WATER SUPPLY PLANNING AND MANAGEMENT:

CLIMATE VARIABILITY AND CHANGE

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IDNR/OWR ISWS ISGS
INTRODUCTION
DEFINITIONS
HISTORICAL CLIMATE
FUTURE CLIMATE
UNCERTAINTY AND RISK IN WATER SUPPLY PLANNING
THE WATER CYCLE: CLIMATE, SURFACE WATER, and GROUNDWATER ARE LINKED
1. CLIMATE CONDITIONS ARE A MAJOR FACTOR IN WATER SUPPLY

2. LONG-RANGE WATER SUPPLY PLANNING REQUIRES CONSIDERATION OF CLIMATIC CONDITIONS TO 2050 AND PERHAPS BEYOND

3. FUTURE CLIMATIC CONDITIONS ARE HIGHLY UNCERTAIN

4. THE CHALLENGE IS HOW TO DEAL WITH UNCERTAINTIES AND ASSOCIATED RISKS
DEFINITION of CLIMATE

- The statistical aggregate of weather conditions over a period of time: temperature; precipitation; wind; cloudiness; storms; etc.
- Climate “normals” are set over 30 year periods: means; extremes; frequencies of occurrence etc.
- Current “normal” period is 1971-2000.
- This will change to 1981-2010 in 2011.
CLIMATE VARIABILITY
and
CLIMATE CHANGE
DEFINITION of CLIMATE VARIABILITY

• Variations (ups and downs) in climatic conditions on time scales of months, years, decades, centuries, and milenia. Includes droughts and floods.
DEFINITION of CLIMATE CHANGE

• A statistically significant change in climate characteristics over a long period of time.
  – From one 30-year period to another
  – From one century to another
  – From one millennium to another

• You can’t have climate change over less than a 30-year period.

• Climate change can be a change in the mean, a change in extremes, or change in frequencies.
EXAMPLES OF CLIMATE CHANGE

• Change in the annual mean

• Constant mean with change in extremes

• Constant mean with change in frequency of extremes
EFFECTS OF CLIMATE VARIABILITY AND CHANGE ON WATER SUPPLY

• Droughts and lower precipitation reduce water availability
• Higher temperatures increase the loss of water and increase water demand
• Droughts and high temperatures combined have the largest impacts on water supply and demand
MEAN ANNUAL TEMPERATURE
1971-2000

Average annual temperature (°F) in Illinois, 1971-2000
Temperature  Annual  Smoothed

Source: Jim Angel, Illinois State Water Survey
ANNUAL TEMPERATURE TRENDS

Figure 1. ANNUAL temperature trends in the U.S. expressed as the total change over the period 1895-2006 in degrees F and derived from climate division data. Copyright 2007. Illinois State Water Survey.
20+ DAYS INCREASE IN GROWING SEASON IN WEST.
NOT MUCH CHANGE IN EAST (K. Kunkel)
10-year running averages of Illinois River watershed precipitation, streamflow (minus Lake Michigan diversion), and groundwater elevation.
Vern Knapp in Winstanley et al. (2006), ISWS IEM 2006-02

Mississippi River at Keokuk, IA

- average watershed precipitation (3 gages)
- streamflow at Keokuk

Annual Precipitation 10-year moving average (inches)
Annual Streamflow, 10-year moving average (inches)

r = 0.878
USA 20th CENTURY PRECIPITATION TRENDS

Trends
%
/100 years

+10  -10
+20  -20
+40  -40
Trends in Heavy Precipitation Events Across USA (K. Kunkel)

![Graph showing trends in heavy precipitation events across USA over 100 years, with a legend indicating 1-yr, 5-yr, and 20-yr anomalies.](image-url)
Trends in Precipitation Events Across USA (M. Palecki)

U.S. 1-day duration, 1-yr return

Year

Precipitation Index

FUTURE CLIMATE

• Future climate will be influenced by natural processes and human influences.

• There are 2 guides to possible future climatic conditions:-
  – The past record (what has occurred can occur again)
  – Climate modeling
QUESTION: IF THE INCREASE IN PRECIPITATION SINCE 1900 IS DUE TO THE INCREASING GREENHOUSE EFFECT, WHAT CAUSED EQUALLY HIGH PRECIPITATION IN THE 19th CENTURY AND A DECREASE IN PRECIPITATION THROUGH THE FIRST HALF OF THE 20th CENTURY?

ANSWER: UNEXPLAINED NATURAL VARIABILITY.
WEAKNESS of GCMs in SIMULATING PRECIPITATION (Wigley, 2004)

Figure 21. Inter-model signal-to-noise ratios for annual-mean precipitation (mean precipitation change per 1°C global-mean warming, averaged over 17 AOGCMs, divided by the inter-model standard deviation). This is a measure of both the sign and strength of the expected precipitation change and the level of agreement between models. Values between −1 and +1 indicate considerable uncertainty in the expected change.
Illinois Annual Temperature Departure from 1971-2000 Normal

The graph shows the temperature departure (in °F) from the 1971-2000 normal for Illinois. The x-axis represents the years from 1825 to 2100, while the y-axis shows the temperature departure. The graph includes lines for different projection scenarios: 20th Century, A2 5th, A2 95th, A1B 5th, A1B 95th, B1 5th, and B1 95th. The temperature departure values range from negative numbers to around 14 °F, with a notable increase starting around the year 2000.
1 in 200 YEAR DROUGHT


ARE WE PREPARED...

...FOR SEVERE DROUGHT?
UNCERTAINTY AND RISK

• WILL THE RWSPC RECOMMEND HOW TO DEAL WITH DROUGHT AND POSSIBLE CLIMATE CHANGE?

• WITH A HOT + DRY CLIMATE SCENARIO DROUGHT FREQUENCY AND MAGNITUDE LIKELY WOULD BE DISASTEROUS, BUT WE CAN NOT PUT A PROBABILITY OF OCCURRENCE ON SUCH A SCENARIO.

• ONE APPROACH WOULD BE TO ANALYZE AND BE PREPARED TO AT LEAST DEAL WITH RECURRENCE OF SEVERE DROUGHTS THAT HAVE OCCURRED IN FIRST HALF OF 20th CENTURY. PLAN FOR 1 in 200 YEAR DROUGHT?
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THANK YOU!