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Iowa Climate Change Adaptation and Resilience: Applying Climate Data to Plans & Ordinances

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Integrating Hazard Planning into Comprehensive Plans
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Iowa Climate Change Adaptation & Resilience Report

April 27
2011

How should hazard mitigation and other community planning programs respond to climate change?

http://epa.gov/smartgrowth/fema_moa.htm

In 2009, EPA and FEMA worked with state and local leaders in Iowa to figure out how the latest science on the changing weather patterns due to climate change could be integrated into local and state level planning efforts that are used to adapt to and mitigate future disasters.

Practical Findings

- Land use is a primary determinant of community and regional climate change adaptation capacity.
- Climate change data must be formatted and distributed in a way that is accessible and usable by state and local planners.
  - Research and development grant programs are needed to develop sustained dialogue between planners, government agencies, and climate information producers to understand how to interpret and use climate-change-based hazard scenarios in community planning.
  - A constructive aid for regional and local planners might be an investment by NOAA, EPA, FEMA, or other federal partners in identifying approaches for including future climate data and illustrating them through case examples to demonstrate potential benefits and provide templates to encourage adoption.)
- Federal and state programs should create incentives that will improve the use of climate change data, including in the production of hazard mitigation plans.
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Climate Data Entry Points

- NFIP: Outreach materials to improve participation
- Hazard Mitigation Plan: Future climate conditions translated into flood plain maps
- Zoning and Ordinances: Extreme rainfall projections

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Illustration: City of Ames

Climate Hazard Literacy

Climate Scenarios within Hazard Mitigation Plans

Climate Hazard Literacy: Relationship between Rainfall and Flood

Rule of Thumb for Iowa:

For every 1% above average annual precipitation, annual streamflow is increased 2.5%. Basins with heavy river way management may be different.

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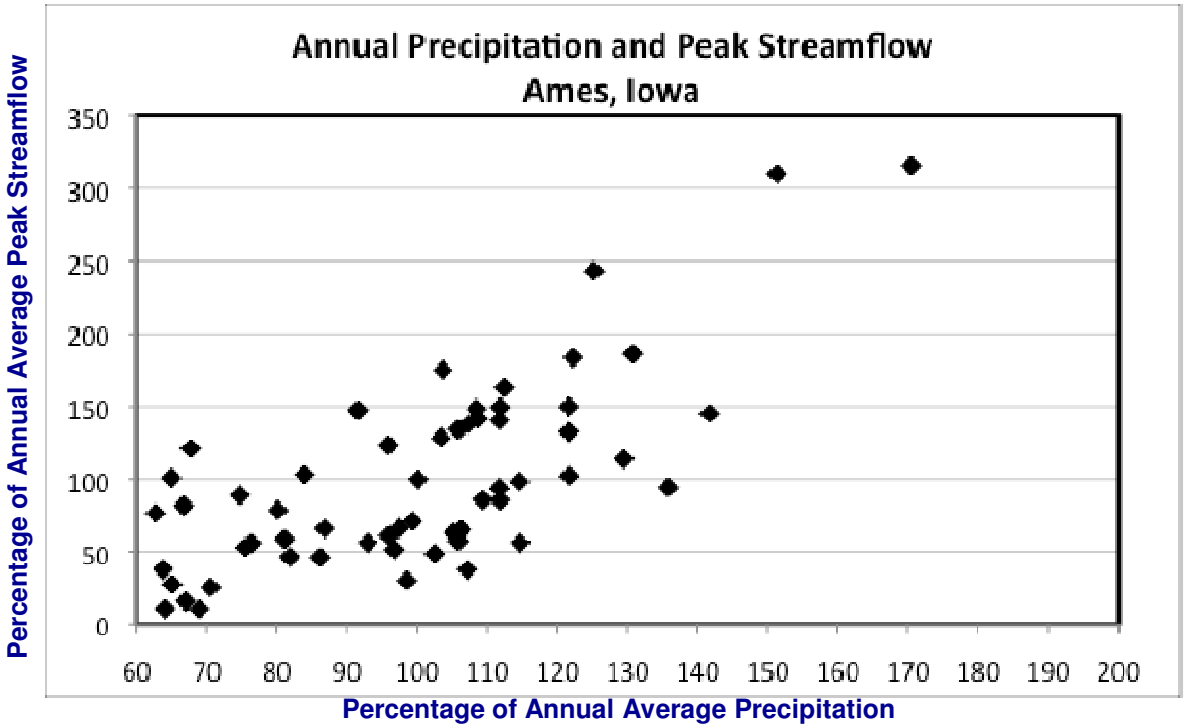
Climate Hazard Literacy: Relationship between Rainfall and Flood

Does Ames follow the Rule of Thumb for Iowa:

Use publicly available data familiar to engineering firms

USGS Annual Peak Streamflow

NOAA Long-term Climate Station



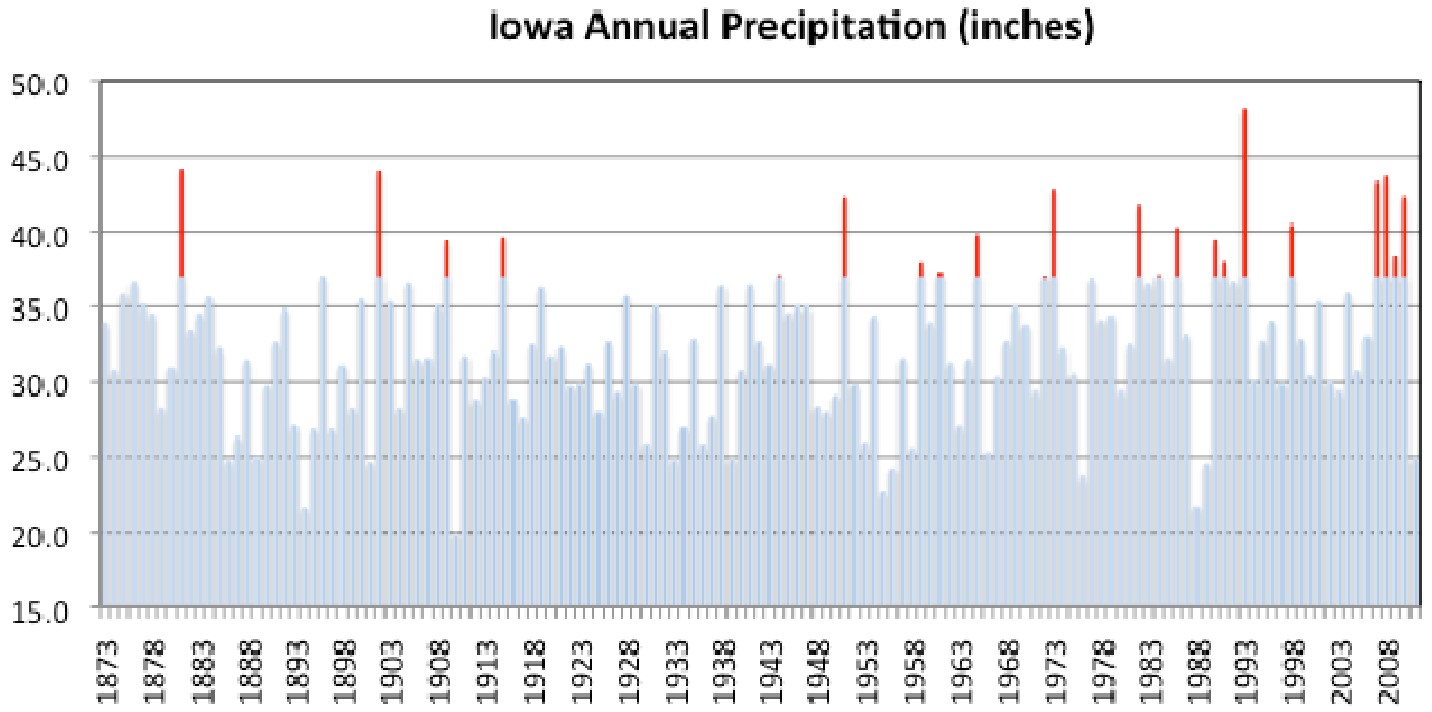
Result:

1.9% peak streamflow increase for 1% precipitation increase

Climate Hazard Literacy: Historical Rainfall Variability and Change

State-wide very wet years (red bars) are more frequent

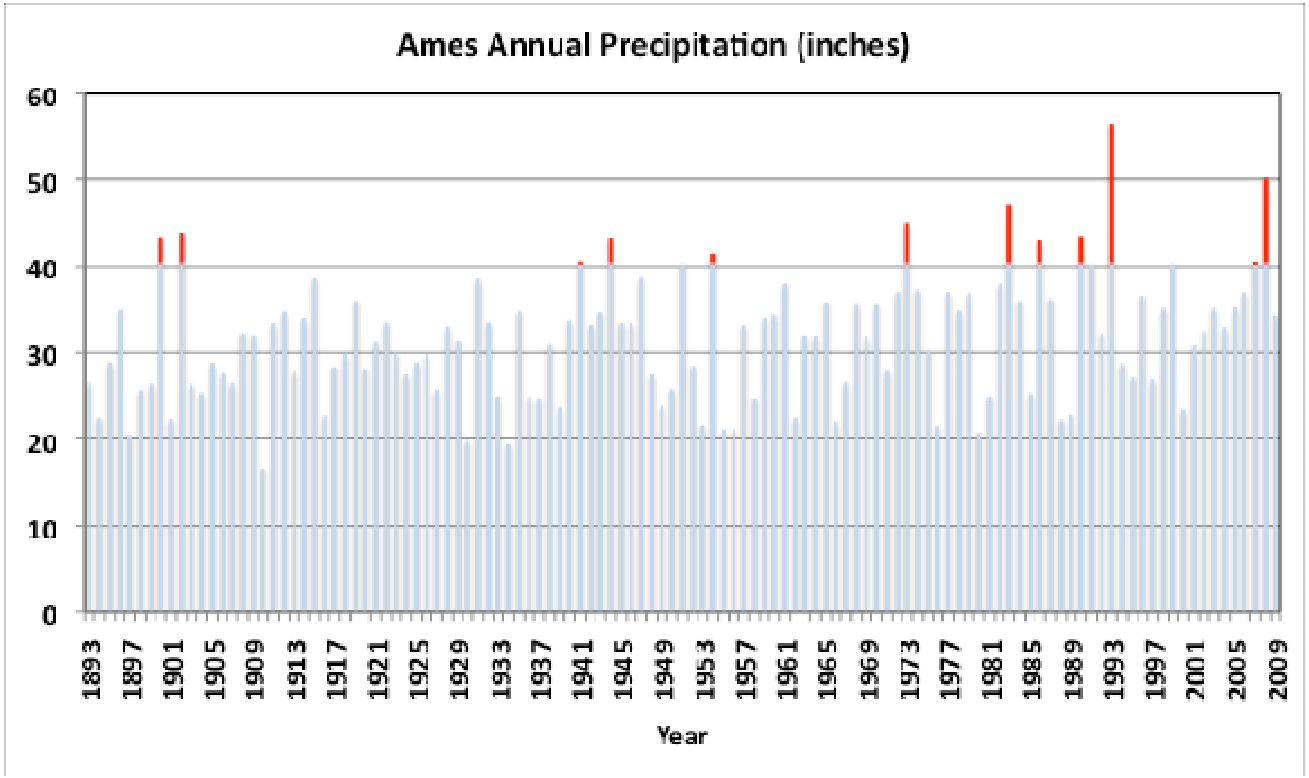
- 1-in-10 prior to 1980; 1-in-3 since



Climate Hazard Literacy: Historical Rainfall Variability and Change

Ames very wet years (red bars) are more frequent

- Very wet year suggests 55% peak streamflow increase



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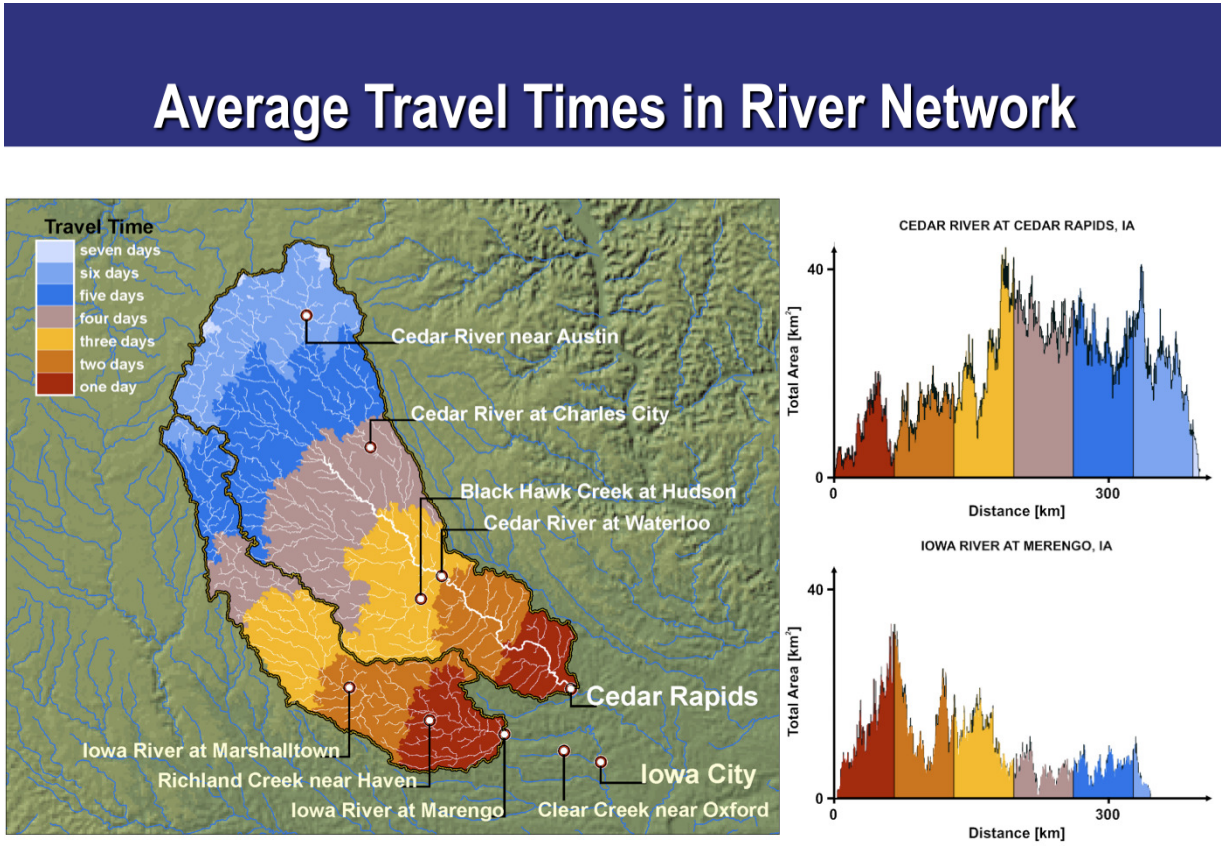
Climate Hazard Liteacy: Rainfall timing is everything Flood depth is determined by "waterway traffic jams"

- Rainfall near Cedar Rapids and near Austin 5 days earlier arrive at Cedar Rapids simultaneously.

- Communities within smaller basins, like Ames, have lower risk of jams.
  - Smaller Target
  - Shorter Exposure



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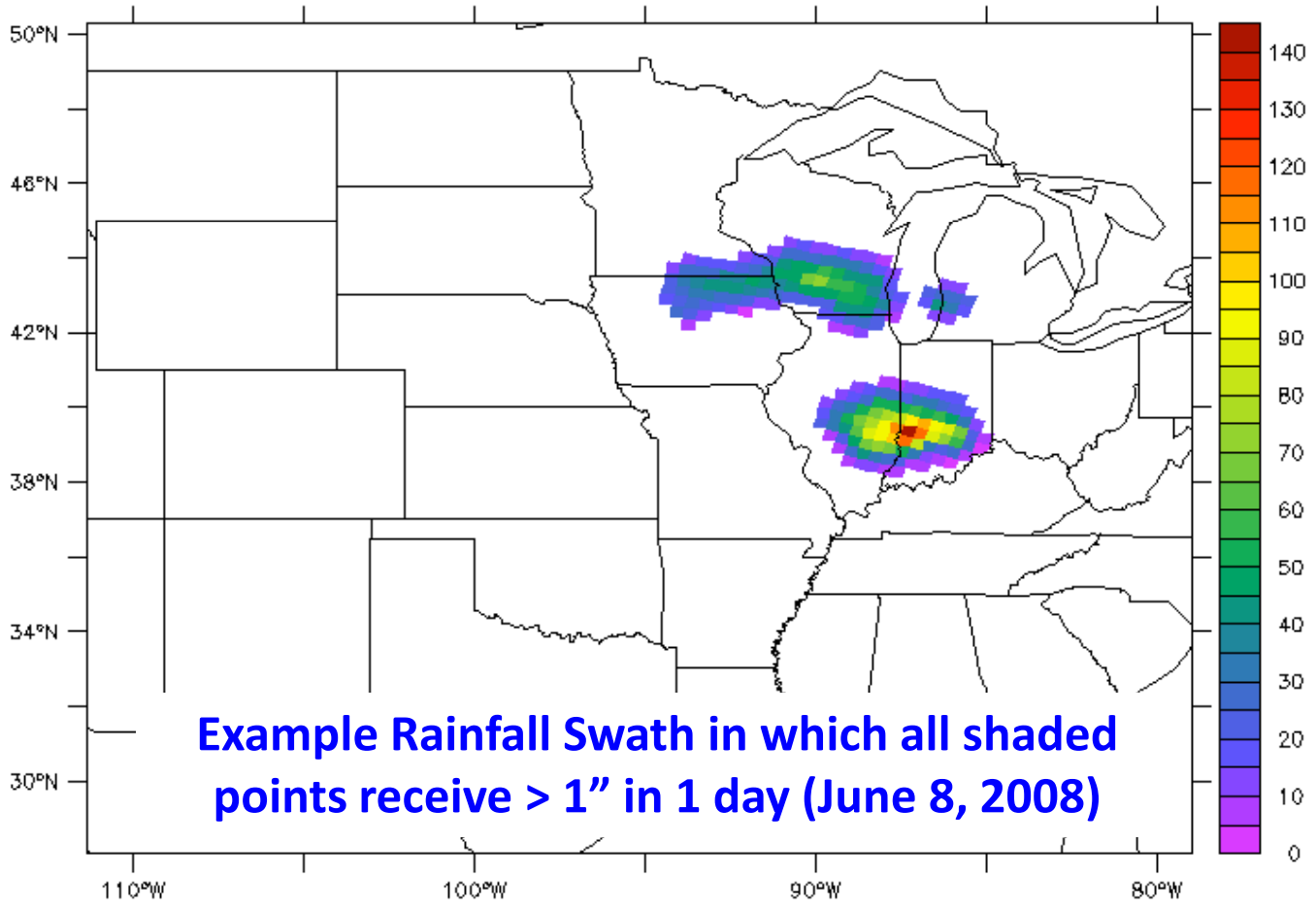
Climate Hazard Literacy:
Wet Years and Poor Timing Relate to Days of Widespread Rainfall.



Example Rainfall Swath in which all shaded points receive > 1” in 1 day (June 8, 2008)

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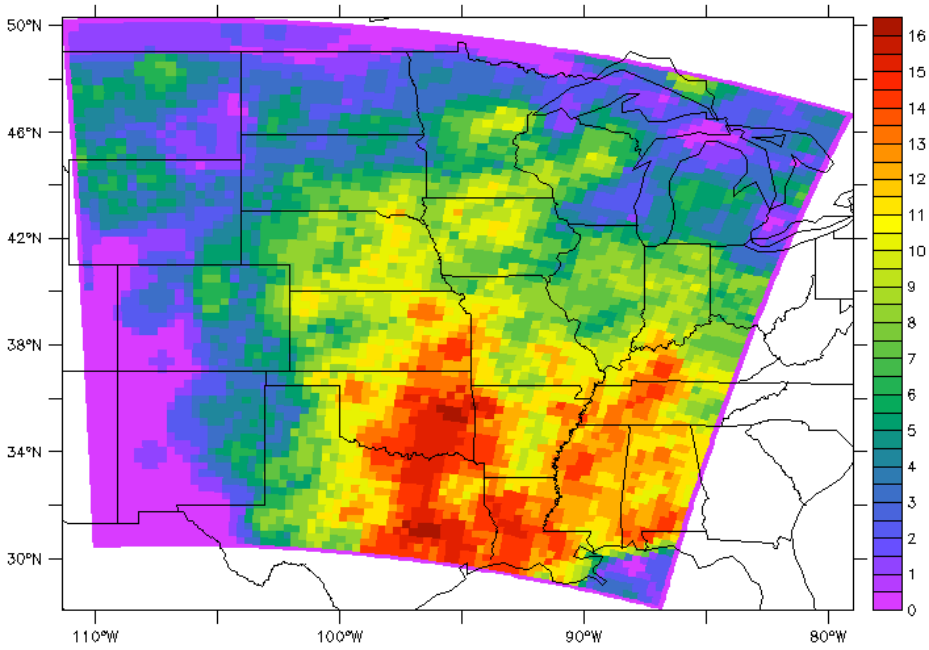
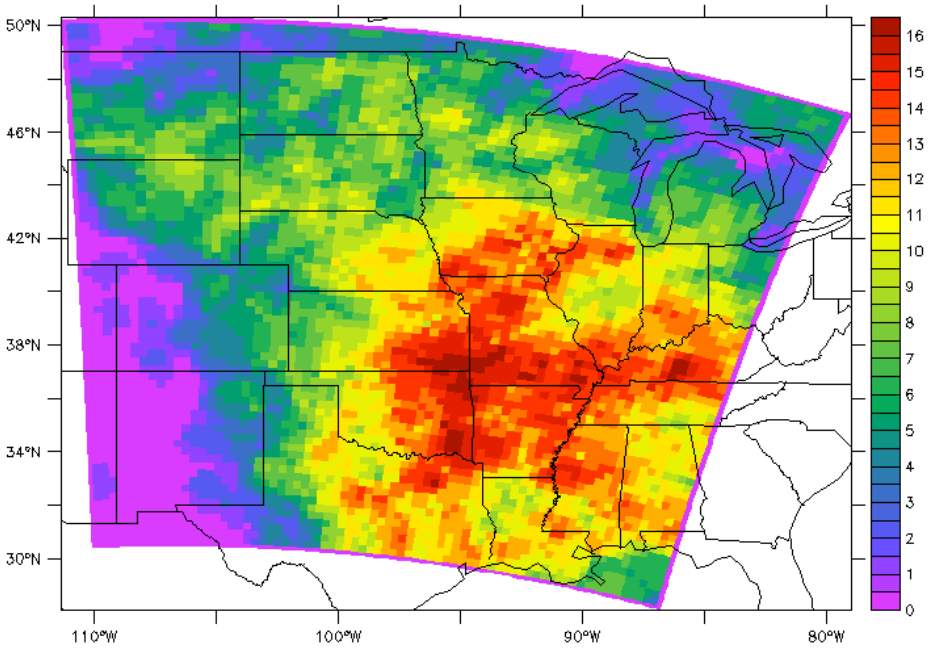
Climate Hazard Literacy:
Days of Widespread Rainfall are more frequent in past 15 years.



During May 1979-1994, 1” swaths occurred 1 in 2 years.



During May 1995-2010, 1” swaths occurred annually.

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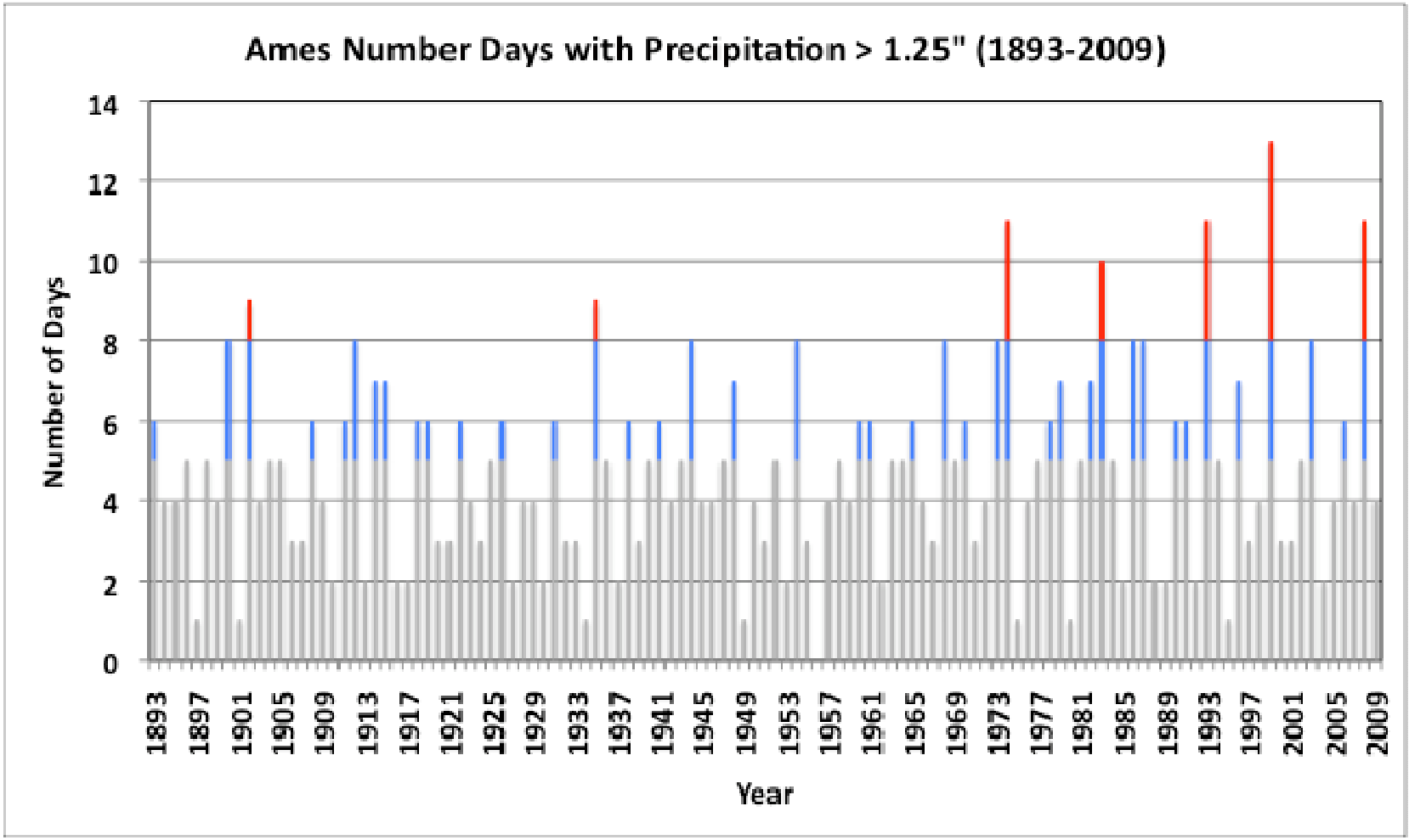
Climate Hazard Literacy:
Wet Days are more frequent in Ames



What is causing heavy rainfall events?

More water vapor is in the air over the Midwest.

- Warmer Gulf of Mexico and Caribbean Sea
- Increase in agricultural production and irrigation

Current Pacific temperature pattern diminishes drought.

- Guides storm systems over rather than north of Midwest
- Likely to continue for ~10 years

Wet soils → more rainfall → wet soils

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Climate Information for Ames Hazard Mitigation Planning: Will the flood hazard occur again in the next 25 years?

Identification of flood interval by standard procedure

Uses historical annual peak streamflow (not precipitation)

Is the more recent record more relevant for the next 25 years?

Simulated streamflow from projected rainfall is cost prohibitive

- A problem shared by every hazard mitigation planner

Use relationship between annual precipitation and annual peak streamflow to identify three planning scenarios

- Next 25 years like the measurement record (historical 1953-2009)
- Next 25 years like the current 30-yr record (adjusted 1873-1979)
- Next 25 years like projections of mid-century (projected 1873-1979)

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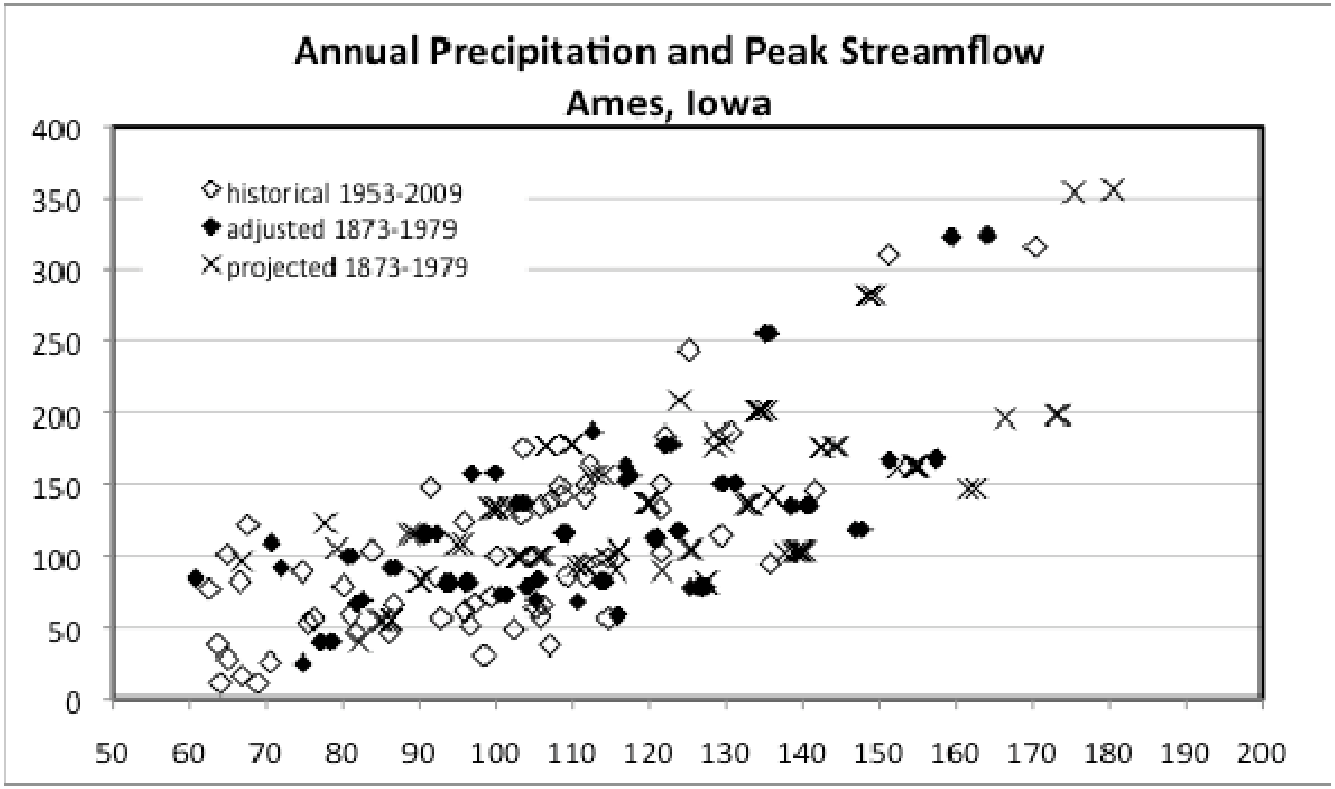
Climate Information for Ames Hazard Mitigation Plan: Three annual precipitation and peak streamflow scenarios

Frequency of Years > 150% precipitation

Historical: 1 in 27

Adjusted: 1 in 21

Projected: 1 in 9



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Application of Climate Projections In Hazard Mitigation Planning

Main limitation continues to be lack of techniques for translating climate projections into streamflow

Climate projections can inform climate hazard literacy

Climate projections can provide scenarios for relevant indicators

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Ancillary Slides Follow

What about greenhouse gases?

Greenhouse gas increases have warmed the oceans, adding water vapor to the air over the Gulf of Mexico and Caribbean Sea.

The relative importance of ocean warming, Pacific temperature patterns, and soil moisture is an ongoing discussion among scientists.

Summary: Evidence of recent increases in Iowa's Rainfall

Years with statewide precipitation > 40" occur 1 in 6 years since 1950 compared to 1 in 38 prior to 1950

24-hr rainfall > 1" in May previously occurred 1 in 2 years but now occurs annually.

Ocean warming from GHG increase, Pacific temperature patterns, and higher soil moisture all contribute to rainfall increases.

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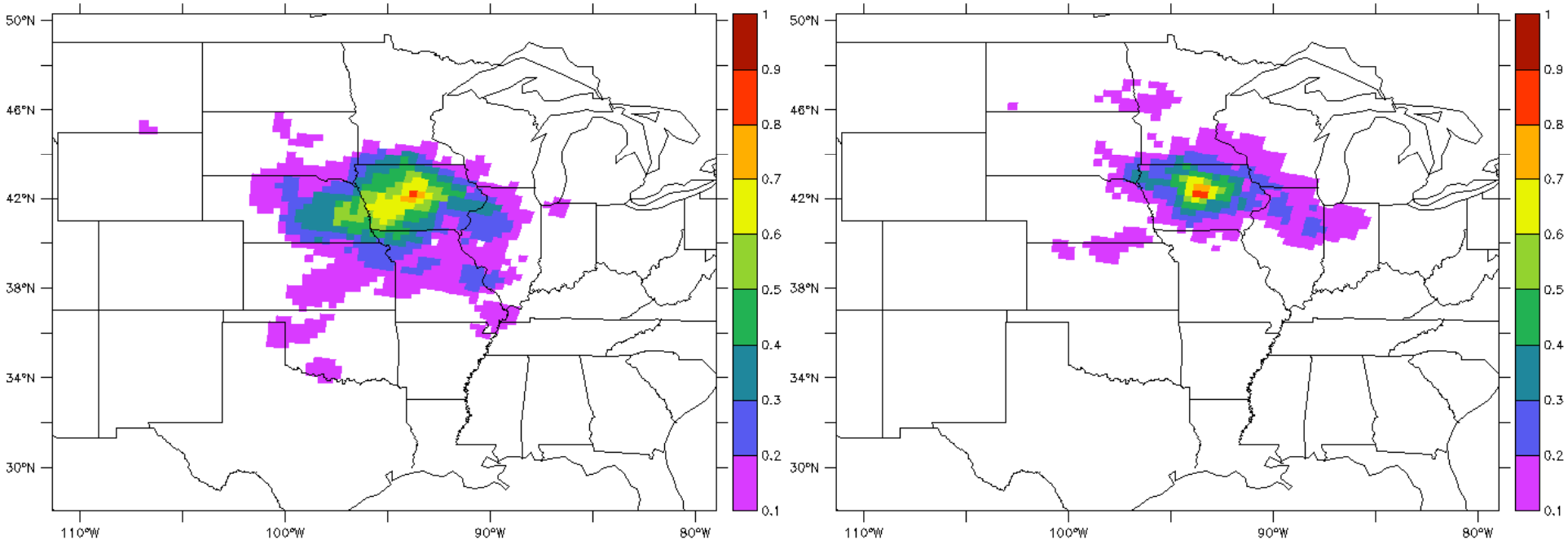
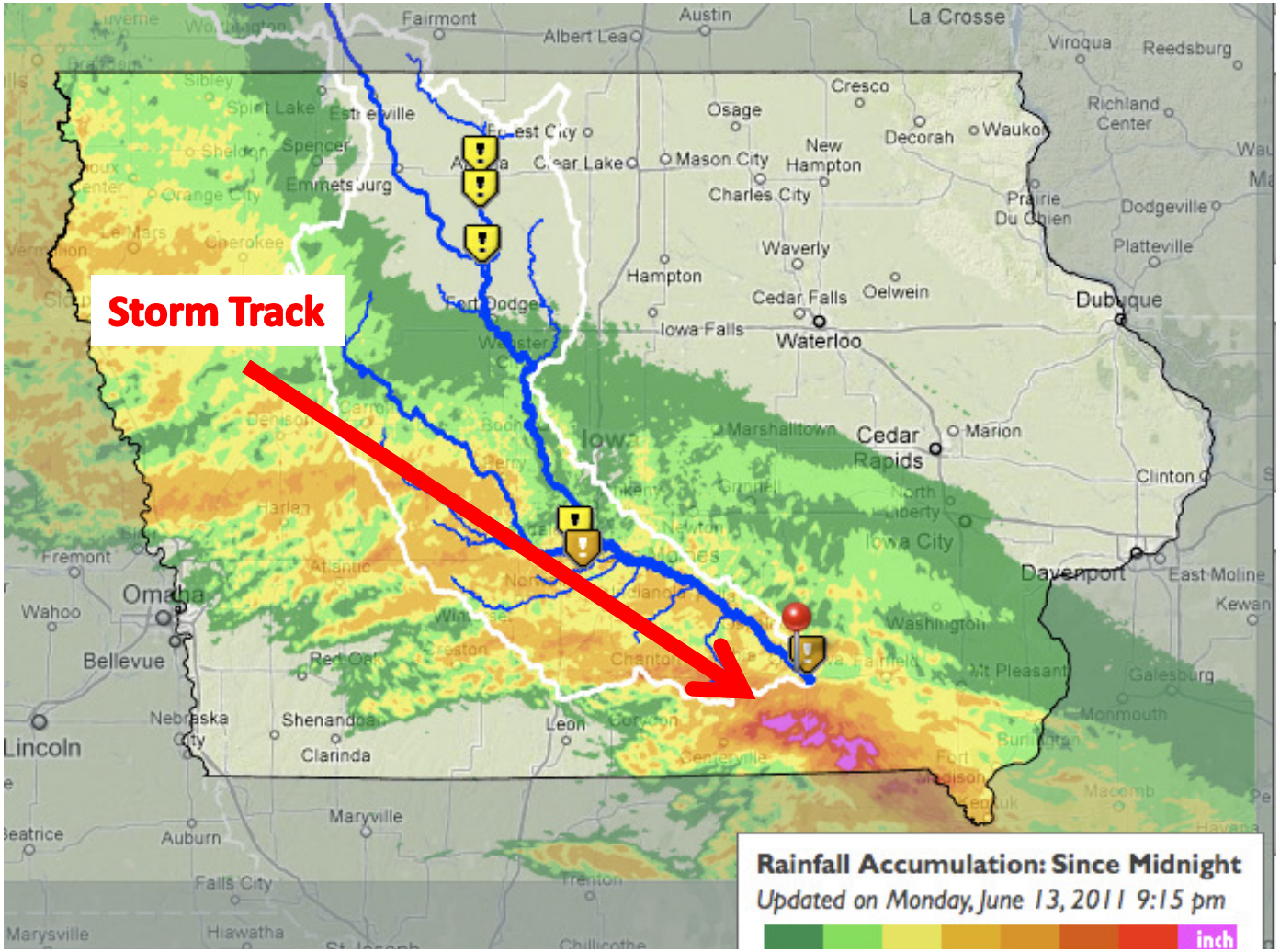
Swaths of 1” Rainfall become oriented along Iowa river basins in the summer



During May, 1” swaths typically stretch from central Iowa to southeast Nebraska.

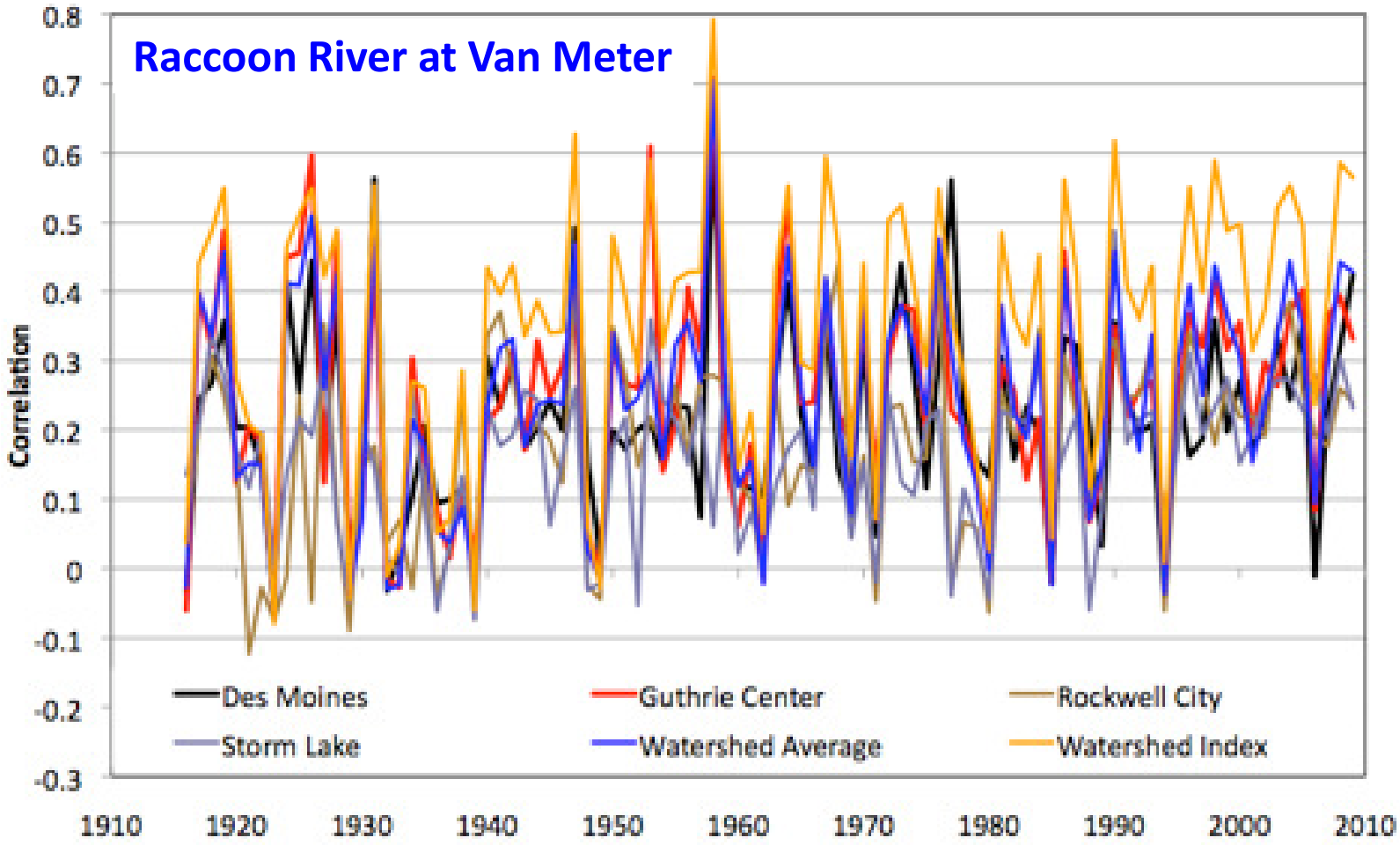
During July, 1” swaths typically stretch from northeast Iowa to east central Iowa.

Example of storm oriented along a river basin



Courtesy Iowa Flood Center http://www.iowafloodcenter.org/

Rainfall Index based on traffic jam explains daily streamflow better than other metrics



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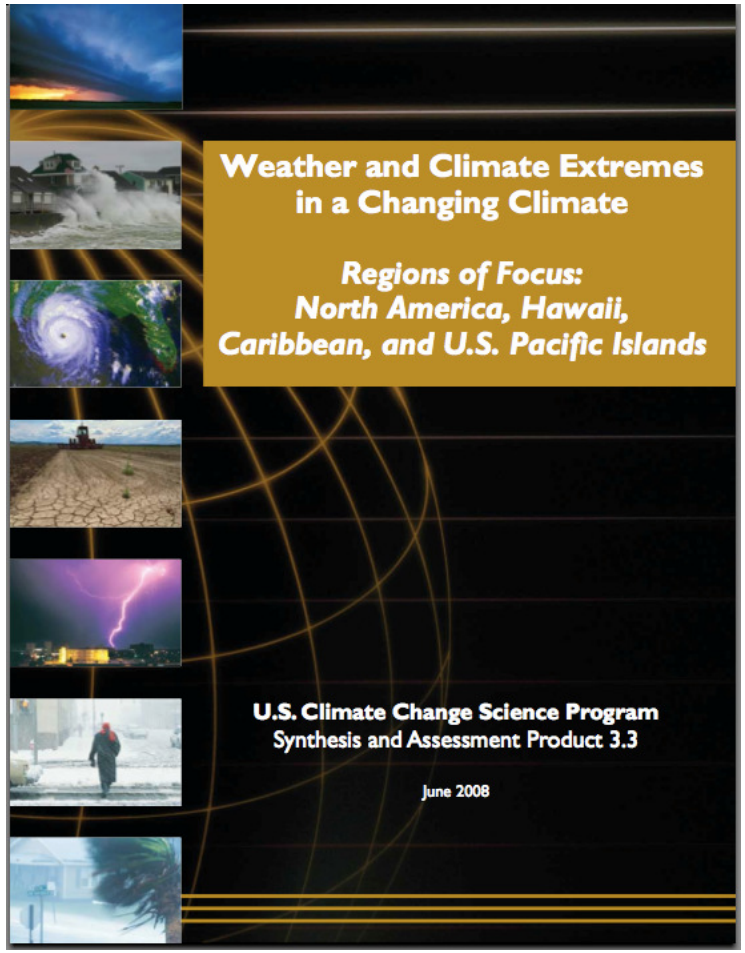
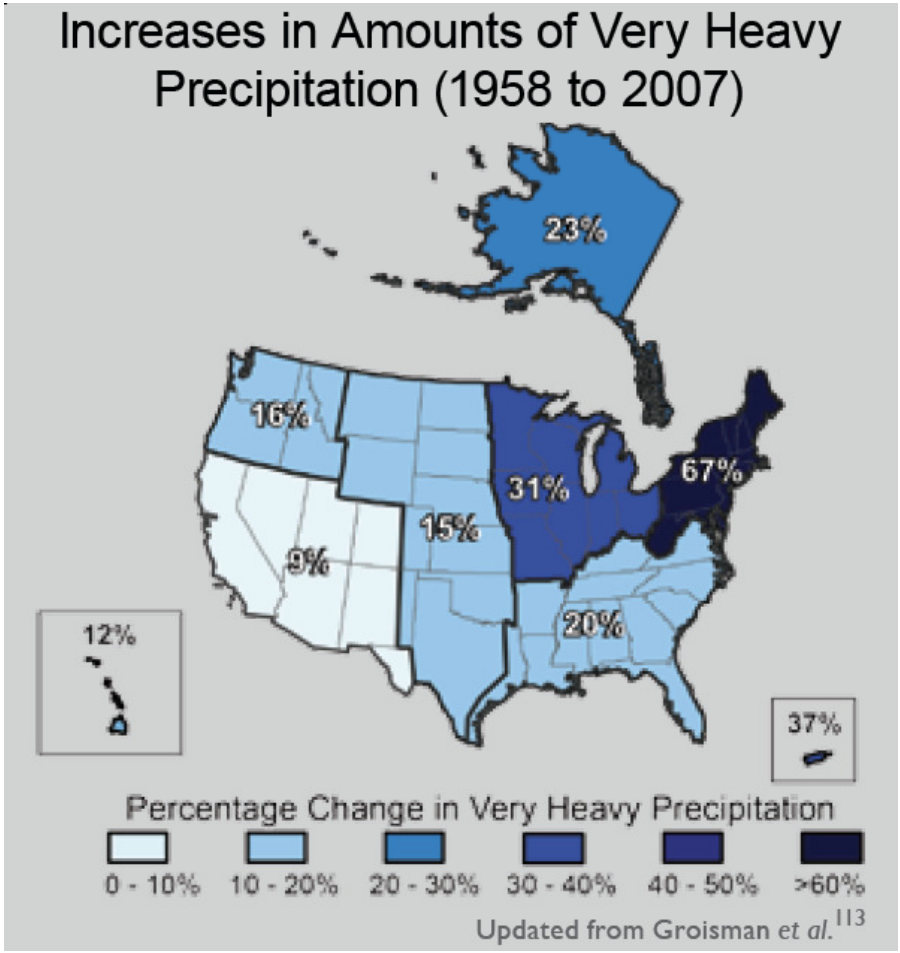
"One of the clearest trends in the United States observational record is an increasing frequency and intensity of heavy precipitation events… This trend is statistically significant."





Potential Uses of Rainfall Index

Estimate streamflow from precipitation prior to availability of streamflow measurements

Provide information to public on role of rainfall versus landuse changes in explaining streamflow increases

Use rainfall projections to estimate potential future daily streamflow extremes

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What does the future hold?

2010-2020

- Rainfall is likely to be similar to the previous 10-15 years.

2020-2040

- Days with heavy rainfall will be mixed with dry periods.

Beyond 2040

- Projected range of Spring state-wide rainfall is 0% - 25%, as much as twice the increase since 1873.

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http://climate.engineering.iastate.edu

Projected Changes* for the Climate of the Midwest

- More (~10%) precipitation annually (medium)
- Change in "seasonality": Most of the increase will come in the first half of the year (wetter springs, drier summers) (high)
- More water-logging of soils (medium)
- More variability of summer precipitation (high)
  - More intense rain events and hence more runoff (high)
  - Higher episodic streamflow (medium)
  - Longer periods without rain (medium)
- Higher absolute humidity (high)
- Longer periods of dew duration and hence higher likelihood of disease, fungus, alflatoxin, mycotoxins, fruit pathogens (medium)
- Stronger storm systems (medium)
- Snowfall increases (late winter) in short term but decreases in long run (medium)
- More winter soil moisture recharge

Follows trend of last 25 years and projected by models

No current trend but model suggestion or current trend but models inconclusive

*Estimated from IPCC reports