SOUTHEAST FLORIDA

CLIMATE CHANGE AND LOCAL CHALLENGES

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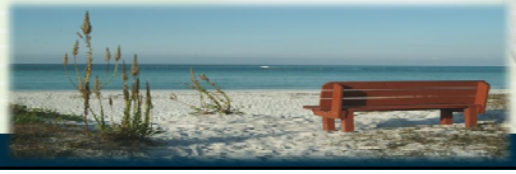
November 18, 2009
South Florida Hydrologic Society

Overview

- Causes of Climate Change
- Mitigation of Greenhouse Gases
- Implications of Climate Change
  - Potential Impacts
  - Uncertainty
  - Vulnerability Analysis
- Challenges for Hydrologists



Greenhouse Gases & Climate Change

Figure 3

The Greenhouse Effect

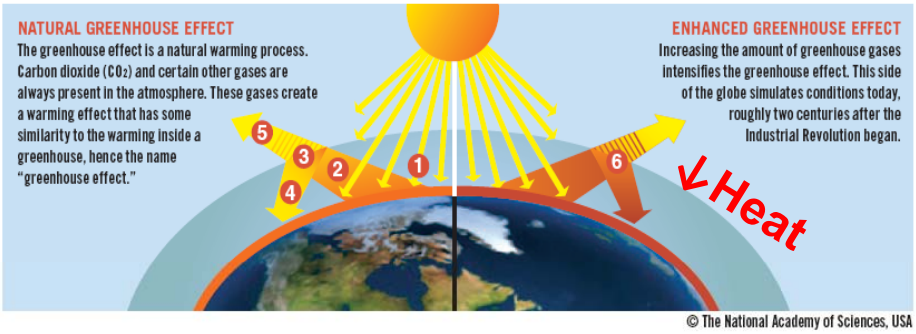


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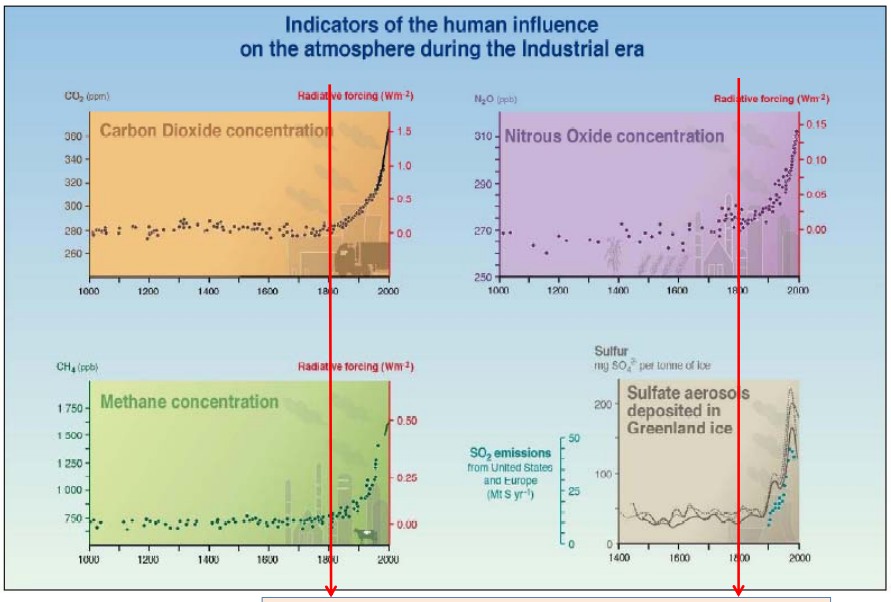
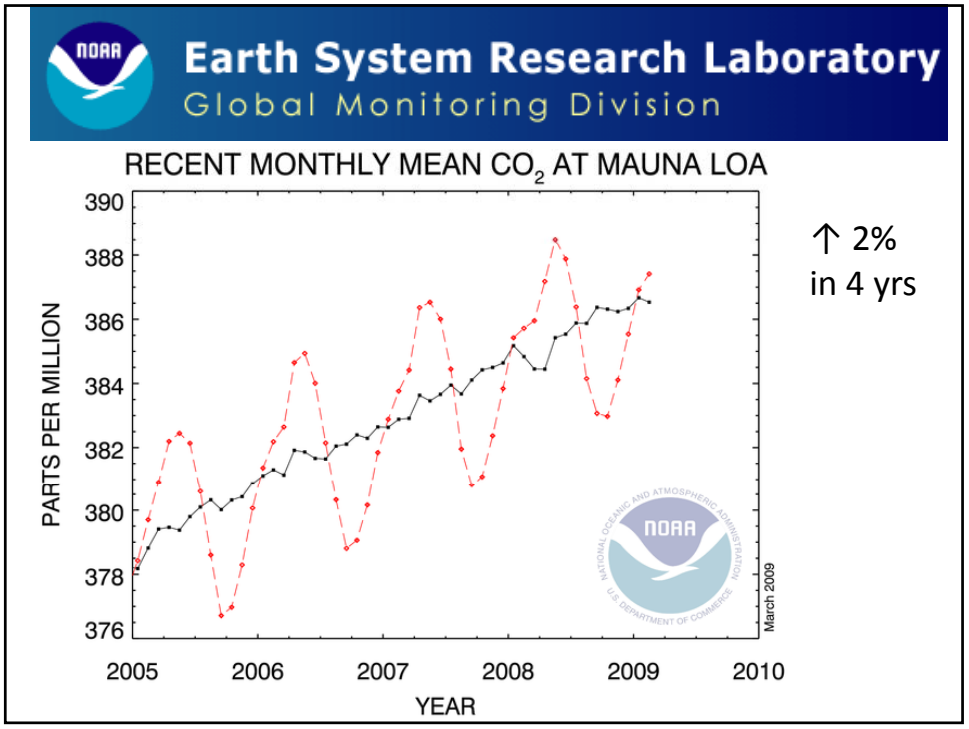
Illustration of the greenhouse effect (courtesy of the Marian Koshland Science Museum of the National Academy of Sciences). Visible sunlight passes through the atmosphere without being absorbed. Some of the sunlight striking the earth ❶ is absorbed and converted to heat, which warms the surface. The surface ❷ emits heat to the atmosphere, where some of it ❸ is absorbed by greenhouse gases and ❹ re-emitted toward the surface; some of the heat is not trapped by greenhouse gases and ❺ escapes into space. Human activities that emit additional greenhouse gases to the atmosphere ❻ increase the amount of heat that gets absorbed before escaping to space, thus enhancing the greenhouse effect and amplifying the warming of the earth.

Figure 1: Trends in Atmospheric concentrations of GHG and Sulfate Aerosols: 1000 – 2000 AD[10]



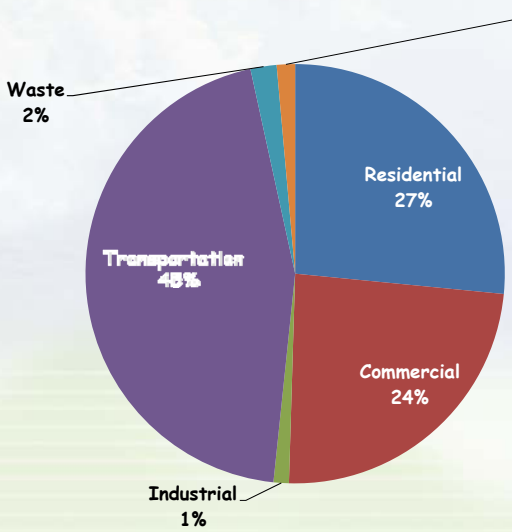
Steep rise in GHG Concentrations from 1800 -2000

[10] IPCC. *Climate Change 2001: The Scientific Basis, 2001. op. cit.*


Earth System Research Laboratory
Global Monitoring Division
RECENT MONTHLY MEAN CO2 AT MAUNA LOA
PARTS PER MILLION
390
388
386
384
382
380
378
376
2005
2006
2007
2008
2009
2010
YEAR
March 2009
↑ 2%
in 4 yrs


BROWARD COUNTY FLORIDA
Source Categories
Broward County's Community-wide GHG emissions inventory captures emissions from all community-related activities.
• Residential Buildings
• Commercial Buildings
• Industrial Buildings
• Transportation
• Waste
• Aircraft

Local Contributors to Climate Change



2007 Broward Community-wide Greenhouse Gas Emissions

Total Community-wide Emissions
22.3 M tonnes eCO_2

We need to understand the source of greenhouse gas emissions to effectively mitigate the causes of climate change.

Broward County Climate Change Policy

- Adopted a Resolution to Reduce Greenhouse Gases and support the U.S. Mayors' Climate Protection Agreement
  - Short term Goal: 7 % below 1990 levels by 2012
  - Long term Goal: 80% below 1990 levels by 2050
- Adoption of Broward County Government Operations Climate Change Report
  - GOAL: 7 percent below 1997 levels by 2015

Call to Action - Mitigation

- Reduce of greenhouse gas emissions 7% below 1990 levels by 2012, 80% by 2050:
  - improving and promoting mass transit;
  - encouraging alternative fuel vehicles;
  - reducing energy use through conservation;
  - increasing use of renewable energy sources (e.g. solar and wind power); and
  - Reducing solid waste generation (1.64 tons/person/yr) especially through recycling and source reduction.

Engineering Societies Agree on Climate Change Action

Three of the world's largest civil engineering societies, including ASCE, have signed a protocol calling for "substantial reductions in greenhouse gas emissions ... to reduce the risk of climate change."

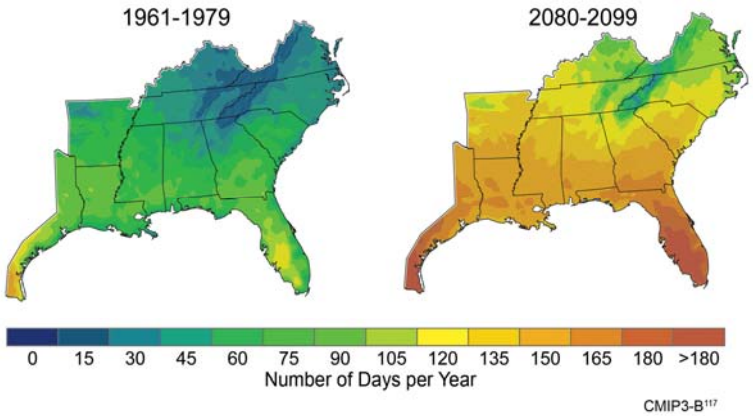
Climate change will continue even as we slow its momentum through mitigation.

Climate Change Impacts in in Southeast Florida

- *Increasing Temp (3 to 10°F) by 2100*
- *Increasing occurrence of extreme weather*
  - *hotter summers*
  - *drier droughts*
  - *wetter rainy seasons*
- *Change in the growing season*
- *Sea level rise (2-5 feet) by 2100*
- *Potential change in the frequency and intensity of tropical storms*

Local Impacts From Climate Change

From 60 days >90°F in the past to 180 days in the future.



The number of days per year with peak temperature over 90°F is expected to rise significantly, especially under a higher emissions scenario[91] as shown in the map above. By the end of the century, projections indicate that North Florida will have more than 165 days (nearly six months) per year over 90°F, up from roughly 60 days in the 1960s and 1970s. The increase in very hot days will have consequences for human health, drought, and wildfires.

Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

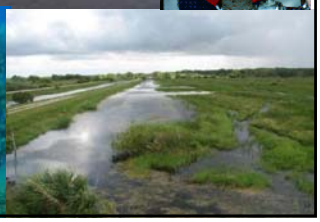
Local Impacts From Climate Change

Sea Level Rise Implications for SE Florida

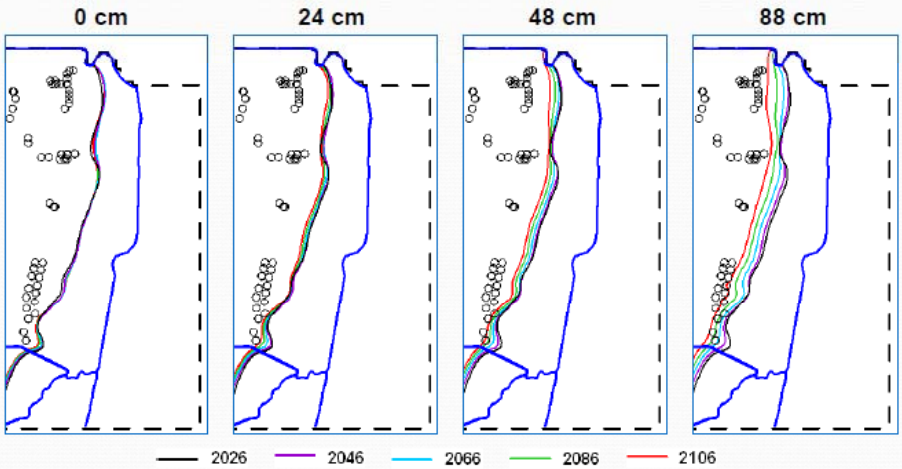
- Saltwater intrusion into our aquifer
- Drainage and flood control compromised
- Impacts to public and private infrastructure
- Beach erosion
- Impacts to coral reefs
- Impacts to Everglades





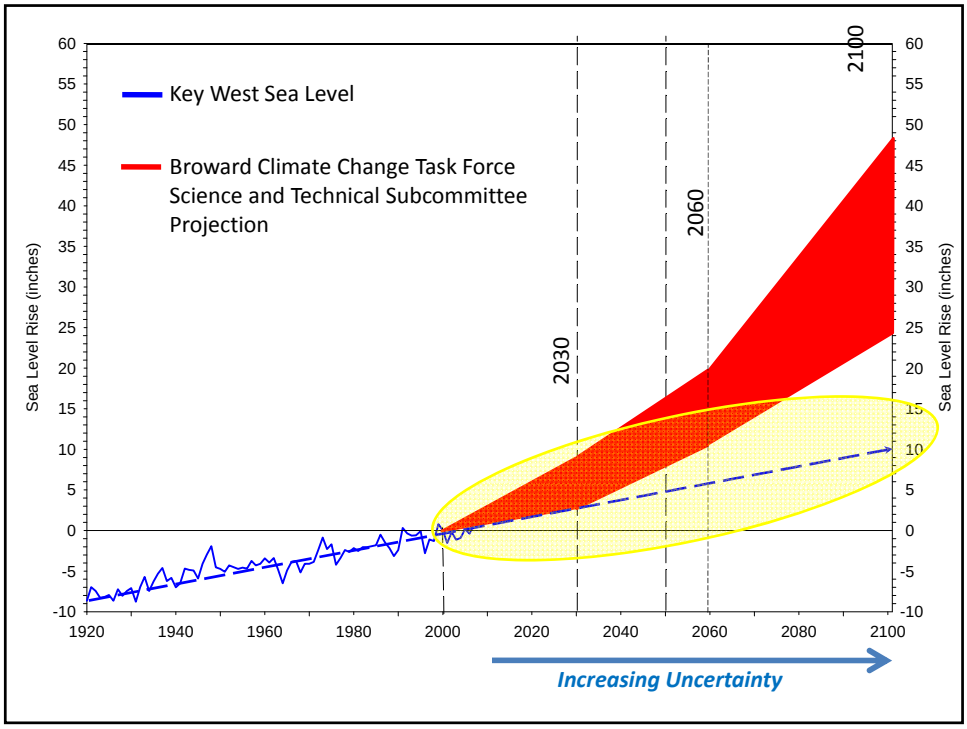


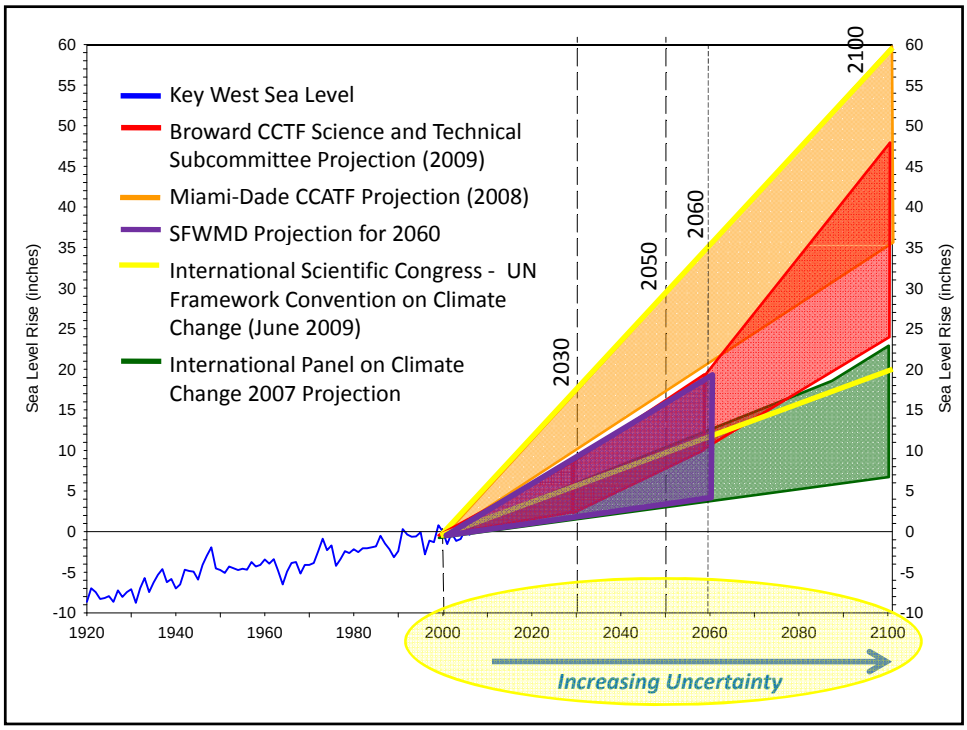
Movement of 250 mg/L Salt Front with Varying Sea Level Rise Estimates



The Effect of Sea Level Rise on Saltwater Intrusion in Northern Broward County, Michael Zygnerski and Christian Langevin, United States Geological Survey, Fort Lauderdale, Florida USA Greater Everglades Ecosystem Restoration Meeting July 28th – August 1st, 2008

USGS science for a changing world


Key West Sea Level
Broward Climate Change Task Force Science and Technical Subcommittee Projection
2030
2060
2100
Sea Level Rise (inches)
Increasing Uncertainty


Key West Sea Level
Broward CCTF Science and Technical Subcommittee Projection (2009)
Miami-Dade CCATF Projection (2008)
SFWMD Projection for 2060
International Scientific Congress - UN Framework Convention on Climate Change (June 2009)
International Panel on Climate Change 2007 Projection
2030
2050
2060
2100
Sea Level Rise (inches)
Increasing Uncertainty

Factors Affecting Sea Level Change

A. Components of Change

a. Water-related
   i. Thermal Expansion of sea water
   ii. Volume increase via
      a. ice sheet melting and
      b. land water storage change e.g. glaciers

b. Land-related
   i. Erosion
   ii. Land subsidence and uplift
   iii. Glacial rebound
   iv. Tectonics

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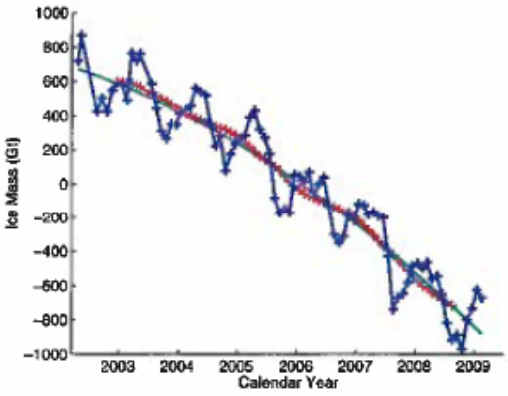


Figure 1. Time series of ice mass changes for the Greenland ice sheet estimated from GRACE monthly mass solutions for the period from April 2002 to February 2009. Unfiltered data are blue crosses. Data filtered for the seasonal dependence using a 13-month window are shown as red crosses. The best-fitting quadratic trend is shown (green line). The GRACE data have been corrected for leakage and GIA.

Demonstrates that the mass loss of the Greenland Ice Sheet is accelerating based on time-variable gravity measurements taken from April 2002 through February 2009.

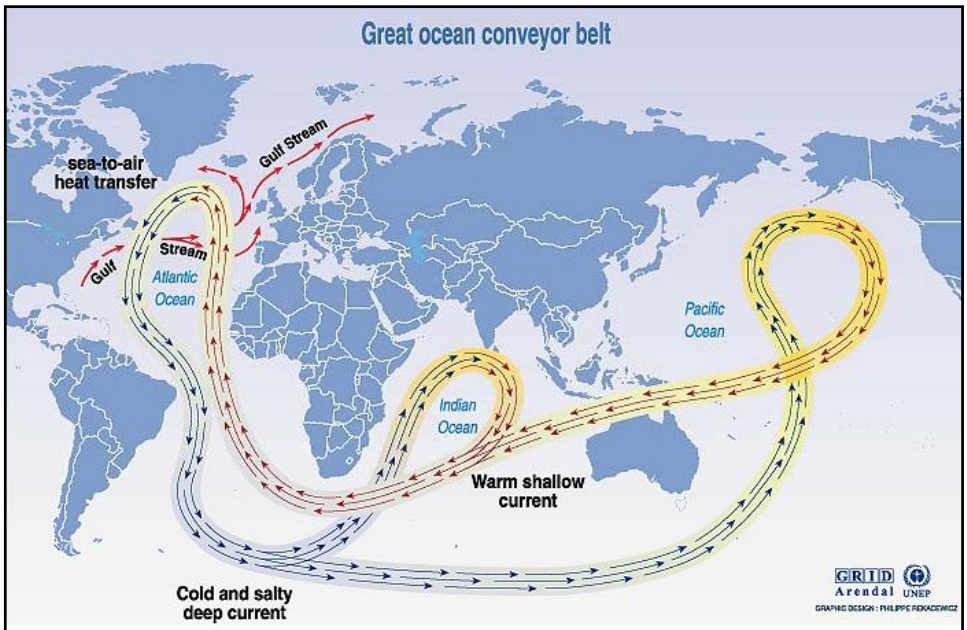
I. Velicogna. 2009. Increasing rates of ice mass loss from the Greenland and Antarctic ice sheets revealed by GRACE. Geophysical Research Letters, Vol 36, 13 October 2009. L19503, doi:10.1029/2009GL040222, 2009

Factors Affecting Sea Level Change

A. Components of Change (cont)

c. Earth-related
   a. Albedo
   b. Gravity*
   c. Rotational effects*

* Result in non-uniform distribution of sea-level rise

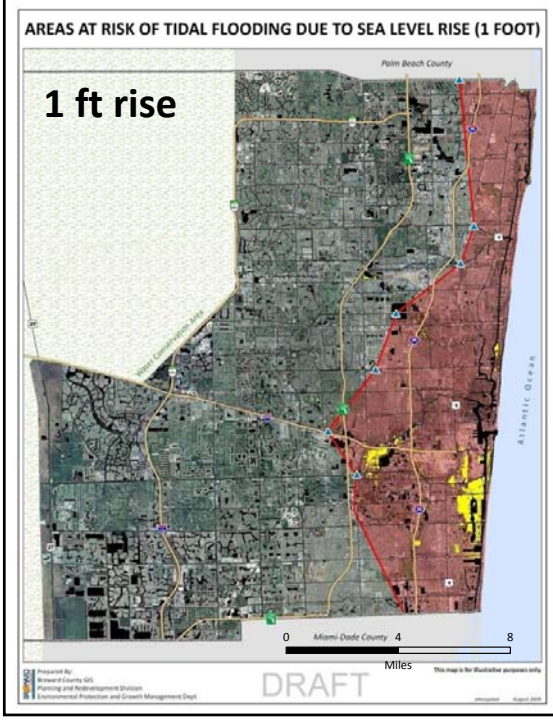


Source: Broecker, 1991, in Climate change 1995, Impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

Vital Graphics Climate Change http://www.grida.no/publications/vg/climate/page/3085.aspx

Projection Concerns

1. Positive environmental feedbacks
2. Greater pace of ice melting than previously predicted
3. Drawbacks in the current models
4. Global scale models which cannot reflect local impacts
5. Assumptions of eustatic change
6. Predictions if no change in global warming occurs – Unclear if current impact is reversible within generational time-scales



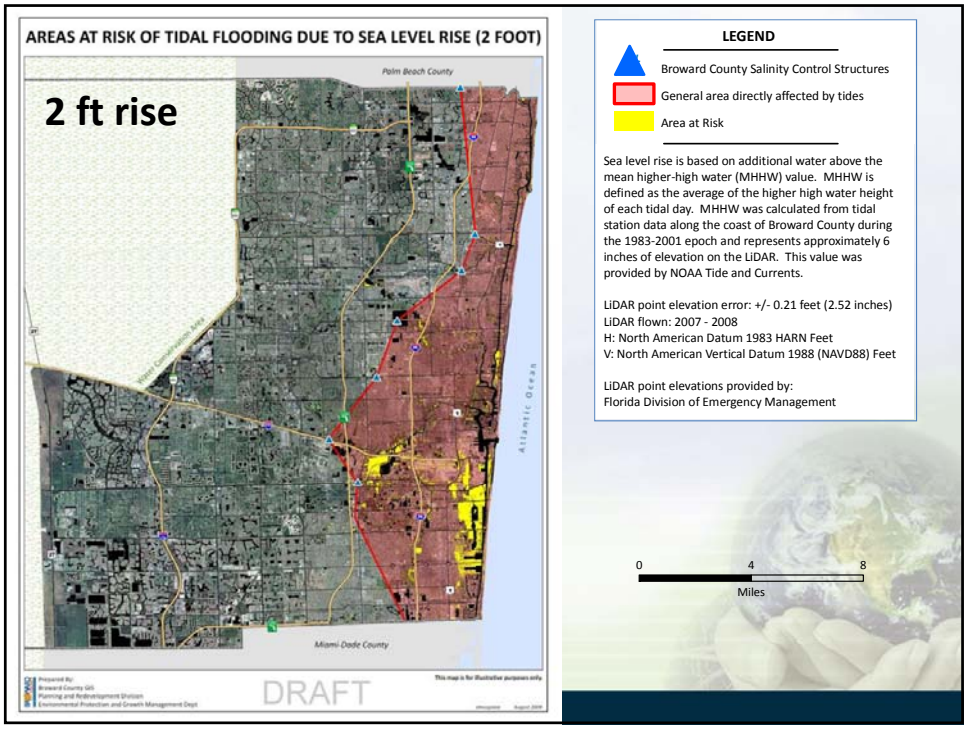
UNDERSTANDING OUR VULNERABILITIES

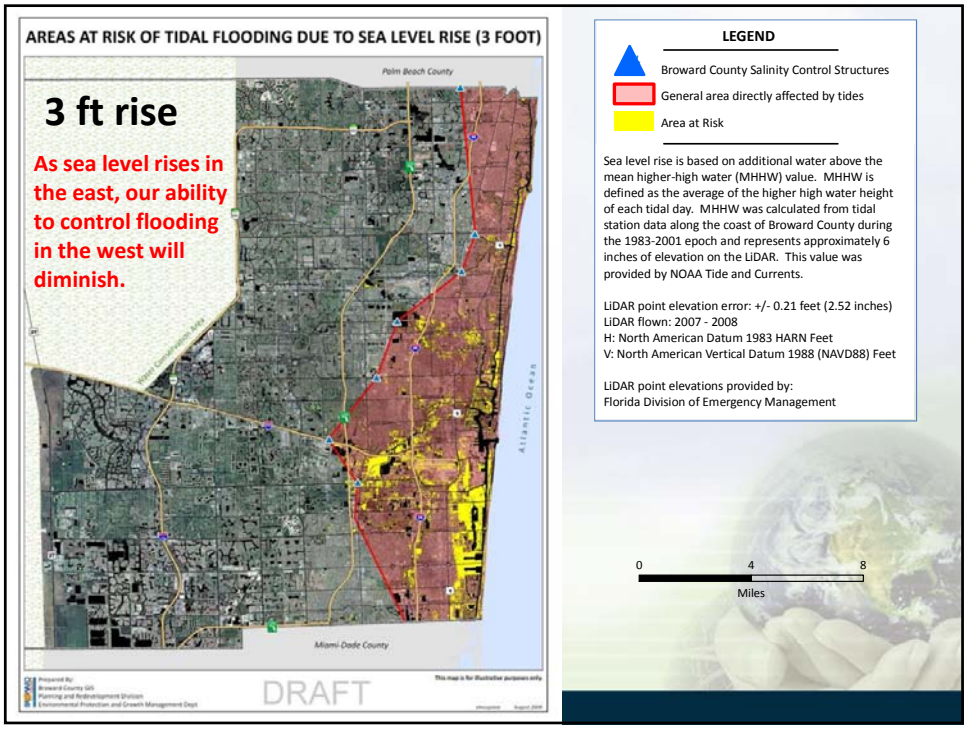
At Risk in Broward:

- **1934 households (4151 residents)**
- **182 business (1812 employees)**
- **Property worth ~ $469M**
- **Library/park/natural area**
- **4 major roads including:**
  - **Hollywood Blvd**
  - **Ocean Dr / A1A**
  - **Dania Beach Blvd**
  - **Sheridan St**

LEGEND

- Broward County Salinity Control Structures
- General area directly affected by tides
- Area at Risk


AREAS AT RISK OF TIDAL FLOODING DUE TO SEA LEVEL RISE (2 FOOT)
2 ft rise
Palm Beach County
Miami-Dade County
Atlantic Ocean
DRAFT
LEGEND
Broward County Salinity Control Structures
General area directly affected by tides
Area at Risk
Sea level rise is based on additional water above the mean higher-high water (MHHW) value. MHHW is defined as the average of the higher high water height of each tidal day. MHHW was calculated from tidal station data along the coast of Broward County during the 1983-2001 epoch and represents approximately 6 inches of elevation on the LiDAR. This value was provided by NOAA Tide and Currents.
LiDAR point elevation error: +/- 0.21 feet (2.52 inches)
LiDAR flown: 2007 - 2008
H: North American Datum 1983 HARN Feet
V: North American Vertical Datum 1988 (NAVD88) Feet
LiDAR point elevations provided by:
Florida Division of Emergency Management
0
4
8
Miles


AREAS AT RISK OF TIDAL FLOODING DUE TO SEA LEVEL RISE (3 FOOT)
3 ft rise
As sea level rises in the east, our ability to control flooding in the west will diminish.
Palm Beach County
Miami-Dade County
Atlantic Ocean
DRAFT
LEGEND
Broward County Salinity Control Structures
General area directly affected by tides
Area at Risk
Sea level rise is based on additional water above the mean higher-high water (MHHW) value. MHHW is defined as the average of the higher high water height of each tidal day. MHHW was calculated from tidal station data along the coast of Broward County during the 1983-2001 epoch and represents approximately 6 inches of elevation on the LiDAR. This value was provided by NOAA Tide and Currents.
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0
4
8
Miles

Challenges for Hydrologists

A. Developing models which can realistic predict impacts of sea level rise
   a. Uncertainties/Barriers
      i. The past can no longer predict the future
      ii. Sea level rise projection
      iii. Climate/Precipitation predictions
      iv. Economy
         i. Availability of monitoring data
         ii. Costs of sophisticated models

B. Balancing adaptation efforts with the generation of greenhouse gases

Today's extreme high tide is tomorrow's average high tide

High Tide on 9/17/09

8 inches higher than normal

The tide breached the seawall on Las Olas Isles

BROWARD COUNTY FLORIDA

For more information on Broward climate issues and what you can do to reduce greenhouse gas emission

ngassman@broward.org

www.broward.org/climatechange

www.broward.org/gogreen

BROWARD COUNTY FLORIDA