



# CoFiRES

CENTER ON FINANCIAL RISK  
IN ENVIRONMENTAL SYSTEMS

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*Director*

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Gillings School of Global Public Health  
UNC Institute for the Environment*

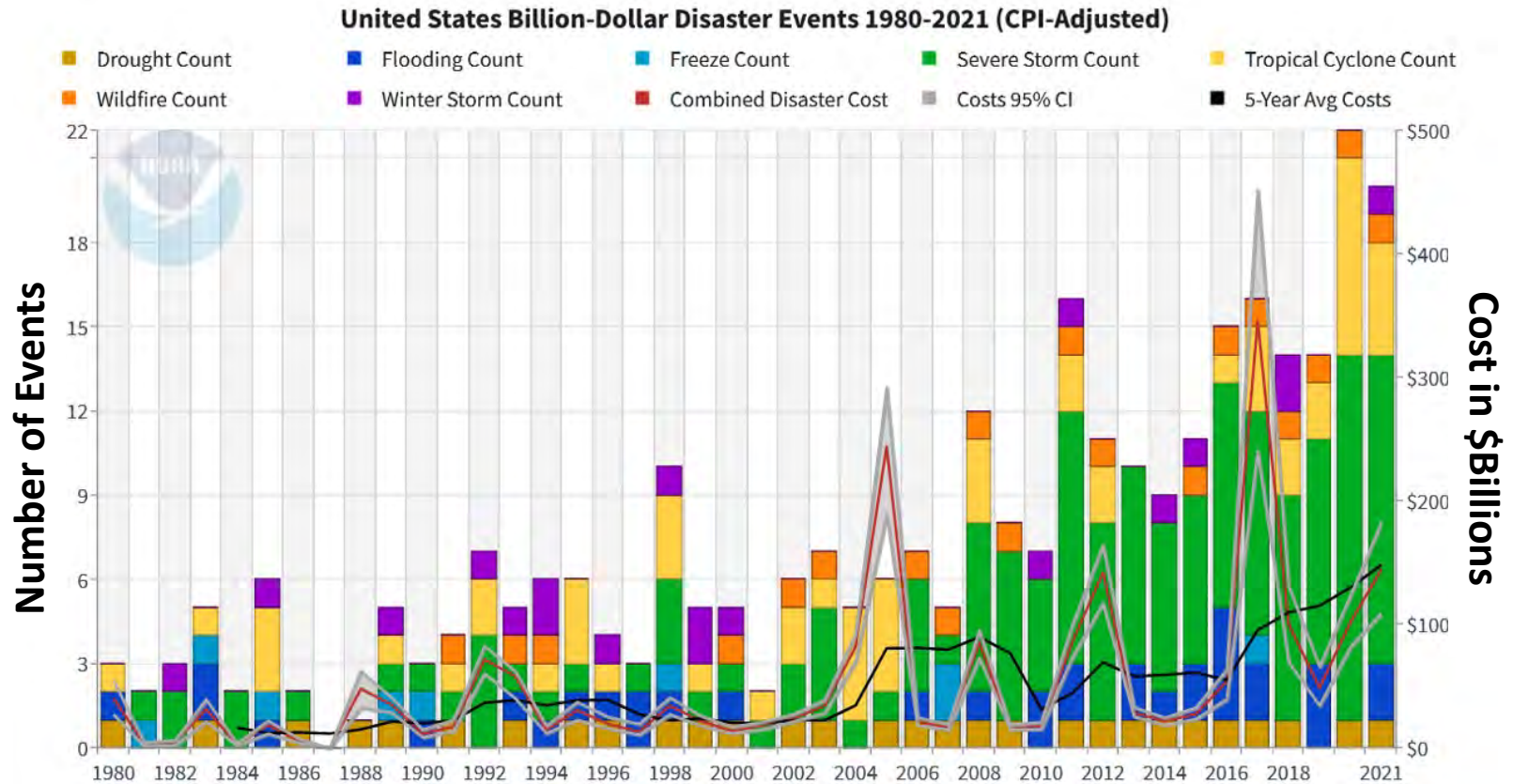


TTI Vanguard, Chapel Hill, March 2024



THE UNIVERSITY  
of NORTH CAROLINA  
at CHAPEL HILL

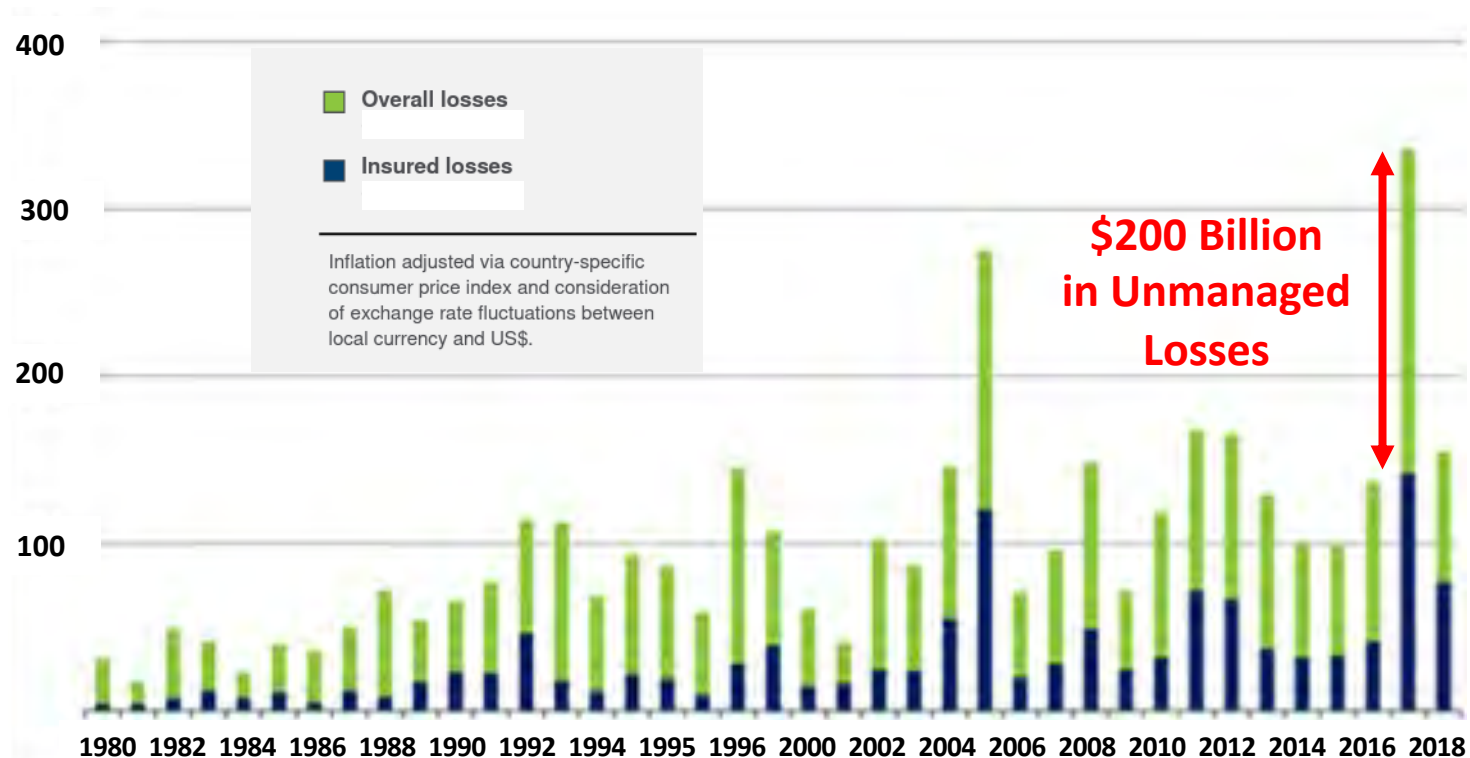
# Environmental financial risks are growing



- Environmental events represent a risk to many sectors and activities
- Risks/Losses growing with increasing wealth and greater natural variability

# Unmanaged portion of risk is also growing

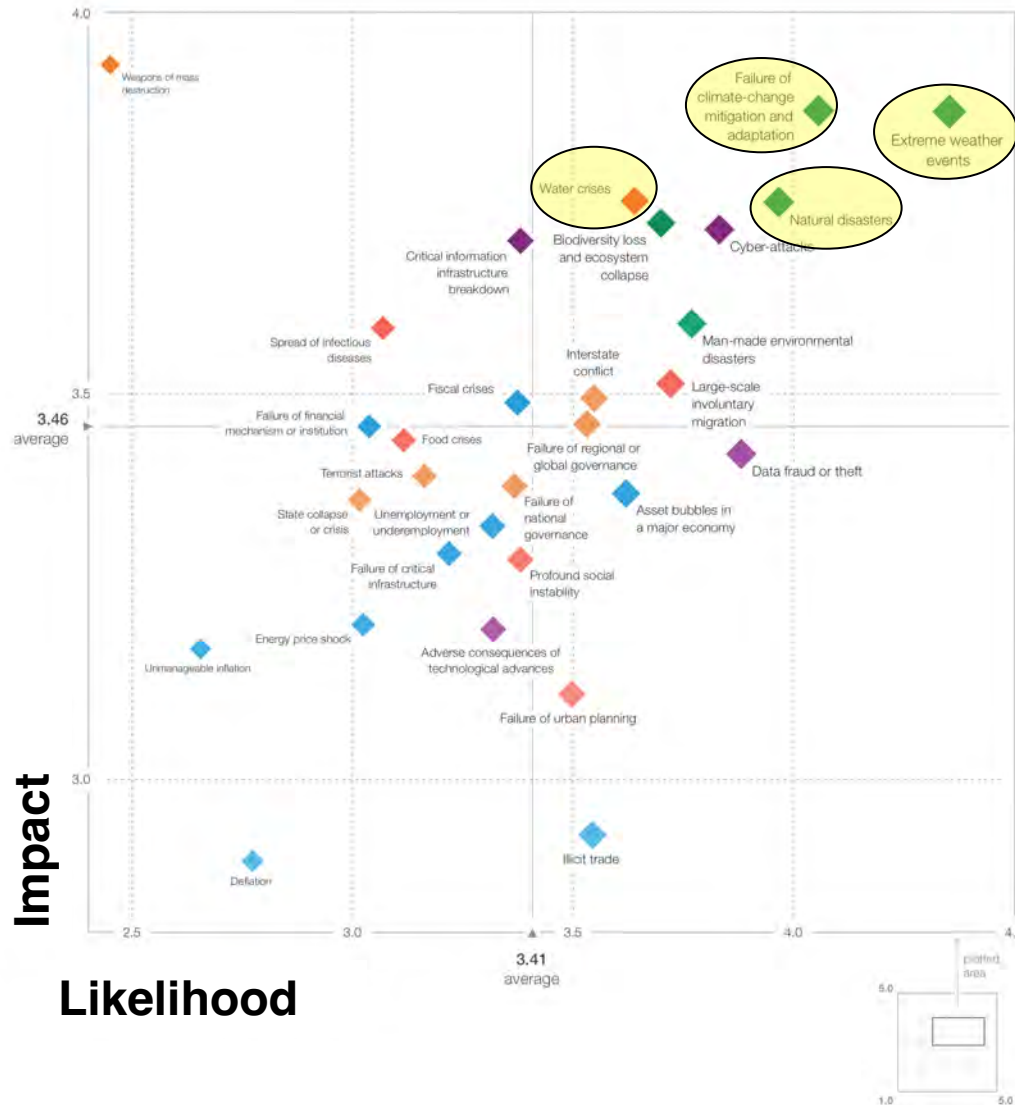
US\$ billions



- Gap between insured and uninsured natural hazard losses is growing
- Suggests the need for improved strategies and tools for limiting losses

# Ranking of Global Risks

(as ranked by participants at the World Economic Forum in Davos)



Source: Global Risks 2019, World Economic Forum

# Attention to these risks has grown recently



However, the existing disclosure regime has **not resulted in disclosures** of a scope, breadth, and quality to be **sufficiently useful** to market participants and regulators

- MANAGING CLIMATE RISK IN THE U.S. FINANCIAL SYSTEM  
Market Risk Advisory Committee  
U.S. Commodity Futures Trading Commission

GT GreenbergTraurig

April 25, 2023 at 9:00 am ET

October 09, 2023 | GT ALERT

California Enacts First-of-Their-Kind Laws Requiring Corporate Climate Disclosures

# “Agents of Change” need actionable information

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**Swiss Re**

 **Marsh McLennan**



**Munich RE** 

 **AMWINS** | 

**Insurers &  
Reinsurers**

**Lenders &  
Investors**

**WELLS  
FARGO**

J.P.Morgan



**CalPERS**

**BlackRock**

**STANDARD  
& POOR'S**

**MOODY'S**

**KBRA** **KROLL BOND  
RATING AGENCY**

**Ratings  
Agencies**

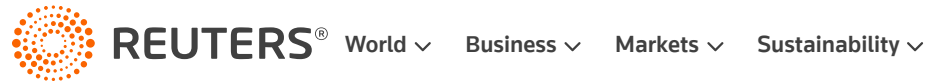
# Market for new products and information is growing



## Use of weather derivatives surges as extreme climate events rock the globe

By Harry Robertson

October 12, 2023 12:14 PM EDT · Updated 4 days ago



Legal | Breakingviews | More

Climate & Energy | Climate Change

## Global economic losses from extreme weather could hit \$5 trillion, Lloyd's says

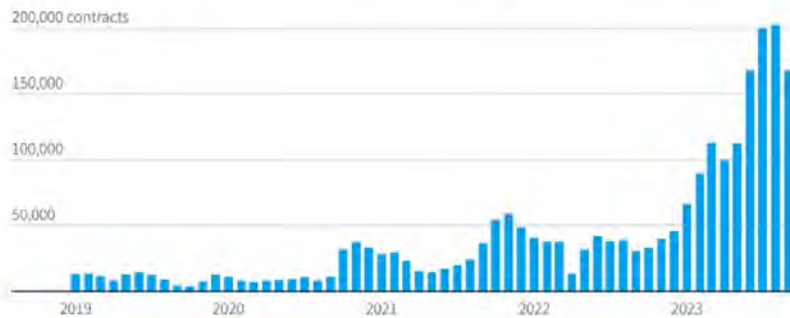
Reuters

October 11, 2023 9:43 AM EDT · Updated 5 days ago



### Exchange-traded weather futures jump in popularity

Average open interest in weather future and options per month, on Chicago Mercantile Exchange



Source: CME Group | Reuters, Oct. 1 | By Harry Robertson

\* Estimated that only 10% of these contracts are traded via exchange

# Opportunities for both quantifying and managing these risks

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Wildfire in Greece on August 9. A recent IPCC report warned that temperatures would continue to rise until at least 2050 and lead to further extreme weather events © AFP via Getty Images

- “Weather (financial) risks” => assumes stationary climate
- “Climate (financial) risks” => uncertainty about non-stationary weather risks
- “Environmental financial risks” => weather + climate + other (e.g., COVID)



# What does CoFiRES do?

1

Identify sectors with linkages between environmental conditions and financial metrics

2

Model the linked natural, engineered and economic systems and assess their vulnerabilities and interdependencies

3

Characterize the financial risk

(i.e. how severe are the losses and how often will they occur?)

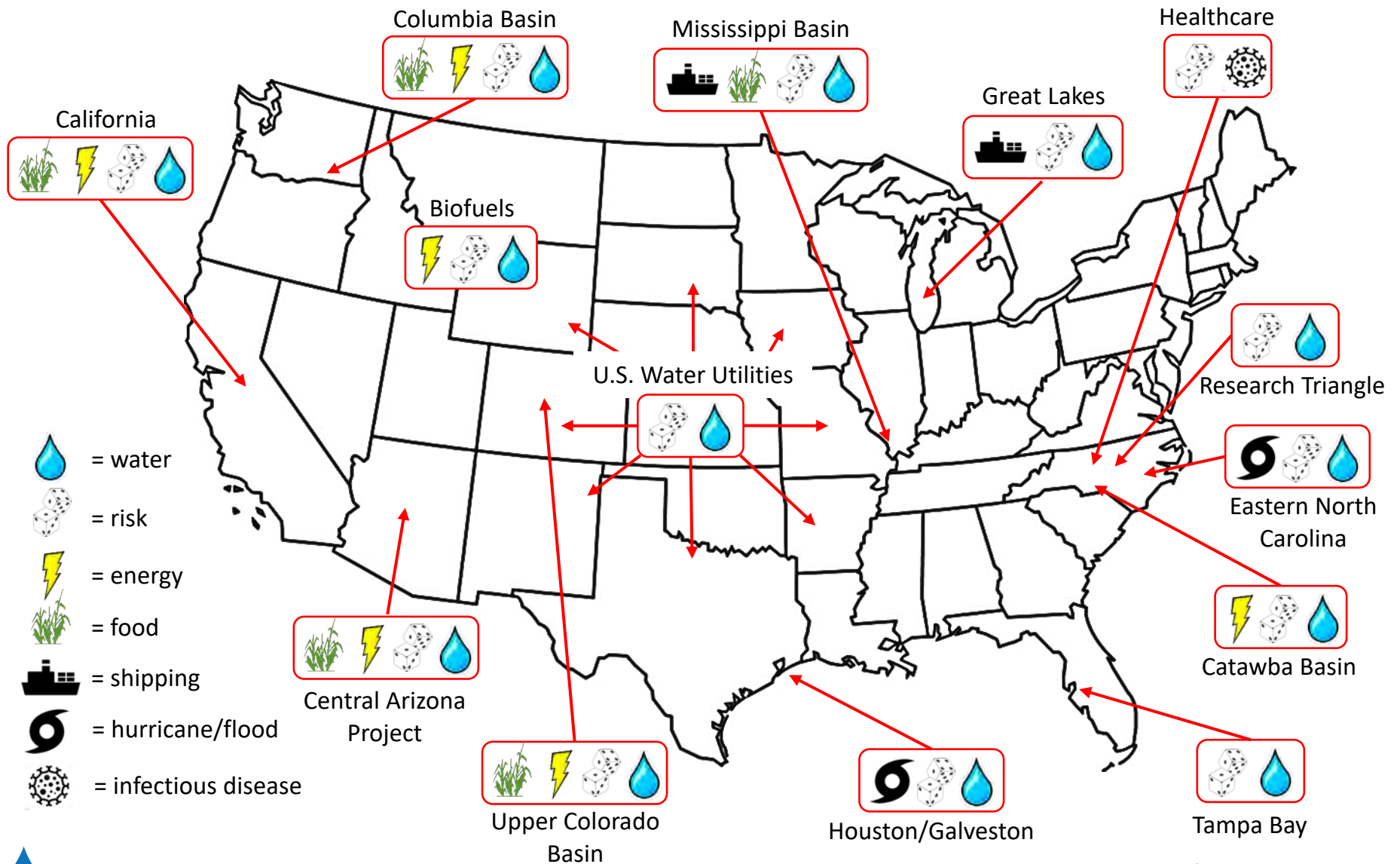
4A

Develop new financial instruments and risk management strategies

4B

Identify and quantify unpriced/mispriced environmental risks

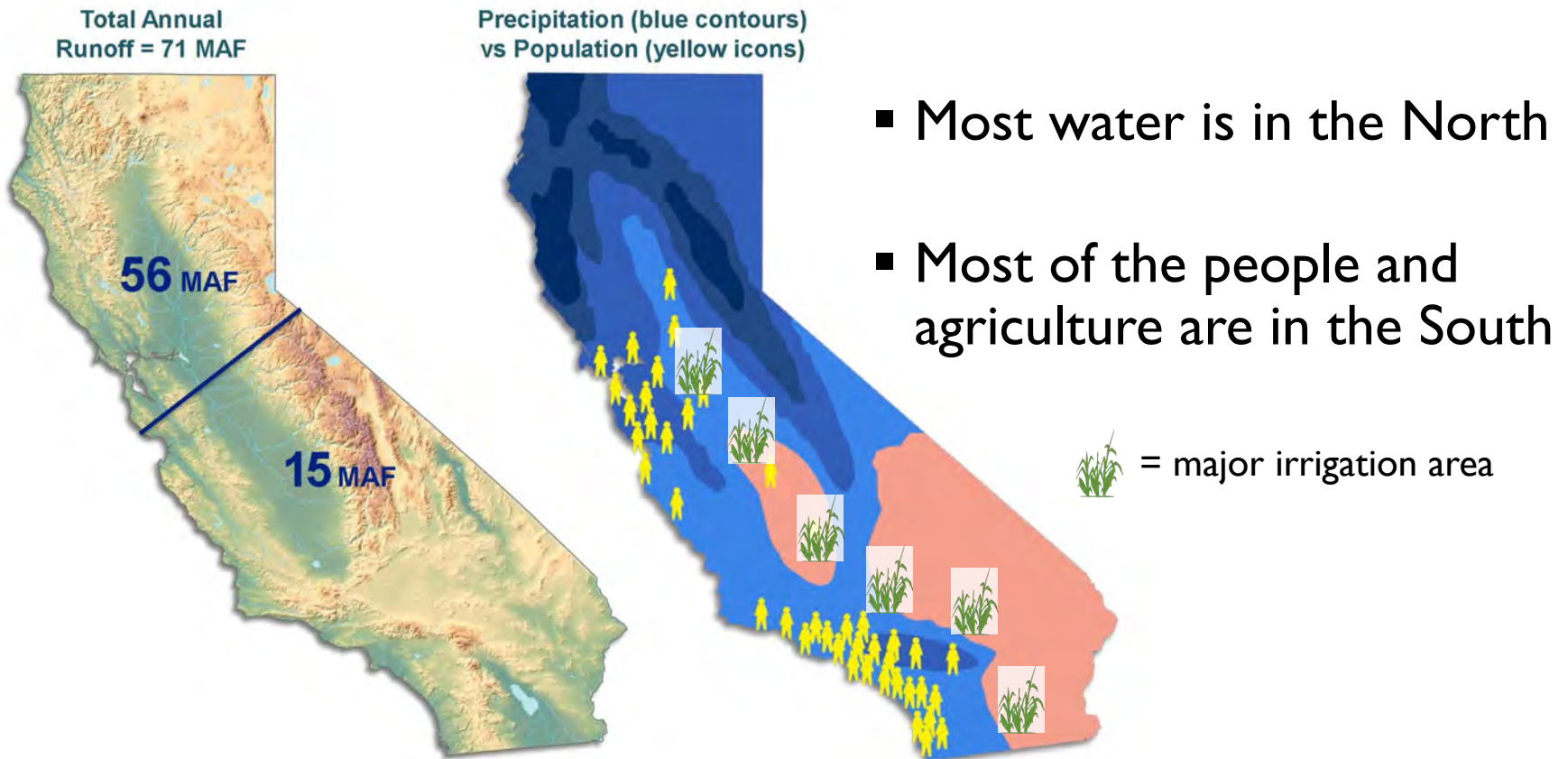
# Research Projects



# Research Projects

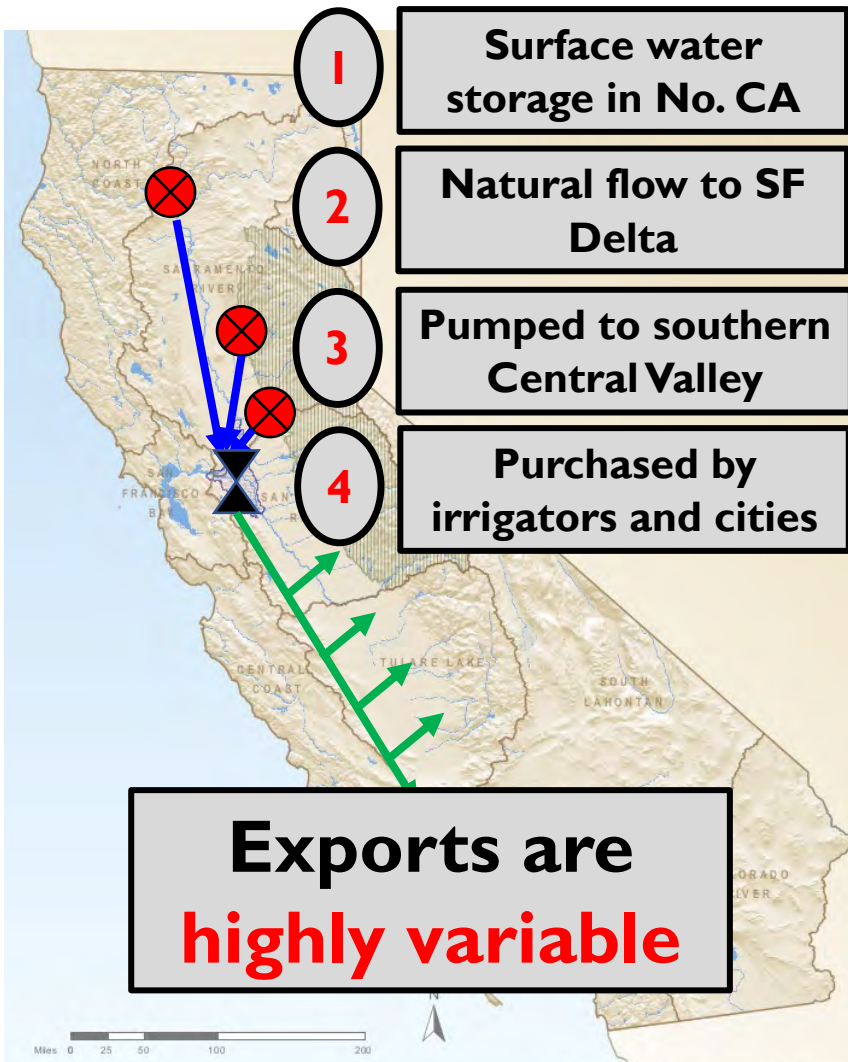


# California's Water Challenge



MAF = million acre-feet

# Northern California exports water to the South



Source: Department of Water Resources, CWP 2013

THE SACRAMENTO BEE 

The Mercury News

WEATHER,  
TODAY'S E EDITION,  
SUBSCRIBE  
NEWSLETTER.

CBS NEWS

CBS/AP February 21, 2014, 7:13 PM

Drought-hit farmers in  
KQED News

Key California Water Project  
Announces Drastic Cuts as  
Drought Deepens

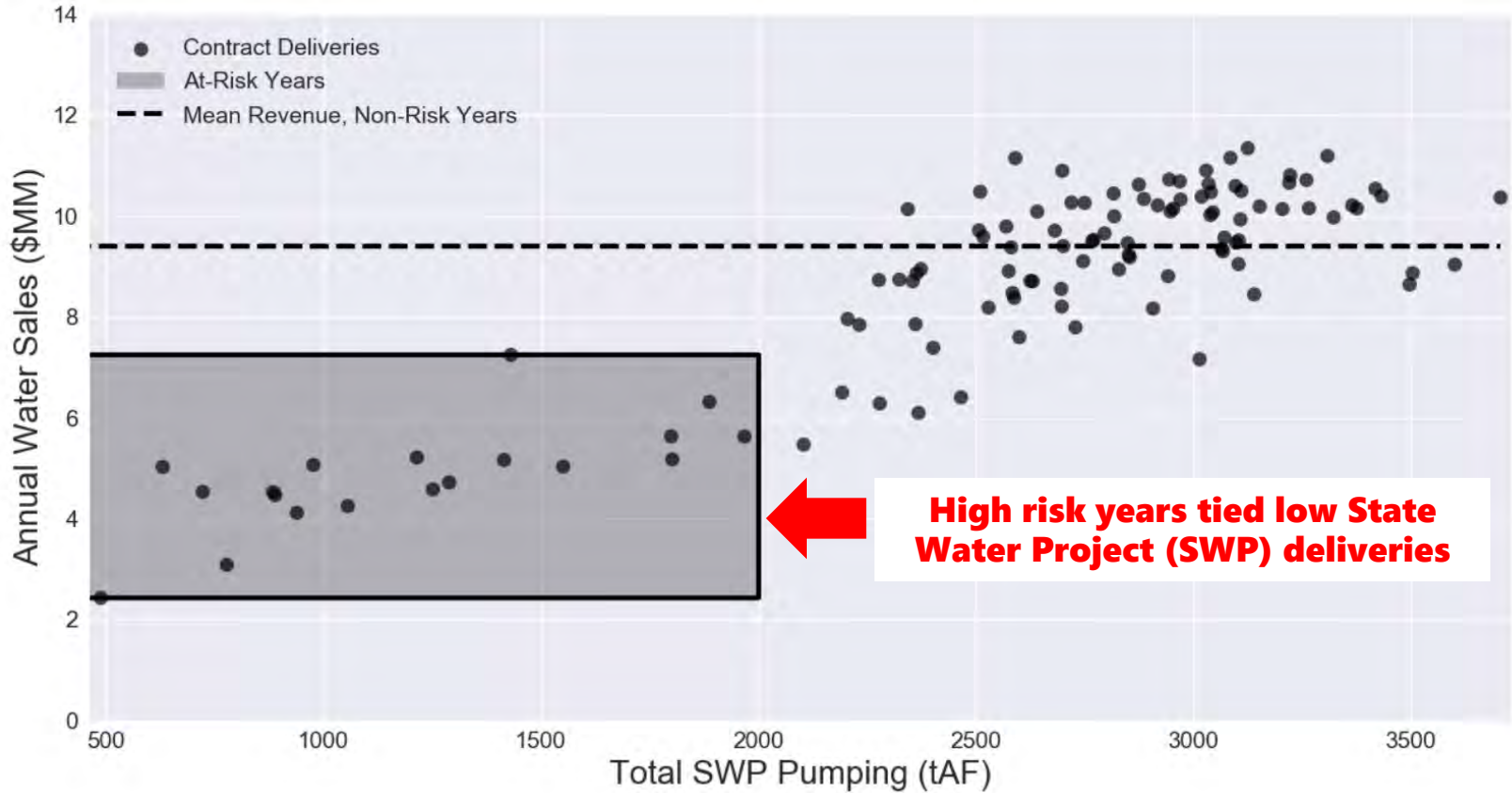
By KQED News Staff and Wires  
FEBRUARY 21, 2014

# Modeling who gets how much and when

## CALFEWS: California Food- Energy-Water System Model



# Irrigation District revenues vs. Export Pumping



# Drought-related revenue losses are a credit risk

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## **S&P Global** Ratings

*“The enterprise risk profile reflects our view of the district’s:*

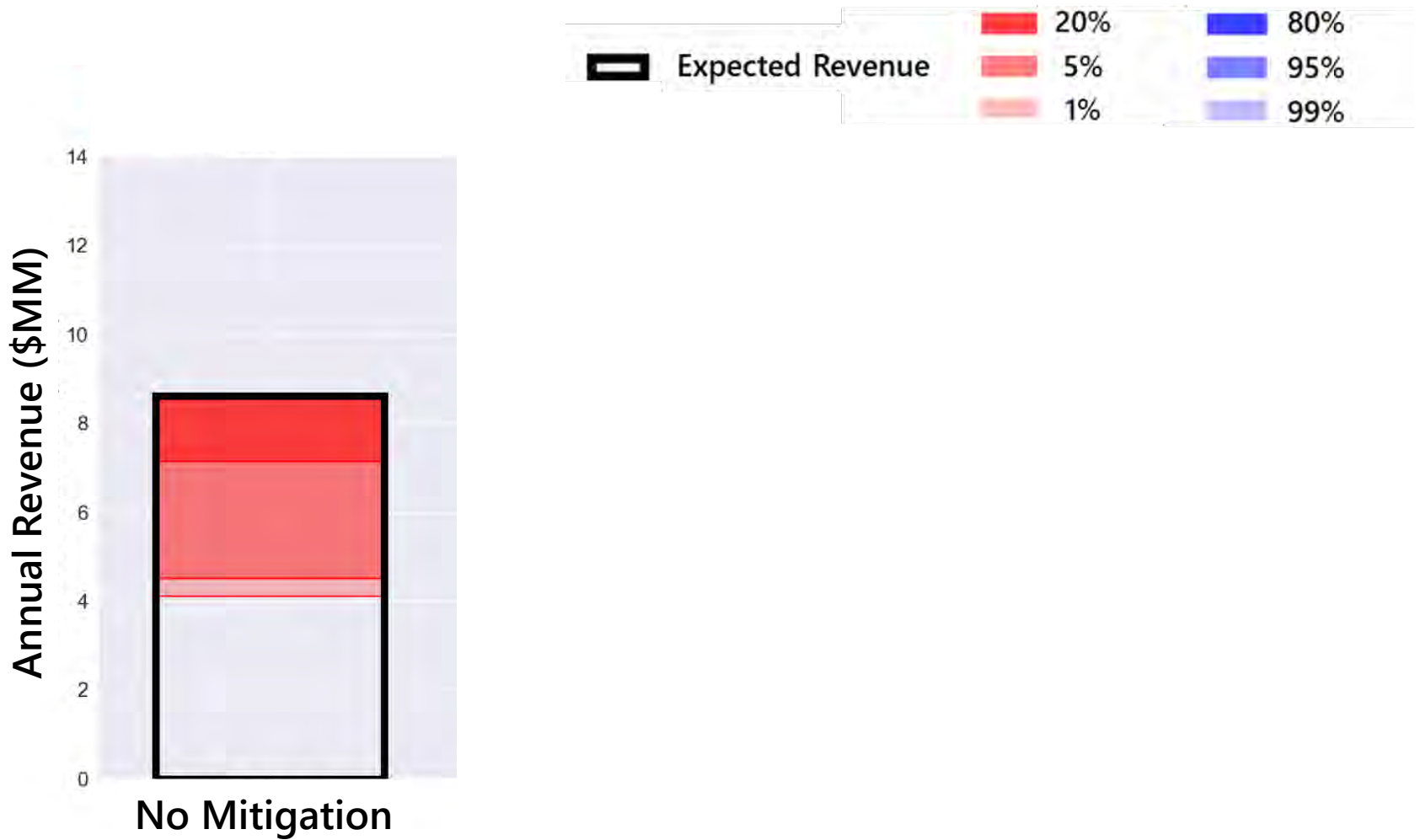
- ***“Volatile and unpredictable water supply ...”***

*“The financial risk profile reflects our view of the district’s:*

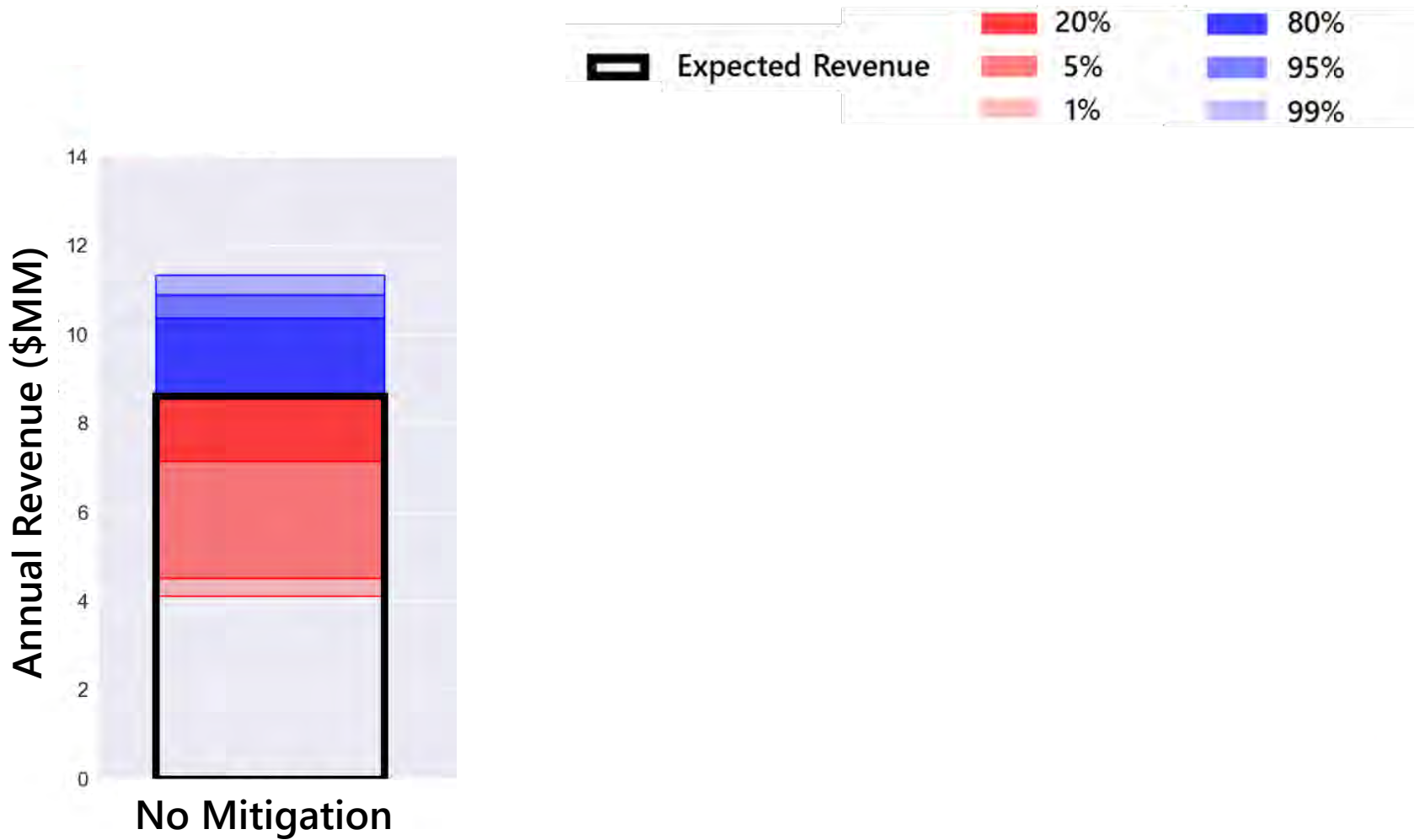
- ***“Insufficient debt service coverage ratio for fiscal 2014\*...”***



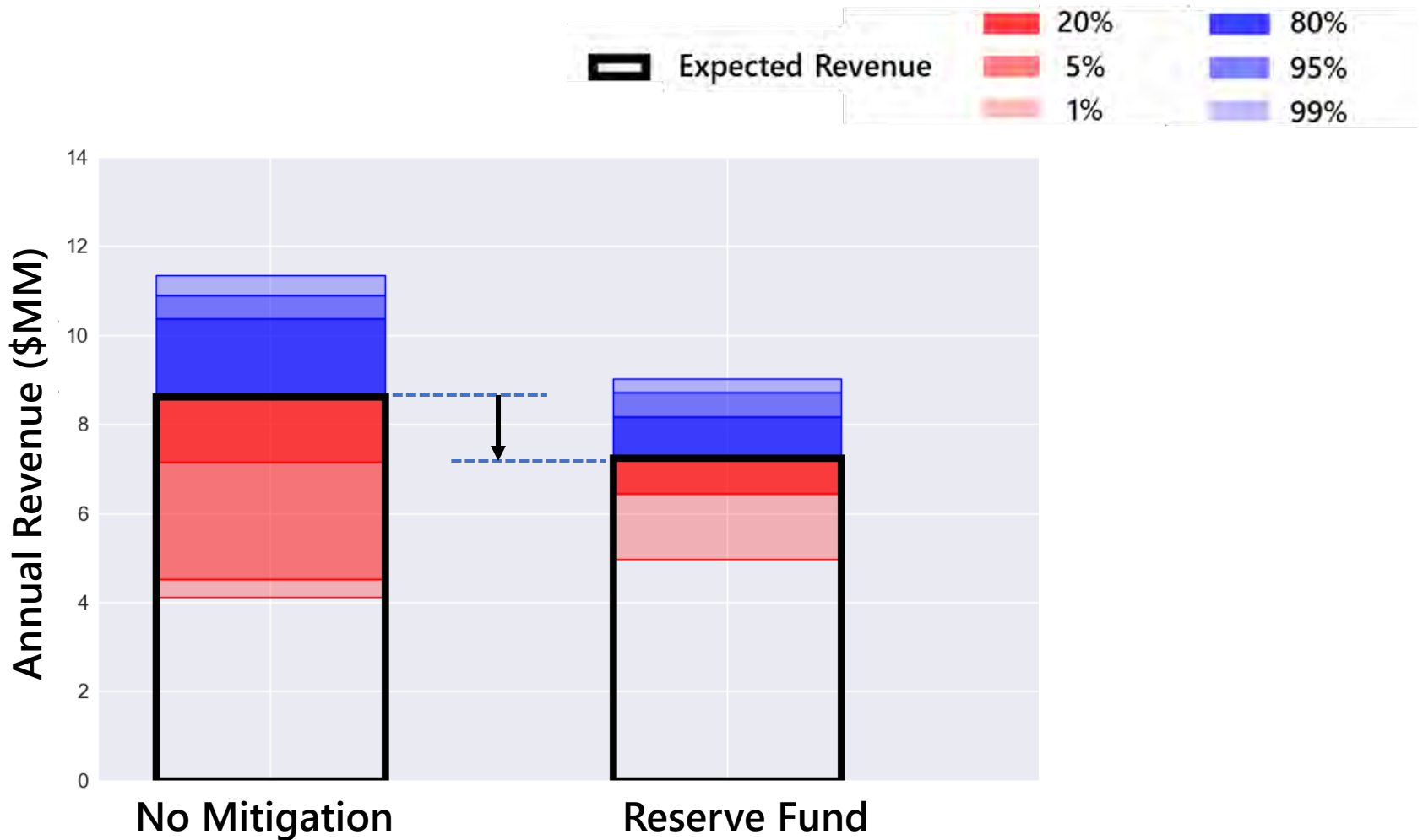
# Assessing and Managing District Financial Risk



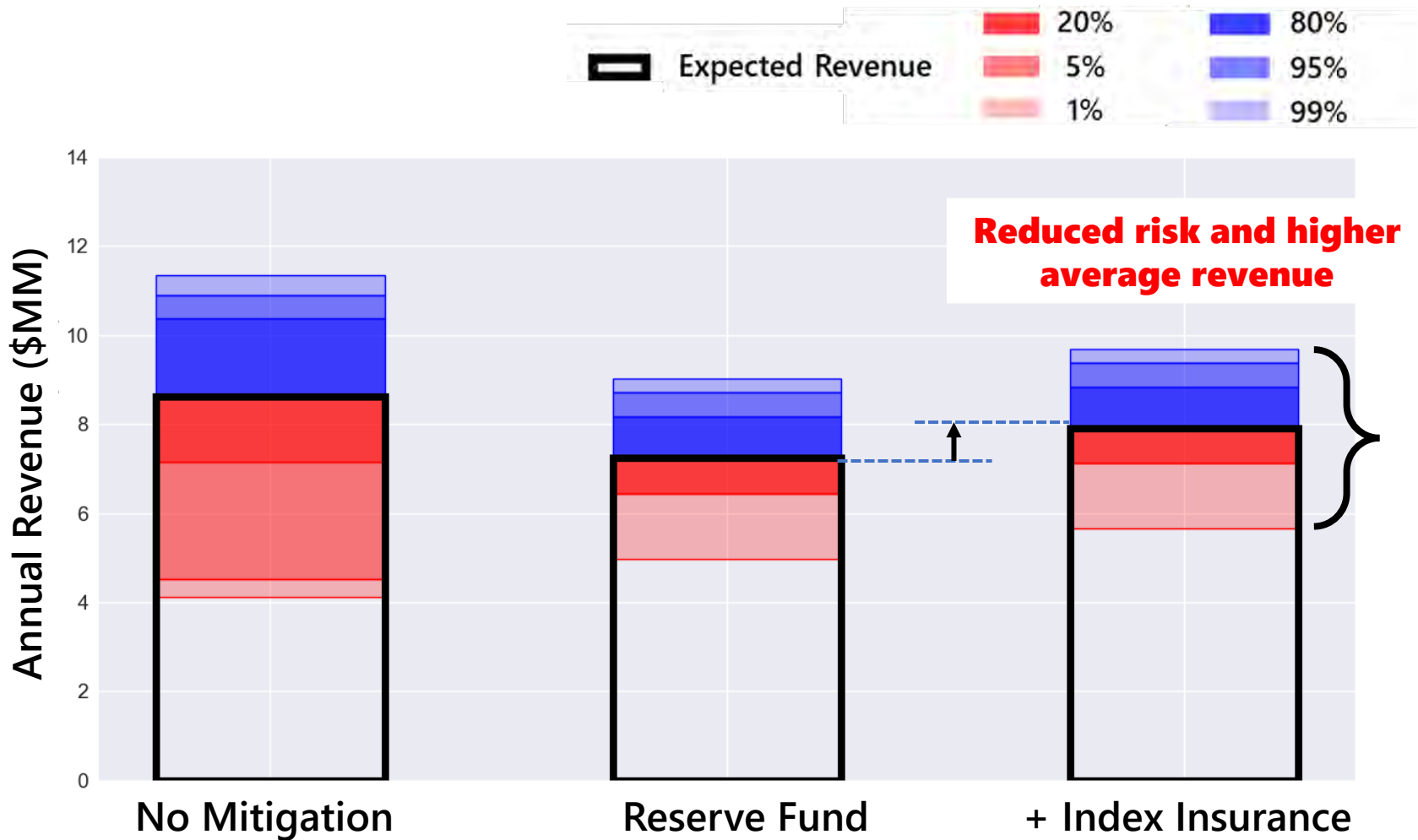
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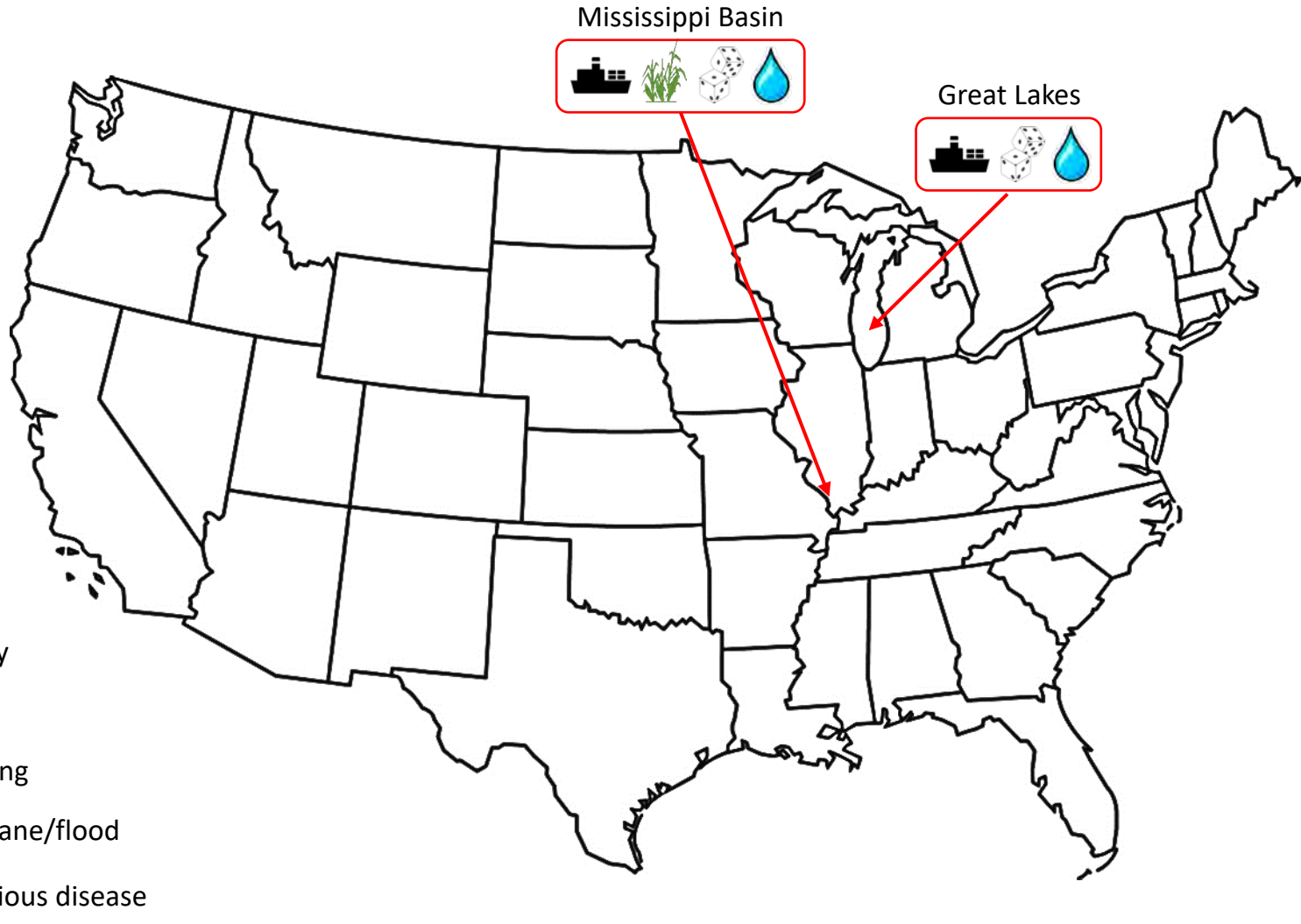
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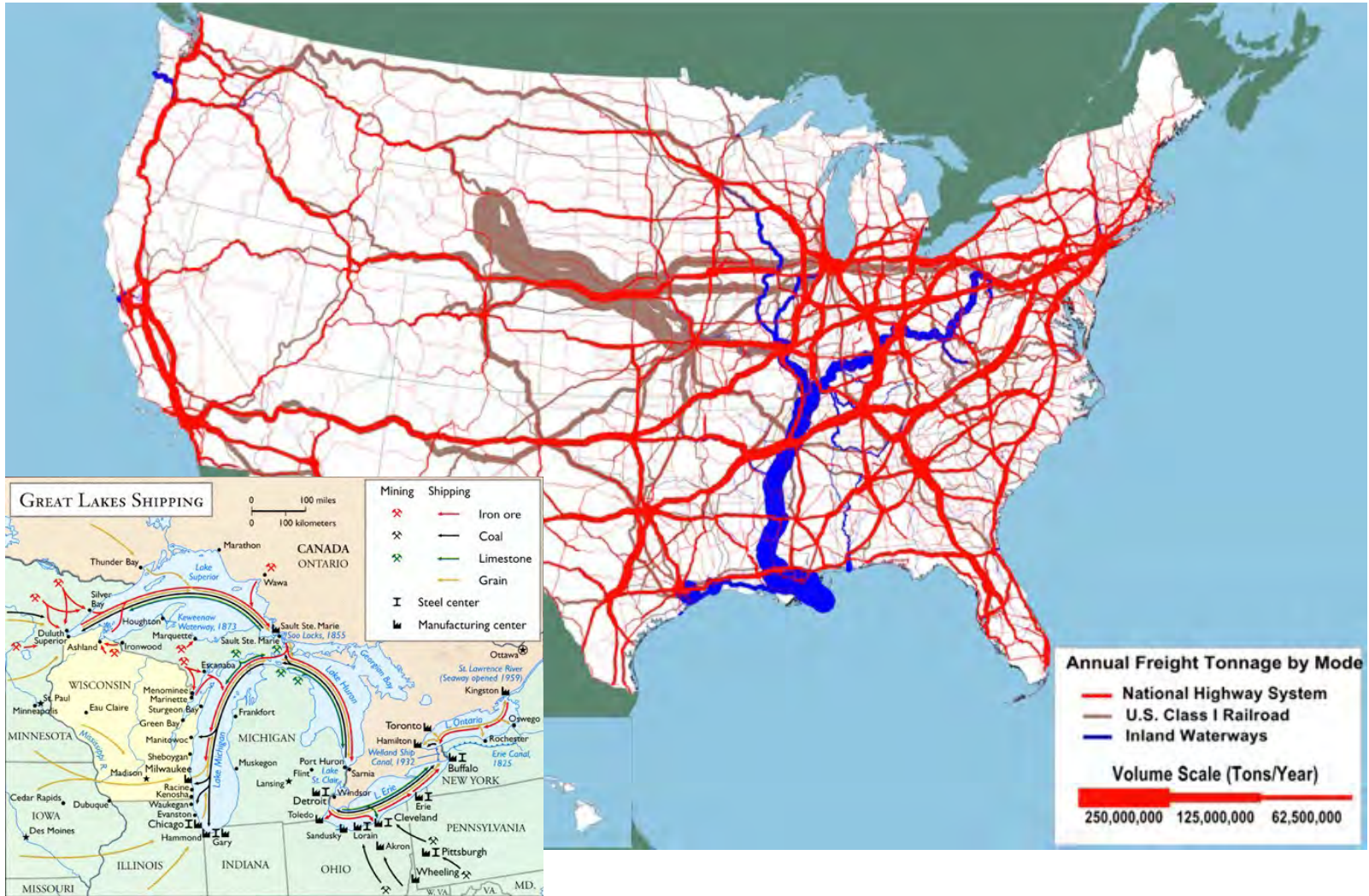
4B

Identify and quantify unpriced/mispriced environmental risks

# Research Projects – Inland Navigation



# Inland waterways are critical to commerce



# Low water levels impact inland navigation

The New York Times

## Inch by Inch, Great Lakes Shrink, and Cargo Carriers Face Losses



James Rajotte for The New York Times

A ship carrying road salt pulls into the Port of Oswego, N.Y., on Lake Ontario. The lake's water level has dropped three inches during this month alone.

By FERNANDA SANTOS  
Published: October 22, 2017

U.S. News & WORLD REPORT

## Barges Grounded by Low Water Halt Mississippi River Traffic

The unusually low water level in the lower Mississippi River is causing barges to get stuck

By Associated Press | Oct. 5, 2022, at 5:23 p.m.

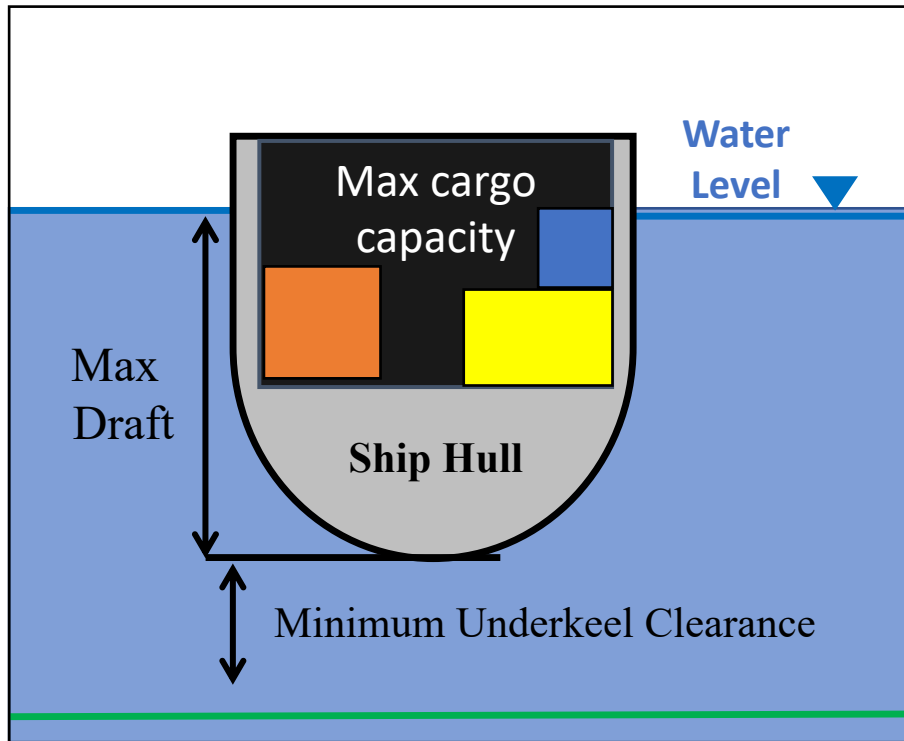


One year ago

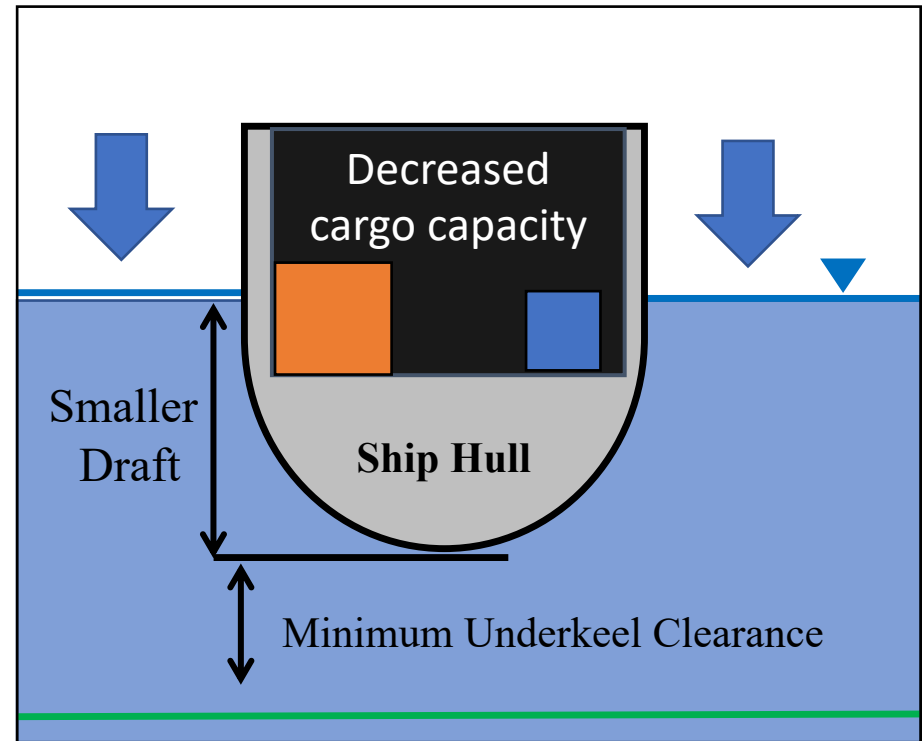


# Managing the financial risks of low water levels

## Normal Water Level

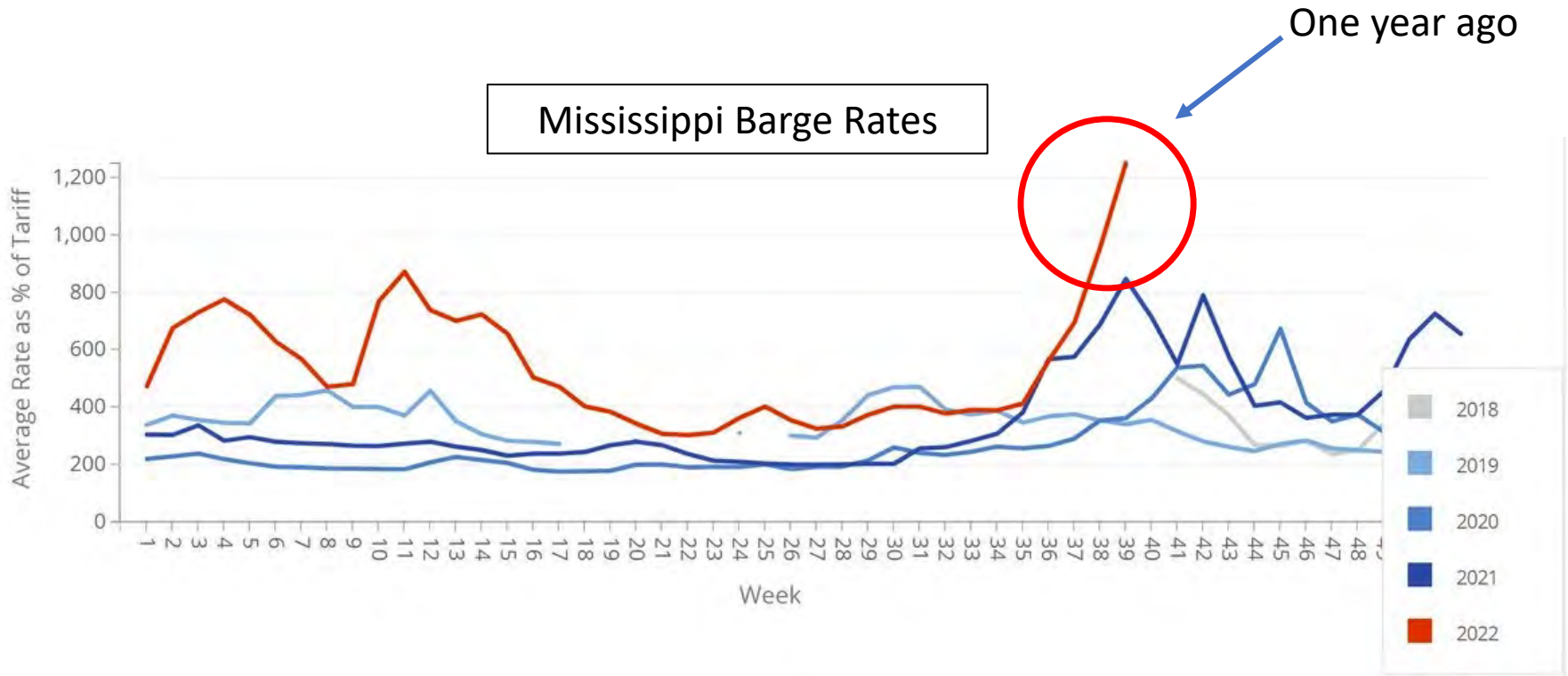


## Low Water Level



**Less cargo = Higher Barge Rates (\$/ton)**

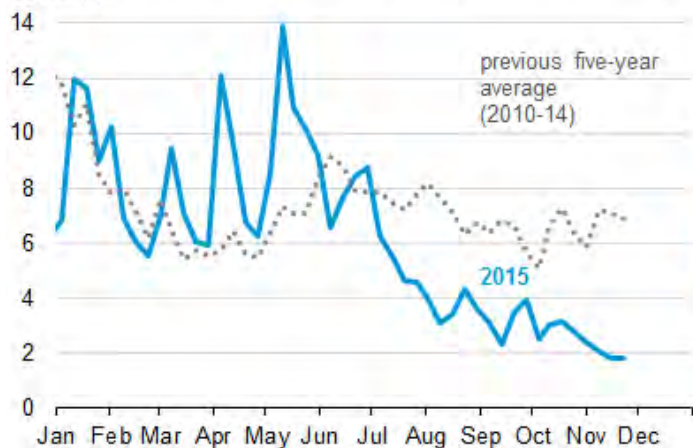
# Low water levels increase barge rates



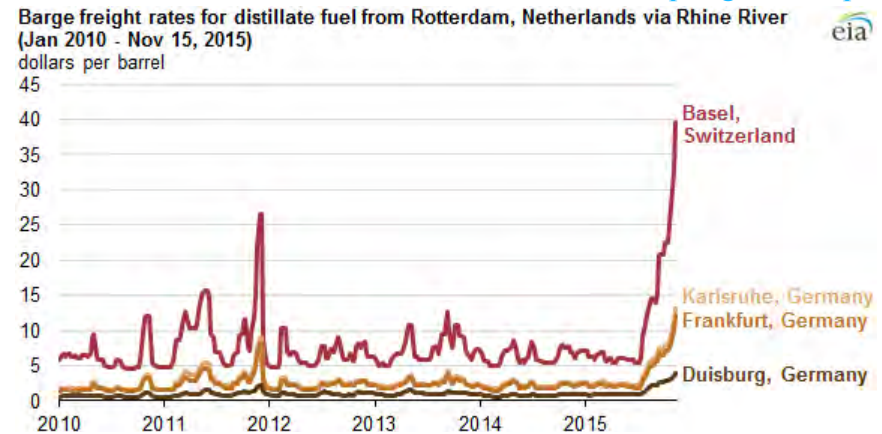
- Barge rates respond to water levels, and transport costs are a significant fraction of overall costs for many bulk commodities
- How do commodity prices (e.g., corn, soybeans) respond to low water levels

# Low water levels impact commodity prices

Weekly Rhine River water levels at Kaub, Germany (2010-15)  
depth (ft)

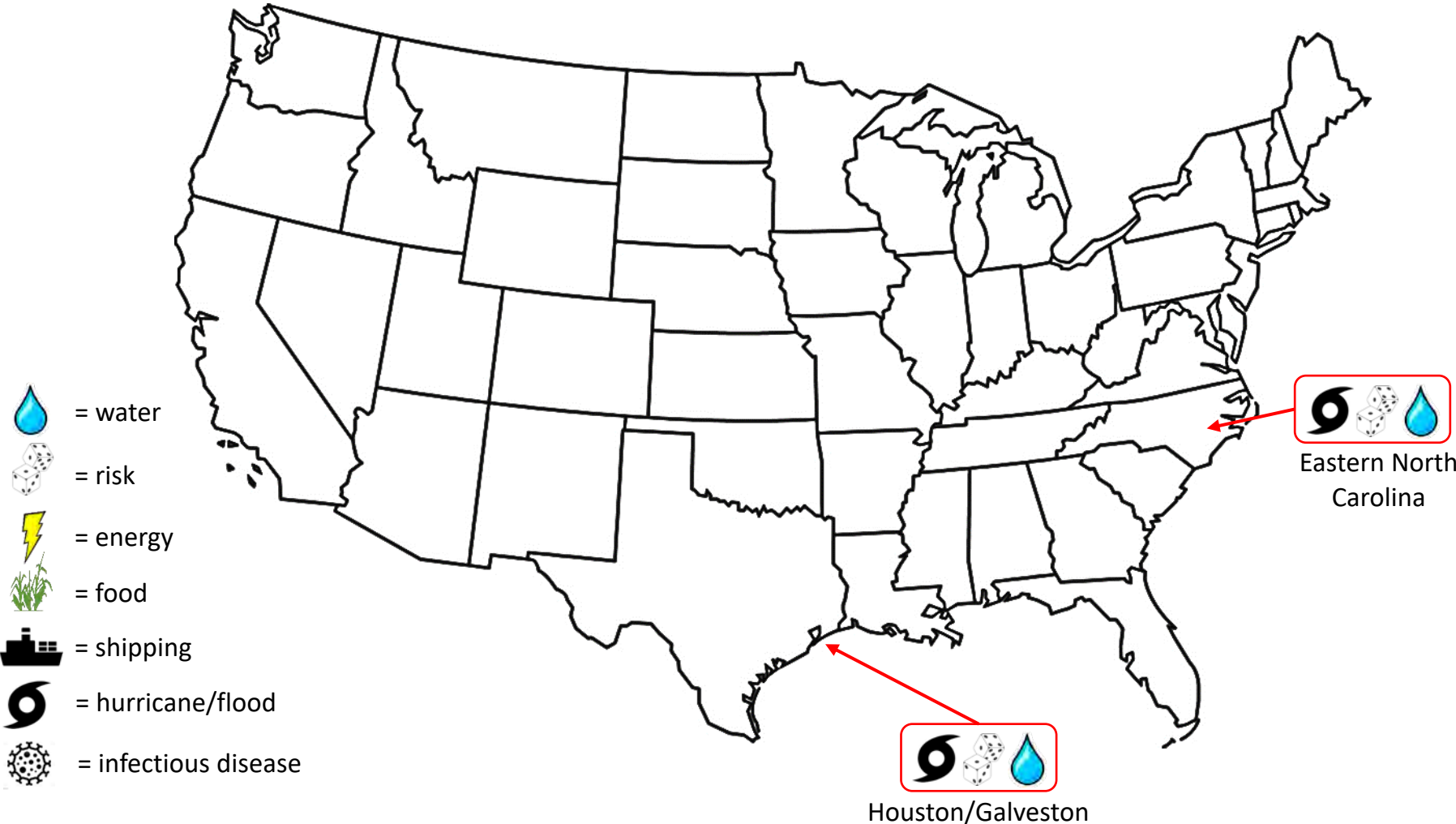


Record-low water levels on Rhine River are disrupting fuel shipments



- We've modeled corn and soybean prices over several low water periods
- Prices for corn and soybeans are highly correlated with water levels
- Is this information fully incorporated into corn/soybean markets?

# Research Projects - Flooding



# Flooding and financial risk in the housing market

## The New York Times

### *Climate Risk in the Housing Market Has Echoes of Subprime Crisis, Study Finds*

WASHINGTON — Banks are shielding themselves from climate change at taxpayers' expense by shifting riskier mortgages — such as those in coastal areas — off their books and over to the federal government, new research suggests.



## Bloomberg

### **When Climate Change Leads to Mortgage Defaults**

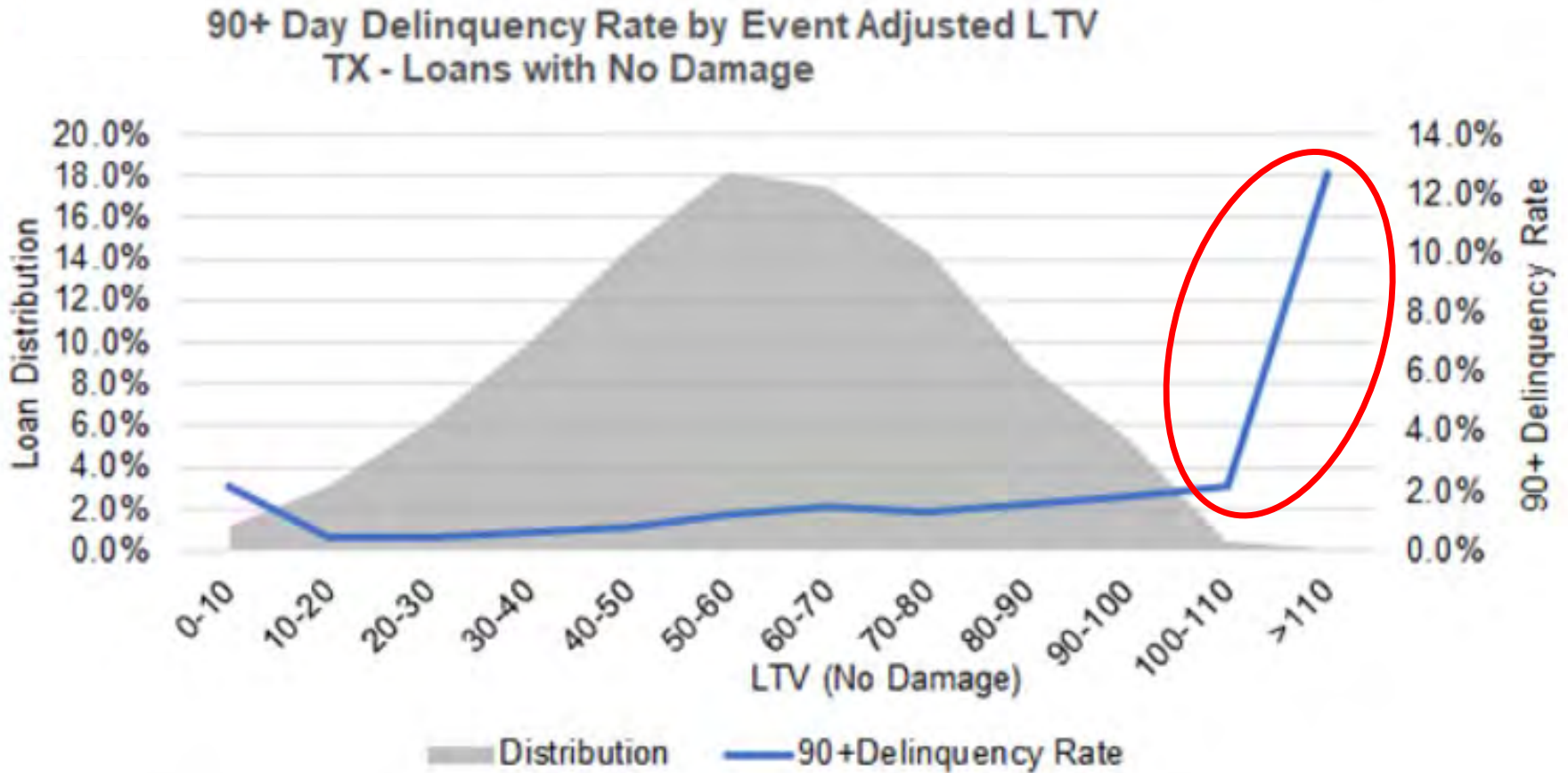


### Unpriced costs of flooding: An emerging risk for homeowners and lenders

By [David D. Evans](#), [Leighton A. Hunley](#), and [Brandon Katz](#) (KatRisk LLC)

28 January 2022

# Probability of default can be impacted by flooding



**Borrowing to finance flood repairs raises debt**

**Flooding often depresses property value**

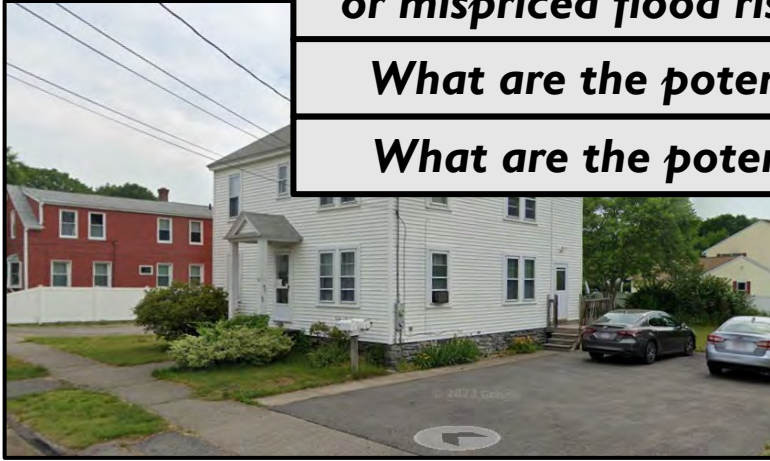
$$\text{Loan-to-Value (LTV) Ratio} = \frac{\text{Loan/Mortgage Balance}}{\text{Property Value}} \times 100$$

# Risks in secondary markets: RMBS and CMBS

*We believe there is the potential for unpriced or mispriced flood risk in both these markets*

*What are the potential costs to the GSEs?*

*What are the potential costs to investors?*



## **Residential MBS (RMBS)**

- \$7.7 trillion market
- Mostly issued by Fannie Mae, Freddie Mac, and Ginnie Mae (GSEs)
- Principal and interest guaranteed: GSEs bear the cost of defaults

## **Commercial MBS (CMBS)**

- \$1.5 trillion market
- Often issued by investment banks (e.g., Wells Fargo, Morgan Stanley)
- No guarantee: investors bear the cost of defaults

# Thanks!

