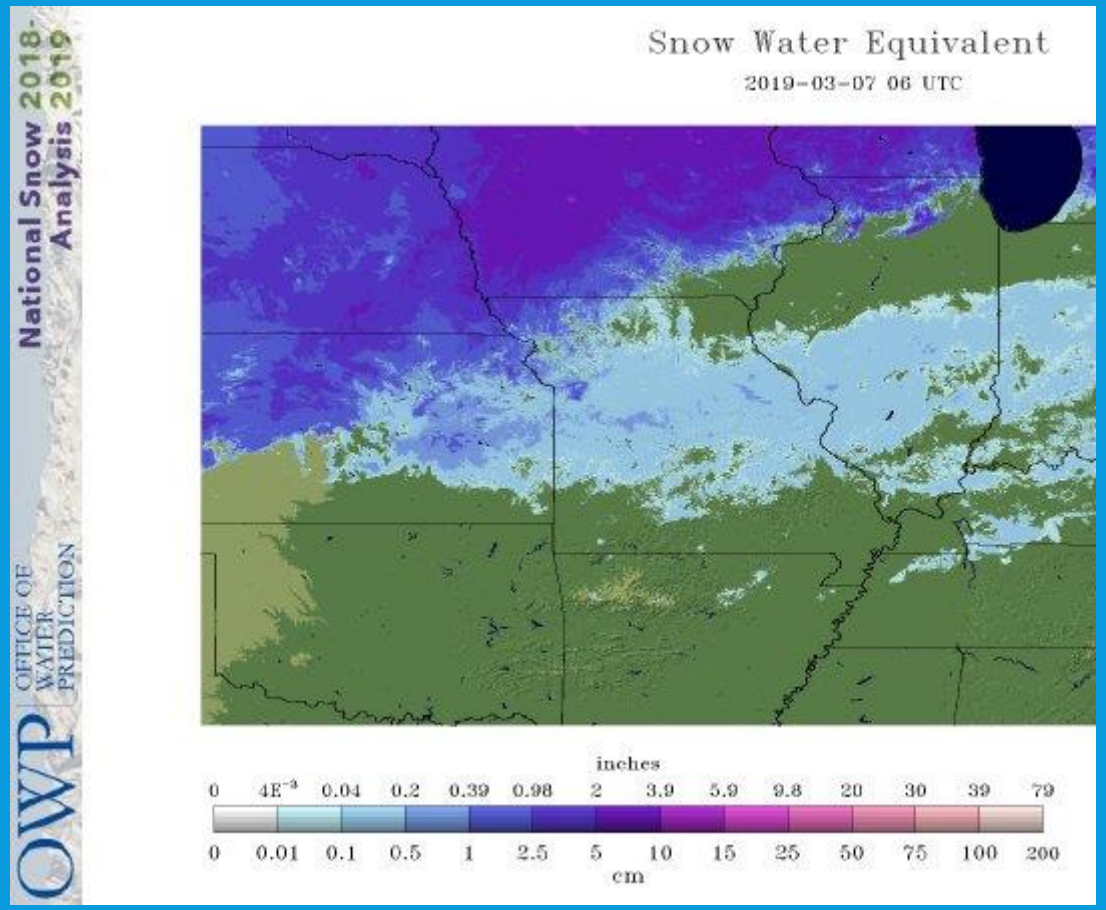
2019 ROCK RIVER FLOODING



Significant Frozen Ground / Frost Depth

- Some locations frozen to a depth of 1-2 feet.
- Little water can penetrate frozen ground – instead goes straight to runoff

2019 ROCK RIVER FLOODING



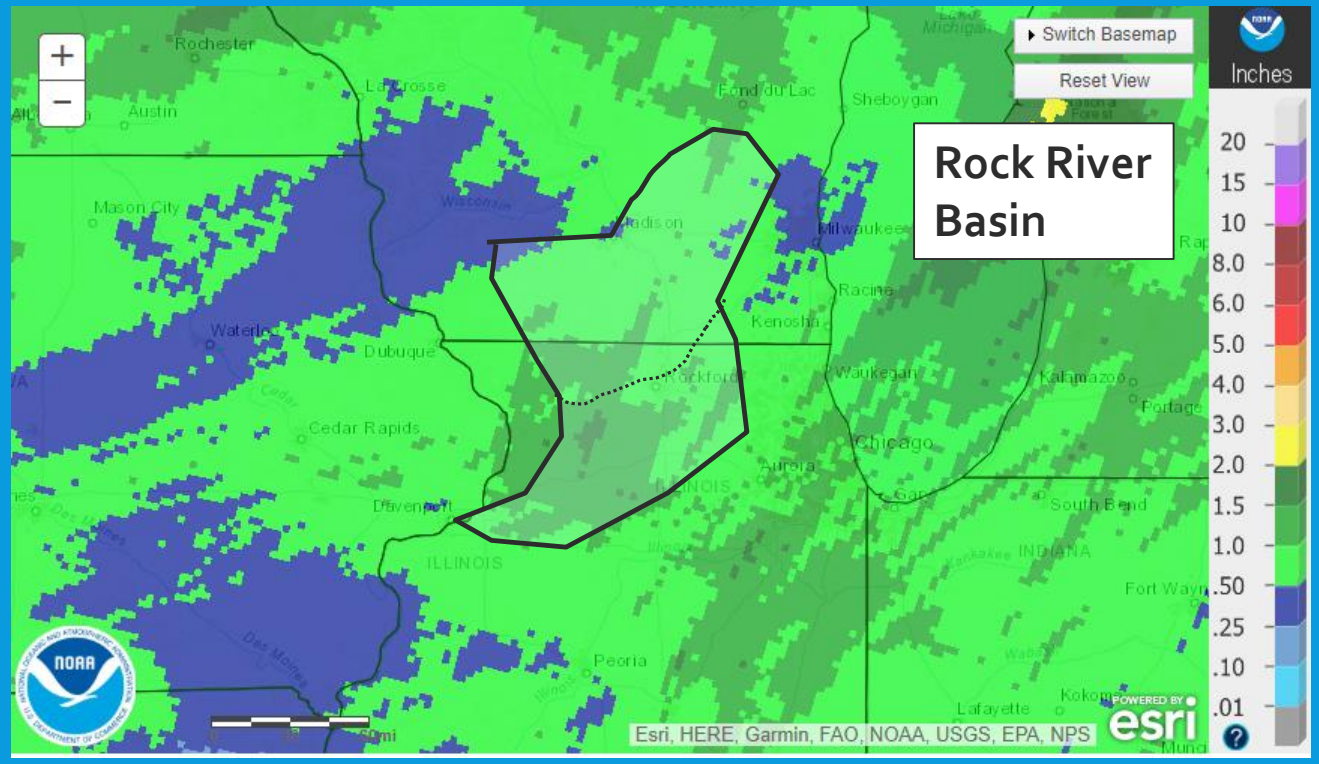
Significant Snow Cover

- Snow cover accumulated up to 8 inches depth in the Rock River Basin, with 2-4 inches of water equivalent

2019 ROCK RIVER FLOODING

Weather System Brings Rainfall

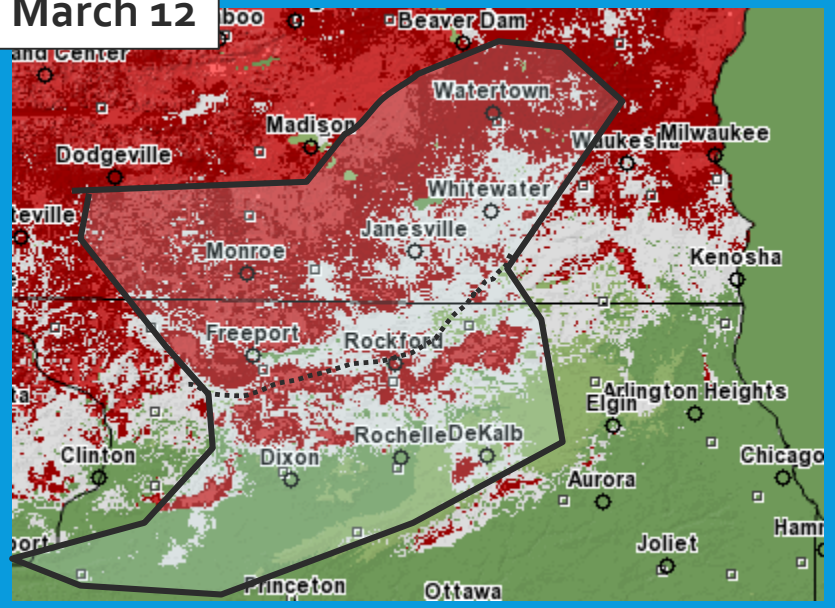
- 0.5 -1.5 inches of rainfall March 12-16 (most Mar 12-14)
- Upstream of Rockford 0.5-1.0 inches
- Generally light, not amounts typically associated with major flooding



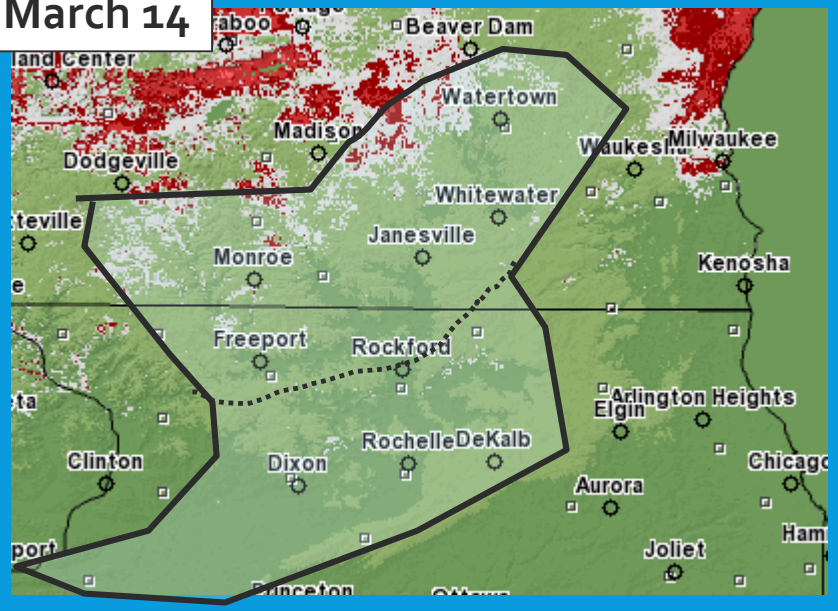
2019 ROCK RIVER FLOODING

…and Snow Melt

March 12

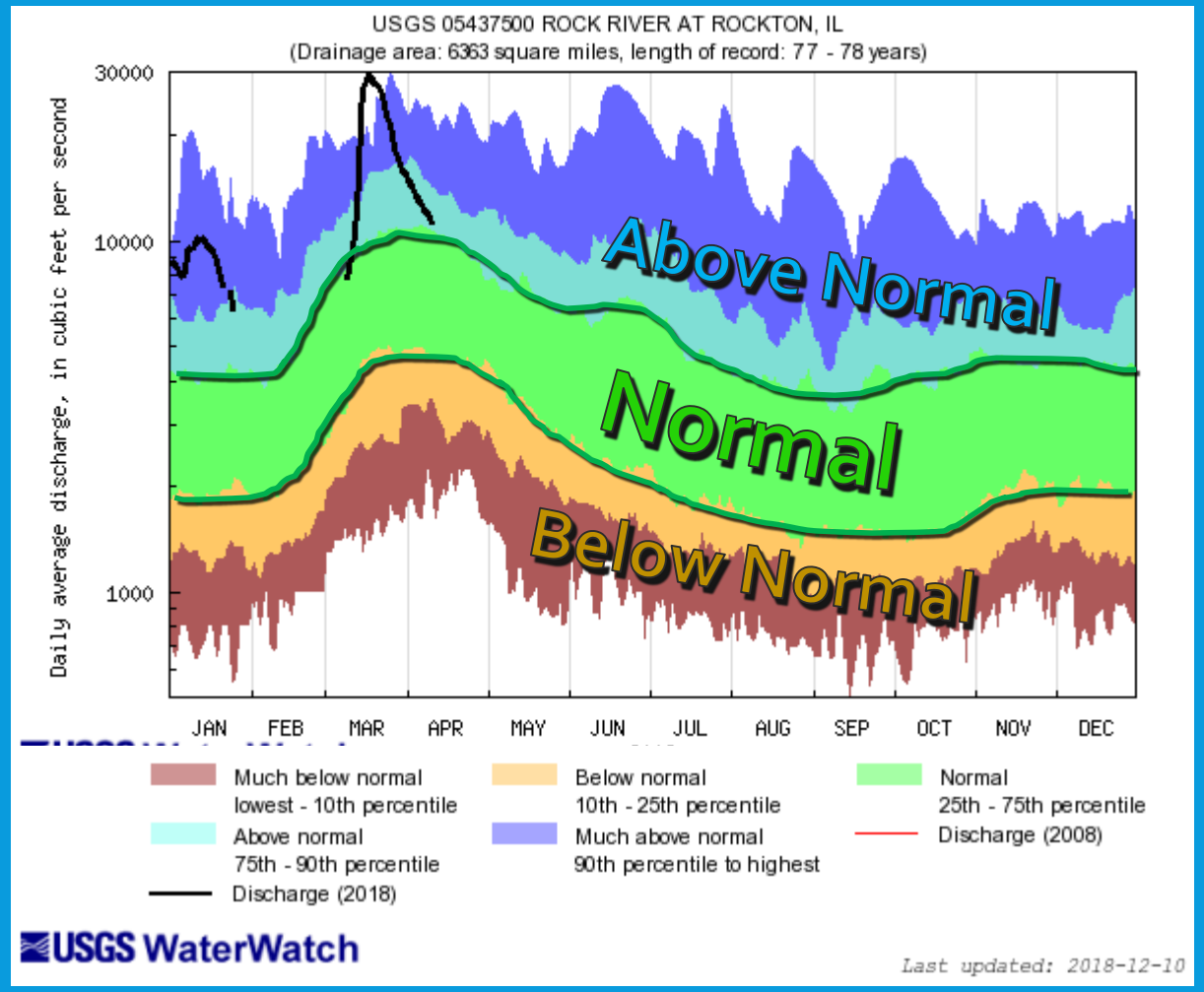


March 14



- Very warm temperatures melt almost all snow
- Like adding another 2-4 inches of rainfall over 2 days

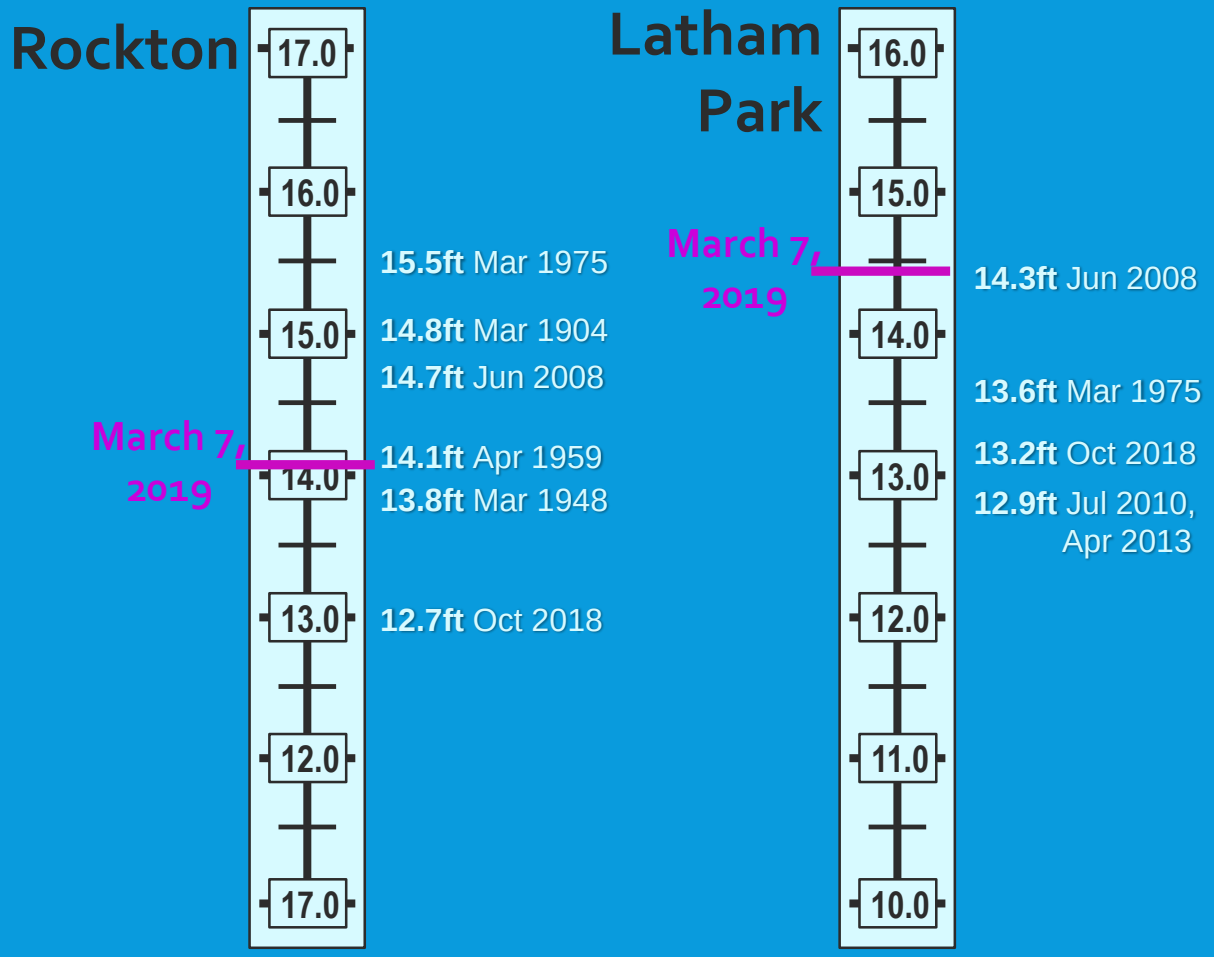
2019 ROCK RIVER FLOODING



Streamflow/River Levels

- Above average streamflow values continued into 2019
- If dry weather continues in Rock River basin, we may get back into near normal territory in a couple weeks

2019 ROCK RIVER FLOODING



Spring 2019 Flood compared to other Rock River floods

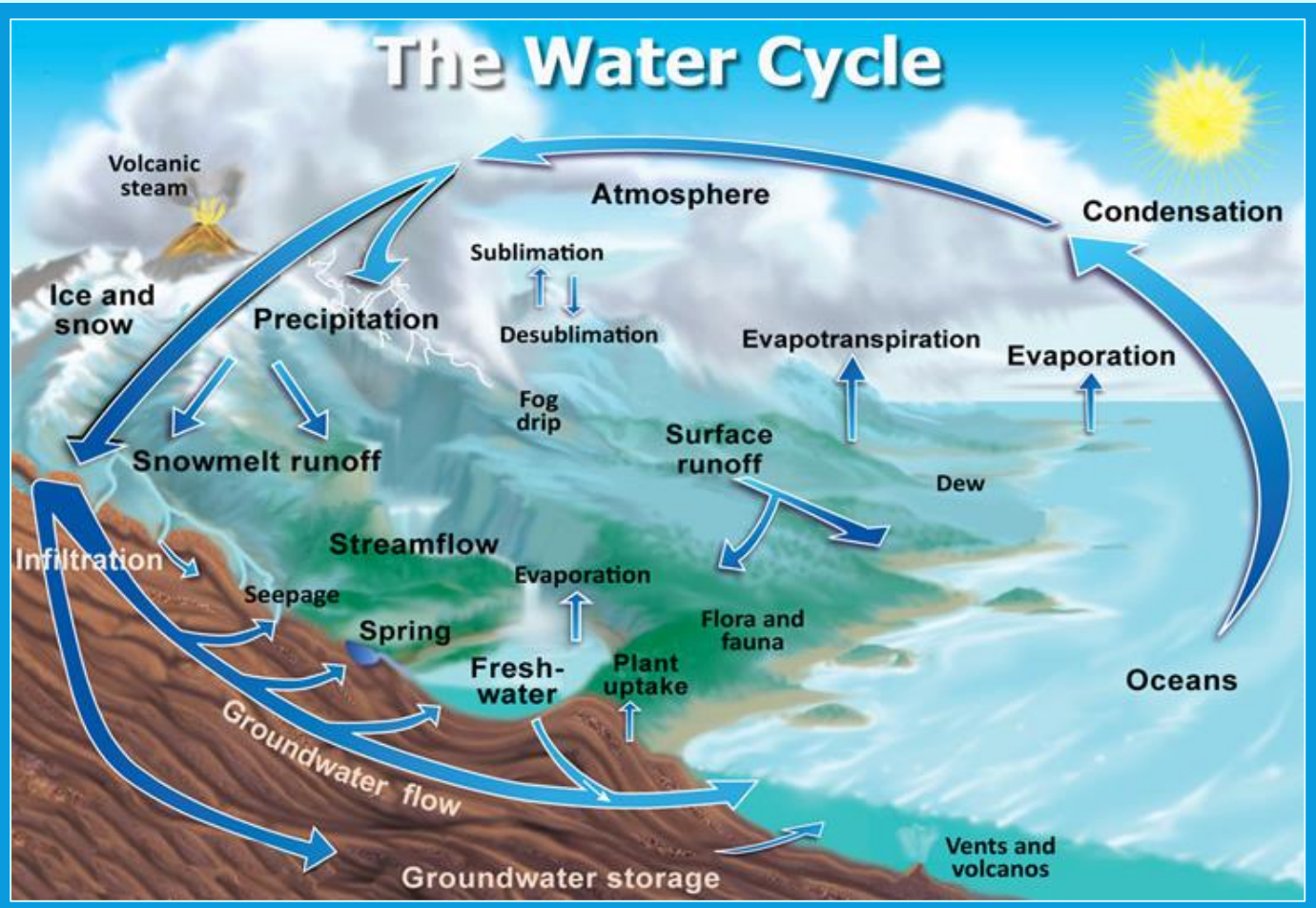
- Among the highest crests recorded for Rockton and Rockford (Auburn).
- Record crest (preliminary)* for Latham Park.
  **Recent surveys by USGS indicate that this may change*
- Flood with a 1-in-25 to 1-in-50 chance of occurring each year (FEMA)

CHANGES IN THE WATER CYCLE OF NE ILLINOIS

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

Photo Credit: Brad Nordlof via Northwest Quarterly

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

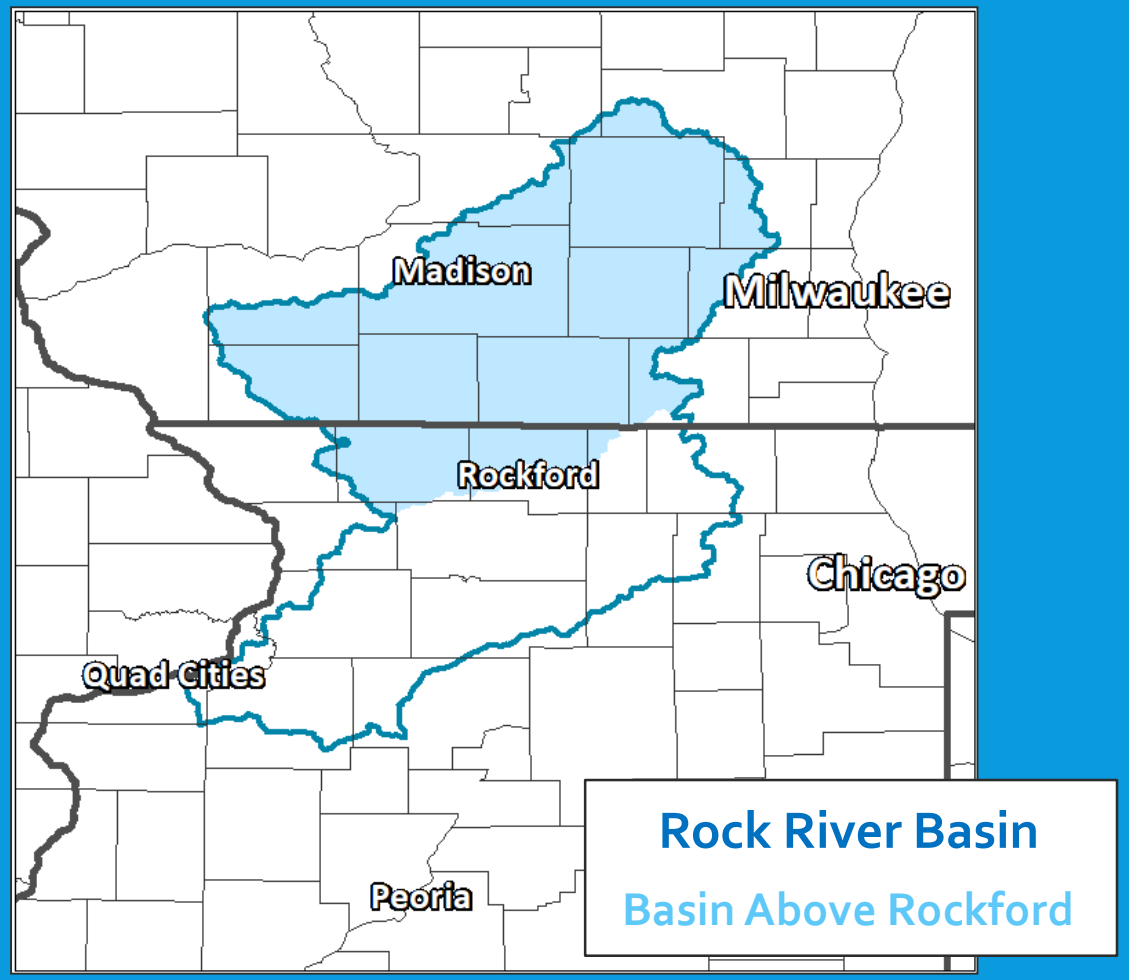


Graphic Credit: Wikipedia

The Water Cycle

- Amount of water in the air and moving over the land is part of the "water cycle"
- The water cycle can change, causing more water in certain places

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Simpler Water Cycle for Rock River Basin

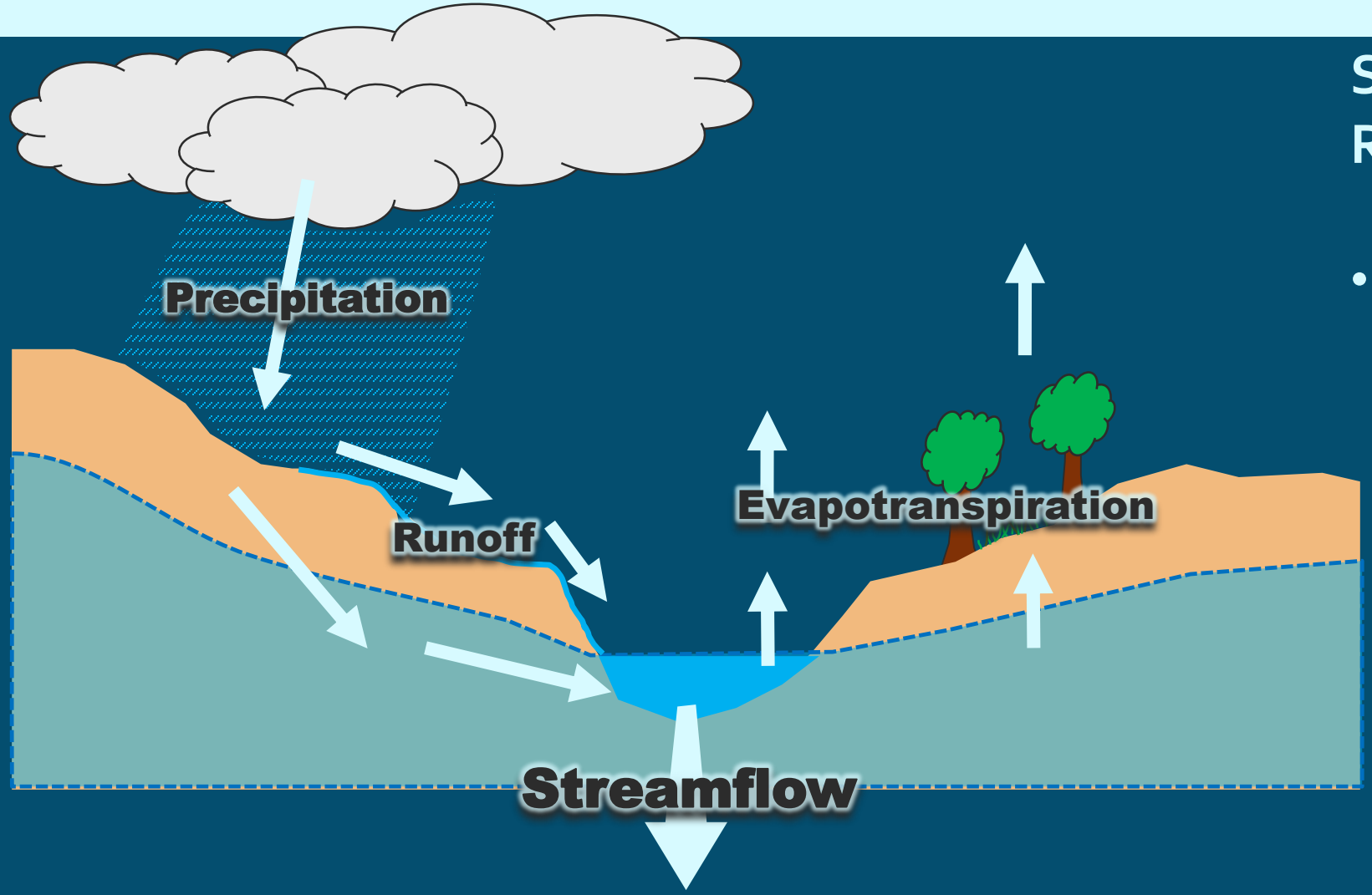
- Amount of water leaving the basin is equal to water entering the basin

Precipitation (Rain/Snow) Entering

Evapotranspiration (Plants)

Runoff (River Flow) Leaving

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Simpler Water Cycle for Rock River Basin

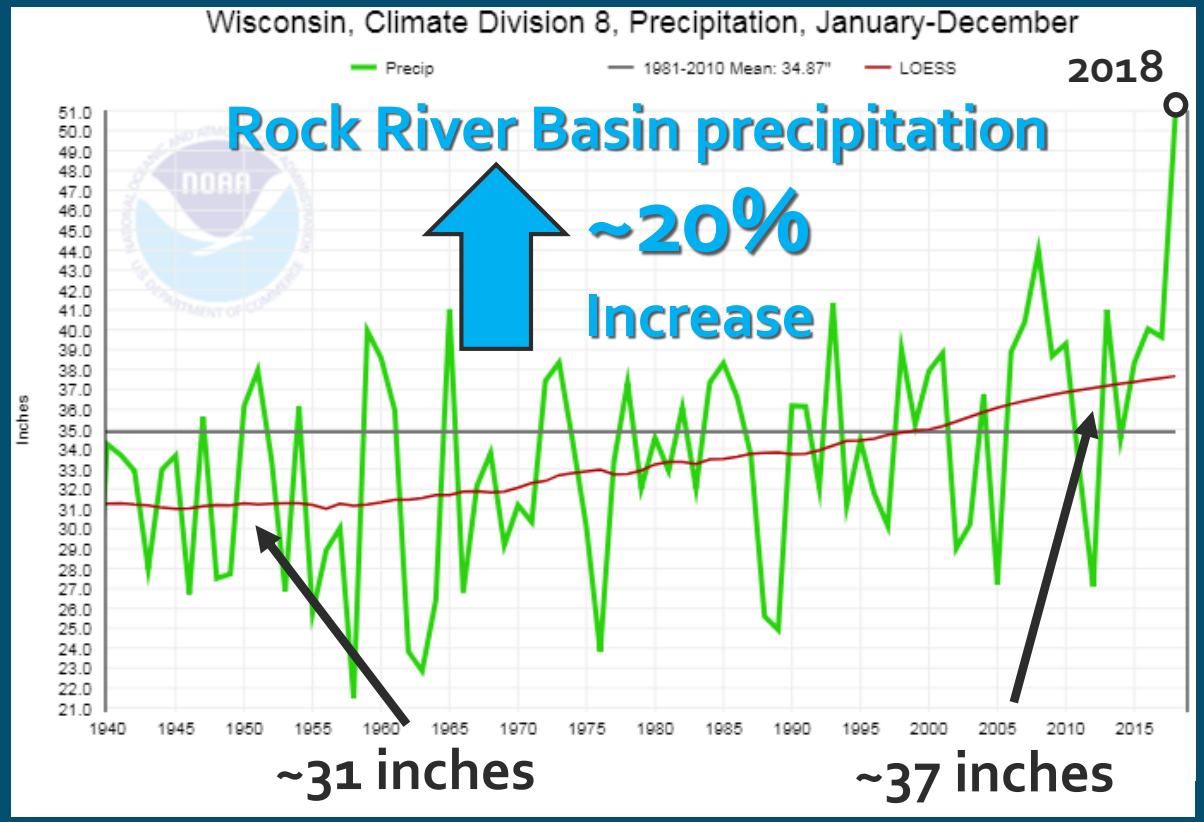
- Water in river (streamflow) is precipitation minus evaporation and transpiration

[Precipitation]

- [Evapotranspiration]

[Runoff & Groundwater]

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

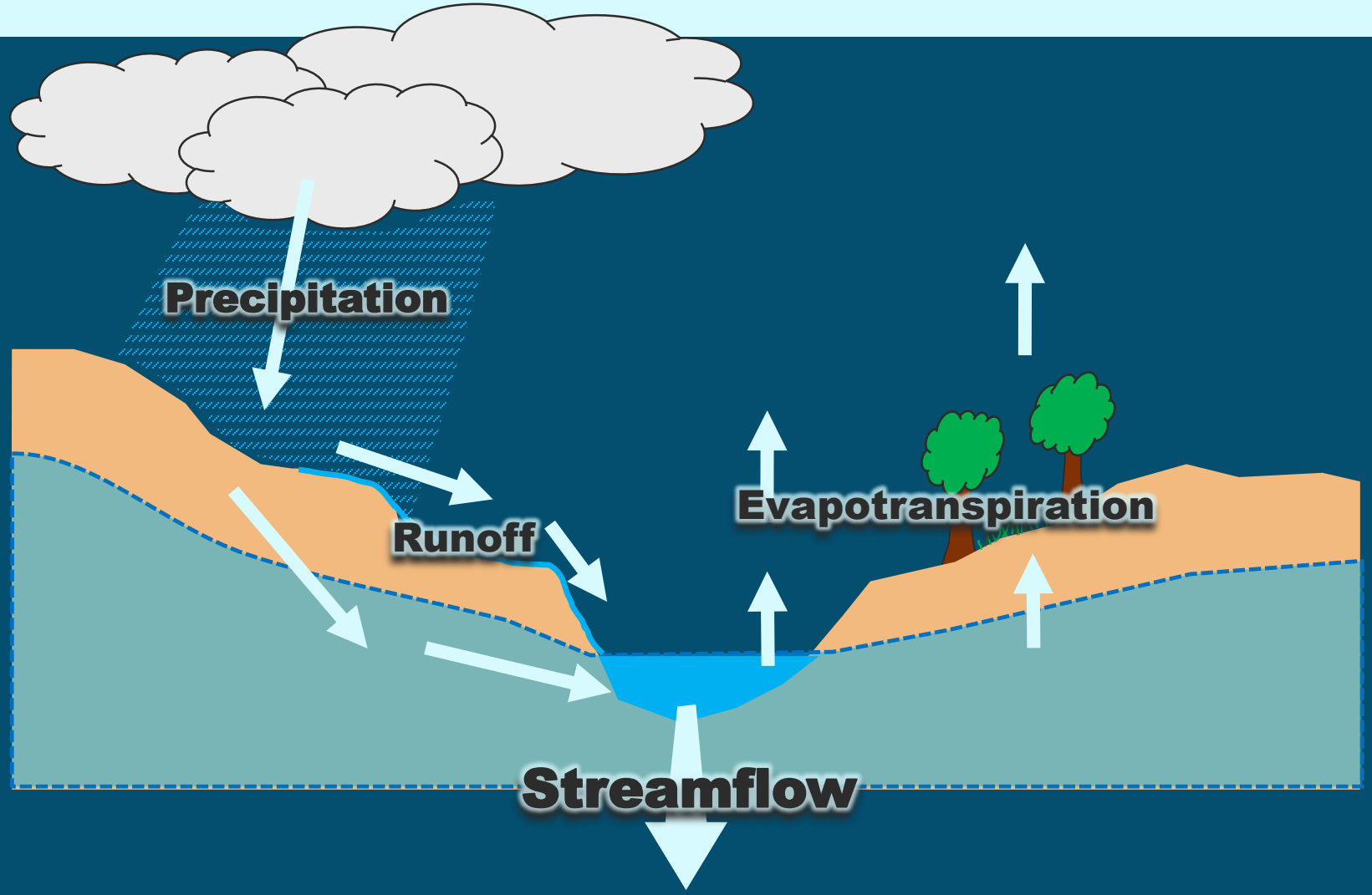


Graphic Credit: NOAA National Center for Environmental Information

Rock River Basin Precipitation

- 2018 was wettest year on record for the basin
- Precipitation (rain and snow) has been increasing since at least the 1960s
- Evapotranspiration has remained relatively stable at 23-24 inches per year

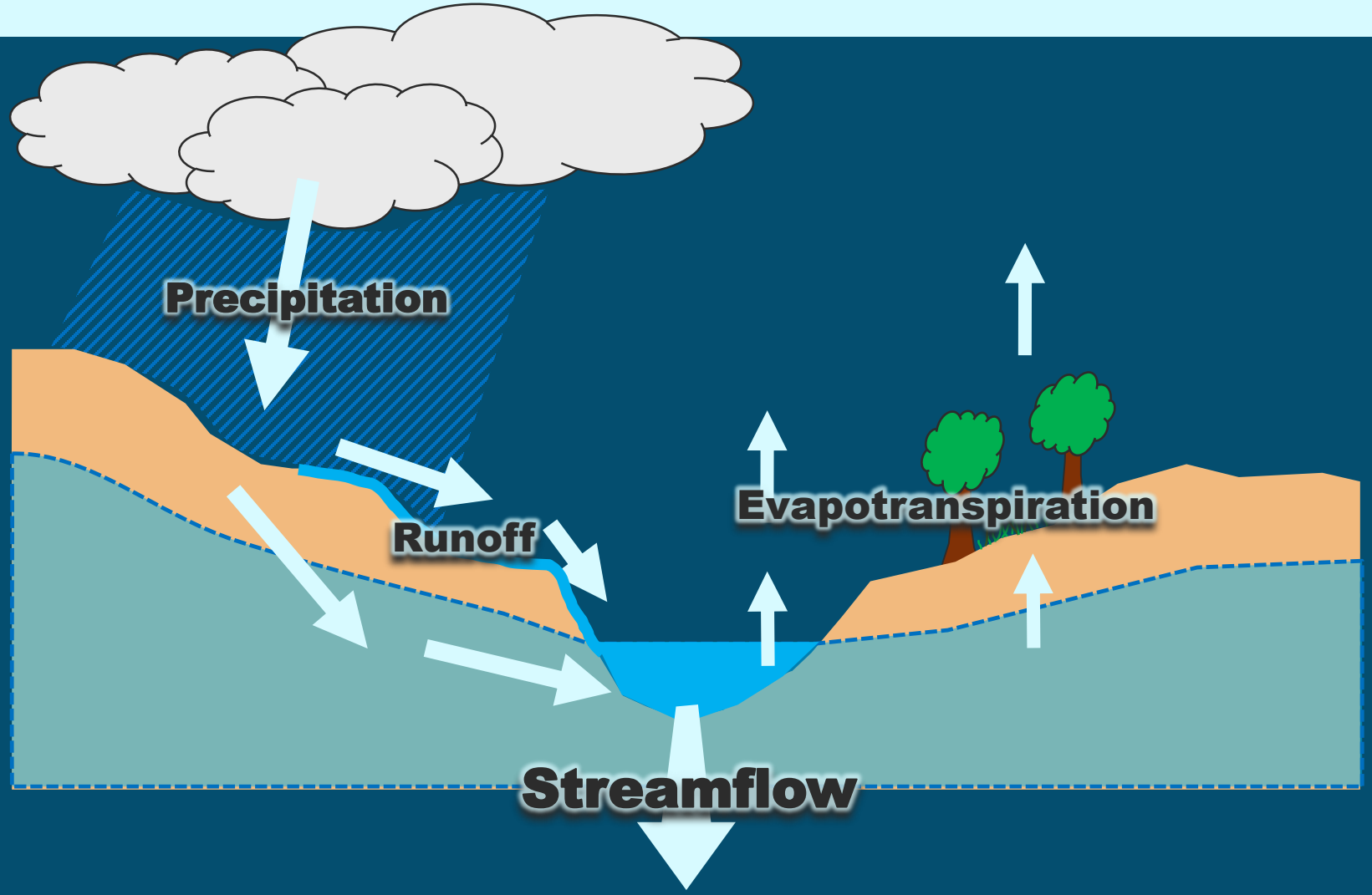
WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Rock River Basin: 1950s

	31.2 inches	Precip.
-	23.5 inches	Evap.
	7.7 inches	Runoff/Gw.

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Rock River Basin: 2010s

37.3 inches Precip.

- 23.5 inches Evap.

13.8 inches Runoff/Gw.

Water *headed for* River

~80%

Increase

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

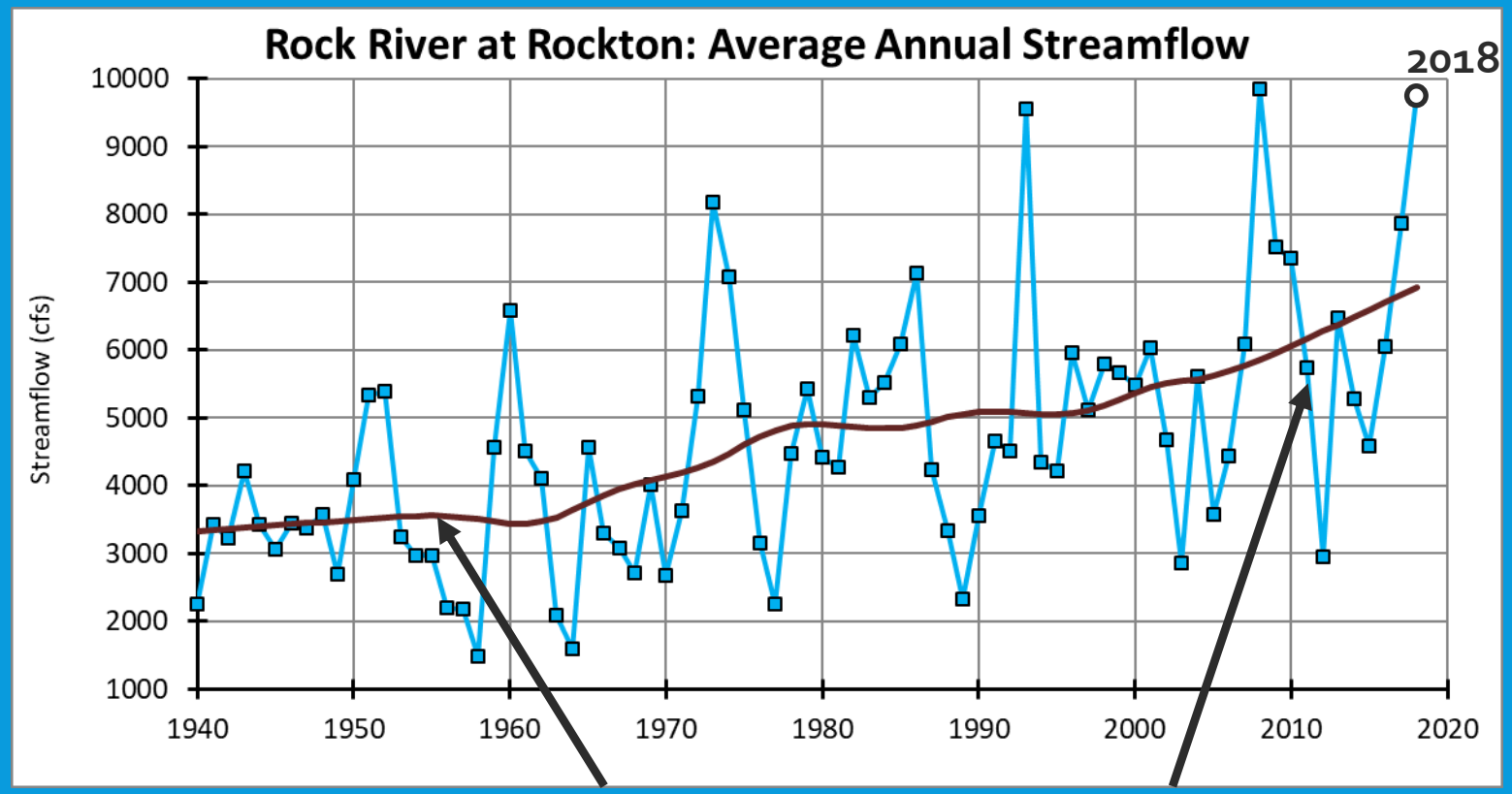
Photo Credit: USGS

USGS Streamflow Measurements

- Are we actually seeing more water in the Rock River?
  We can confirm with measurements.

- USGS has streamflow information for Rockton since the 1940s

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Data Credit: USGS

Rock River Basin: 1950s

~3600 cfs

Rock River Basin: 2010s

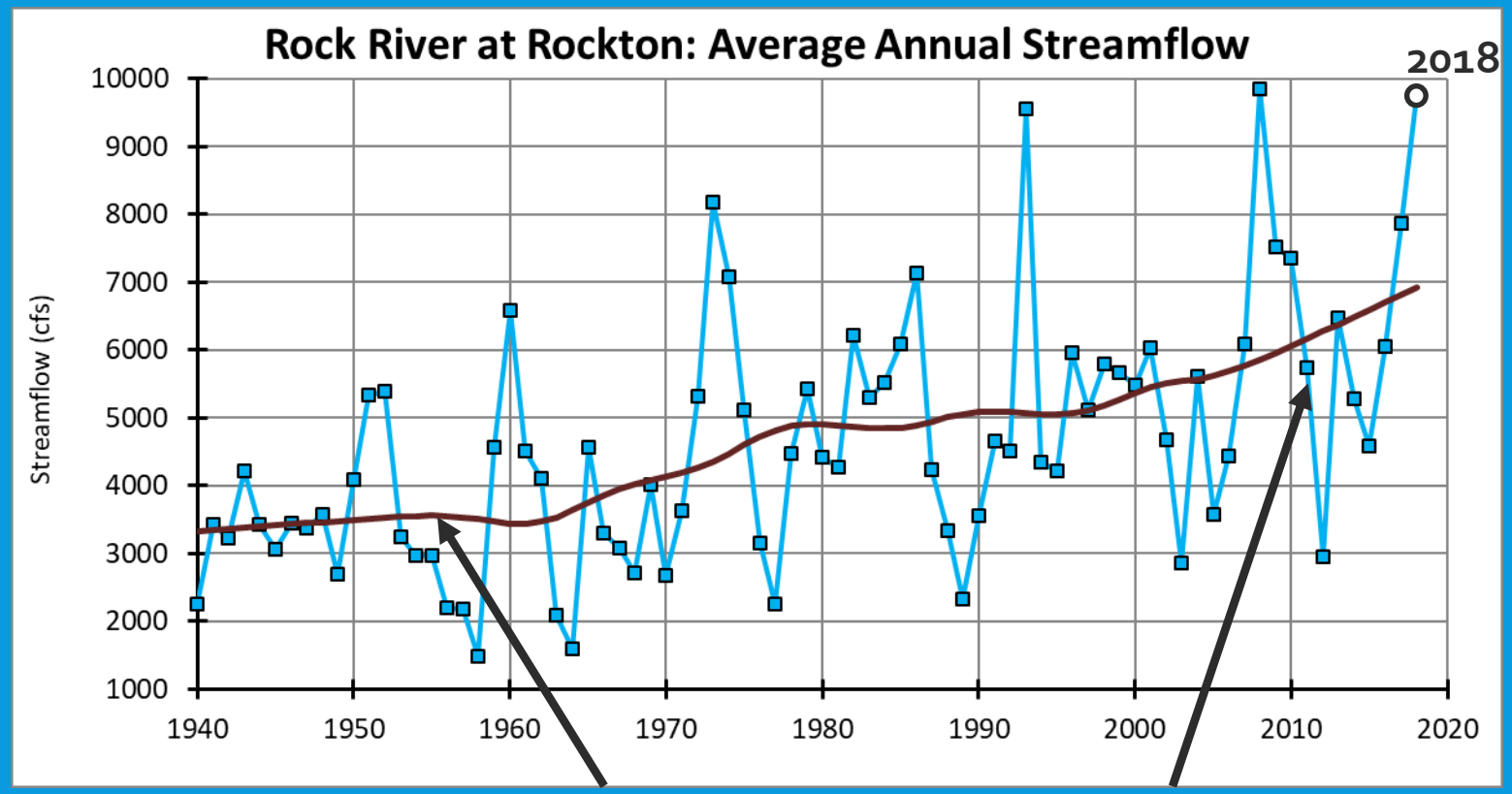
~6300 cfs

Water *in* the River

~80%

Increase

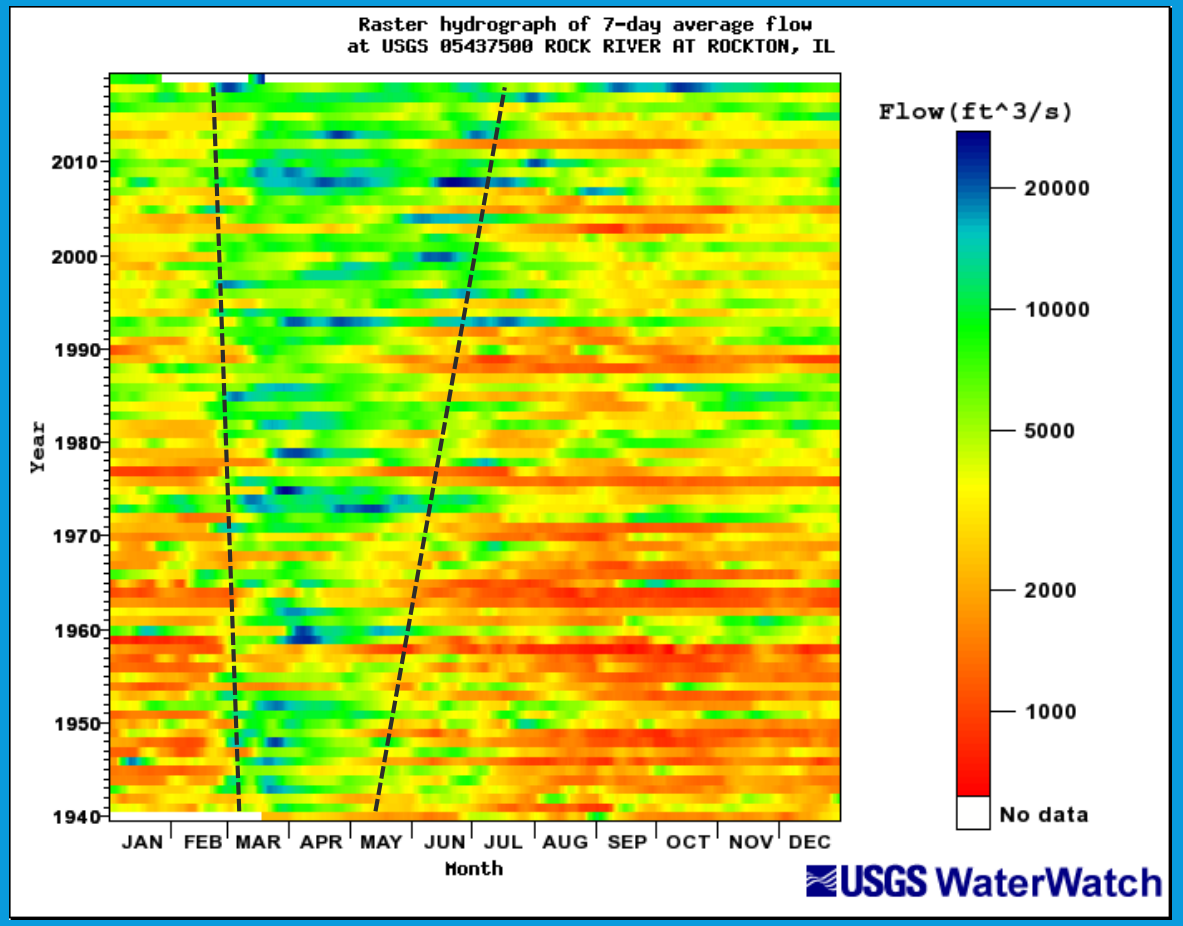
WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Data Credit: USGS

- Increase in streamflow large enough to increase water levels by noticeable amount
- 1-2 foot increase in annual low/high stages at Latham Park

WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

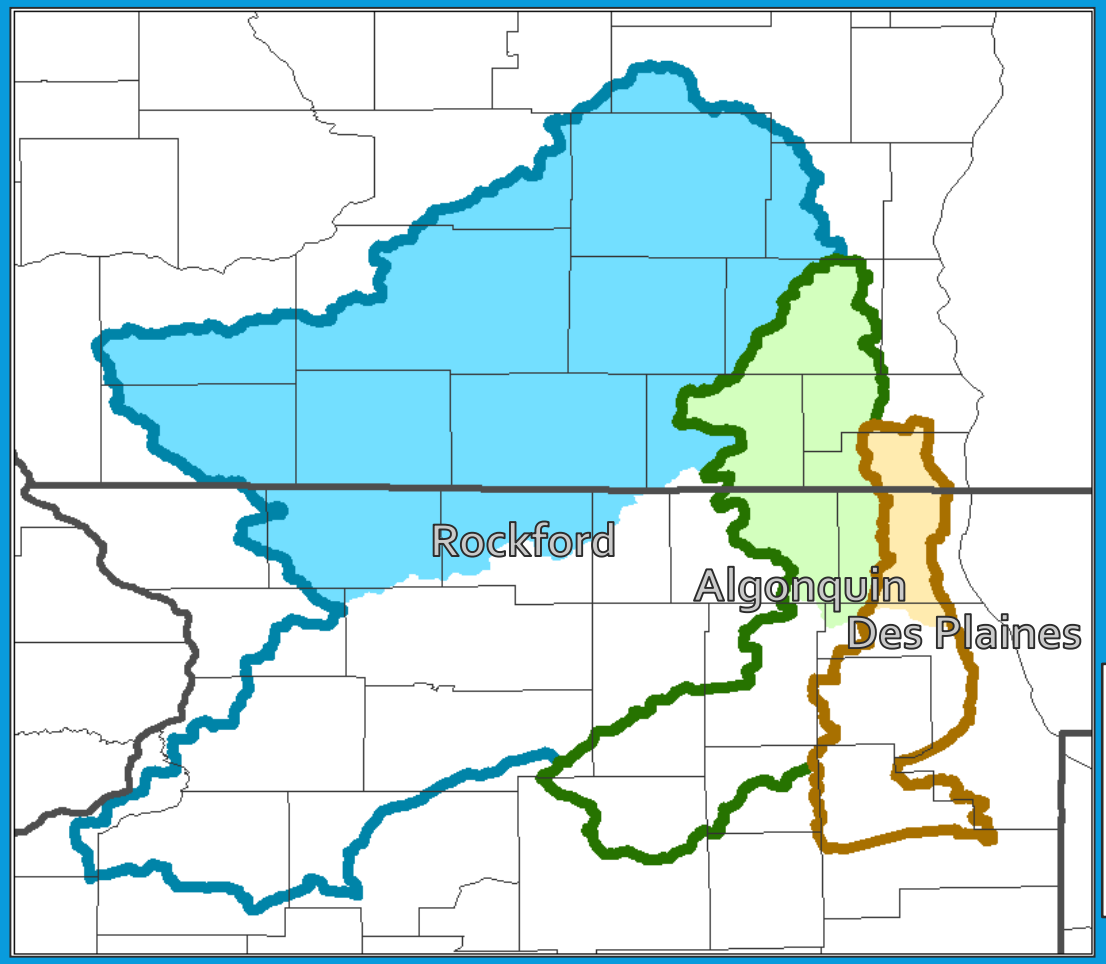


Graphic Credit: USGS

Changes in Streamflow

- "Wet season" may also be expanding
- Summer/Fall dry periods less common

WHAT ABOUT OTHER NORTHEAST ILLINOIS RIVERS?

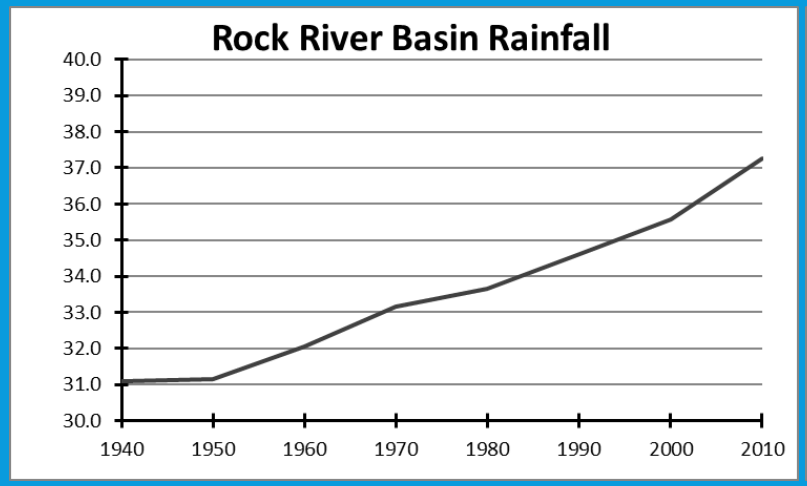


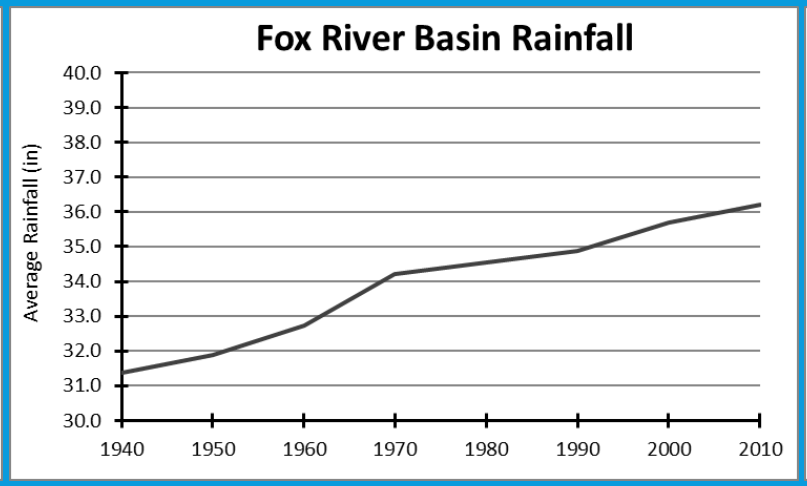
Changes in Streamflow

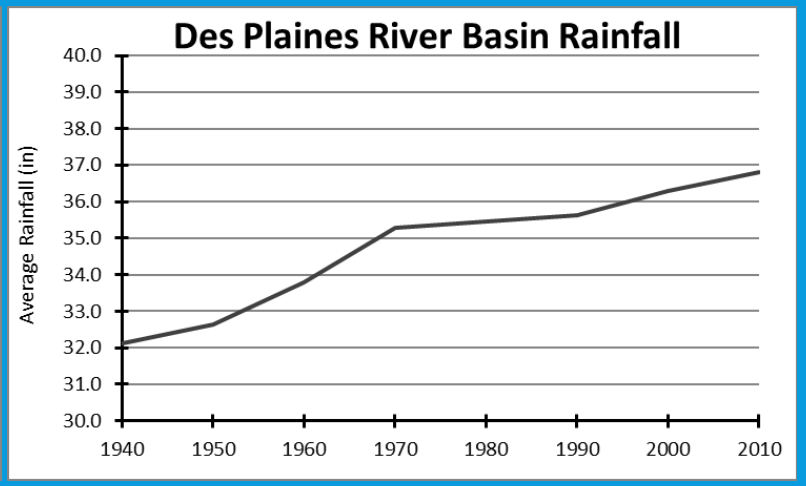
- Begs the question… what about other river basins? Are we seeing similar trends?

Rock River Basin
Fox River Basin
Des Plaines River Basin

CHANGES IN RAINFALL ACROSS NORTHEAST ILLINOIS







~20% Increase

~15% Increase

~15% Increase

**Rainfall estimated based upon NCEI climate divisions*

CHANGES IN RUNOFF ACROSS NORTHEAST ILLINOIS

ROCK

	1950s	2010s
Precipitation	31.2	37.3
Evapotranspiration	23.5	23.5
Runoff	7.7	13.8

FOX

	1950s	2010s
P	31.9	36.2
ET	24.0	24.0
R	7.9	12.2

DES PLAINES

	1950s	2010s
P	32.6	36.8
ET	23.5	23.5
R	9.1	13.3

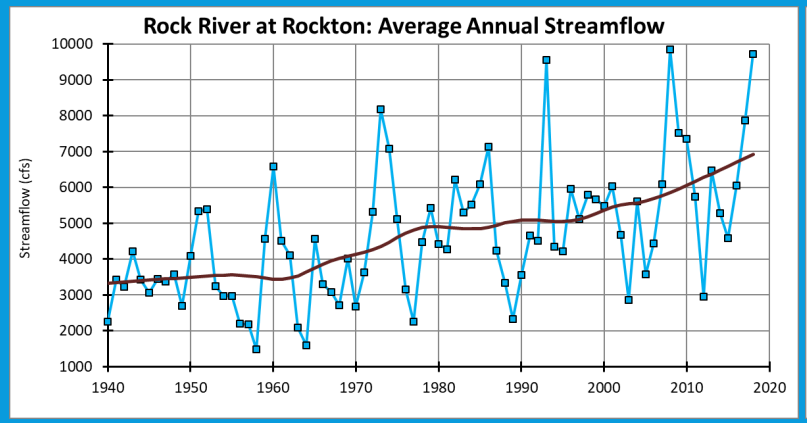
~80% Increase in Runoff

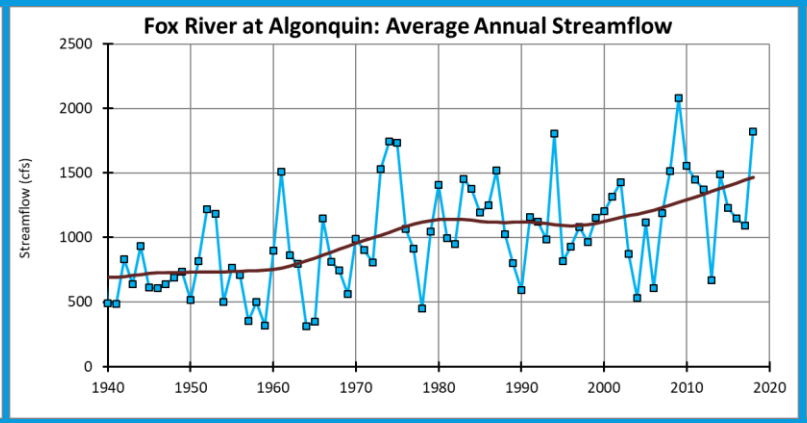
~55% Increase in Runoff

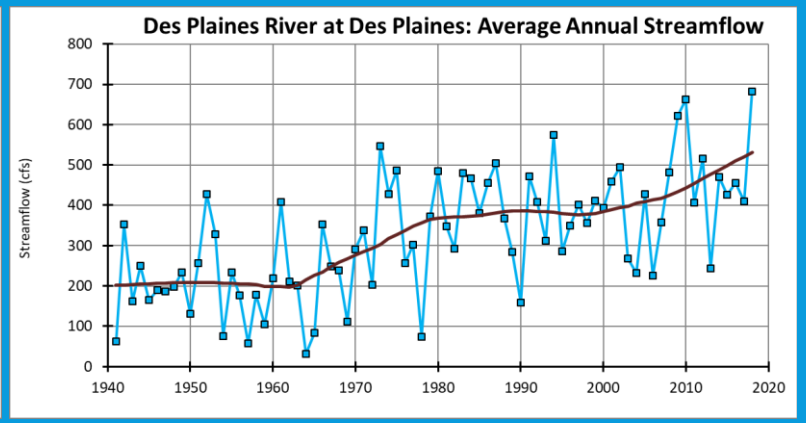
~50% Increase in Runoff

**Calculations assume steady ET. ET may be changing, especially in Fox/Des Plaines, but hard to verify*

CHANGES IN OBSERVED STREAMFLOW ACROSS NORTHEAST ILLINOIS





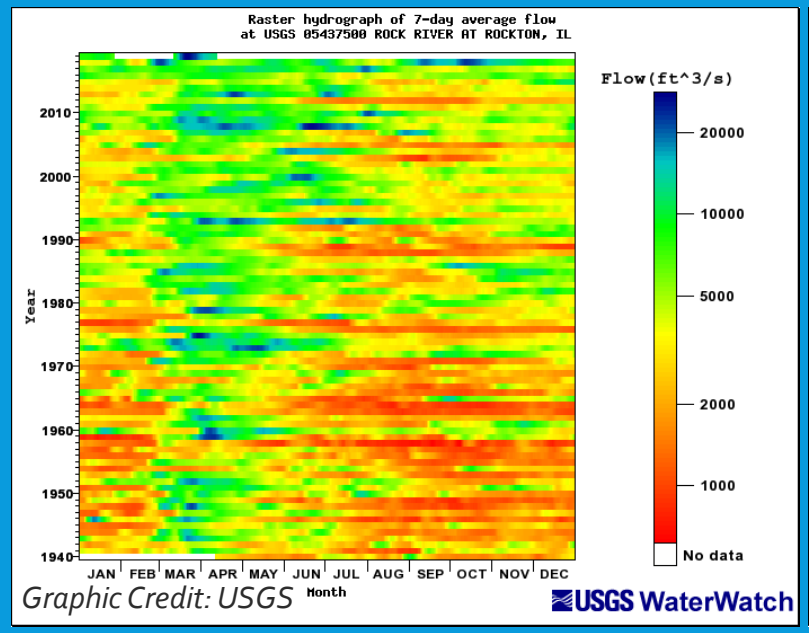


~80%
Increase
Water *in* the River

~85%
Increase
Water *in* the River

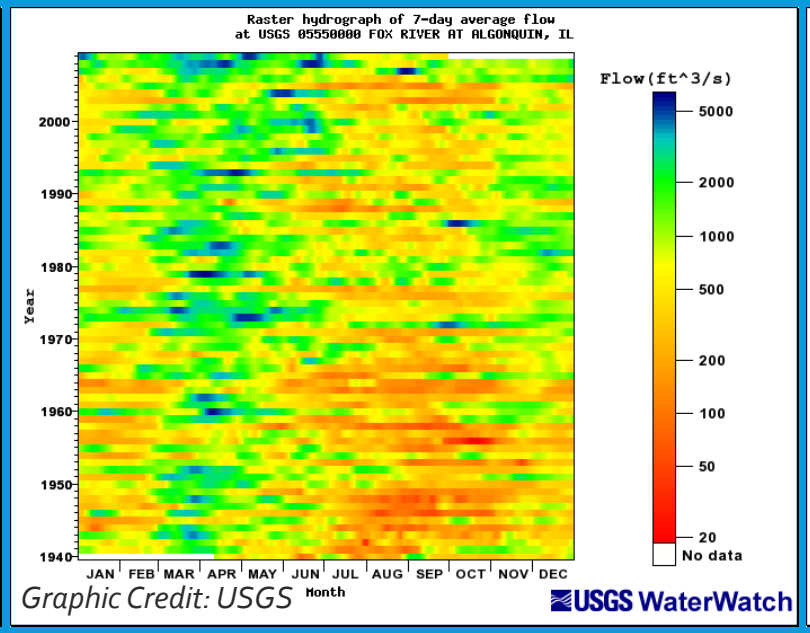
~140%
Increase
Water *in* the River

CHANGES IN OBSERVED STREAMFLOW ACROSS NORTHEAST ILLINOIS



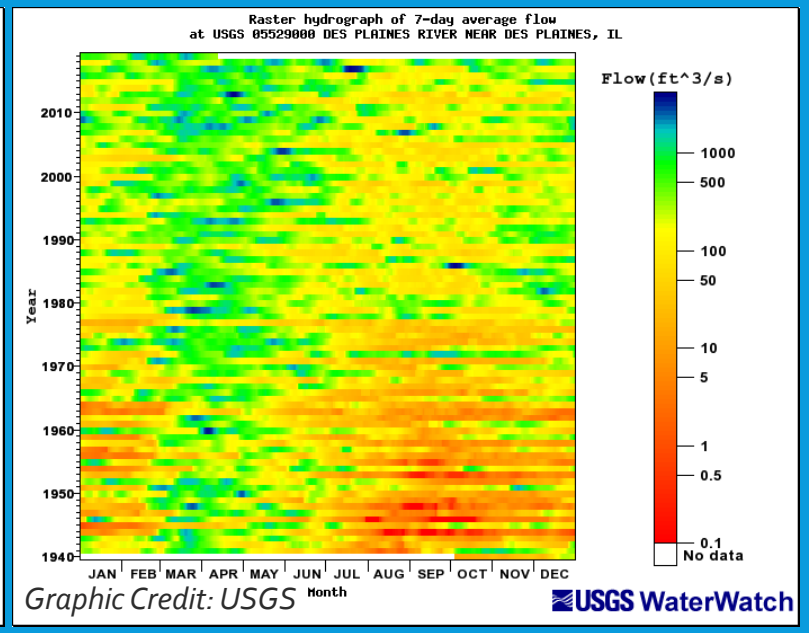
Graphic Credit: USGS

Rock River at Rockton



Graphic Credit: USGS

Fox River at Algonquin



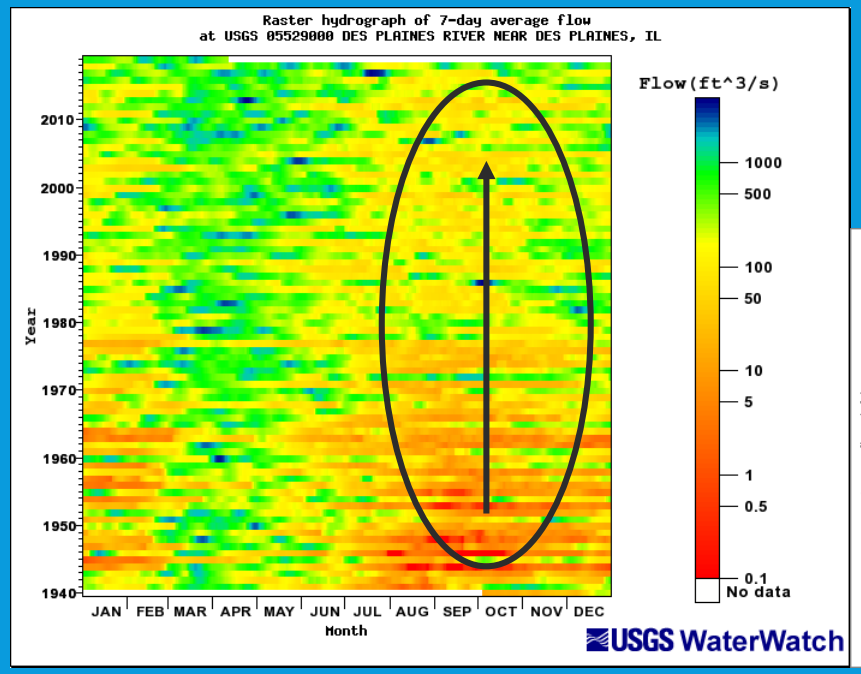
Graphic Credit: USGS

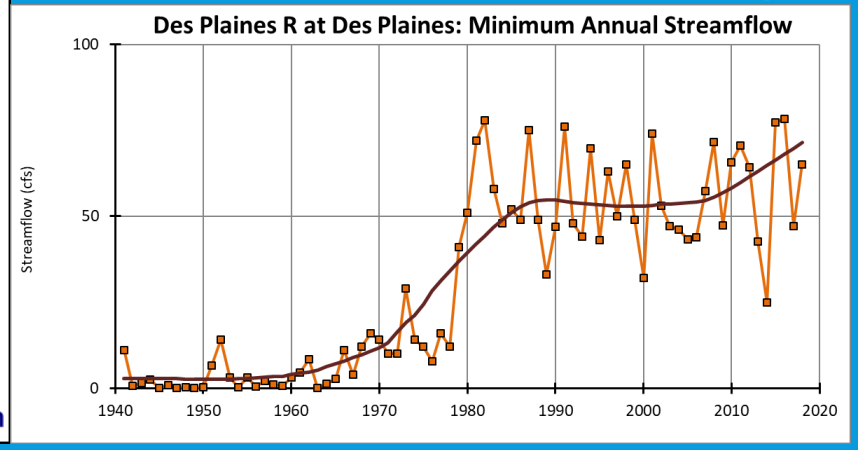
Des Plaines River at Des Plaines

CHANGES IN OBSERVED STREAMFLOW ACROSS NORTHEAST ILLINOIS

Changes in Streamflow

- Biggest change in streamflow occurring at lower flows
- For Des Plaines, this is due to sewage treatment plant releases.





Graphic Credit: USGS

WHAT'S NEW WITH HYDRO AT NWS CHICAGO?

RECENT CHANGE YOU MAY HAVE NOTICED

- River flood warnings describe river reach, not just gauge location…

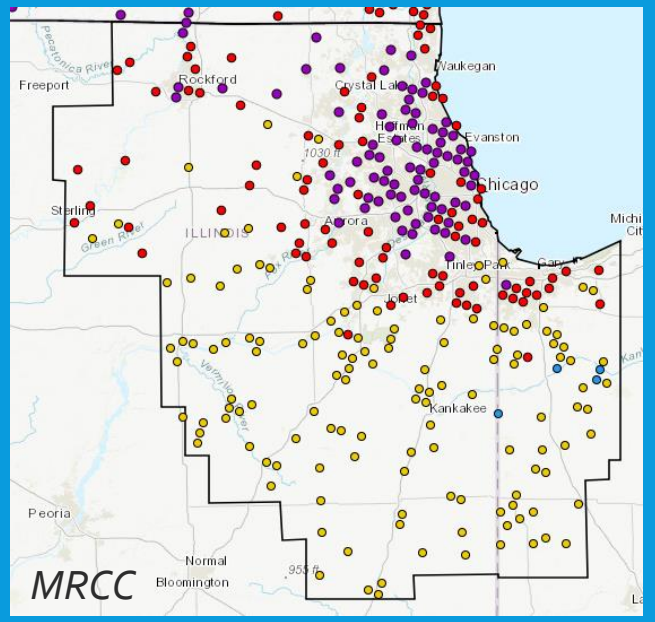
The National Weather Service in Chicago has issued a

* Flood Warning for
  The Illinois River at La Salle, **or from Starved Rock Lock and Dam downstream to confluence with Big Bureau Creek.**
* from Sunday afternoon to late Thursday night.
* At 945 AM Saturday the stage was 17.8 feet.

…

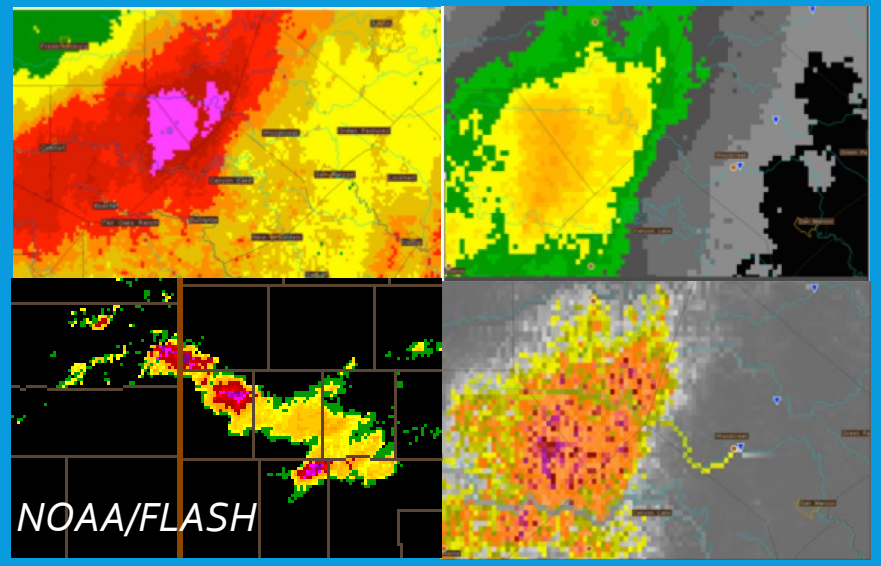
- Machine learning techniques providing probability of flash flooding* based upon recent soil conditions.

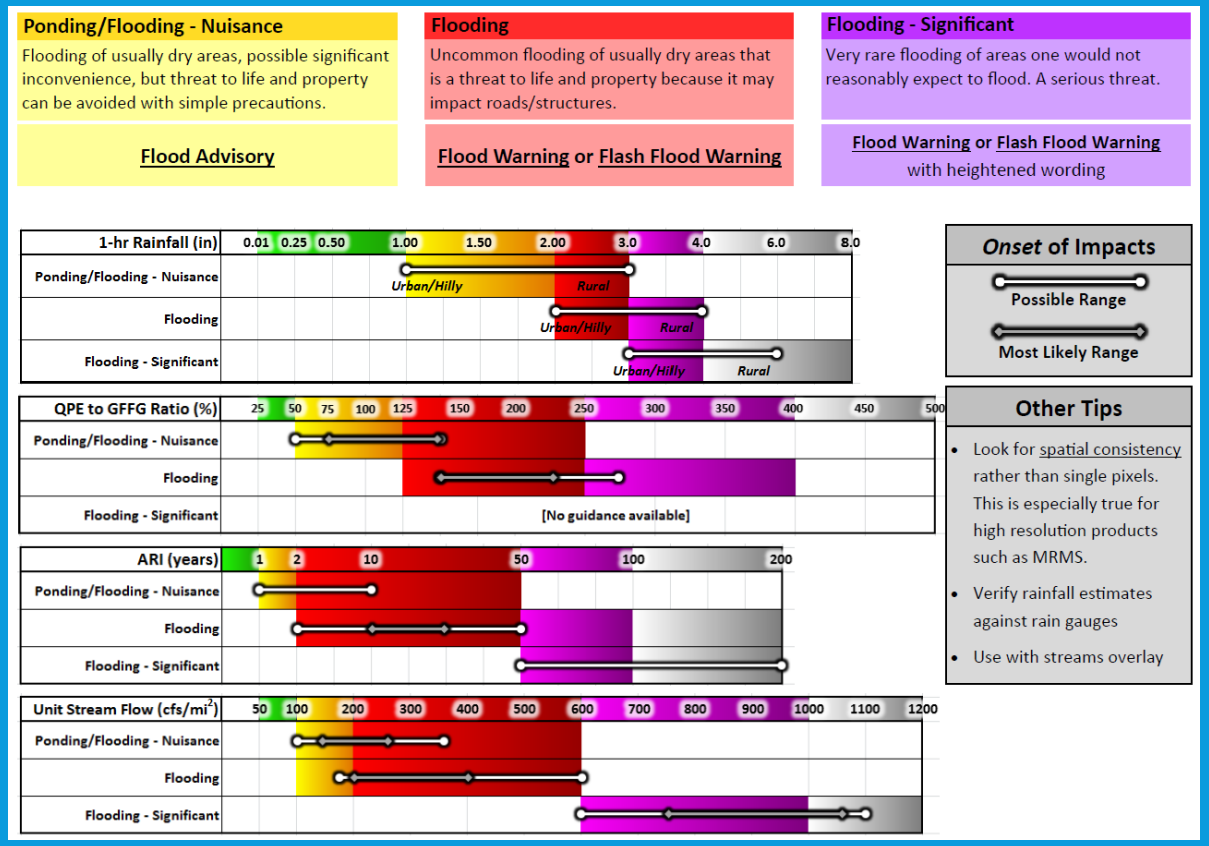
**Based upon previous flash flood reports*



NEW TOOLS FOR THIS YEAR

- 4 different MRMS/FLASH products together in one display:
  rainfall, flash flood guidance, average recurrence interval, unit streamflow





COMMENTS/QUESTIONS?

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