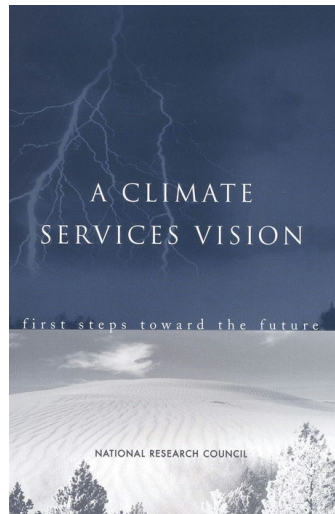


# Going to Extremes in Weather and Climate Services: Some Transdisciplinary Lessons from the U.S. Midwest and Elsewhere



Roger S. Pulwarty<sup>1</sup>, Doug Kluck<sup>1</sup>, Mark Svoboda, D.  
Todey<sup>3</sup>, R. Webb<sup>1</sup>, Colin Wellenkamp<sup>4</sup>

<sup>1</sup>NOAA, <sup>2</sup>University of Nebraska, <sup>3</sup>USDA, <sup>4</sup>Mississippi River  
Cities and Towns Initiative (MRCTI)



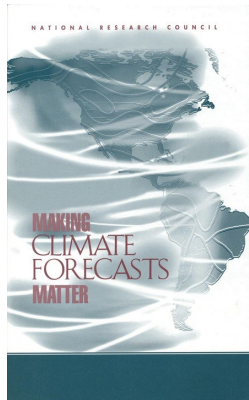
**Climate Services:** *“The timely production and delivery of useful climate data, information and knowledge to decision makers” (NRC, 2001)*

*Regional Climate Services: as above but at regional/local scales*

**Climate Services Requirements:** Systematic consideration of

- (1) Scientific and technological capabilities and current products,
- (2) User needs and desired climate information applications, and
- (3) Institutional components of a national climate services system

**More specifically:** *A network of activities that maintain well-structured paths from observations, modeling, and research to the development of relevant place-based knowledge and usable information to inform decisions*



United States Government Accountability Office  
Report to Congressional Requesters

November 2015

CLIMATE  
INFORMATION

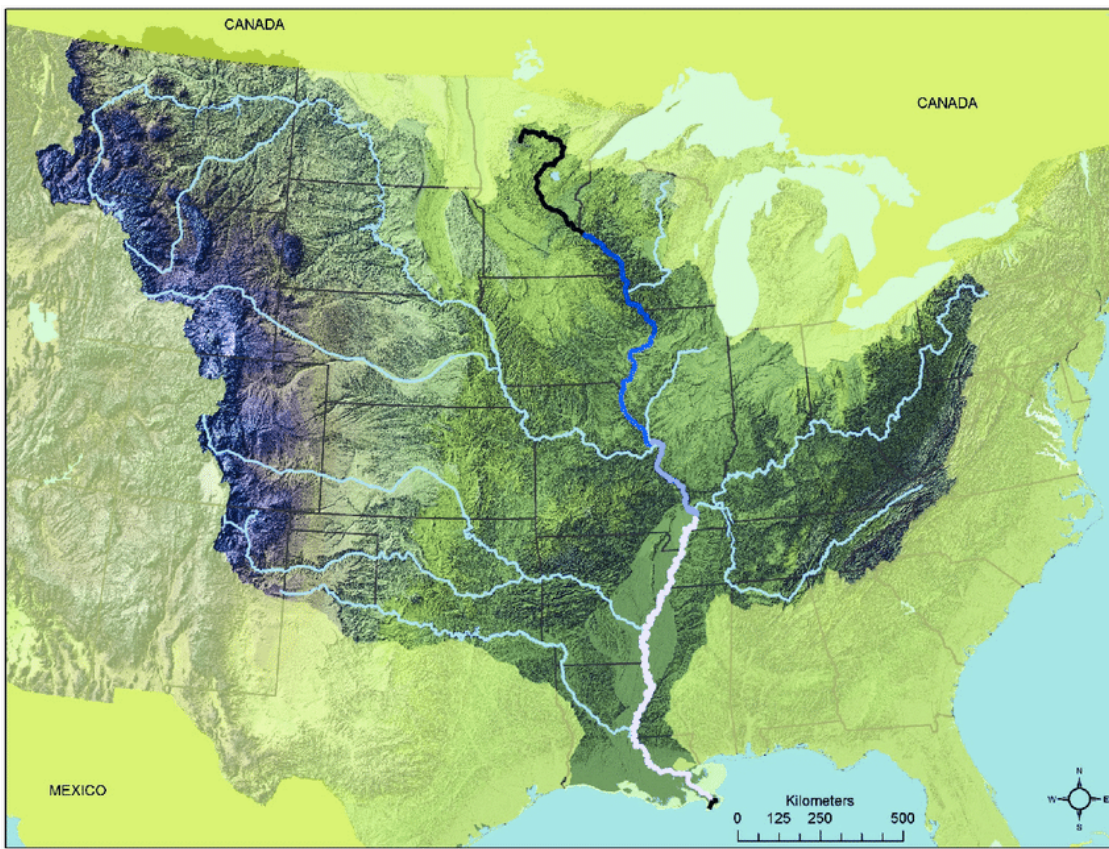
The Science of Regional  
and  
Global Change

PUTTING KNOWLEDGE TO WORK



NATIONAL RESEARCH COUNCIL





The Missouri-Mississippi River System at (1.25 m sq. miles, 3.22 m km<sup>2</sup>) fourth largest river system and the most economically valuable corridor in the world.

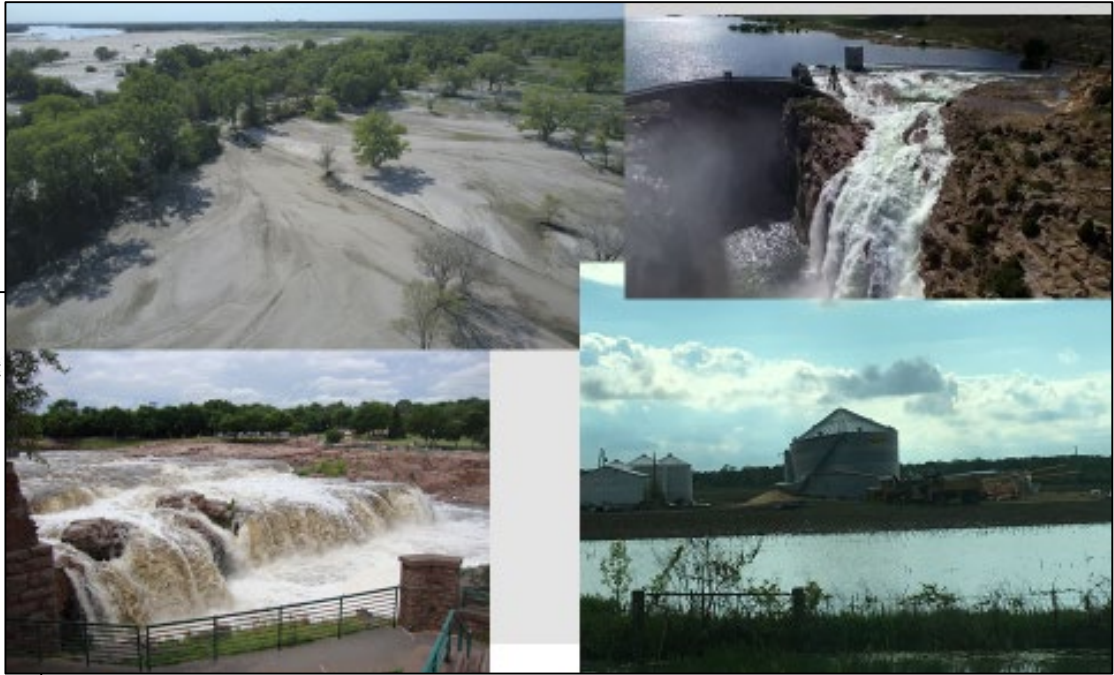
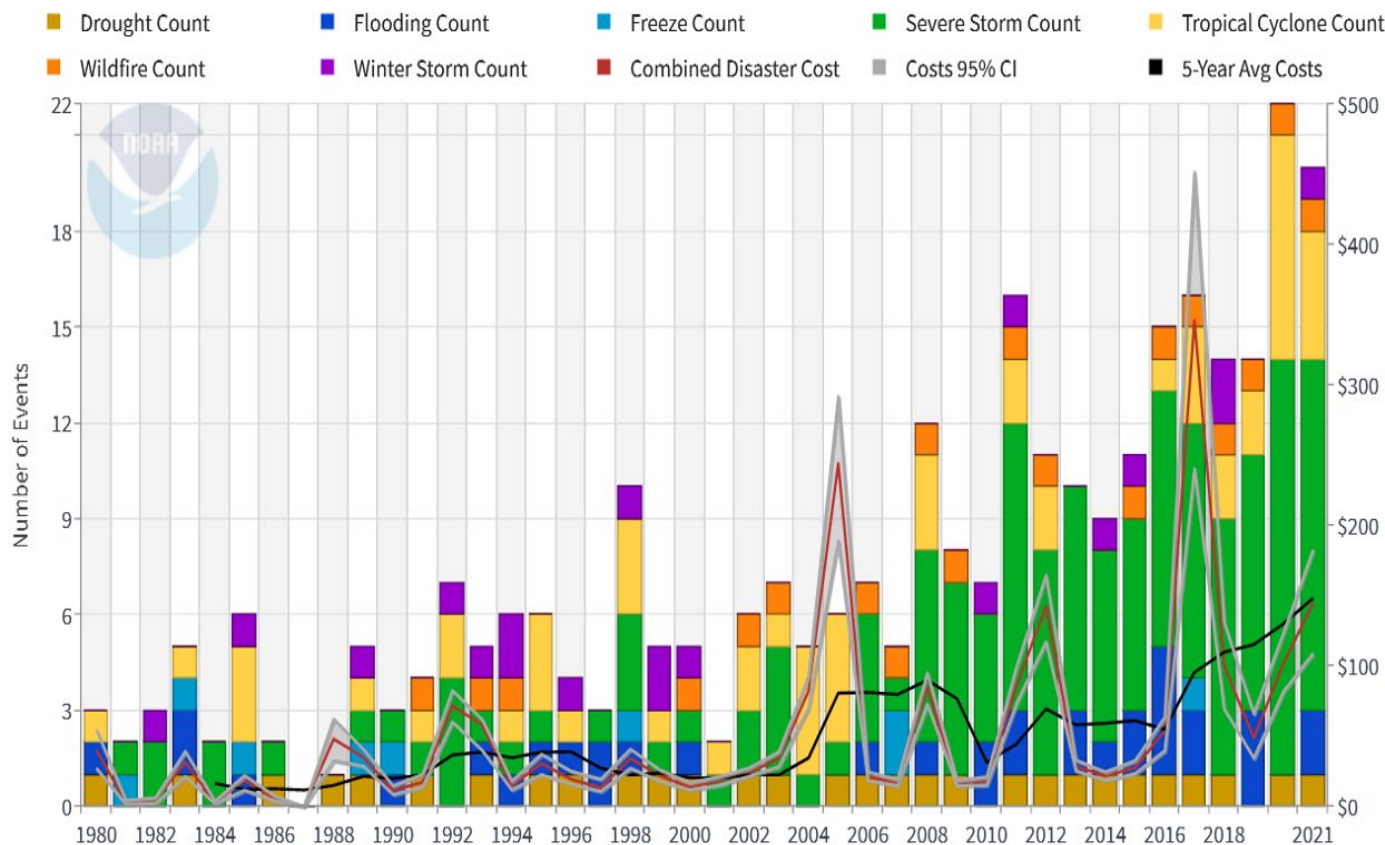
Highest volume for the transportation of goods in the US.. Over 460 million short tons (420 million metric tons) and 3.25 million short tons of shipments respectively each year, with 92% of the nation's agricultural exports and 78% of the world's feed grains and soy beans.



# What extremes?

The total cost of these 310 events exceeds \$2.155 trillion

United States Billion-Dollar Disaster Events 1980-2021 (CPI-Adjusted)



Disasters are becoming more prevalent and costly

## A Complex System

- Local governments
- State governments
- Federal agencies
- Business and industry
- Universities
- Regional entities
- Non-profit organizations
- International connections

The Basin appears to be becoming even more variable in terms of runoff. Annual runoff variability has nearly doubled in the last 20 years (Livneh 2016)

A few recent episodes:

1993 Flooding

2011 Flooding/Drought

2002-2007/2012/2017/2020-present Drought

2019 Flooding



MRCTI

# From Too Much to Too Little:

How the central U.S. drought of 2012 evolved out of one of the most devastating floods on record in 2011



# From Too Much to Too Little:

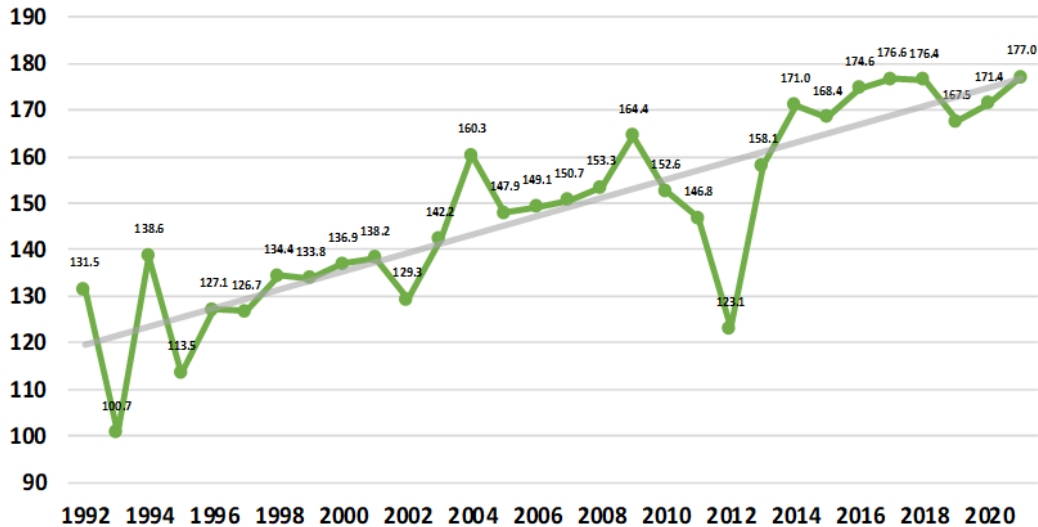
How the central U.S. drought of 2012 evolved out of one of the most devastating floods on record in 2011

2012: First time U.S. corn yield fell three years in a row since 1928-30 (USDA)

## Corn Yield United States



Bushels per Acre



## Flood: Weather

est"

tor Apr 19, 2013

ent" window

ngthened a partnership with the Mississippi

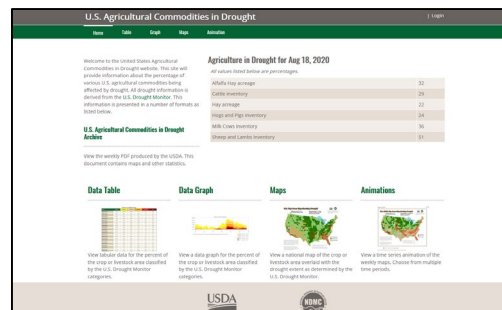
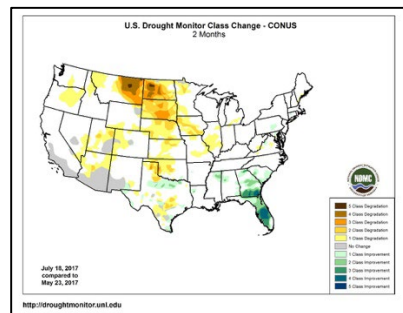
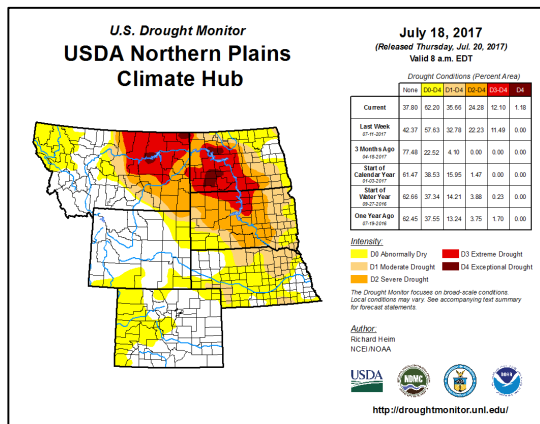
r constituencies



# Mississippi River Cities and Towns Initiative (MRCTI): A bipartisan consortium of the 124 Mayors on the mainstem

An innovative organization undertaking initiatives to attract green jobs, move towards sustainable economies and achieve local environmental protection goals, and with public and private partners ranging from the UN to the mainstem barging industry, and local agricultural producers





# Upper Midwest "Rapid-onset" Drought 2017



The 8-week change map between the July 18, 2017 and May 23, 2017. Large parts of the Northern Plains saw a 4-5 class deterioration over this two month period.

Agricultural Commodities in Drought:  
<https://agindrought.unl.edu>

Cumulative risk:  
 Antecedent conditions

In May 2017, the region was mostly drought-free, and at least average summer precipitation was forecasted.

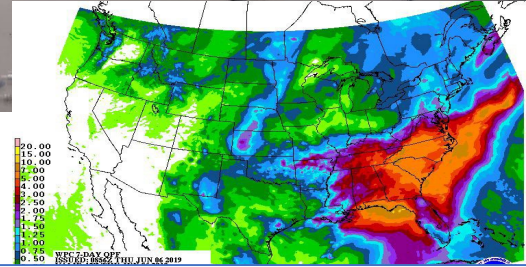
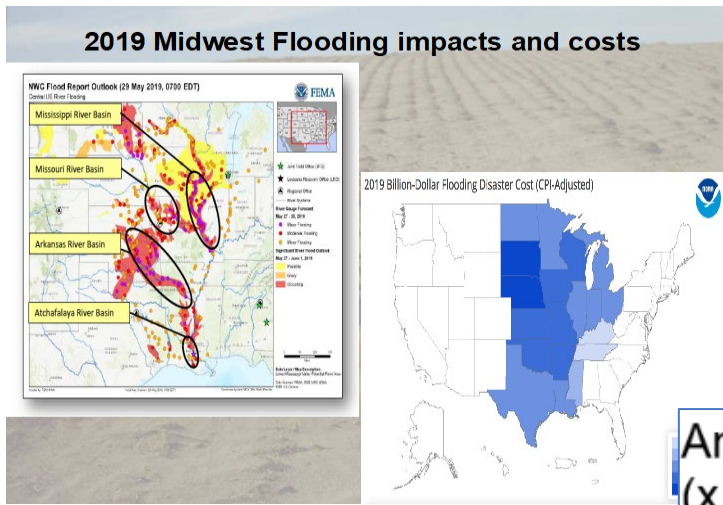
By July 2017, North Dakota, South Dakota, eastern Montana, and the Canadian prairies were experiencing severe to extreme drought, resulting in fires that burned 4.8 million acres across both countries and U.S. agricultural losses in excess of \$2.6 billion dollars

(Hoell et al 2020)

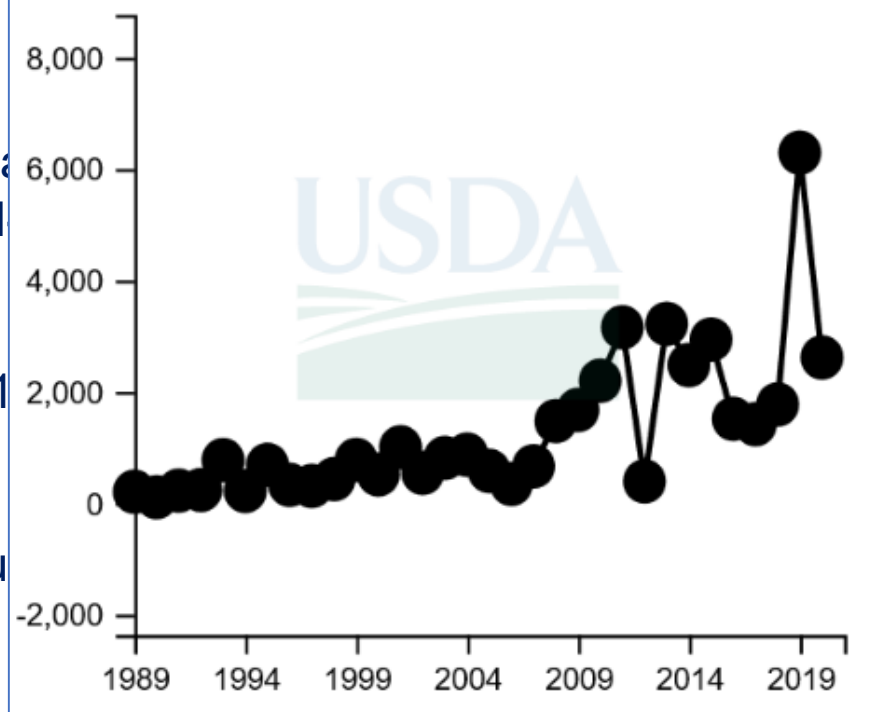




# 2019 Central Floods



Annual excess moisture/precip/rain totals (x 1,000,000)



The wettest spring and summer on record occurred in 2019.

- 14 million acres of insured farmland were destroyed, the largest since USDA's 'prevented planting' program in 2007,
- Reduced corn and soybeans – 1 billion bushels and 1 billion bushels respectively.
- 5 million acres were planted in upland crops. One expert "it turned out to be a

Cumulative risk: Antecedent conditions

# Climate information: looking through the window

Historical	Climatologies	Indices	Status reports	Near real time	Web accessible
Data	Special	Analyses for CC	Reviews	analysis/data	statistics, graphs,
	Publications	Metadata			Maps



**Structural      Management      Operations      Public      Strategic Planning**

**Working in Concert: Regional Climate Services Director, Midwest Climate Hub, Regional Climate Centers, River Forecast Centers, USACE, USGS, Climate Prediction Center, Physical Science Lab, State Climate Offices**

- Research-stakeholder Workshops and meetings
- Presentations and briefings
- One-on-one technical assistance (ex: watersheds, producers)
- Work with the local media
- Product Development
- Web site development and updating



## Resulting actions from towns and cities (MRCTI 2019, 2020, 2021)

- Cities were able to make informed decisions regarding continued flood-flight activities, mainly to maintain them at full measure;
- Member cities were able to more confidently begin longer term mitigation and recovery planning such as insurance arrangements;
- Member cities began to coalesce around mixed infrastructure solution, including drawing lessons from each other, incorporating more natural assets at a scale more extensive than previous expected;
- New partnerships at greater scale over more service areas stretching across multiple states were sought given the patterns NOAA shared;
- Most importantly, aggressive action was taken to coordinate with state and federal agencies thanks to prompting of impacts from NOAA, USDA and partners



# Fed back up the chain to improving questions for use-inspired research and development

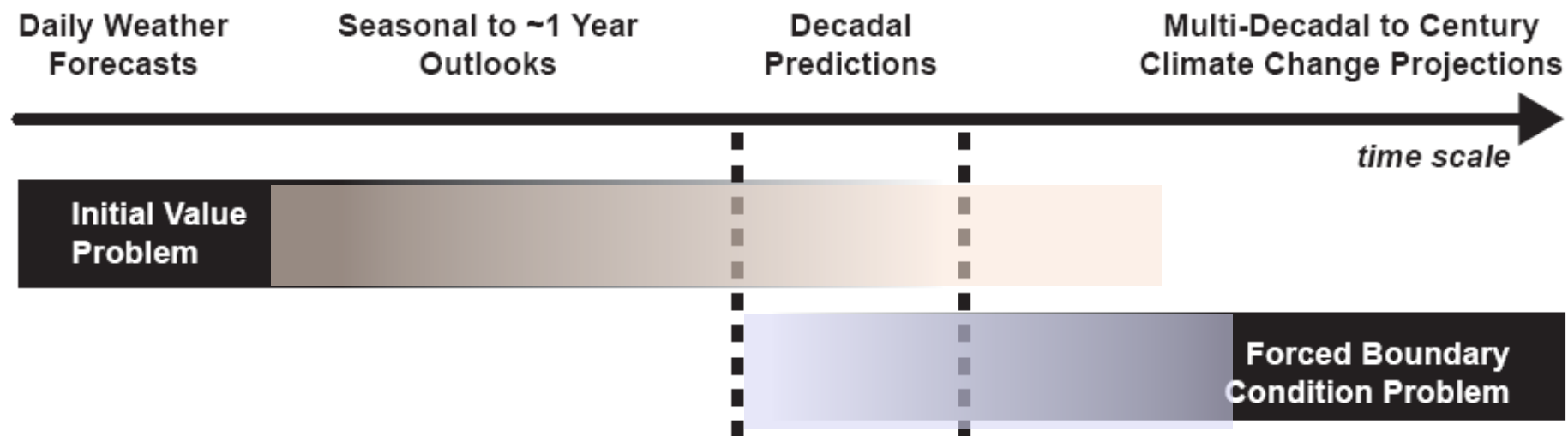
- Invest in new and existing monitoring and observation networks- development of better indicators to provide early warning with decision-makers (ex: Upper Missouri Monitoring Network, 2011 & 2019 floods, 2012 & 2017 droughts)
- Improve the understanding of the relevant processes that inform forecast models in the region, which could improve seasonal forecasts to enhance drought/flood preparedness (ex: OAR studies)
- Improve drought mitigation and response plans to consider vulnerabilities, trade-offs and actions that benefit from a better understanding of the weather–climate continuum at subseasonal to seasonal timescales e.g. “flash-droughts”
- Strengthening relationships and networks to share information between federal, state/provincial, tribal, and local stakeholders before, during, and in between events, thereby. This work and resultant report(s) involved a partnership of around 20 groups from a variety of backgrounds including academic, state, federal, tribal and involved partners from Canada as well.
- The actions derived from these discussions included the development of the interagency National Drought Resilience Partnership (2012). Among the NDRP goals are to improve coordination of Federal Drought Activity including Drought Planning and Capacity Building, and facilitate public, private and NGO approaches for infrastructure efficiency and technology innovations



# Moving forward.....managing “through” changes not just “for” change

- Most events were outside the range of projected climate changes for the region
- Impact assessment and scenario development must approach climate model output far more critically, that treat the full spectrum of variability and change

i.e. understand the “anatomy of an extreme” (see Dole et al 2010)



# Beyond co-production to risk governance: Broadening the actor network vertically and horizontally

Management and policy making agencies and groups

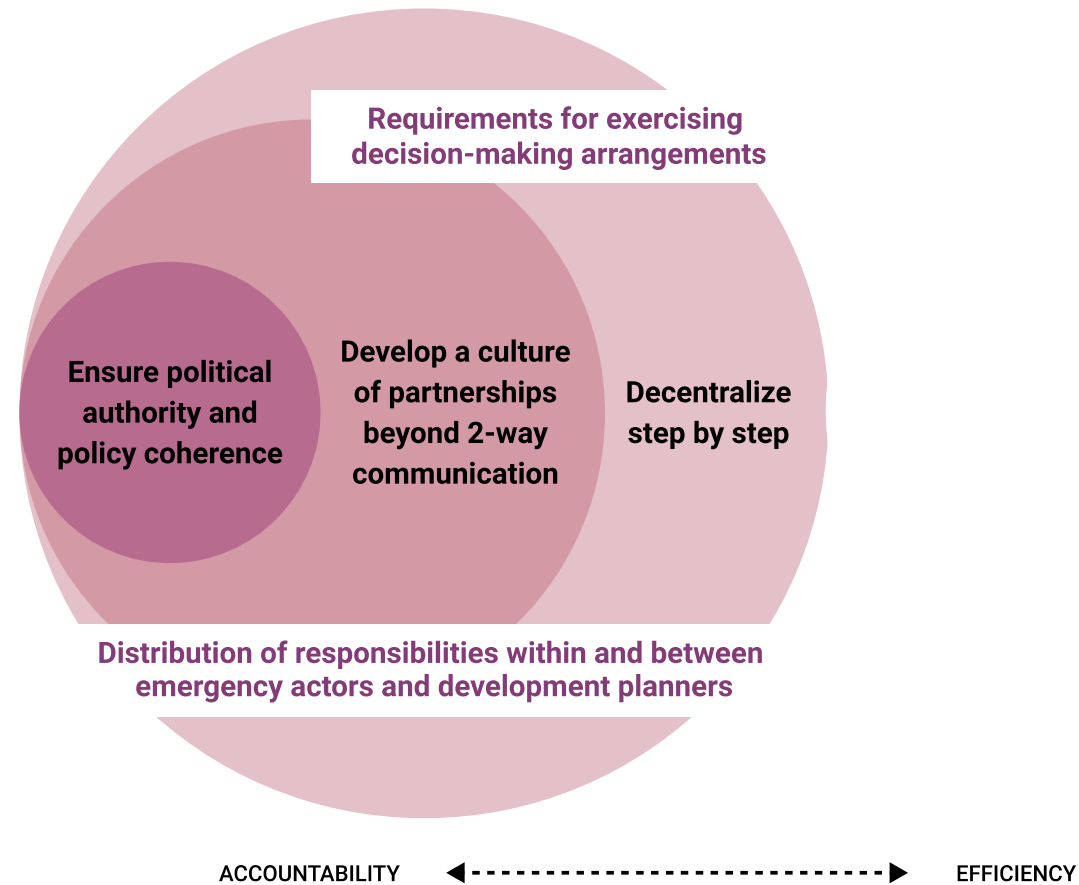
Knowledge systems: Research, information systems and mechanisms- understand and assess climate-related risks, paths and benefits

Financial services Impact Investors, lenders, and Insurance

Implementing agencies and offices informing responses : Coordinating roles, authority, and relationships

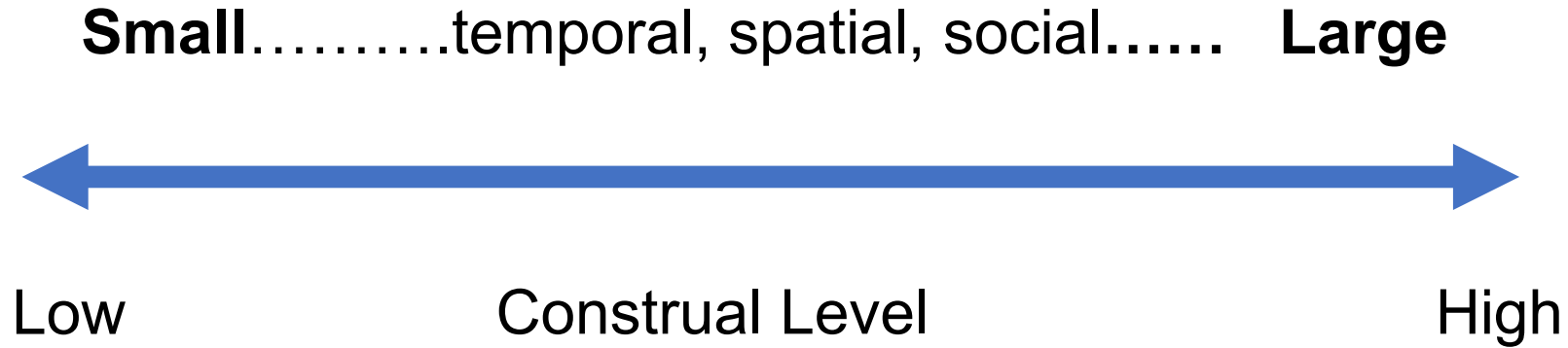
## Risk governance: broadening the “actor network”

Collaborative process for individual and institutional learning





# Ongoing challenges-Addressing mental models and cognitive distance



Both researchers and practitioners can become “prisoners” of their world views (Fischhoff, 2020)

Trans-disciplinarians will operate most effectively with knowledge of the process combined with knowledge in the decisionmaking process

Throughout the cases above...success or at least improvements were determined by “Norm entrepreneurs” -- actors (paper authors) skilled at promoting and structuring the normative foundations for partnerships

- Impediments to the flow of knowledge among existing components
- Policies and practices that can give rise to failures of the component parts working as a system
- Opportunities for and constraints to learning and institutional innovation-pulling towards use-inspired research (not just user “needs”)

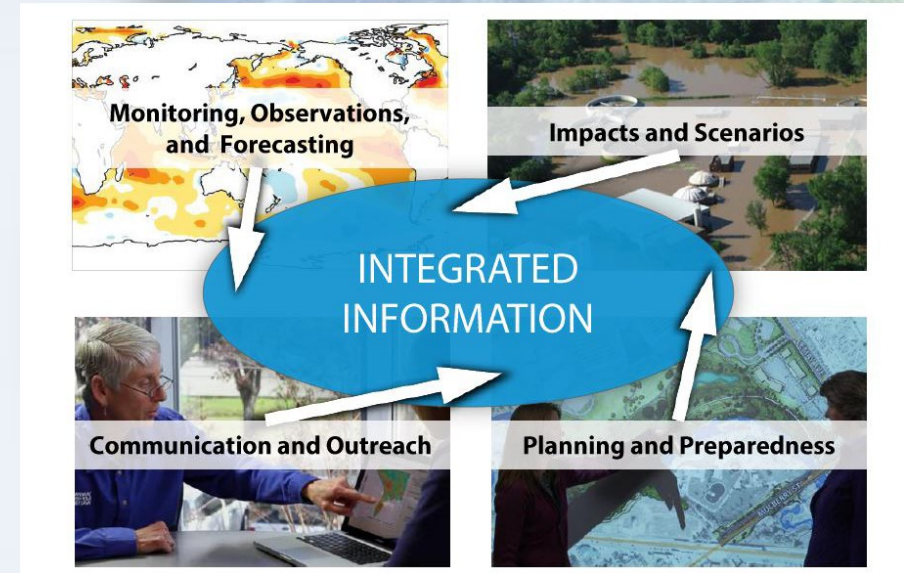
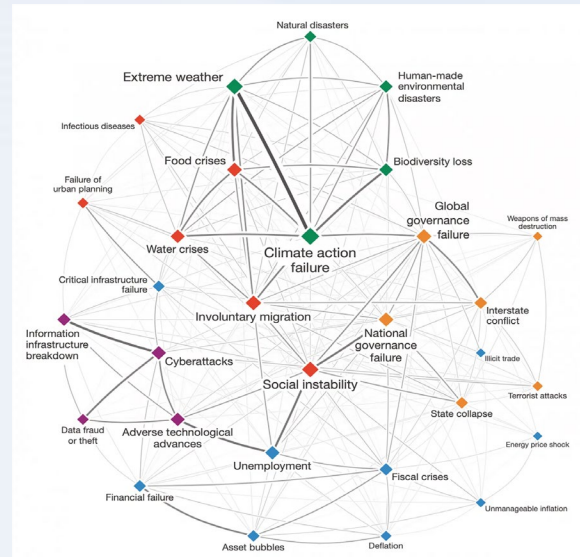
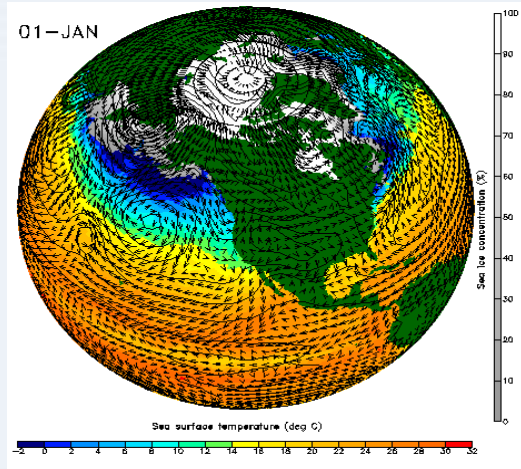
## **Recognize and foster varieties of trust processes in knowledge exchange vs “impacts” alone**

- rational - credibility of expected benefits and risks;
- procedural - fairness and integrity of the procedures involved;
- affinitive - shaped by emotions, shared identities or feelings
- dispositional - willingness trust another entity.



# Ongoing Challenge:

Develop professionals and researchers who analyze complex risks and sustain collaborative networks within and across systems



Thank You