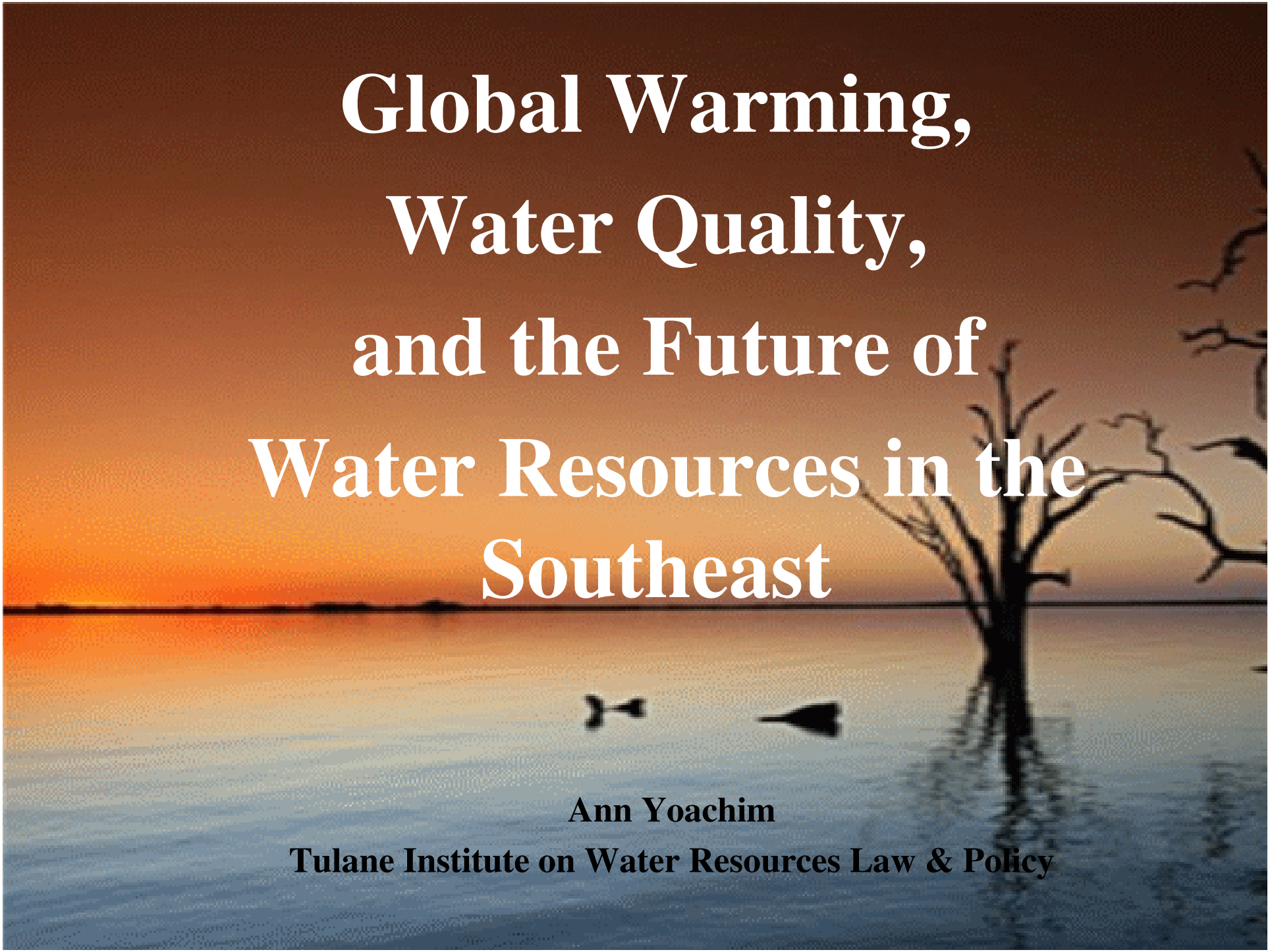

Global Warming, Water Quality, and the Future of Water Resources in the Southeast

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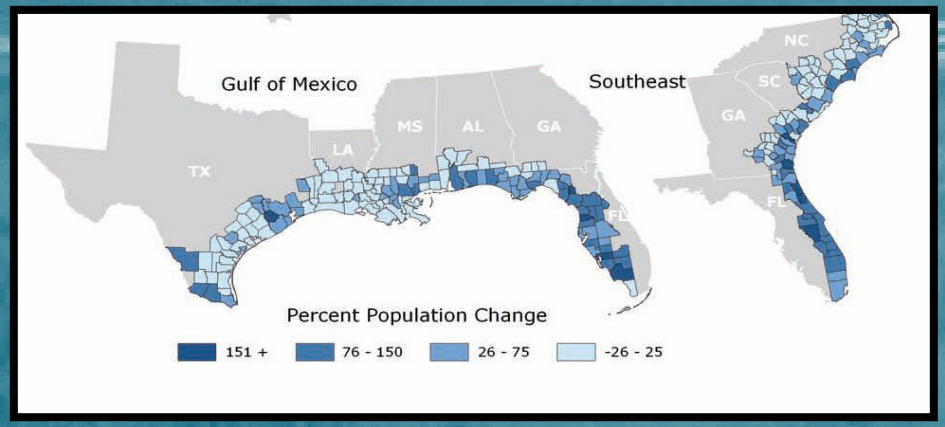
The Southeast

- Population growth rates upward 30-40% (1970-2000)
- 25% of Nation's agricultural crops
- 50% of Nation's timber supplies
- 50% of wetlands in the lower 48



Source: U.S. Global Change Research Program& NOAA Coastal Population Trends

Anthropogenic Global Warming

- Sea Level Rise
- Rising Temperatures
- Increasing Carbon Dioxide Concentrations
- Changes in Precipitation Patterns

SEA LEVEL RISE

- Intergovernmental Panel on Climate Change (IPCC) – has stated that sea levels will rise between 7.1 – 23.2 in by 2100.
- Estimates based on thermal expansion and glacial melting.
- Estimates largely considered conservative
  - Models have underestimated past sea level rise
  - Greenland Ice Sheet melt may be accelerating

Surface melt on the Greenland ice sheet descending into a moulin. The moulin is a nearly vertical shaft, worn in the glacier by the surface water, that carries the water to the base of the ice sheet.

Source NASA GISS

Coastal Land Loss

- **Miami, FL is home to approximately 362,000 people**
- **Known as the "Gateway to the America's," Miami is a major hub for international air travel.**
- **With a little over 3 feet of sea level rise, much of Miami's economic center would be underwater.**

Coastal Land Loss Cont.

- **Dr Bruun's Eastern Shoreline Loss Formula:**

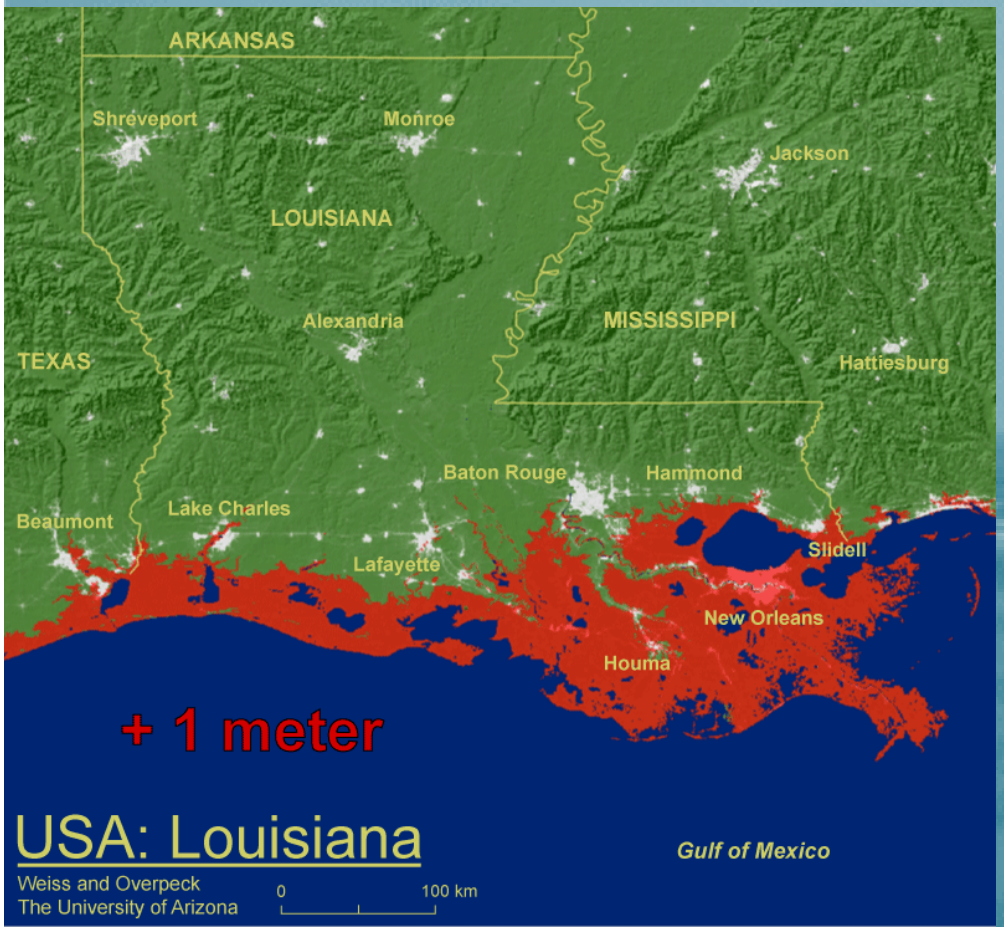
  1 cm sea level rise = 1 meter of beach lost

- **Shorelines erode from natural tidal forces and powerful storms**
  - **Both become more destructive as sea levels rise.**

- **Given IPCC projections for sea level rise, Dr Bruun's model would indicate that Florida's eastern shore stands to lose 59 – 193 feet of shoreline by the end of this century.**

Coastal Land Loss Cont.

- **Coastal modeling suggests a possible 33% loss of wetlands globally by 2080**



• Over the next 45 years Louisiana could lose another 640,000 acres including important areas like Chauvin, Dulac, Lacombe and Grand Isle taking one of the world's richest fish spawning grounds with it

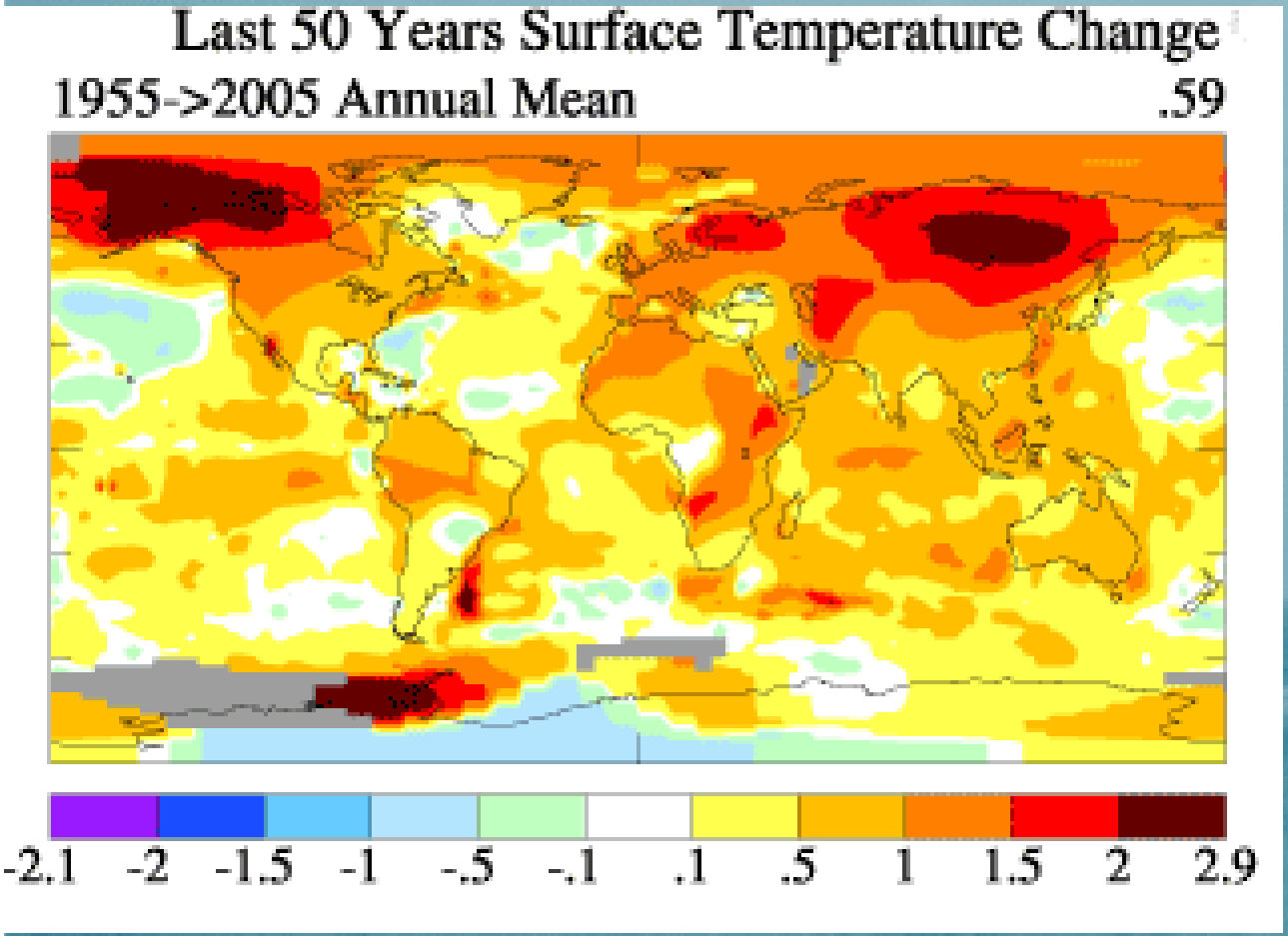
Fisheries Loss

- **The Gulf Coast is one of the most productive fishing regions in the World**
  - **25% of the nation's commercial fishing revenue**
- **Industry is largely dependent on productive coastal wetlands and clean coastal waters**
  - **Salt tolerance of marshes, mangroves, and sea grass may be exceeded as sea water inundates these areas.**
- **IPCC 2007 stated that changes in freshwater flowing into estuaries could disrupt the juvenile phase of many estuarine and marine species**

Loss of Freshwater

- Sea level rise leads to salt water contamination of groundwater and underground aquifers
  - Salty water can not be used for drinking or irrigation
  - Wells along the gulf coast have already been impacted (Mobile Bay and Gulf Shores, AL)
- Fresh Water shortages threaten residential, agricultural, and industrial users.
- Salt can kill off inland freshwater marshes
  - Provide water storage and purification
- Population and demand is increasing

GLOBAL TEMPERATURES INCREASING



Source: NASA GISS

- Oceans, rivers, and lakes are warming along with the land areas.
- The sea surface temperature increased 0.6℃ (1.08℉) over the past three decades

Getting Hot Down Here

- **Invasive Species**
- **Changes in Water Chemistry**
- **Increased Hurricane Intensity**
- **Land Losing Water**

Invasive Species

- As the climate warms, species are able to shift their ranges northward
- Often, these invaders are able to out-compete the native inhabitants
- Wetlands are highly susceptible because intense development has disturbed the natural function of the ecosystem.

Common and giant salvinia are two examples of invaders wrecking havoc on coastal wetlands. In a very short time, these floating plants can completely cover the surface of a pond or lake. Photo Courtesy of Barataria Terrebonne National Estuary Program.

Changes in Water Chemistry

- **Water evaporating faster leaving behind concentrated salt water.**
- **Increased salinity in the Gulf could create problems for marine animals and plants.**
- **The biggest threat to the Gulf's oyster industry is *Perkinsus marinus*, a pathogen whose infection rates increase as temperature and salinity rise. This has serious implications for both public health and oyster industries**

Land Losing Water

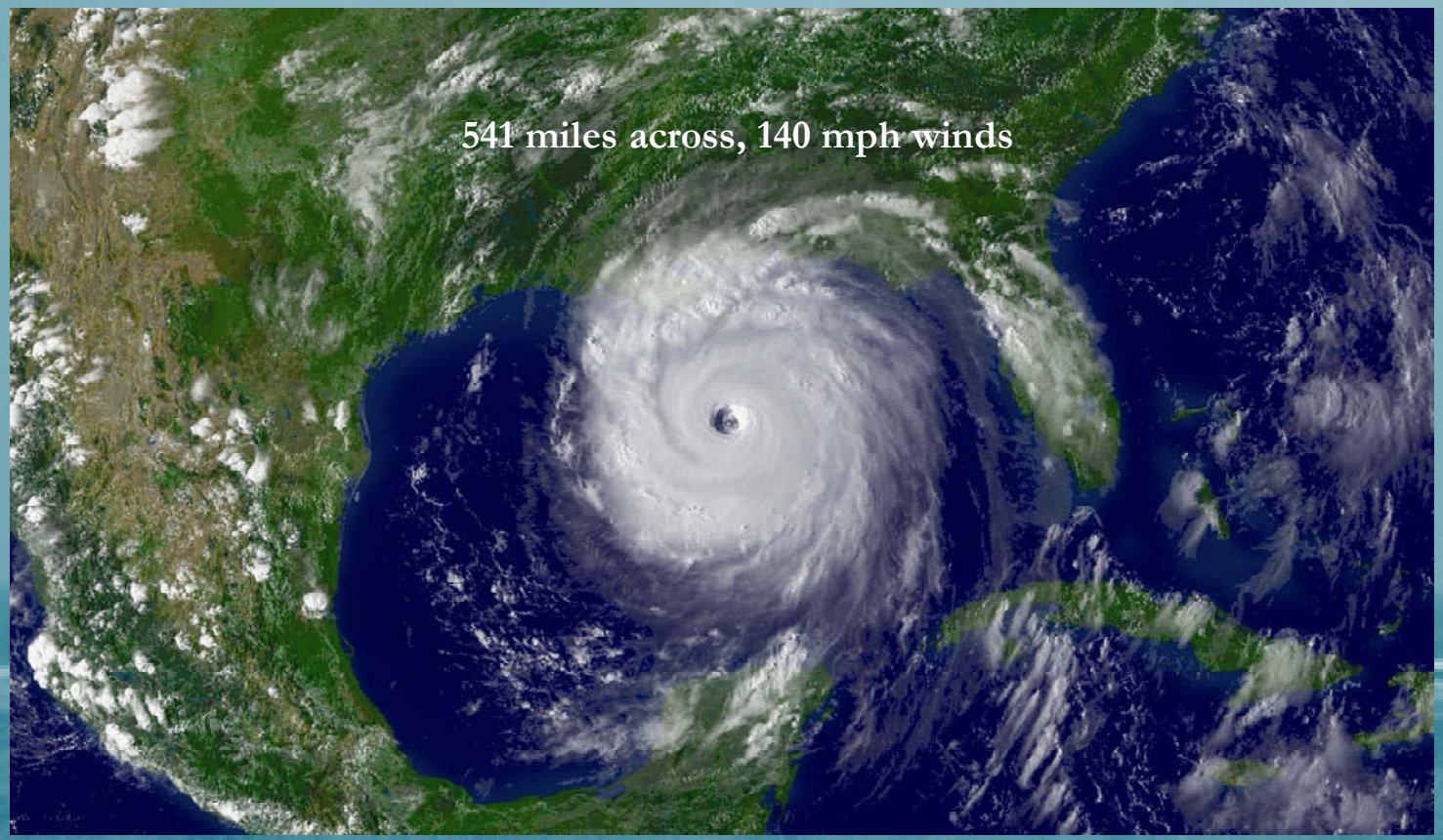
- **Evapo-transpiration is the loss of water from the ground surface**
  - **Evaporation (loss of water from ground surfaces)**
  - **Transpiration (loss of water from plants).**
- **As temperatures rise more water will be lost**
  - **Lower river flows and lake levels, reductions in the water table, water for wetlands, and groundwater supplies.**
- **Droughts will become more common**
  - **Even if rainfall levels remain the same**
- **Increased competition over decreasing fresh water resources.**

Harmful Algal Blooms (HABs)

Photo Courtesy of NOAA

- Dissolved CO2 acts like a fertilizer
- Algae like warm water
- HABs, also known as red tides, produce toxins that can kill off fish, birds, marine mammals, and other organisms. (Manatees off FL)
- Later, when the algae die off, they leave a large dead zone behind.

Cat Fives Are On the Rise



CHANGES IN PRECIPITATION

- **Wetter or Drier?**
  - **Climate modeling has difficulty predicting small regional impacts**
  - **Some models predict a 15-20% increase in precipitation across the Southeast whereas other models predict that precipitation will remain the same or decrease.**
- **Extreme precipitation events may be increasing**

Wetter Scenario

- **An increase in the number and size of dead zones in the gulf**
- **An increase in destructive floods**
- **More overloading of sewage systems contaminating surface and coastal waters harming public health and the fishing industry.**

Drier Scenario

- More and longer droughts
- Increased loss of wetlands
- Drop in available freshwater resources

Brown Marsh Phenomenon

Spartina alterniflora, or smooth cordgrass, the primary plant in highly productive marshes, began turning brown and dieing off in 2000 after a prolonged drought. These marshes, found along the Gulf of Mexico and east coast, depend on regular flooding.

WET OR DRY, DOES IT MATTER?

- **Shifts in Agricultural Production**
- **Fisheries and Forestry Impacts**
- **Loss of biodiversity**
- **Increased competition for freshwater resources**

Extreme Precipitation

- Extreme precipitation events have increased in the Southeast over the past 60 years.
- Evaporation increasing
- Warmer air can store more water vapor
- Effect: amount of water vapor available to fall as rain and snow has grown
- Result: Floods
  - US Geological Survey states that floods were the number-one national disaster in terms of lives lost and property damaged.
  - $50 billion worth of damage in the US during the 1990's
  - Damage includes crop losses, sewage overflows, inundation of roads, homes, and businesses, erosion, etc.

Source: "When It Rains It Pours"

The Basics of Freshwater Law

State laws determine property rights to use water

- **Riparian Doctrine**

  Eastern States

  – **Ownership of land adjacent to a body of water conveys the right to use the water in any way that is "reasonable" and make "natural" use of water to meet residential needs.**

The Basics of Freshwater Law II

- **Prior Appropriation Doctrine**
  - **Western States**
    - **Water rights belong to anyone who first diverts water from its natural setting and puts it to a "beneficial use" anywhere**
    - **Right remains valid as long as water is used for initial purpose**

Management of Freshwater

The Options

- **Legislative/Congressional Apportionment**
- **Judicial Allocation (Litigation)**
- **Interstate Compacts**

Water Wars

- Conflict between Alabama, Florida, Georgia (ACF &ACT river basins)

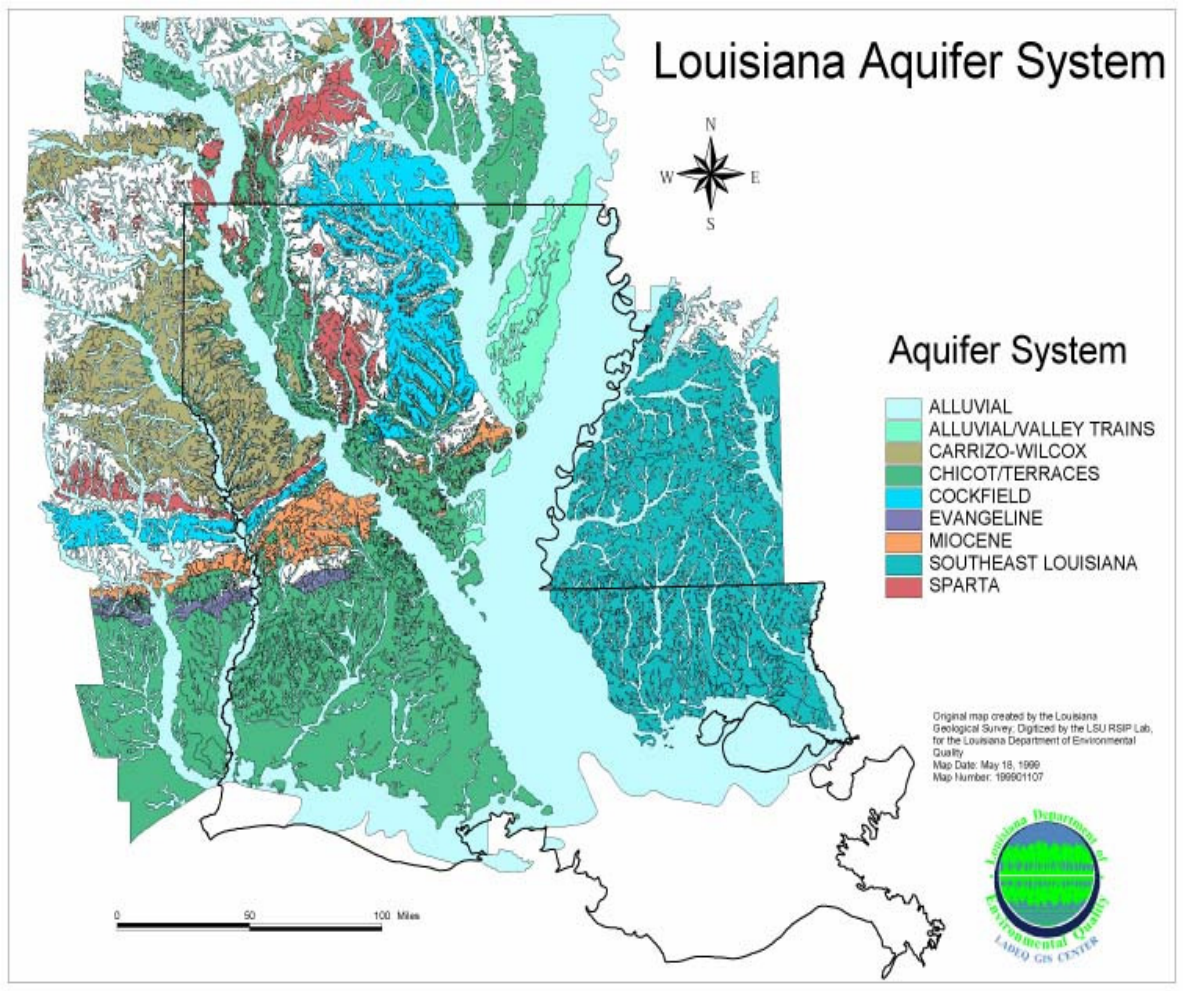
- Industry
- Drinking Water
- Fisheries & Ag
- Endangered Species Habitat

Who Owns Groundwater?

- Difficult to Determine
  - Law and Policy Overlays
  - Rarely Litigated
  - Diverse Management Structures Within States
- Five Doctrines

Case Study: Louisiana

- Concerns
  - Saltwater Encroachment
  - Water Level Declines
  - Water Quality
- Response
  - Area of Groundwater Concern
  - Increased Education
  - Well Registration



Connecting Energy & Water

- Oil Shale
  - Colorado River
  - Northern Louisiana
- Hydroelectric/Thermoelectric Power
- Oil & Gas Industry

Learning to Live With Water

- Coastal Restoration
- Storm Protection
- Resilient Communities

Defining Resilient Communities

"How Safe, How Soon"

Diverse Communities

Regional Academic Institutions

Local and National Non-Profits

Technical Expertise

Philanthropy

Creating Space for Collaboration

A New Water World

- Water laws and policies that incorporate climate change
  - Groundwater Withdraws
  - Discharge Permits
  - Statewide Management Plans
  - Hazard Mitigation/Building Codes
  - Interstate Transfers
- Community Adaptation Efforts
- Research and Development
- Role of Federal Government