

***Opportunities to Anticipate and Adapt  
to the Effects of Climate Change  
in the Great Lakes Region***

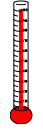


**2008 MAWWECC**

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# The Potential Impacts of Climate Change

**Climate Changes**

-  **Temperature**
-  **Precipitation**
-  **Sea Level Rise**

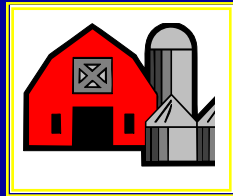


**Cultural Resources**



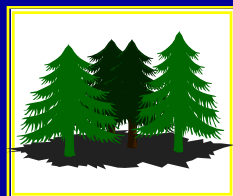
## Health Impacts

Weather-related Mortality  
Infectious Diseases  
Air Quality-Respiratory Illnesses



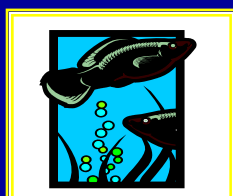
## Agriculture Impacts

Crop yields  
Irrigation demands



## Forest Impacts

Change in forest composition  
Shift geographic range of forests  
Forest Health and Productivity



## Water Resource Impacts

Changes in water supply  
Water quality  
Increased competition for water



## Impacts on Coastal Areas

Erosion of beaches  
Inundate coastal lands  
Costs to defend coastal communities



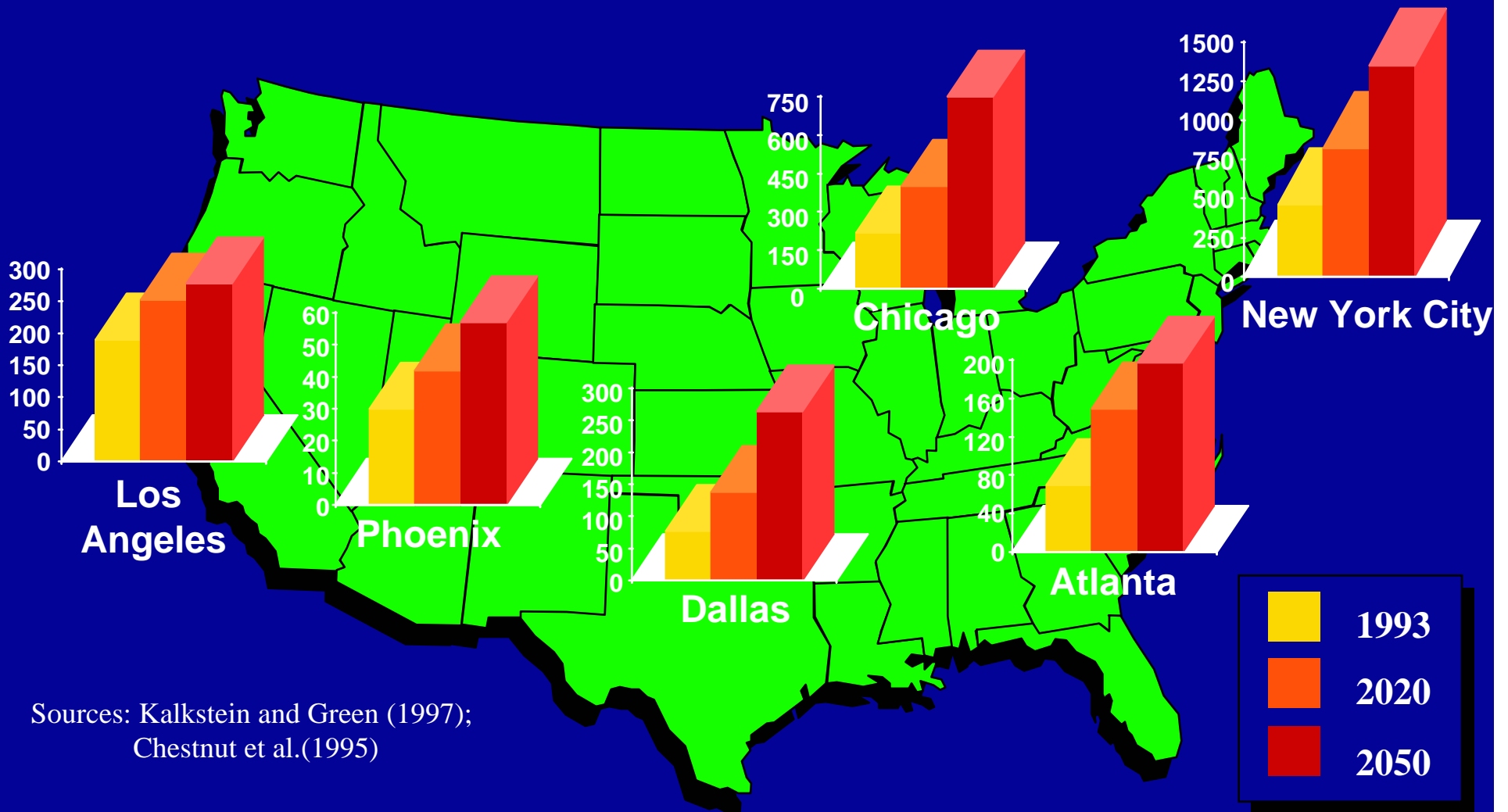
## Wildlife and Ecosystems

Shift in ecological zones  
Loss of habitat and species

# A Smart Approach to Shaping the Future Requires a Mix of Strategies

- Consists of a mix of strategies to **mitigate** GHG emissions and to **adapt** to a changing climate
- **Mitigation**: essential to slow the rate of change
- **Adaptation**: essential because climate will continue to change
  - regardless of actions taken to mitigate
  - due to **natural variability** in climate
  - as well as **human-induced** climate change
- Adaptation increases resilience to change
  - reduces **risks** and takes advantage of **opportunities**
  - ✓ potential payoffs *today*

# Increased Mortality Risk During Heat Waves (1993, 2020 and 2050)



Sources: Kalkstein and Green (1997);  
Chestnut et al.(1995)

Note: Includes both summer and winter mortality.  
Assumes full acclimation to changed climate.  
Includes population growth.

GFDL Climate Change Scenario





## Climate Change and Air Quality

- Climate change will likely affect air quality (e.g., ozone) in our cities
- Climate change may make it more difficult to attain air quality standards in certain areas
- “Climate penalty” may push areas that are in attainment into non-attainment
- Additional emissions reductions may be required in the future
- Opportunity to anticipate and adapt: We have an opportunity to begin folding considerations of climate change into our planning

***Forthcoming: EPA Assessment of the Implications of Climate Change for Regional Air Quality in the U.S. (Spring 2008)***

# Economic Activity will be Affected: Lower Lake Levels and Commercial Shipping



- Climate change will likely lower Great Lakes levels
- Drops of 5 feet are possible

## Implications for shipping:

- 5 foot reduction would lead to a 20-40% reduction in outflow to St. Lawrence Seaway
- **Increased costs of navigation of 5 to 40%**
  - For each inch of draft lost, 1000-foot ships must offload 270 tons of freight

## Other effects:

- ✓ Reductions in hydropower generation downstream of up to 15% by 2050
- ✓ Reduced shoreline damage due to high lake levels ranging from 40-80%

# Climate Change and Water Quality

- What does climate change mean for water quality?
  - ✓ Infrastructure (wastewater; drinking water)
  - ✓ Aquatic ecosystems



- **What can be done to protect water quality as the climate changes?**



# ***Implications of Climate Change for Water Quality:***

## ***Infrastructure***



**RESEARCH & DEVELOPMENT**

*Building a scientific foundation for sound environmental decisions*

# Infrastructure: Combined Sewer Systems

- 770 systems serve around 40 million people
- 182 CSSs in the Great Lakes Region
- 1,260 billion gallons untreated sewage and storm water released yearly
- \$45 billion in future investment needs (EPA estimate in 2001)

“CSOs are recognized as major contributors to the water pollution encountered in the Great Lakes...”  
- Environment Canada

CSS Communities



Source: EPA

Past Precipitation Trends



Source: National Climatic Data Center/NESDIS/NOAA





# Combined Sewer Overflow in the Great Lakes Region

(Public review draft released  
in March 29<sup>th</sup> Federal Register Notice)

- Key Questions:
  - ✓ Does climate change matter to the redesign of combined sewer systems in the Great Lakes Region?
  - ✓ When the climate changes, how might CSO event frequency change, and in how many cases will the four CSO events per year threshold be exceeded?
- If combined sewer systems are designed to meet the EPA's CSO Control Policy design standard of 4 events per year, but fail to plan for climate change:
  - ✓ climate change may result in failure to meet the standard
  - ✓ **there could be an average of 237 events per year above the control policy's objectives across 182 communities**

# Valuable Insights for City Planners

1. Climate change will affect future performance of many CSSs in the Great Lakes Region.
2. Calculations of system size should not be based on current hydrology and historic precipitation data.
3. A *policy* decision must be made about additional investments to build in a margin of safety.
4. **The risks posed by climate change to CSSs are manageable\*.**

\* *Opportunities to link adaptation to Smart Growth policies*

# ***Implications of Climate Change for Water Quality:***



## ***Aquatic Ecosystems***

# Impacts on Aquatic Ecosystems of Higher Intensity Precipitation Events

- Increase delivery of sediments, sediment-enriched pollutants (e.g., phosphorous, pesticides) and soluble pollutants (e.g., nitrates) to rivers and streams
- Can affect the cost of environmental protection
- **Particular concern: Streams, rivers and lakes that do not meet water quality standards -- even though most large point sources are complying with discharge limits**
  - More stringent TMDL limits must be developed for all pollutant sources
  - For point sources, increasing treatment efficiency to meet TMDLs can be costly

# TMDLs in the Great Lakes Region

(Public review draft released  
in March 29<sup>th</sup> Federal Register Notice)

EPA's TMDL program  
allocates pollutant loads  
to water bodies



**Publicly-Owned Treatment  
Works (POTW)**

Climate change could increase annual  
POTW treatment costs in the Great Lakes  
Region

- by \$8-\$97 million
- on impaired stream and river reaches
- further widening gap between funds  
needed for POTWs and funds  
available

**Problem is manageable, but costly**

# Impacts on Aquatic Ecosystems

**Aquatic ecosystems are highly sensitive to the effects of warmer water temperatures**

- Reduce dissolved oxygen concentrations
- Decreased volume of water for dilution of chemical inputs
- Increased concentration of nutrients and pollutants
- Changes in the rate of chemical reactions in the water column, sediment-water interface, and water-atmosphere interface
- Thresholds for certain species may be reached
- **Invasion by temperature-sensitive exotic species**
- Cooling effect on streams of ground water discharge reduced
- Cold-water fish lose important habitat

# Effects of Climate Change on Aquatic Invasive Species

- Invasive species are displacing native, high-value fish
  - ✓ changing water quality
  - ✓ leading cause of degraded ecosystems and ecosystem services
  
- Climate change (warmer water temperatures) has the potential to interact with them to exacerbate their effects
  
- Issues of concern:
  - ✓ ballast water
  - ✓ TMDLs and impaired waters
  - ✓ economic consequences
  - ✓ pesticide usage for control
  
- September 2007 EPA report:
  - ✓ Assessed state of science of climate change effects on aquatic invasive species
  - ✓ **identified management actions that influence the impact of aquatic invasive species on ecosystems under changing conditions**



***What can be done to protect air quality, water quality, human health, and economic activity, as the climate changes?***

**Anticipating and preparing for climate change offers an opportunity to shape the future of Minnesota**

- protect public health
  - protect air quality
- protect water supplies (quantity & quality)
  - protect aquatic ecosystems
  - protect economic activity
  - enhance the quality of life

# We can plan ahead.... or we can react

**Wildlife can only react**



**But humans can anticipate**



(Main CN Line Near Amherst, NS)

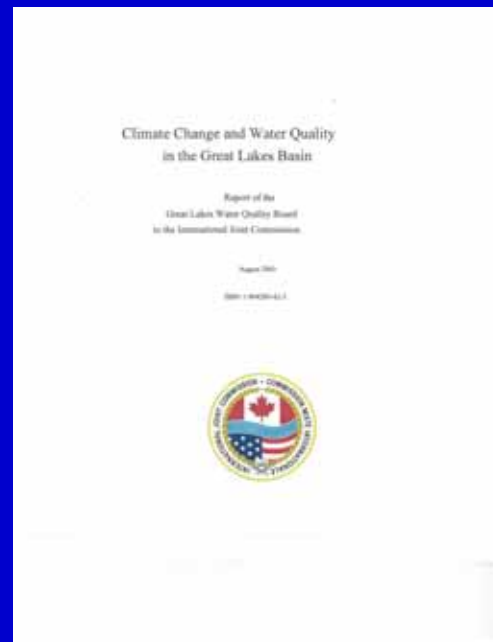
# Many Opportunities to Adapt Exist (examples)

- Modify long-term planning, engineering standards, and infrastructure design (e.g., to deal with melting permafrost)
- Land use planning (e.g., limit development in flood-prone areas!)
- Development of riparian buffer zones
- Shipping: shallower draft ships; dredging ports; length of shipping season; shift to land transport
- Restore and maintain watersheds as an integrated strategy for managing water quality and quantity
- Changes in management and political institutions
- Develop response management plans for invasive species
- Establish heat stress warning systems
- Reduce urban heat island effect
- Enhance water use efficiencies

# Participants in Bilateral Initiatives Related to Climate Change and Water Resources

US/Canada International Joint Commission

Report from the Water Quality Board:  
“Climate Change and Water Quality in the Great Lakes Basin”



August 2003

**Tools\*** are being developed  
to support adaptive management decisions  
by EPA and its stakeholders

\* non-prescriptive

# “Enhanced” BASINS: An EPA Decision Support Tool for Water Resource Managers

- BASINS is a widely distributed tool designed for use by regional, state, and local agencies in performing watershed and water quality-based studies
  - EPA’s Office of Water encouraging use of BASINS to support regulatory compliance (e.g. TMDLs)
  - New version (ver. 4) released in May 2007
- Enhanced BASINS with a **Climate Assessment Tool** (CAT)
- CAT provides a capability for understanding
  - how water resources could be affected by a range of potential changes in climate
  - the effectiveness of management practices for increasing the resilience of water resources to changes in climate (e.g., the **future effectiveness of a proposed TMDL implementation plan** under a projected climate change scenario)

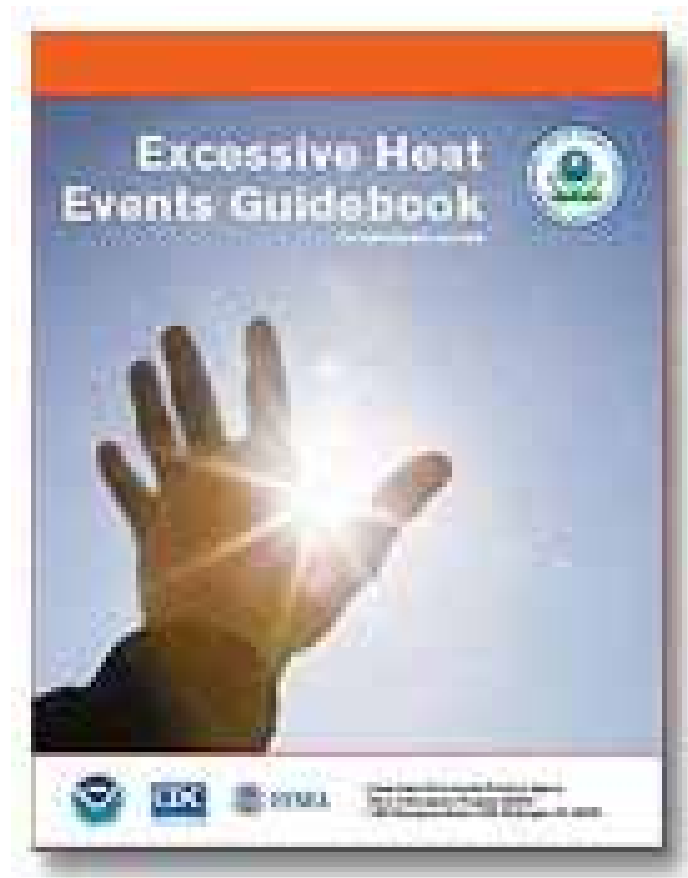
<http://www.epa.gov/waterscience/BASINS/>

# ***Tool for Assessing Development of Riparian Buffer Zones***

- Soil erosion is highly sensitive to amount and intensity of rainfall
- Sediment management strategies must be developed
- Water Erosion Prediction Project (WEPP) model
  - One of best known and validated models for simulating soil erosion
  - Now includes riparian buffers
- EPA enhancement:
  - Incorporate Climate Assessment Tool (CAT)
  - Develop online capability for assessing and managing impacts of climate change on sediment loading to streams
  - Capability for assessing effectiveness of BMPs including riparian buffers under a range of climate change scenarios

**FY2008: Complete prototype, online WEPP CAT tool**

## EPA's "Excessive Heat Events Guidebook"



[http://www.epa.gov/heatisland/about/pdf/EHEguide\\_final.pdf](http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf)

# Cities can adapt effectively



**Chicago**  
**Extreme Weather**  
**Operations Plan**

## Four key steps:

1. Dissemination to the public of information about populations at risk
2. Activation of network of private & public resources in how-weather emergencies
3. Annual “Chicago Heat Awareness Week”
4. Consistent message for public to hear (with NWS; weather forecasters, local community organizations)

**Plan saved lives in 1999 heat wave!**  
**(CDC)**

**Opportunities exist *today* to anticipate  
and adapt to a changing climate**

**-- and to protect public health, air and water  
quality, ecosystems, and economic activity**