# Climate Change in the Great Lakes Region
## Starting a Public Discussion

Tonight:

# Climate Change Coming to the Coasts of Wisconsin:

# How It May Affect Coastal Communities and Property Owners

Sea Grant University of Wisconsin

Wisconsin Coastal Management Program

NOAA

Ozaukee County

www.seagrant.wisc.edu/ClimateChange

# Content of this presentation:

1. Climate change evidence and climate change scenarios: view presentations by Trenberth and Magnuson on this web site.
2. Expected impacts on the stability of coasts and on levels of lakes Michigan and Superior.
3. Increasing the resiliency of coastal land and coastal investments.

# Summary of observed climate changes

The global climate is changing.

Wisconsin's climate is changing; warmer, more extreme precipitation events, shorter winters, shorter ice cover season.

# Will we recognize a climate change?

Our society depends on climate variability: not too much precipitation, not too much dryness.

A climate change is a climate shift that didn't reverse course in a reasonable period of time.

"We may very well not know how local climates will change until after the fact."
…….Ken Potter (2007)

# Global Warming Is Unequivocal:

**• The recent IPCC report has clearly stated that "warming of the climate system is unequivocal" and it is "very likely" caused by human activities.**

**• Moreover, most of the observed changes are now simulated by models over the past 50 years, adding confidence to future projections.**

**•……. Kevin Trenberth. April 2007**

# What value are climate models?

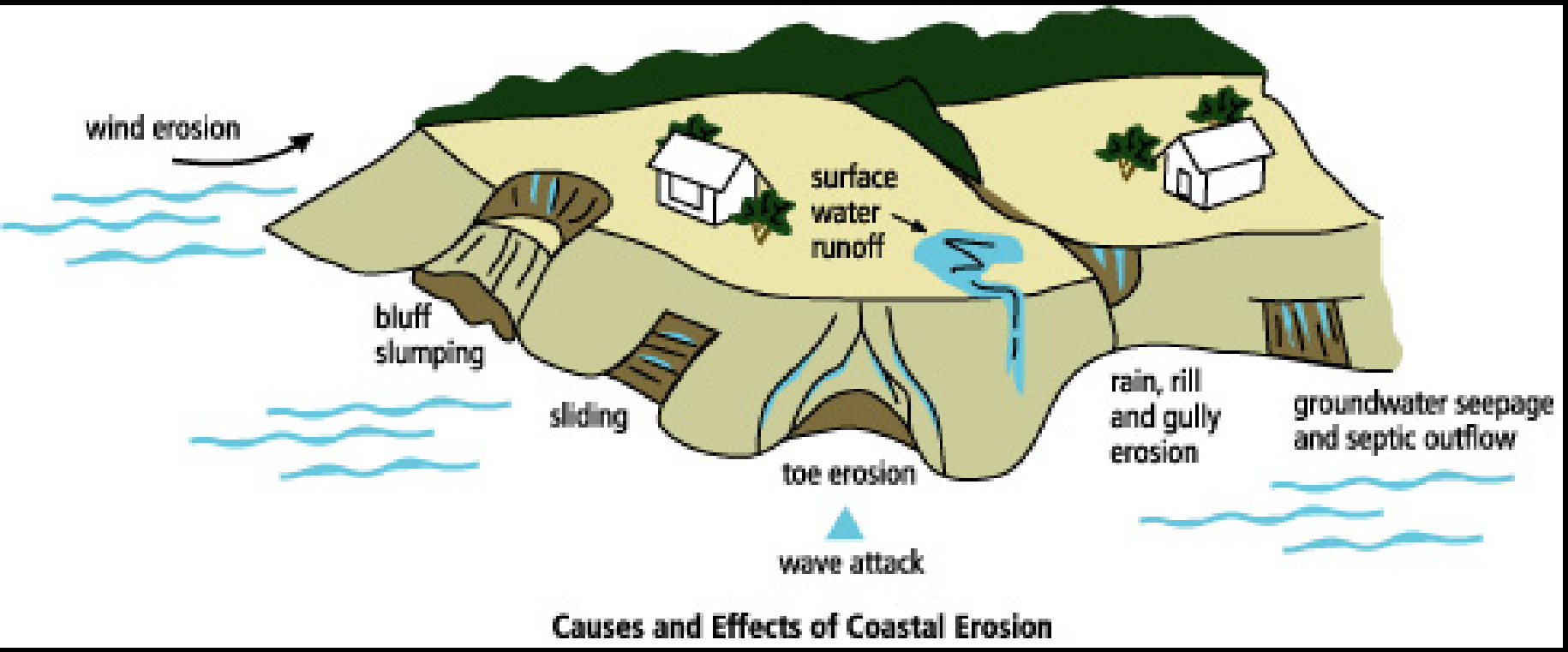
"While the model projections cannot be used as predictions of the future, they do represent a range of plausible scenarios of what the climate may look like later in the century. The scenarios can be used to understand the range of risks and opportunities…and adaptation options that would increase society's resilience to change."

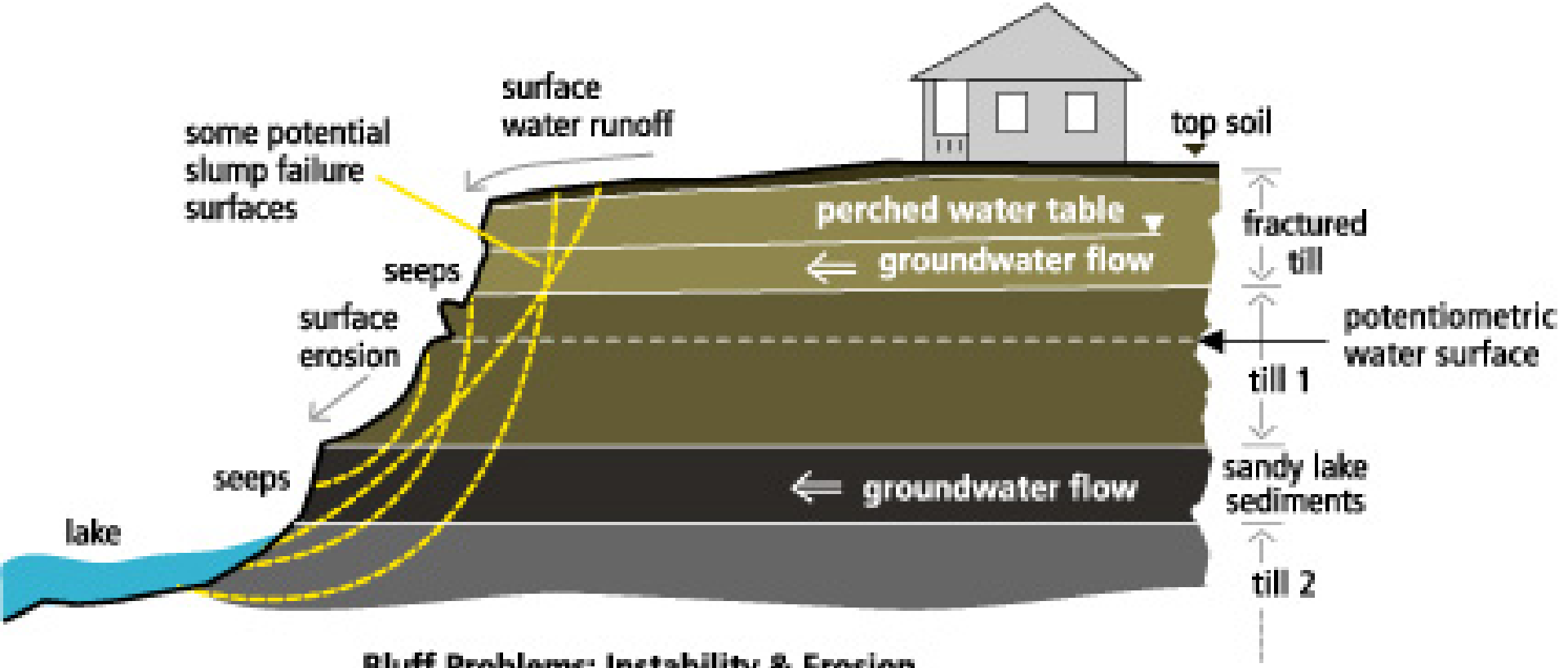
…….Joel Scheraga and John Furlow. 2002

# Some coastal impacts of climate change

- More erosion of coastal slopes
- Added stress on structures (extreme events)
- Lake levels beyond historic ranges disrupting human activities

# Causes and effects of coastal erosion






**Bluff Problems: Instability & Erosion**
**Surface Water Runoff Groundwater Seepage**

# Warmer, wetter winters, shallow frost , more/ longer freeze/thaw periods lead to:

More failures on cohesive slopes subject to deep slips and massive failures with complete thaws

More shallow slides

More surface erosion

Even more erosion where soil creep exists (Lake Superior coast)

# Winters without frozen soil, with more extreme precipitation events, lead to:

More failures on cohesive slopes subject to deep slips and massive failures as groundwater levels rise

More shallow slides

More surface erosion

Even more erosion where soil creep is a problem (Lake Superior coast)

# Dryer soils in summer and fall but with more extreme precipitation events lead to:

No greater effect on cohesive slopes subject to deep slips and massive failures unless groundwater rises

More shallow slides

More surface erosion

Even more erosion where soil creep is a problem (Lake Superior coast)

# No ice cover on Lake Michigan or Superior leads to:

No protective ice ridges or ice shelves along the shore

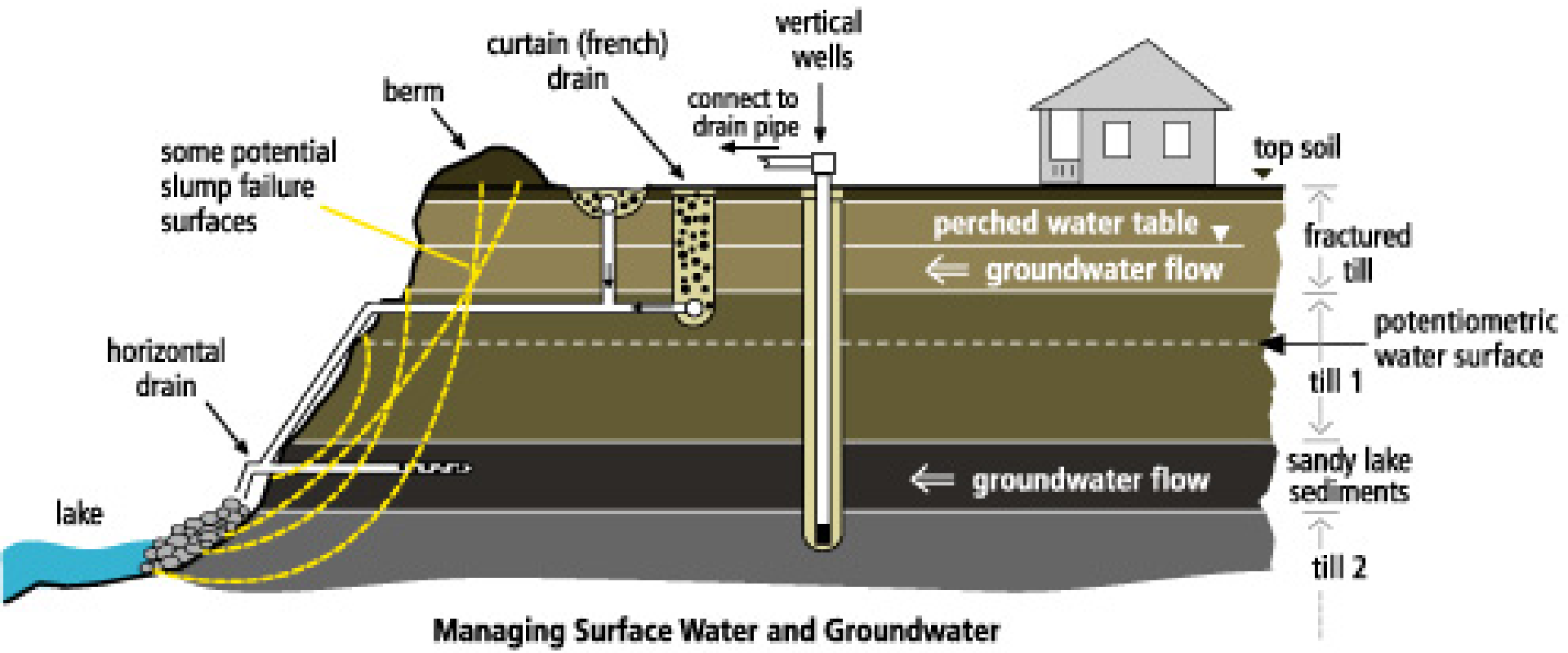
More wave attack on erodible slopes

More massive slope failures

More shallow slope failures

# What to do about the greater erosion risk due to climate change?

- Control surface water on coastal property
- Intercept groundwater beneath coastal property
- Monitor development in the neighborhood that may send more groundwater and surface water through your coastal property




Managing Surface Water and Groundwater

# Controlling water on coastal land is part of a strategy of Moderating Erosion

Other ways to moderate erosion:

Slow wind erosion by planting vegetation.

Improve existing shoe protection structures

# Four strategies to cope with erosion:

1. Moderate erosion (previous slides)
2. Adapt to natural processes
3. Restore natural shorelines
4. Armor the shore as a last resort

# Adapt to natural coastal processes

- Adopt greater setback distances for new construction
- Build houses that are easily relocatable
- Relocate houses threatened by erosion or flooding

# Restore natural shorelines

Create and preserve coastal environmental corridors

Improve or restore natural shore protection features (beaches, dunes, nearshore shoals and islands)

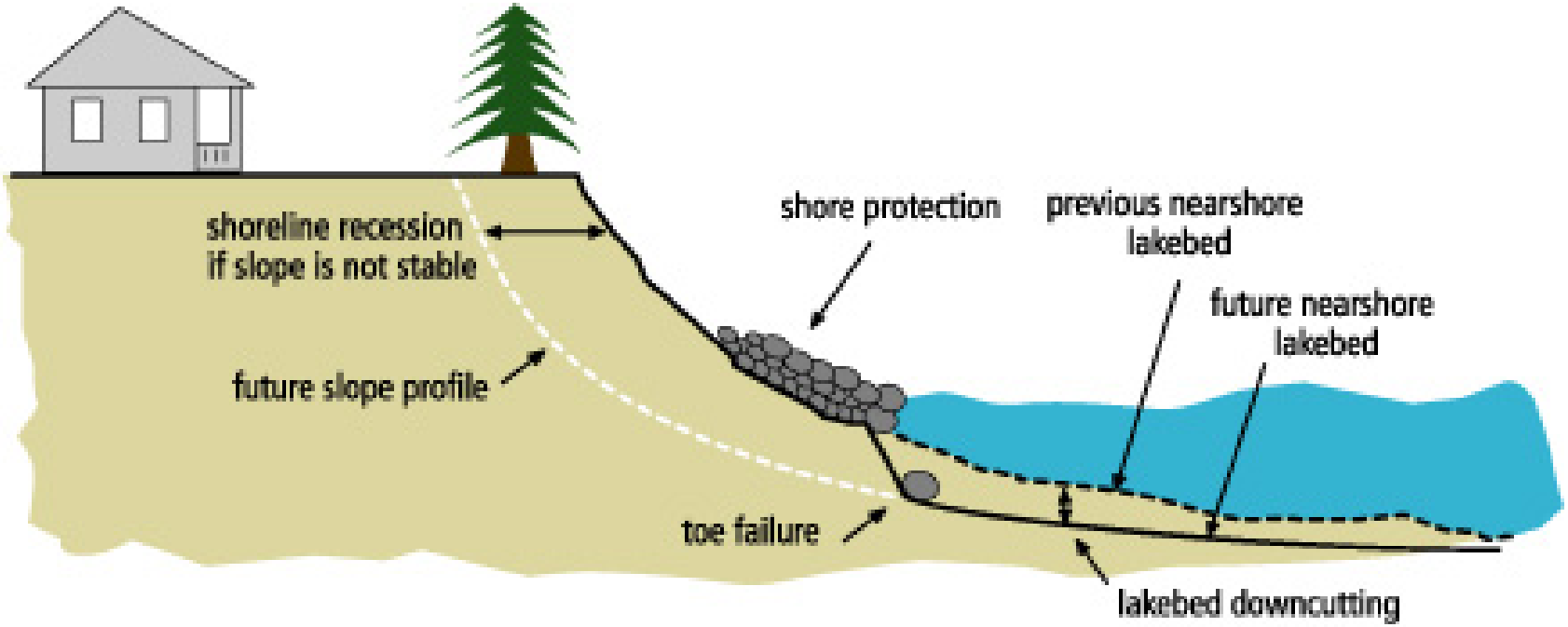
# Armor the shore as a last resort

Caution: shore protection structures may have adverse impacts on the property to be protected and on neighboring property.

Lakebed erosion (if occurring on site) can undermine and destroy virtually every type of shore protection structure.

# Typical lakebed erosion: 1-6 inches per year

….Coastal Processes Manual (1998)




**Lakebed Erosion with Slope Recession and Failure of Shore Protection Structure**

# Lakebed erosion

Significant and continuing where and when waves, currents, and abrasive sand and gravel move across soft clayey sediments.

How significant? 1-6 inches per year of erosion results in nearly 1 to 5 feet of lowered lakebed in a decade (evidence from other Great Lakes states – not Wisconsin)

Source: Wis. Sea Grant Coastal Processes Manual. 1998.

# For more information on reducing coastal erosion and improving slope stability:

Living on the Coast, protecting investments in shore property on the Great Lakes. 2003. U.S. Army Corps of Engineers and the University of Wisconsin Sea Grant Institute.

Stabilizing Coastal Slopes on the Great Lakes. 2005. UW Sea Grant Institute.

# More extreme precipitation events will lead to:

- More catastrophic failures of coastal slopes
- More failures of old bulkheads, dockwalls, seawalls
- Washouts of coastal roads, storm sewers
- Threat of flooding and other damage to harbor infrastructure
- Record stormwater discharges

# Will lakes Superior and Michigan move beyond their historic range of levels?

Superior: about to decline in September below the record low level of 1925…….(USACE August 2007)

”…this (140-year) record is too short for a confident prediction of future lake-level fluctuations in a changed climate, particularly if projected global warming induces more extreme fluctuations than observed over the past 140 years”…..Blasco and Lewis (2002)

# How far can lakes Michigan and Superior levels go beyond the historic range?

# Has the outlet of lakes Michigan and Huron eroded and the lakes lowered?

The elevation difference between lakes Michigan/Huron and the lower lakes has decreased by as much as 33 cm (13 inches) since the early 1960s…..in critical sections of the St. Clair River, “erosion of 2 to 6 m (6.6 – 21.6 feet) has occurred”……. (Baird and Assoc. 2005)

# The IJC's Upper Great Lakes Study

Plan of Study includes: ….."examine physical processes and possible ongoing St. Clair River changes and its impacts on levels of Lake Michigan and Huron…recommend and evaluate potential remedial options."

Study Board appointed 2/07. A five year study. Physical changes in the St. Clair River "will be investigated early in the study."

…..www.iugls.org/

# Climate surprises from shifts in storm tracks?

"The atmospheric circulation has changed….in most seasons in both hemispheres" …..Trenberth (2006)

Abrupt climate change may be caused by changing storm tracks…this is an important issue…IPCC studies don't provide much information……Trenberth (2007)

# Climate surprises coming to the western Great Lakes?

Fall, winter, spring storms crossing the Lakes come from: the Gulf, Rocky Mountains, from western Canada

One possible surprise: a persistent shift in storm tracks into, or out of, the Great Lakes Basin

El Nino in the S. Pacific affects storm tracks crossing North America and the Great Lakes

# How fast have Lake Michigan's lake level risen?

Historical rapid rises: more than 3 feet in a year and a half, or less (1928-1929, 1951-52 and 1959-60), 5.6 feet in 8.5 years (1965-1973)

Source: NOAA hydrograph

# How fast has Lake Michigan's water level declined?

Historical declines: nearly 5 feet in 3.5 years (1929-33 and 1997-00), 4.0 feet in 2.3 years (1986-89)

Max. one year declines in monthly mean levels: 3 feet in 1930-31 and 1998-99), 2.7 feet in 1986-87

Sources: NOAA Hydrograph and Quinn et al 2002

# How fast has Lake Superior's level declined?

From August 1996 to March 2001, the lake level declined 2.8 feet in 4.5 years

From April 1926 to October 1928, the lake level declined 3.3 feet in 2.5 years

Source: NOAA Hydrograph

# How fast can Lake Superior rise?

We don’t know, but hydrologic modeling indicated that if Lake Superior had the climate conditions of the Mississippi River Flood of 1993, the lake would have risen about one foot in three months from a near average elevation of 5 inches above Low Water Datum

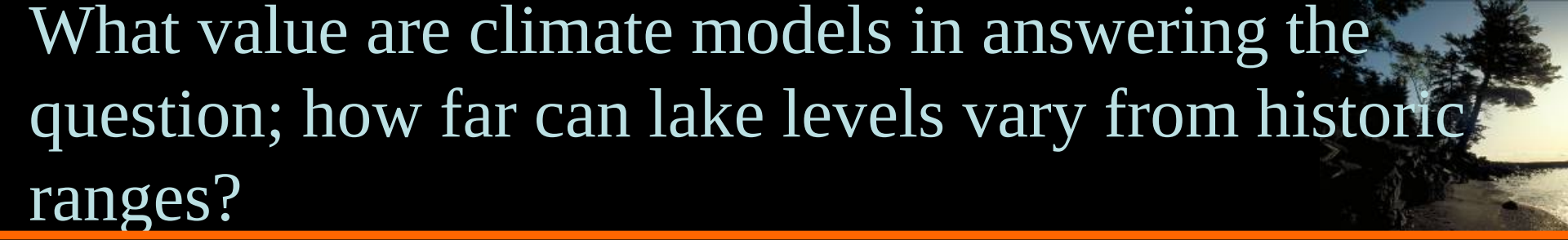
Source: Croley, et al 1996

# How far might Lake Michigan rise?

If the very wet weather of 1985 had continued for years, the maximum monthly mean lake level on lakes Michigan and Huron would have risen 1.3 feet above the record high level set in October 1986

……..Hartmann 1986

# What value are climate models in answering the question; how far can lake levels vary from historic ranges?



"While the model projections cannot be used as predictions of the future, they do represent a range of plausible scenarios of what the climate may look like later in the century. The scenarios can be used to understand the range of risks and opportunities…and adaptation options that would increase society's resilience to change."

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# How far can Lake Michigan decline?

possible changes in the long-term, average levels:

Nearly a one foot decline with a warmer climate like Ohio, S. Illinois, Kentucky, Tennessee

Over a 10 feet decline with a warmer, dryer climate like Kansas, Oklahoma, Missouri.

……..Croley et al 1996

# How far can Lake Michigan decline?

Results from 5 climate warming models: changes in long-term average lake levels

By 2020, lower by 1.3 -4.6 feet (4 models)

By 2030, lower by 2.3 feet (1 model)

By 2050, lower by 3.3 feet (1 model)

……Sousounis and Bisanz 2000, Lofgren et al 2002

# How to prepare for lake levels beyond historic ranges?

The question of future lake levels in the Great Lakes is the equivalent to the question of future sea level rises

Coastal communities and infrastructure were developed for a range of water levels that no longer seems valid

# How to prepare for lake levels beyond historic ranges?

We need to know how sensitive such places are to lake levels beyond the design ranges.

We need to know how the lakes would respond to some additional, plausible scenarios such as: “If the drought conditions of the early 1960s returned year-after-year at present low lake levels…..”.

# With climate change already here in Wisconsin, state residents need:

Regional climate models to be developed and coupled to global climate models in order to provide the public with better information about climate changes 20 – 50 years from now.

Easy access to information about the state's changing climate and anticipated climate

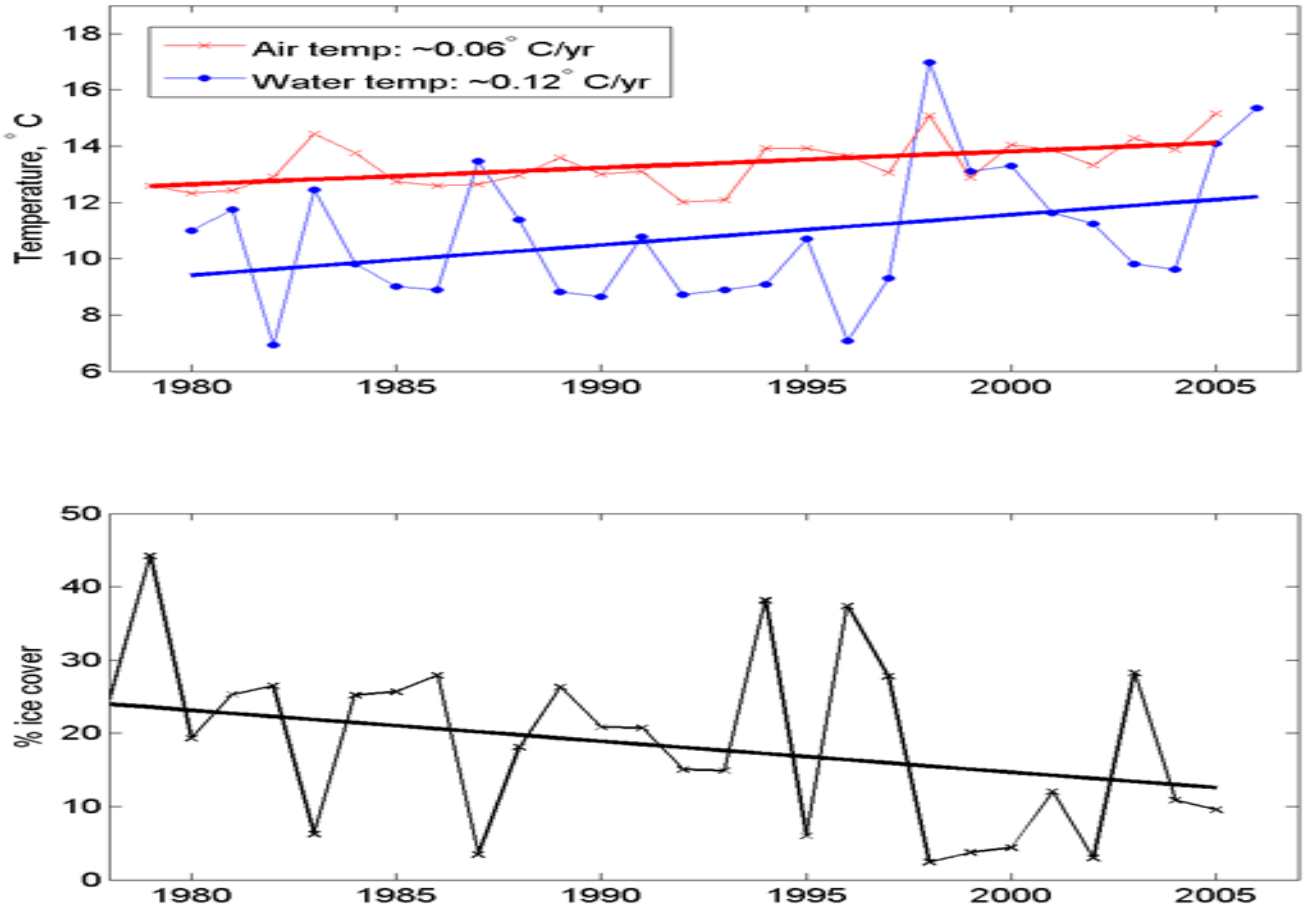
Tools and examples of climate change risk management with contingency planning

# Climate changes coming faster than you think

Example: Lake Superior summer temperatures are warming faster than air temperatures are warming: “a positive feedback” (Austin and Colman 2007. www.d.umn.edu/~jaustin/ICE.html)

The feedback: less ice cover (and less reflected sunlight) means more open water absorbing sunlight and warming earlier in the year

# LAKE SUPERIOR AIR TEMP.(RED), WATER TEMP.(BLUE) ICE COVER (BLACK)….FROM AUSTIN AND COLMAN (2007)



# Example of a “positive feedback”

A home temperature control system wired backwards: the furnace comes on during a hot summer day when the air temperature inside rises above the thermostat setting. The air conditioner comes on during a cold winter day when the air temperature inside falls below the comfortable thermostat setting.

“Negative feedbacks” are good in home heating/cooling systems and in global warming.