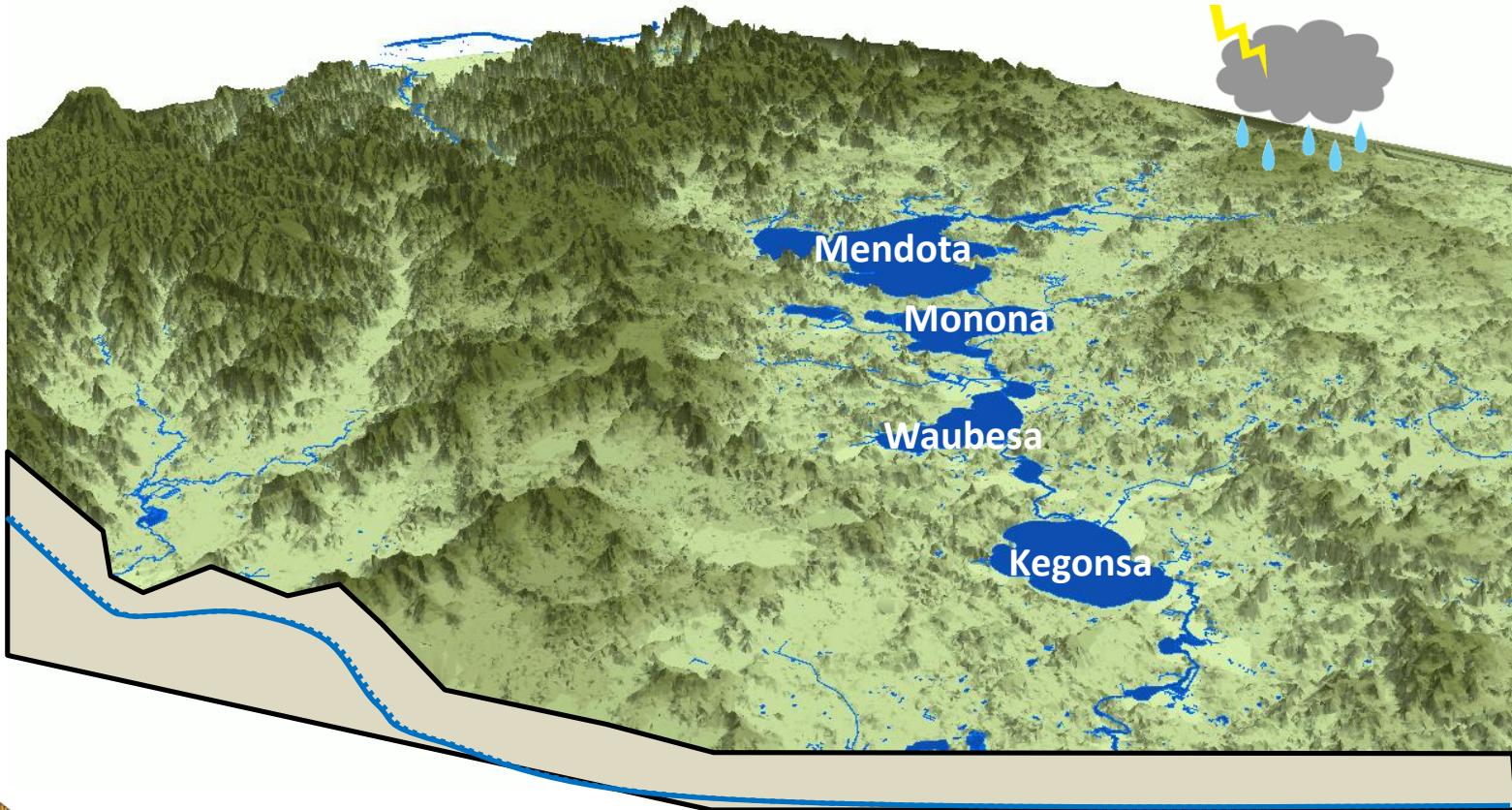




Flood Risk and Warning

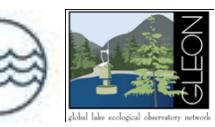


for the Yahara River Chain of Lakes (RCL)



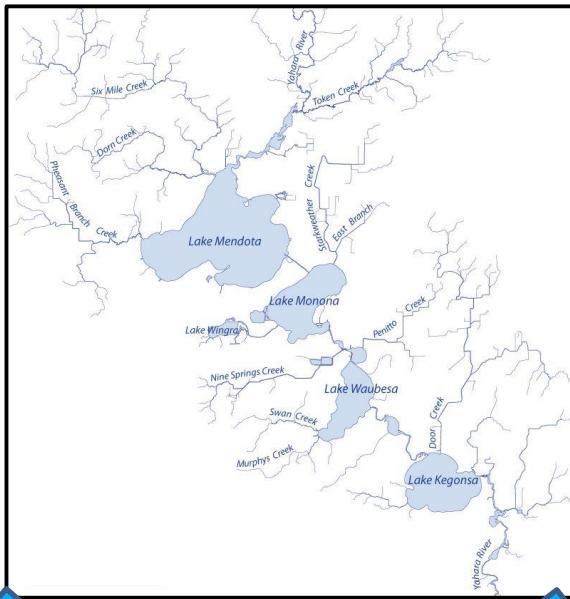
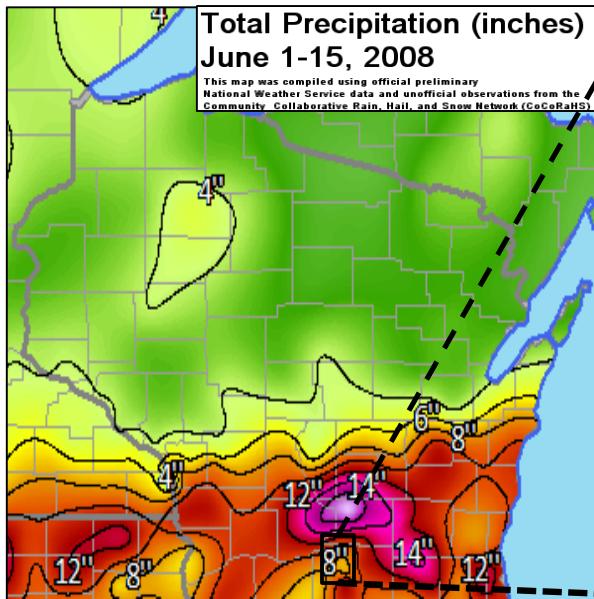
John Reimer, Chin Wu
University of Wisconsin, Madison

AWRA Wisconsin, 42nd Meeting
March 8, 2018



THE UNIVERSITY
of
WISCONSIN
MADISON

Motivations



Strong rains cause flooding damage in 60-plus campus buildings

July 27, 2006

Email | 2 | Tweet | 0 | Share | 0

A powerful noon-hour storm that dropped more than an inch of rain in central Madison caused a rash of flooding problems at the University of Wisconsin-Madison campus. No major flooding was reported involving either humans or animals. The university is open for the remainder of the day and will be open on Friday. If you have any issues related to the flooding are encouraged to contact the Offices of the Dean of Students at (608) 262-2222.

Alan Fish, associate vice chancellor for facilities, said immediately after the downpour that crews were dispatched to 68 sites as of 3 p.m. to deal with water problems across the campus. But the campus' utility



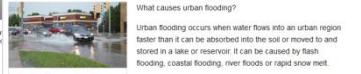
Pedestrians wade through floodwaters on Library Mall as heavy rain delays the UW-Madison campus, closing streets and walkways to flood.

Photo: Jeff Miller



Ask the Weather Guys: Urban flooding more than an inconvenience

Facebook | 8 | Tweet | 3 | Print | Email | 0 | Share | 0



What causes urban flooding?
Urban flooding occurs when water flows into an urban region faster than it can be absorbed into the soil or moved to and stored in a lake or reservoir. It can be caused by flash flooding, coastal flooding, river floods or rapid snow melt.

On Tuesday, the Madison area experienced urban flooding caused by an intense rainfall. On that day, a daily record rainfall of 1.46 inches fell at Dane County Regional Airport, breaking the city's previous May 27 record of 1.27 inches.

The city's sewage system and storm drains did not have the necessary capacity to drain away the large amounts of rain that fell in a short period of time.

Flash floods occur suddenly, and the water can rise very quickly. Urban flooding is most often an inconvenience, particularly when it occurs during commuting time as Tuesday's did, but it can also be dangerous.

Never drive your car across a flooded road. The economic cost of urban flooding can also be high.

Lake Flooding



Loss



Emergency Information | Plans | Partners | Special Needs | Contact

Date	Event	Property Damage (\$ Million)	Crop Loss (\$ Million)	Total (\$ Million)
June, 1993	Flood	\$12.6	\$10.0	\$22.6
May, 1998	Severe Storms	\$3.1	\$0.15	\$3.3
June, 2000	Flood	\$6.1	\$3.2	\$9.3
Summer, 2002	Drought	\$0	\$4.4	\$4.4
June, 2004	Tornado	\$1.5	\$0	\$1.5
August, 2005	Tornado	\$34.3	\$0.75	\$35.1
May, 2006	Hail	\$5.6	\$0	\$5.6
July, 2006	Flood	\$10.0	\$0	\$10.0
August, 2007	Flood	\$6.6	\$5.0	\$11.6
June, 2008	Severe Storms and Flooding	\$13.5	\$64.4	\$77.9
Total		\$93.5	\$87.9	\$181.5

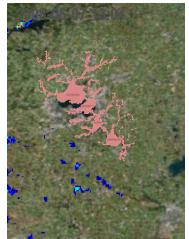
Urban Flooding



Objectives

- Characterize Flood Risk

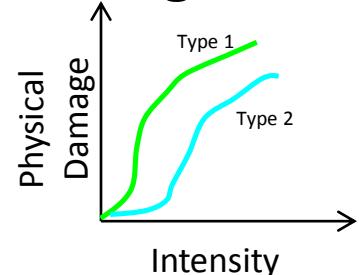
Hazard
(Rainfall)



Vulnerability
(building)

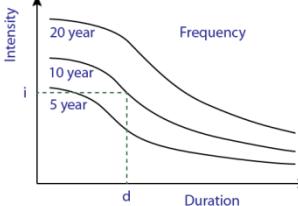


Damage Curve



= Risk

RP	A # B	V*A Eco	V*A # B (10 ⁷)
5	368	32	1.93
10	490	69	3.44
25	699	194	10.00
50	856	375	19.91
100	1588	1096	51.07



Probability



Loss



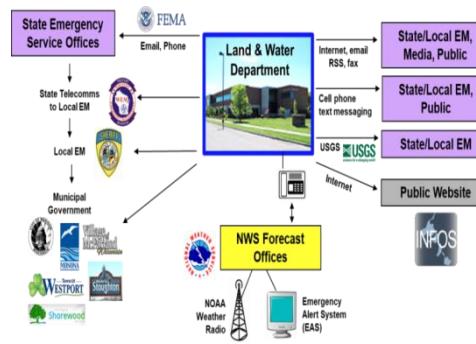
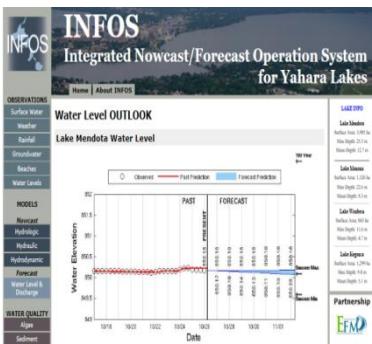
EMERGENCY MANAGEMENT		
Floods, Severe Storms, Tornadoes, Hail, and Other Natural Disasters		
Month	Event	Property Damage (\$ Millions)
June, 1992	Floods	\$3.0
May, 1995	Severe Storms	\$3.1
June, 2000	Floods	\$3.2
June, 2000	Tornado	\$0
June, 2004	Tornado	\$1.5
August, 2004	Floods	\$0.3
May, 2005	Hail	\$0.5
July, 2006	Floods	\$0.0
August, 2007	Floods	\$0.3
June, 2008	Severe Storms and Flooding	\$13.0
Year		\$47.4
Total		\$47.4



= Probability of Loss

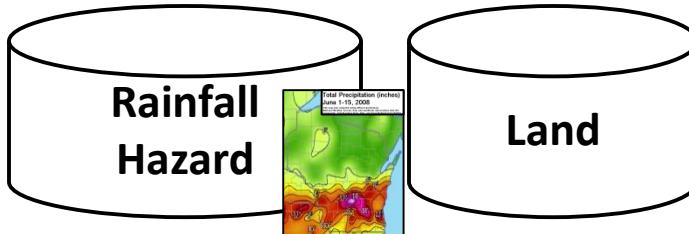


- Develop Flood Forecast and Warning

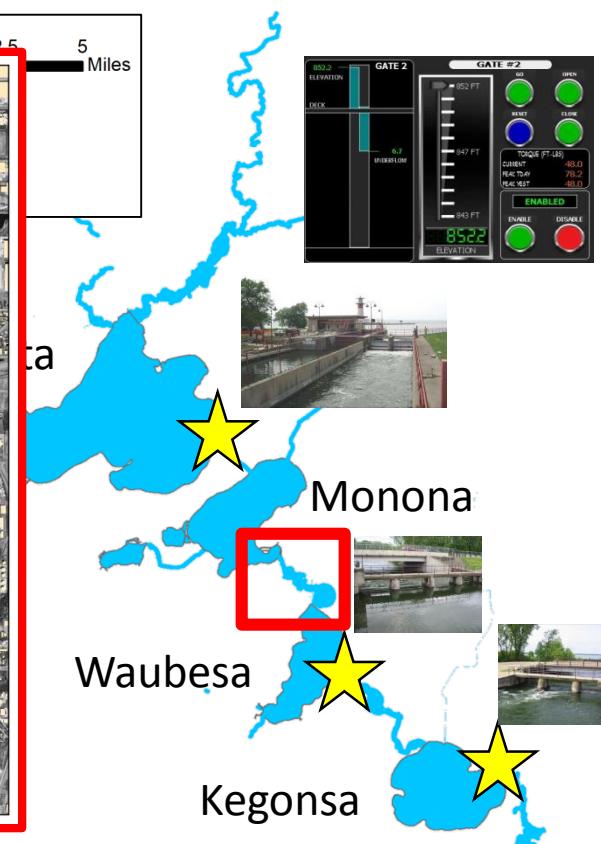
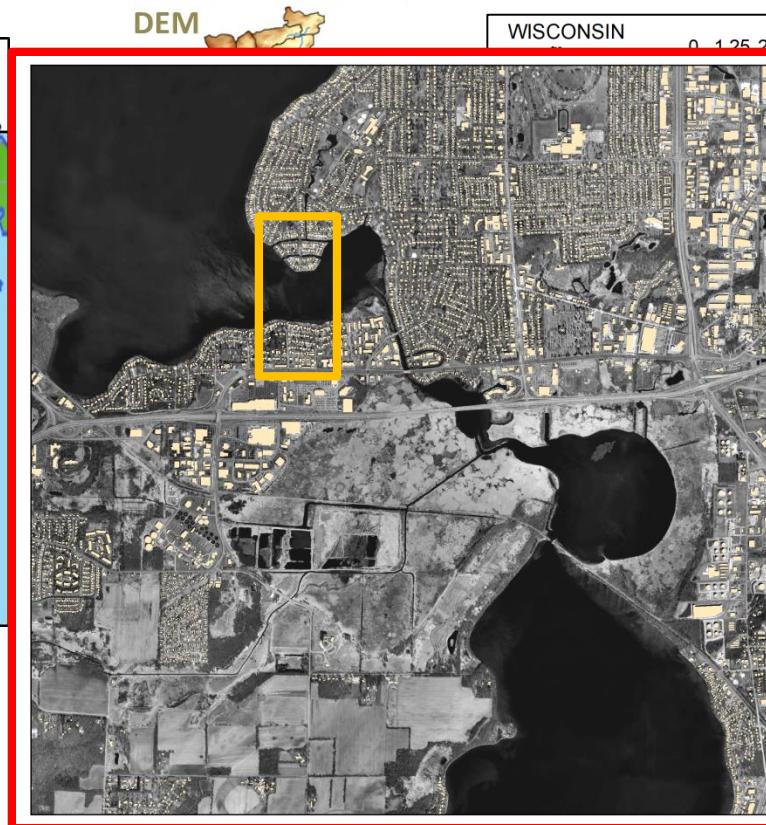


COMMER Procedure

COmpiling Data

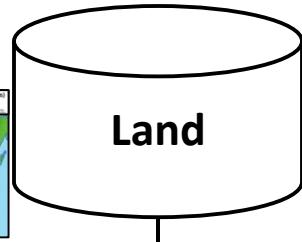
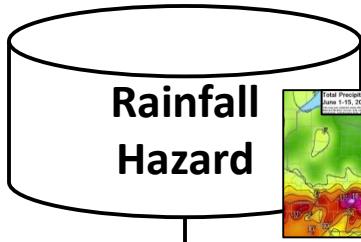
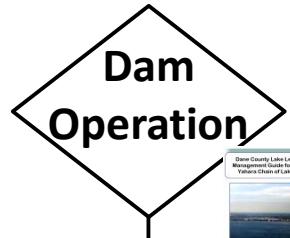


2008 Storm

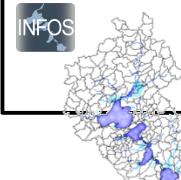


COMMER Procedure

COmpiling Data



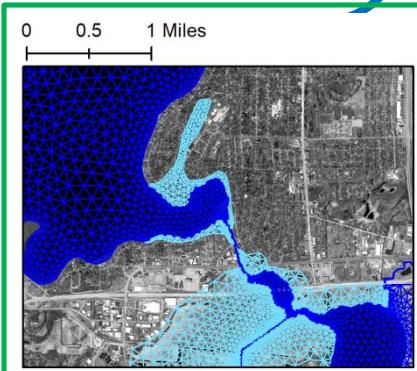
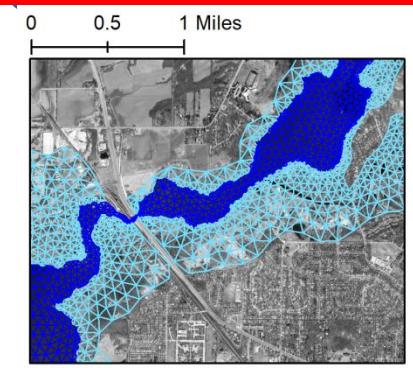
Modeling



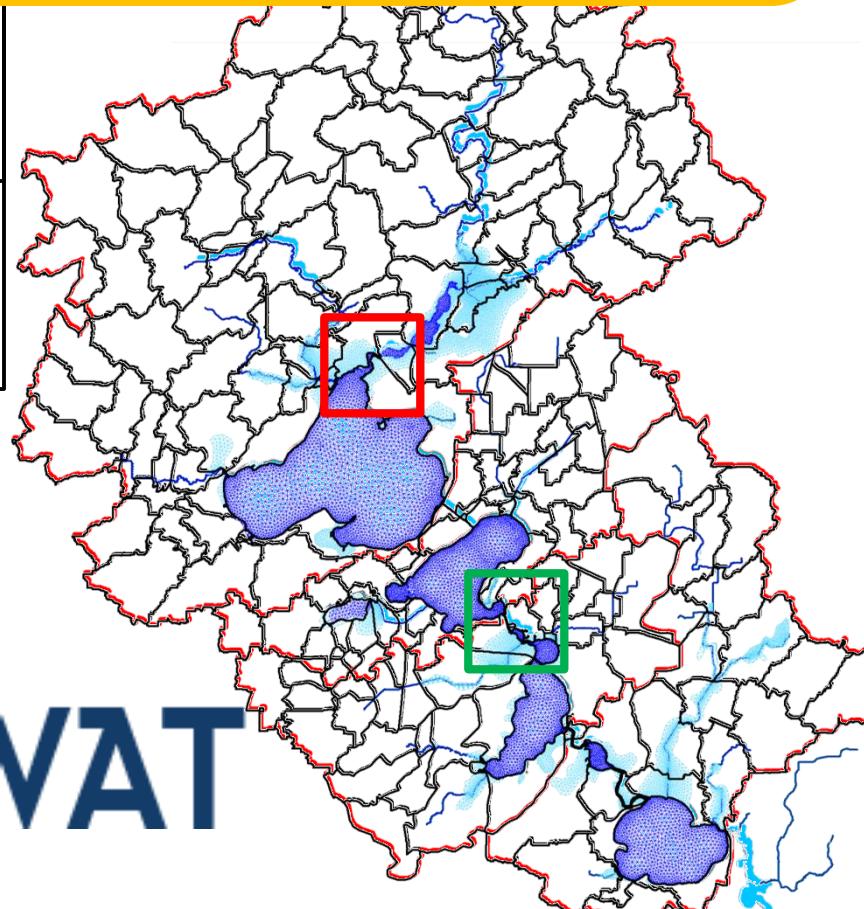
LIDAR DEM
Land Use

LIDAR DEM

Reimer and Wu, 2016

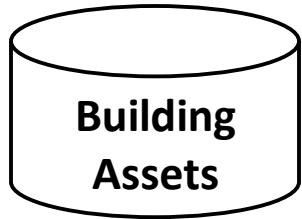
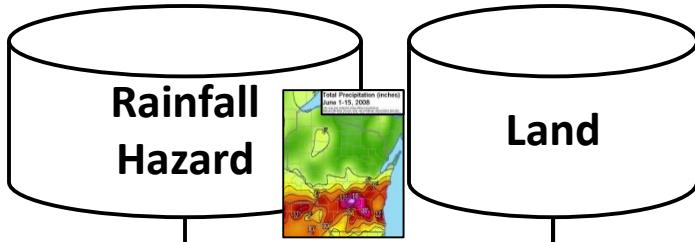
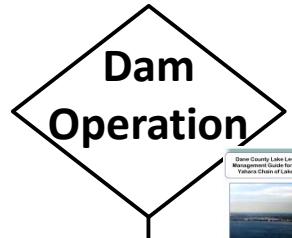


SWAT

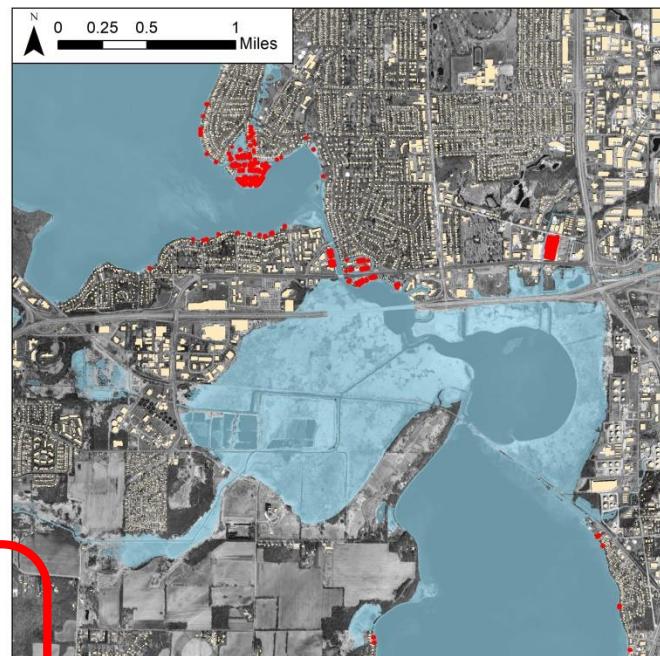
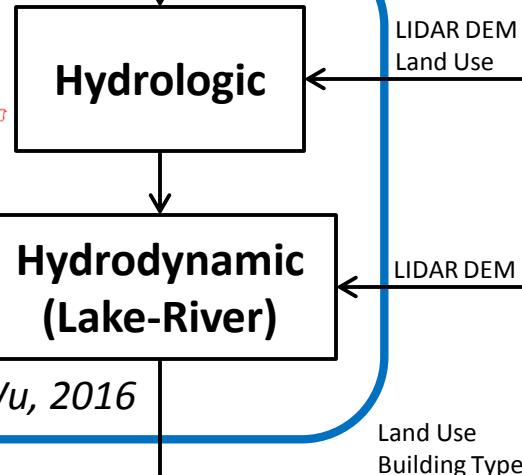


COMMER Procedure

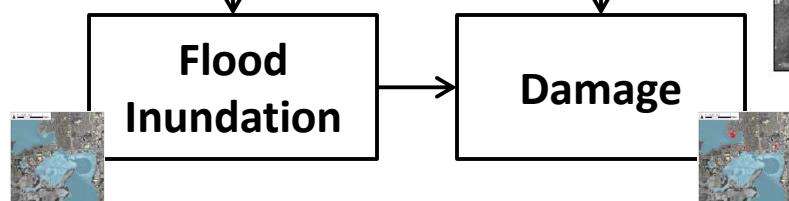
Compiling Data



Modeling

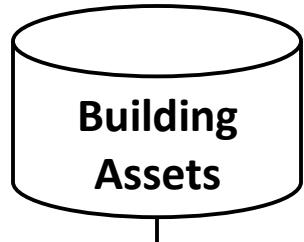
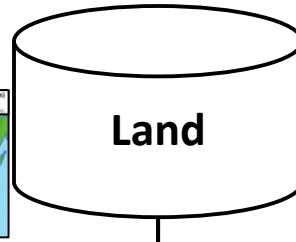
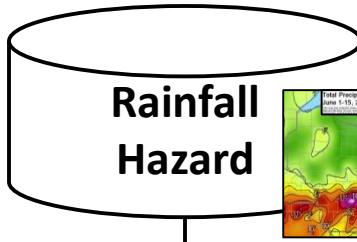
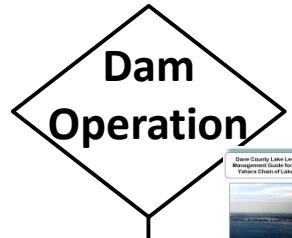


Mapping



COMMER Procedure

Compiling Data

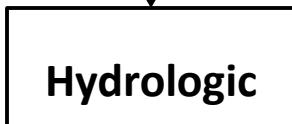


Modeling



INFOS

Reimer and Wu, 2016



LIDAR DEM
Land Use

LIDAR DEM

Land Use
Building Type

Estimating Loss

HAZUS MH

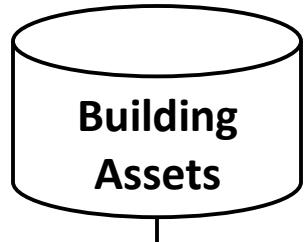
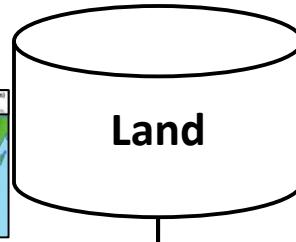
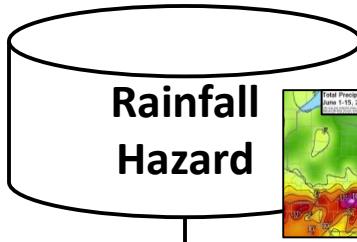
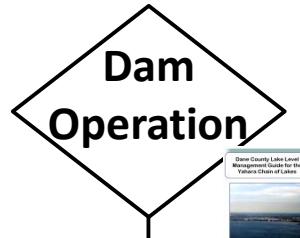


Mapping

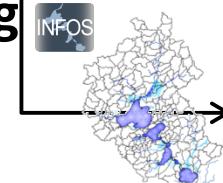
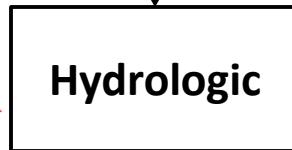


COMMER Procedure

COmpiling Data



Modeling



Reimer and Wu, 2016

LIDAR DEM
Land Use

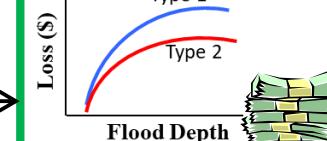
LIDAR DEM

Land Use
Building Type

Mapping

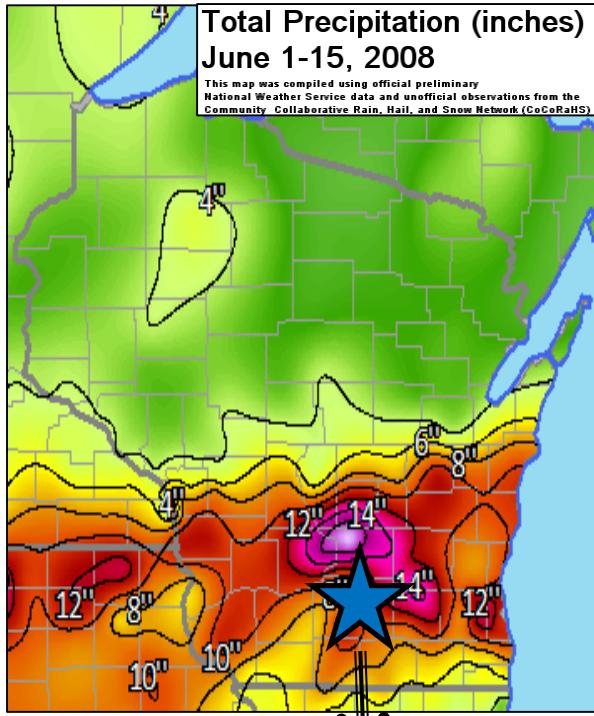


Estimating Loss

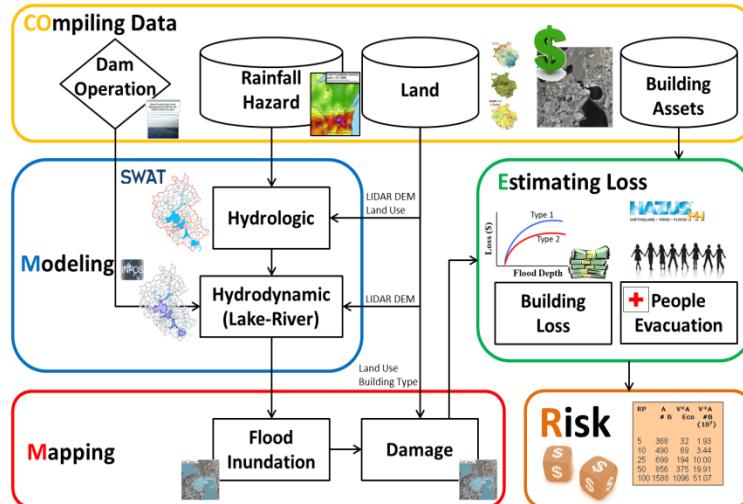


Risk

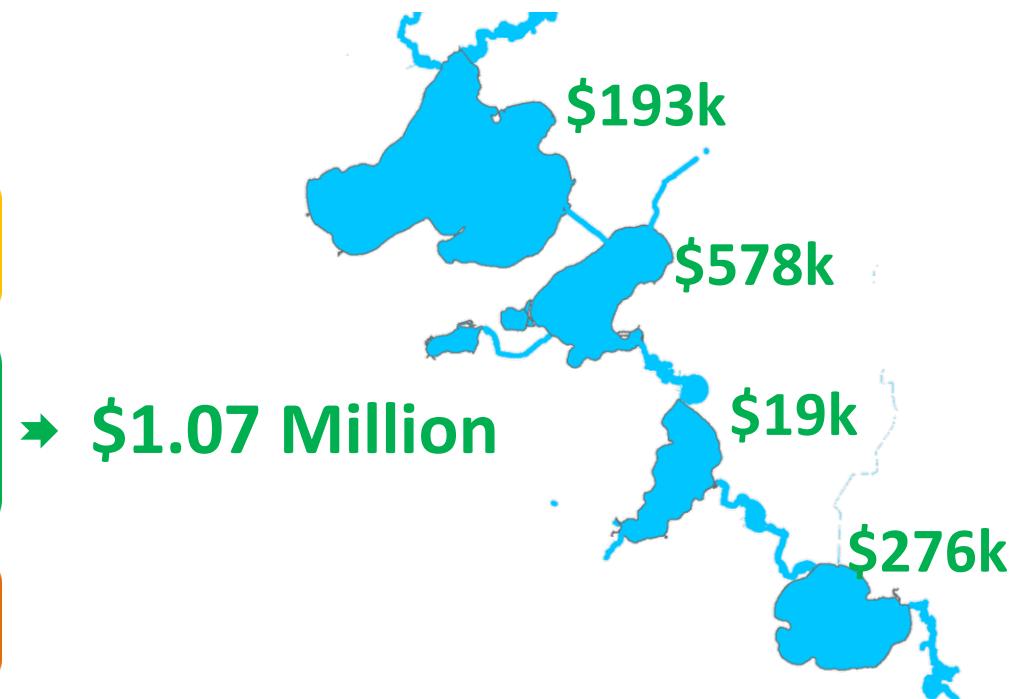
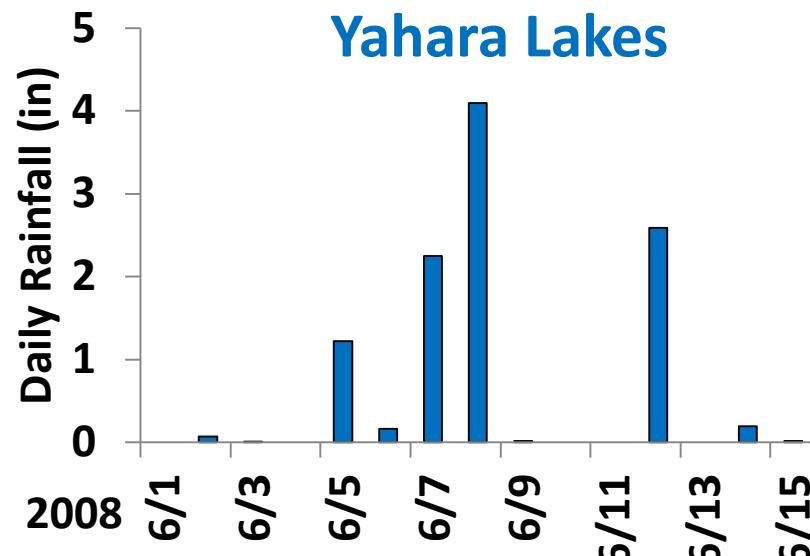
RP	A	V*A	V*A
# B	Eco	# B	(10 ⁷)
5	368	32	1.93
10	490	69	3.44
25	699	194	10.00
50	856	375	19.91
100	1588	1096	51.07

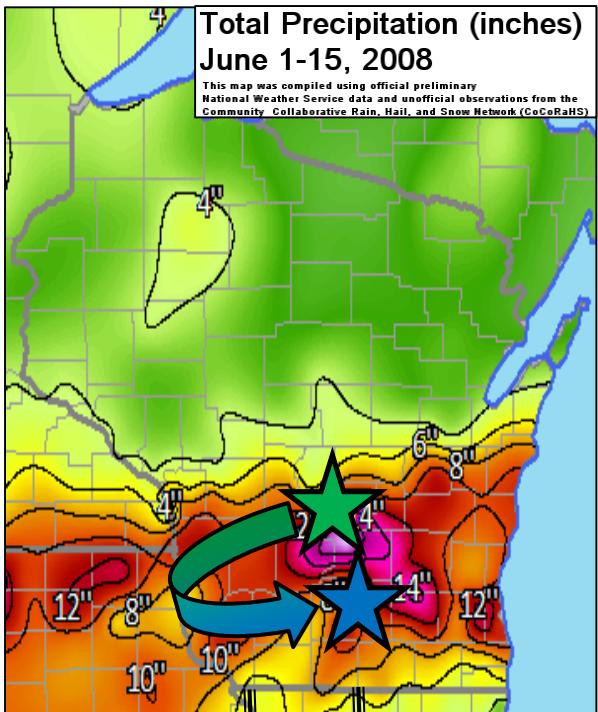


COMMER

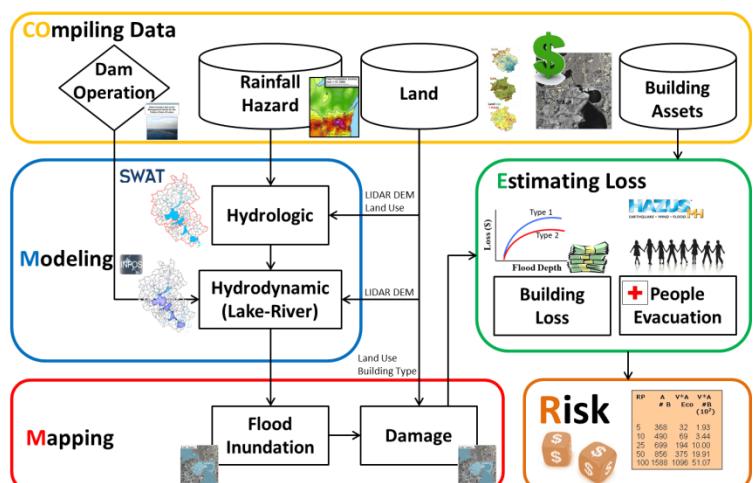


Reimer and Wu, 2016





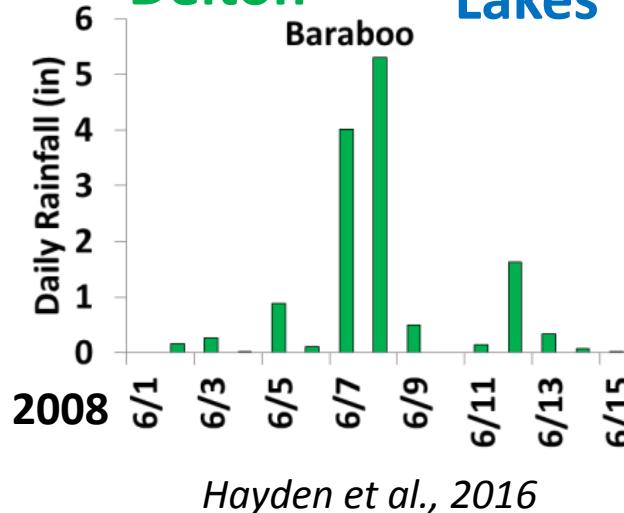
COMMER



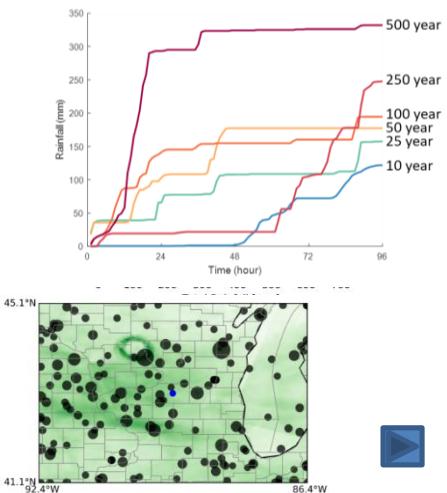
Reimer and Wu, 2016

Storm Transposition

Deterministic
Lake Delton → Yahara Lakes



Stochastic
RAINY DAY



→ \$??? Million

Rainfall Probability



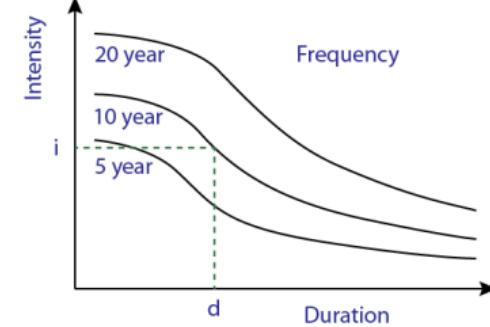
Rainfall Duration (days)



2
4
6
8
10

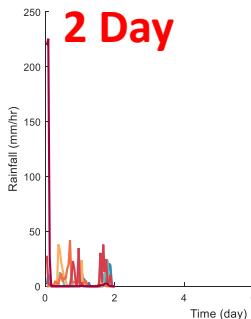
Return Period (years)

1
10
25
50
100
250
500

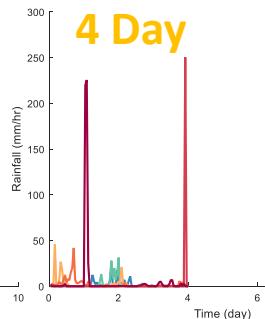


10 Year
25 Year
50 Year
100 Year
250 Year
500 Year

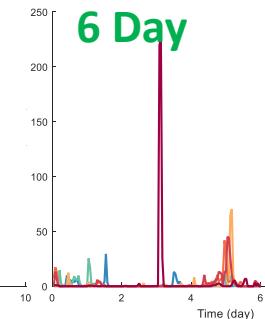
2 Day



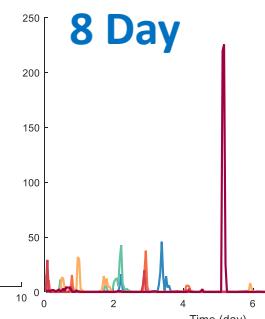
4 Day



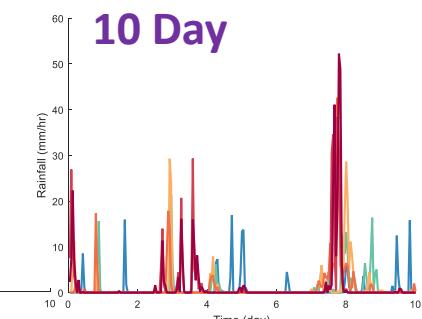
6 Day



8 Day

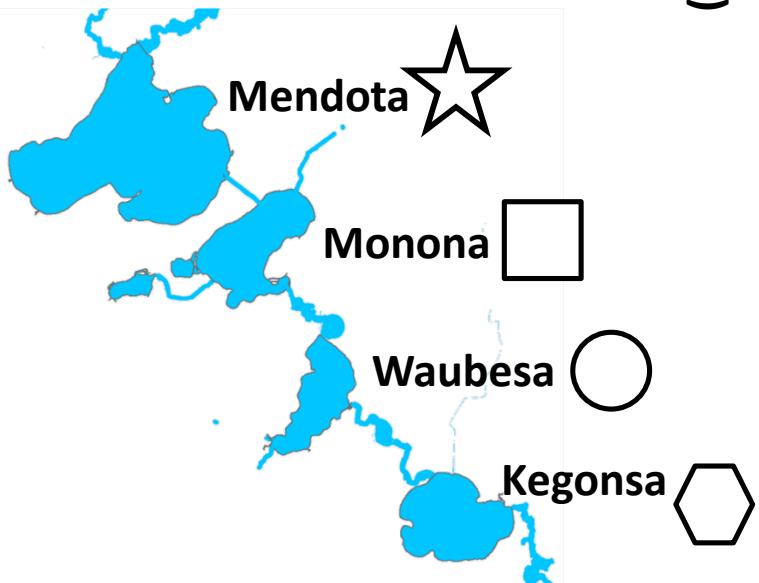


10 Day

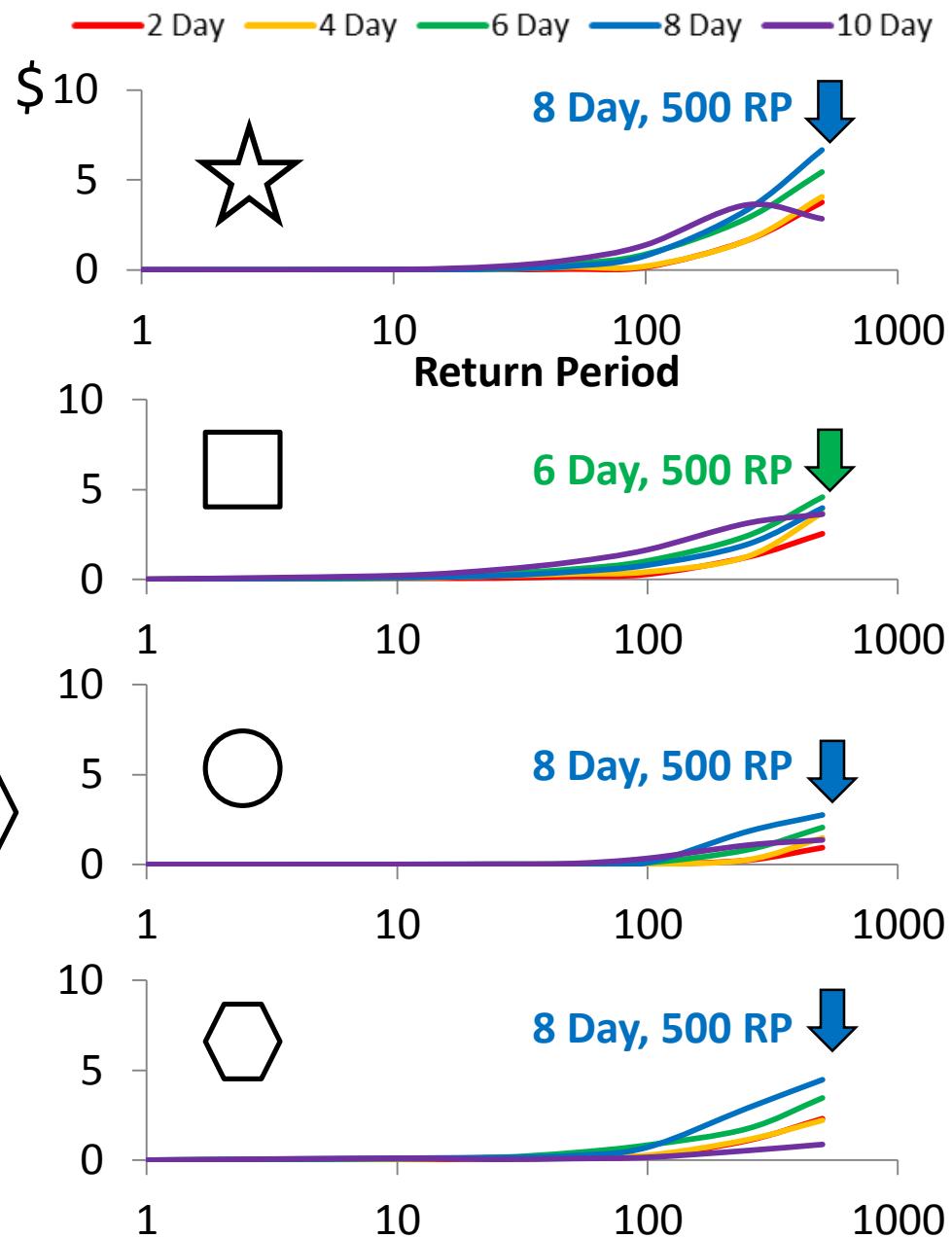


Results:

LOSS of Building Infrastructure

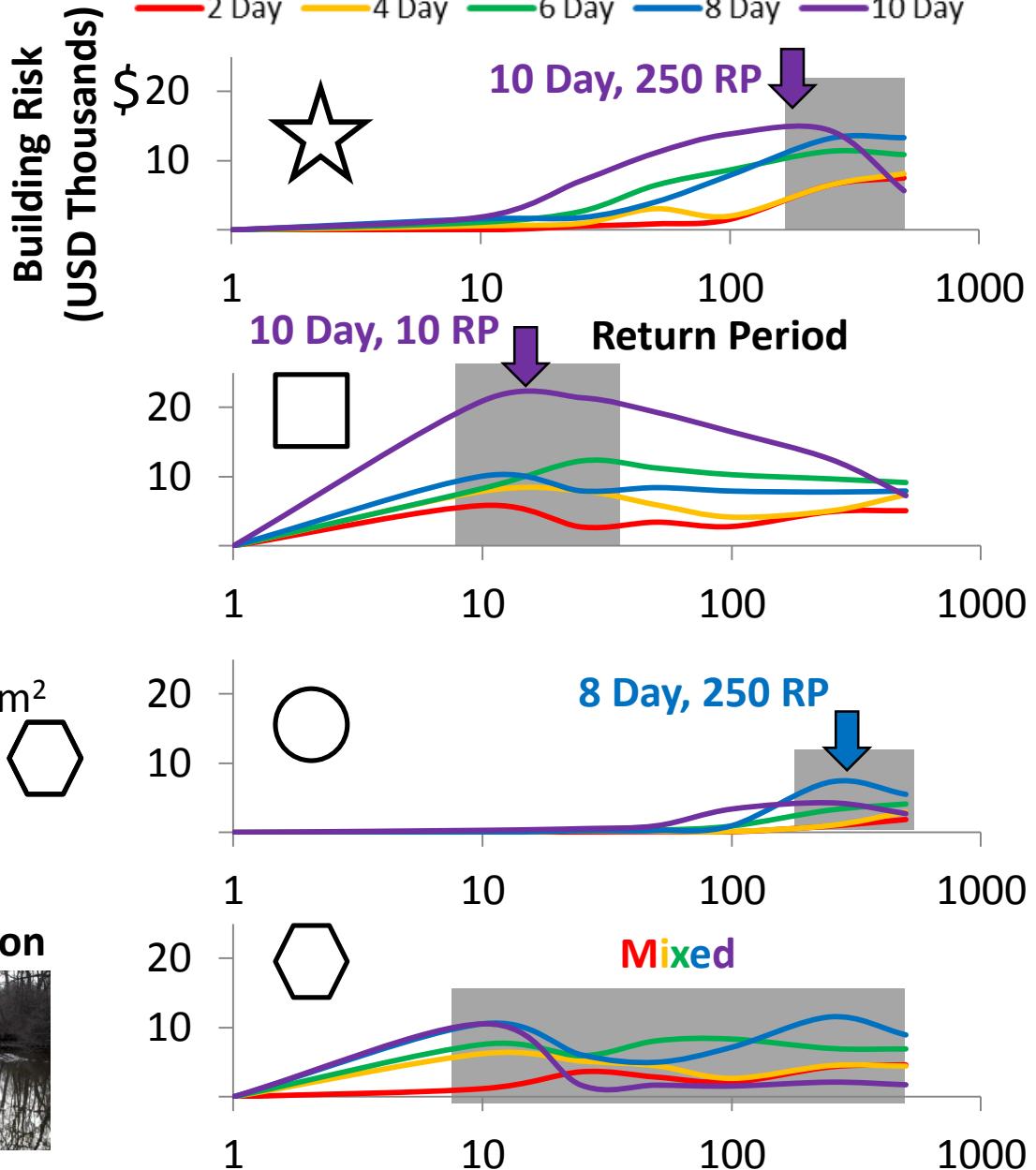
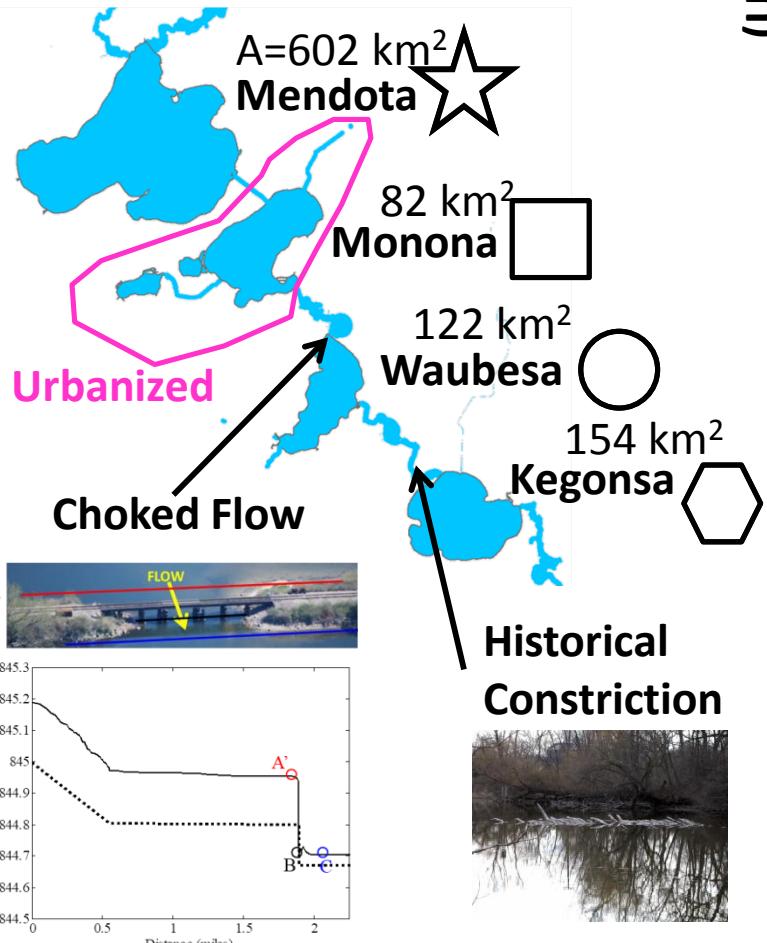


Building Loss
(USD Millions)



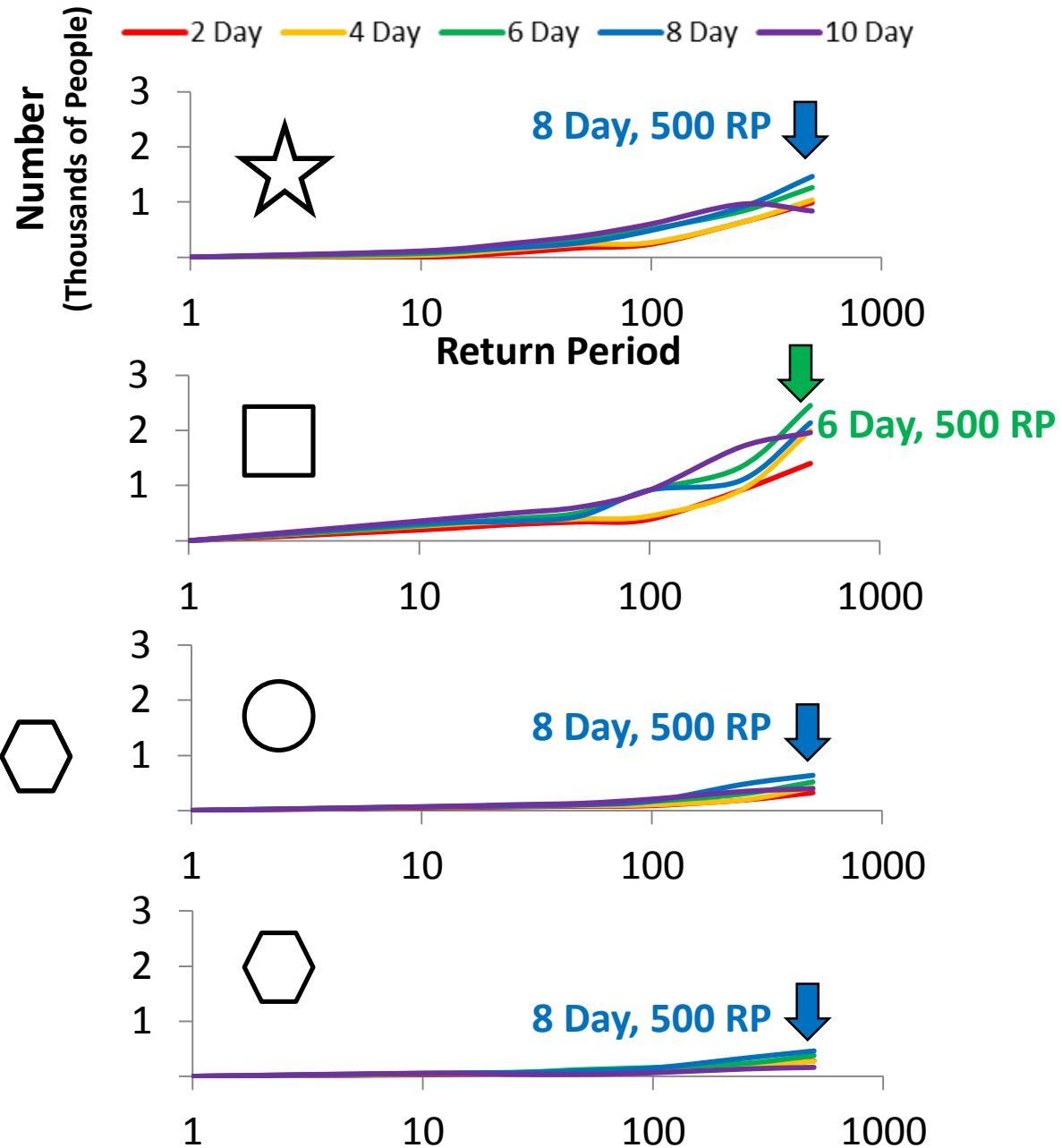
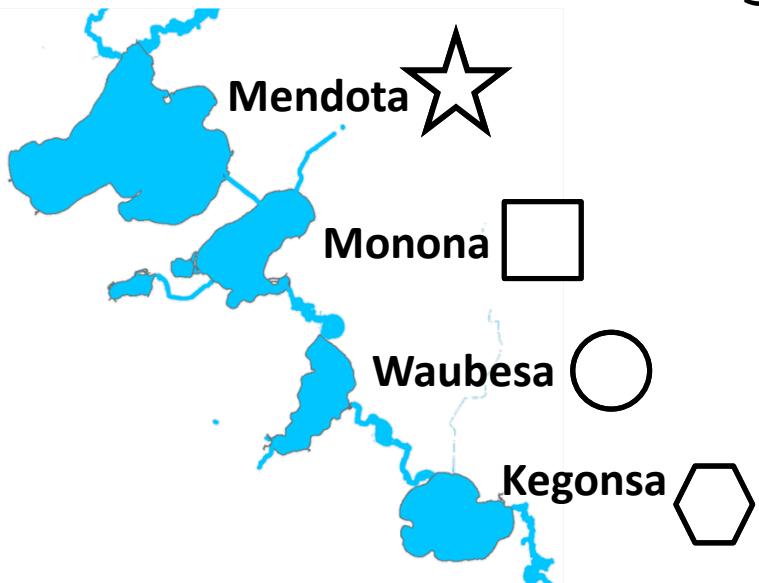
Results:

Risk of Building Infrastructure

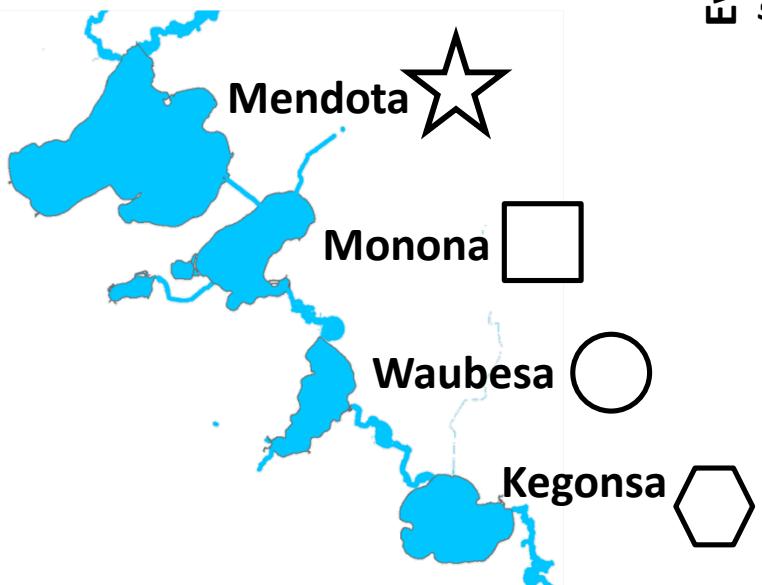


Results:

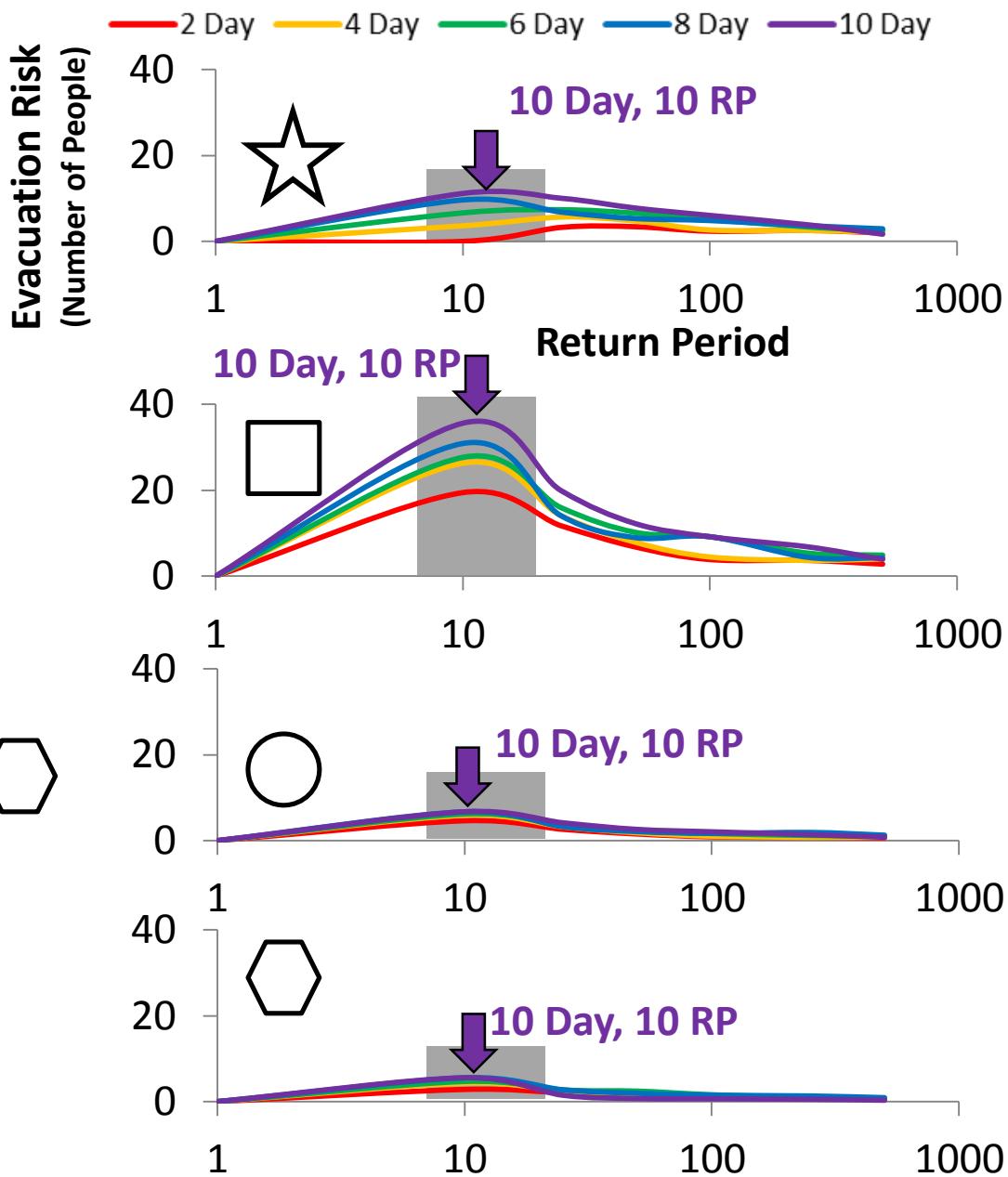
Evacuation of People



Results:



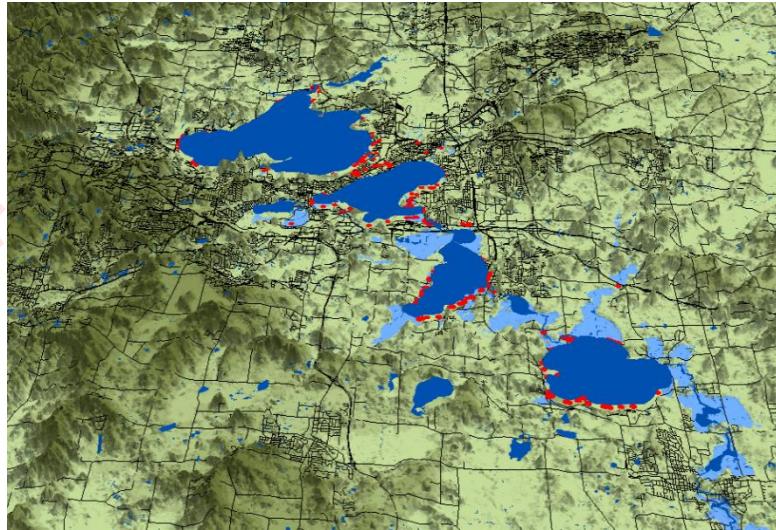
Risk of Evacuation



RECALL: Objectives

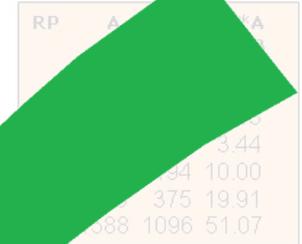
- Characterize **Flood Risk**

Hazard
(Rainfall)



Risk

= Risk



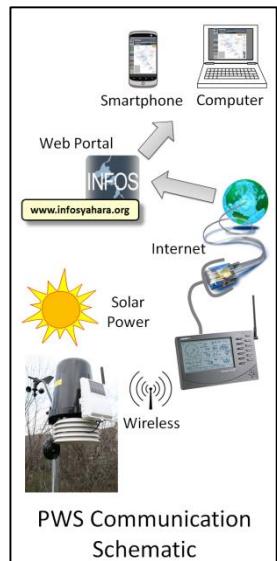
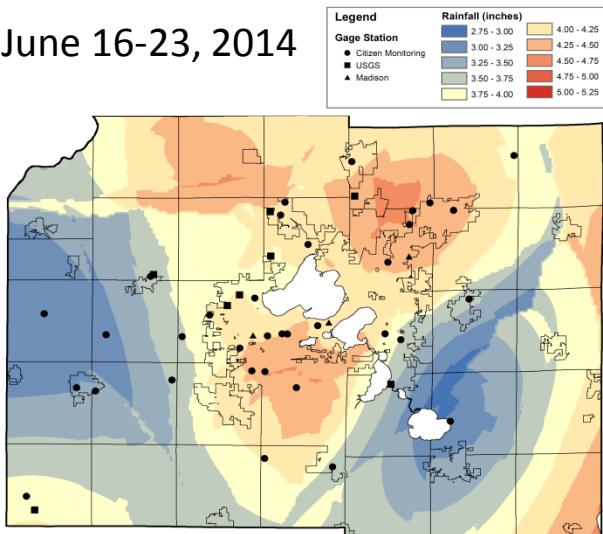
Vulnerability Mitigation

*Are we prepared today for tomorrow's **flood?***

Flood Forecasts

Past Rainfall

June 16-23, 2014



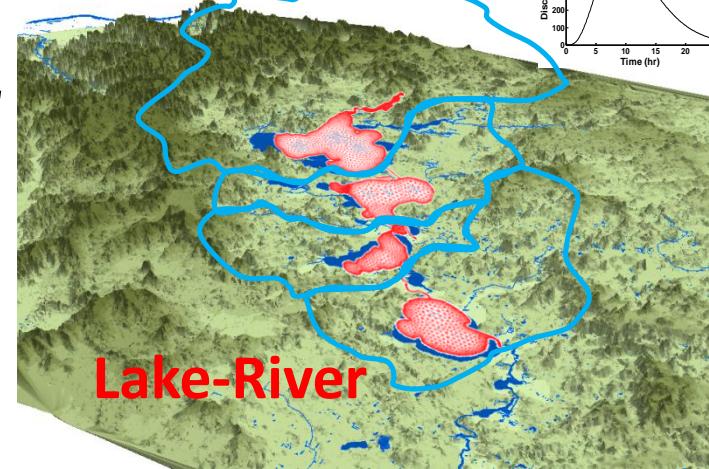
Forecast Rainfall

Weather Elements	Fire Weather	Probabilistic Forecasts (Experimental)
<input checked="" type="checkbox"/> Temperature (°F) <input checked="" type="checkbox"/> Dewpoint (°F) <input checked="" type="checkbox"/> Wind Chill (°F) <input checked="" type="checkbox"/> Surface Wind [mph] <input type="checkbox"/> <input checked="" type="checkbox"/> Sky Cover (%) <input checked="" type="checkbox"/> Precipitation Potential (%) <input checked="" type="checkbox"/> Relative Humidity (%) <input checked="" type="checkbox"/> Rain <input checked="" type="checkbox"/> Thunder <input checked="" type="checkbox"/> Snow <input checked="" type="checkbox"/> Freezing Rain <input checked="" type="checkbox"/> Sleet <input type="checkbox"/> Fog	<input type="checkbox"/> Mixing Height [x100 ft] <input type="checkbox"/> <input type="checkbox"/> Haines Index <input type="checkbox"/> <input type="checkbox"/> Trans. Wind [mph] <input type="checkbox"/> <input type="checkbox"/> Vent Rate ([x1000 mph-ft]) <input type="checkbox"/>	Description / Survey Quantitative Precipitation [6-hr] <input type="checkbox"/> info <input type="checkbox"/> 0.10 <input type="checkbox"/> 0.25 <input type="checkbox"/> 0.50 <input type="checkbox"/> 1.00 Snowfall [6-hr] <input type="checkbox"/> info <input type="checkbox"/> 0.1in <input type="checkbox"/> 1in <input type="checkbox"/> 3in <input type="checkbox"/> 6in <input type="checkbox"/> 12in



Integrated Models

Watershed

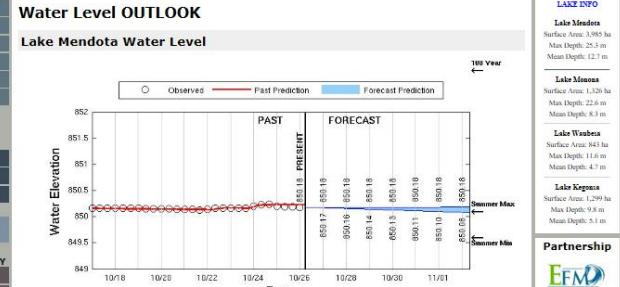


www.infosyahara.org



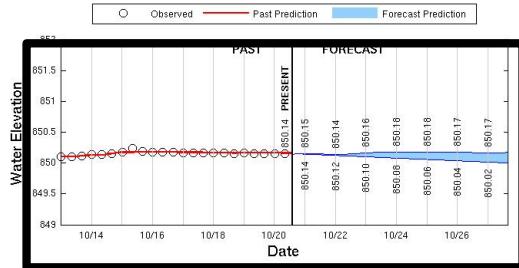
INFOS
Integrated Nowcast/Forecast Operation System
for Yahara Lakes

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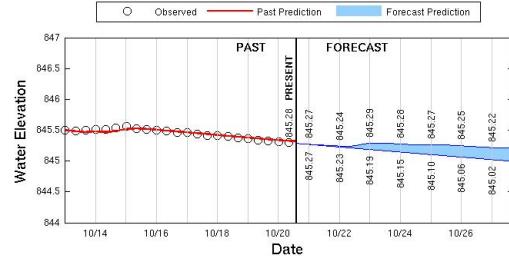


NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

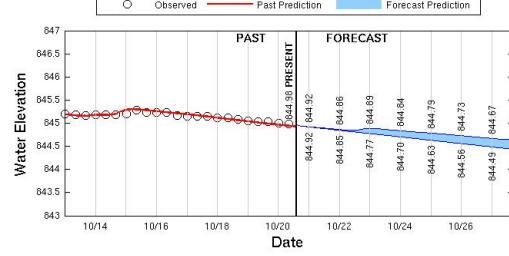
Flood Warning



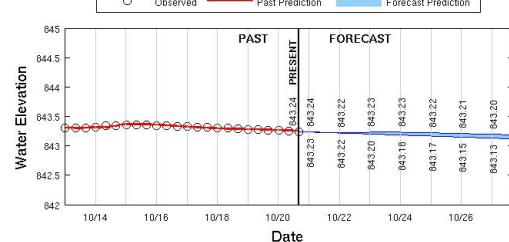
Lake Mendota



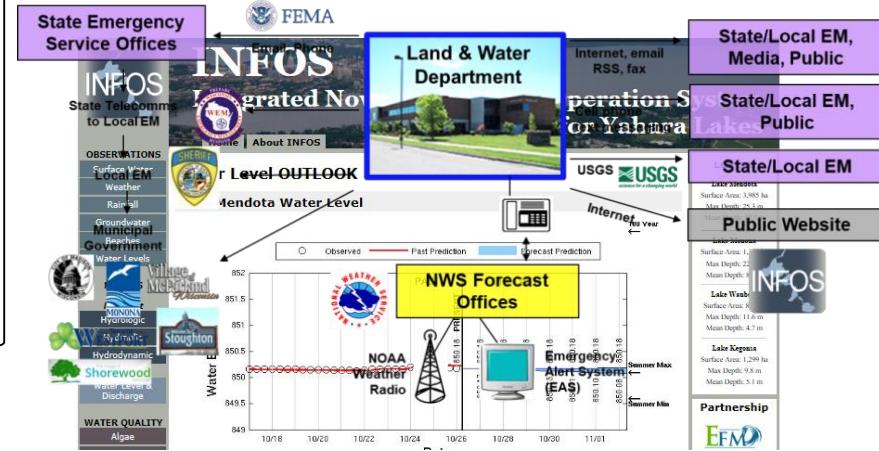
Lake Monona



Lake Waubesa



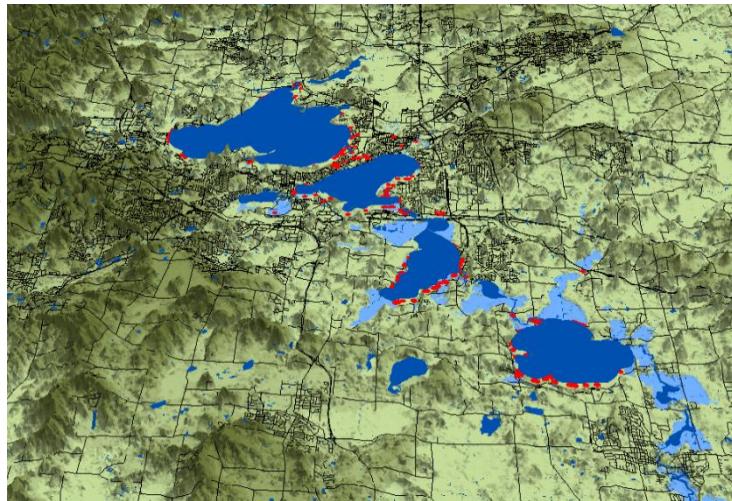
Lake Kegonsa



RECALL: Objectives

- Characterize **Flood Risk**

Hazard
(Rainfall)



Curve

Intensity

Frequency

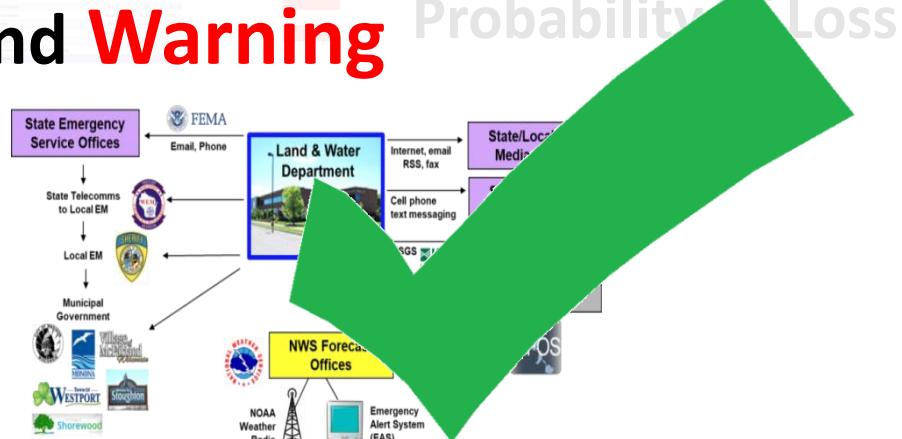
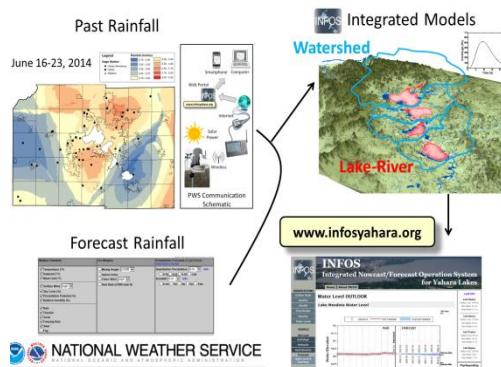
Duration



	V*A	V*A	Eco	#B	(10 ⁷)
368	32	1.93			
10	490	69	3.44		
25	699	194	10.00		
50	856	375	19.91		
100	1588	1096	51.07		

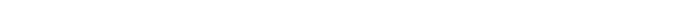
Vulnerability Mitigation

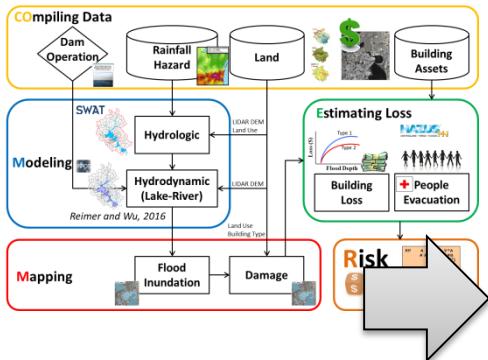
- **Develop Flood Forecast and Warning**



Resilience & Preparedness

Summary

- Characterize Flood Risk
Vulnerability Mitigation



	LOSS		RISK	
	Building	Evacuation	Building	Evacuation
Mendota	500 Year	500	250	10
Monona	500	500	10	10
Waubesa	500	500	250	10
Kegonsa	500	500	Mixed	10

- Develop Flood Forecast and Warning Resilience & Preparedness

