

# Climate Change in Maryland

## What You Need to Know

***Lost in Translation: Linking Climate Science to Local Communities***

**April 23, 2012**

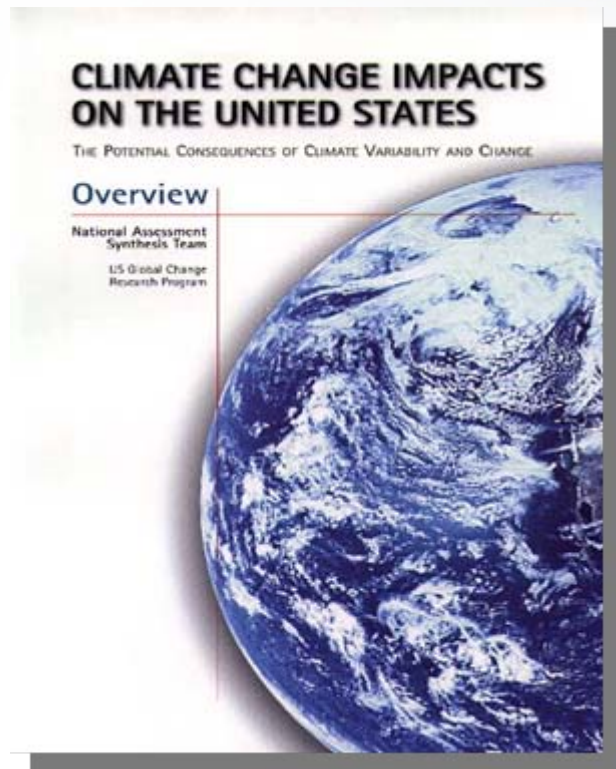
**Donald F. Boesch**



University of Maryland  
CENTER FOR ENVIRONMENTAL SCIENCE



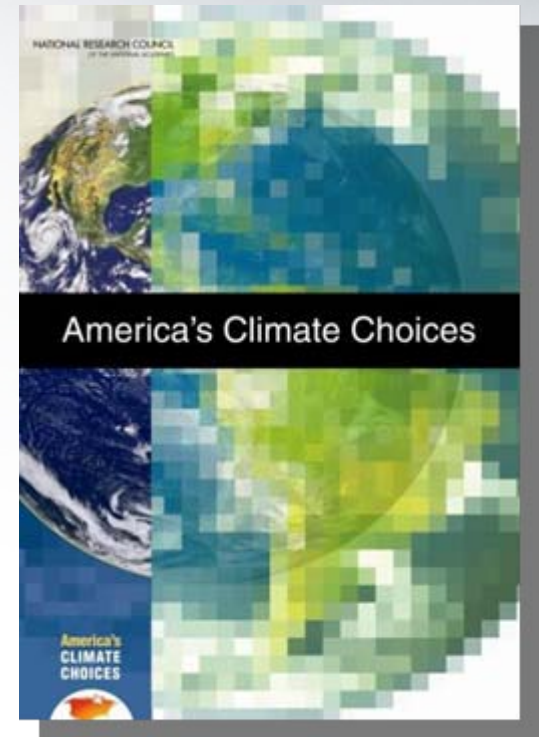
# National Climate Impact Assessments



[www.usgcrp.gov/usgcrp/nacc/](http://www.usgcrp.gov/usgcrp/nacc/)



[www.globalchange.gov/](http://www.globalchange.gov/)



[nas-sites.org/americasclimatechoices/](http://nas-sites.org/americasclimatechoices/)



# Bottom-line Conclusions



- Climate change is occurring, is caused largely by human activities, and poses significant risks for—and in many cases is already affecting—a broad range of human and natural systems.
- These risks indicate a pressing need for substantial action to limit the magnitude of climate change and prepare for adapting to its impacts.

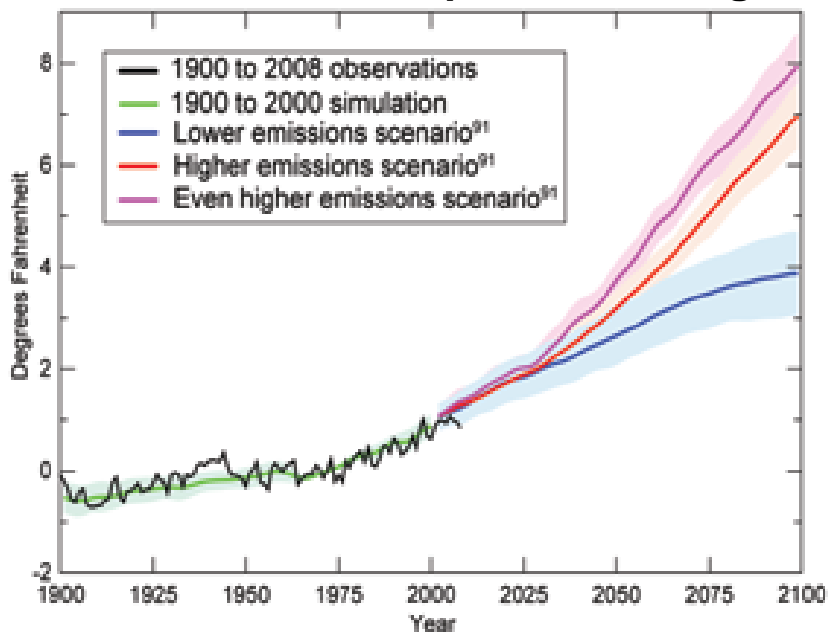


# Key Sources of Uncertainty

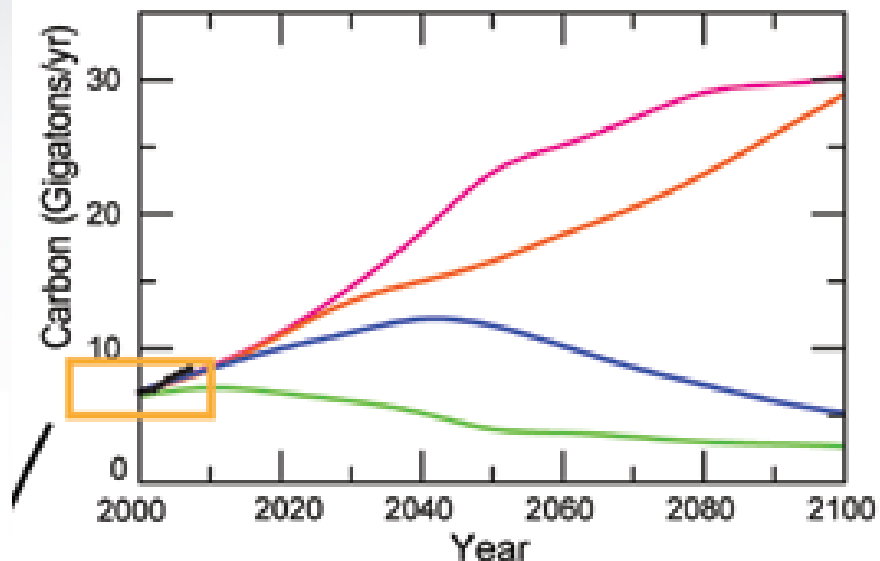


## Projecting Future Greenhouse Emissions

### Global mean temperature change



### Carbon from Fossil Fuel CO<sub>2</sub> Emissions



## Sensitivity of Climate System to Greenhouse Gases

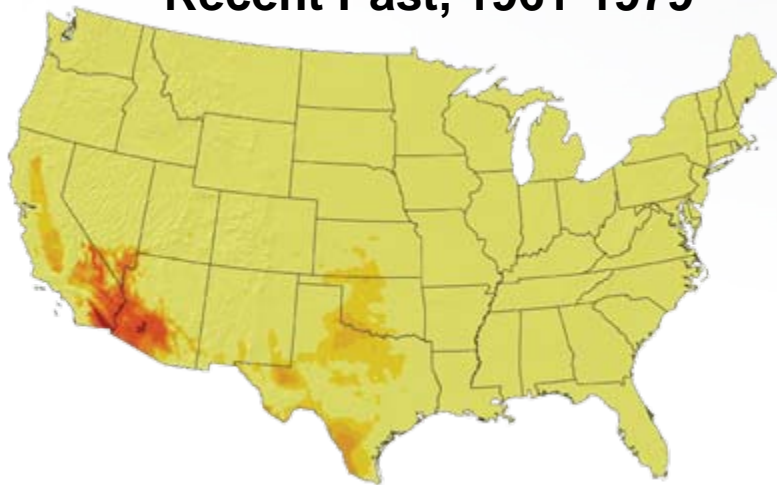


# Risks Increase with Emissions

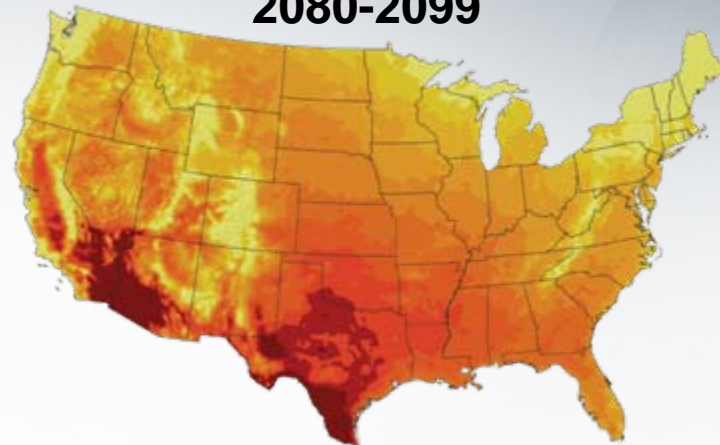


## Number of Days Over 100°F

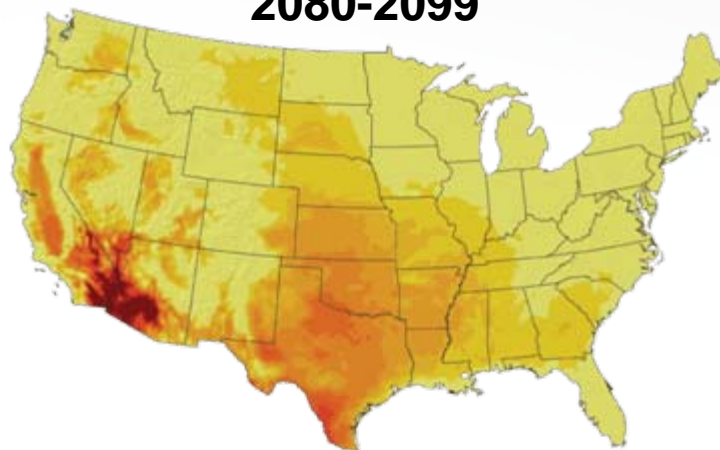
Recent Past, 1961-1979



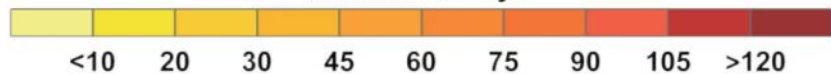
Higher Emissions Scenario  
2080-2099



Lower Emissions Scenario,  
2080-2099



Number of Days

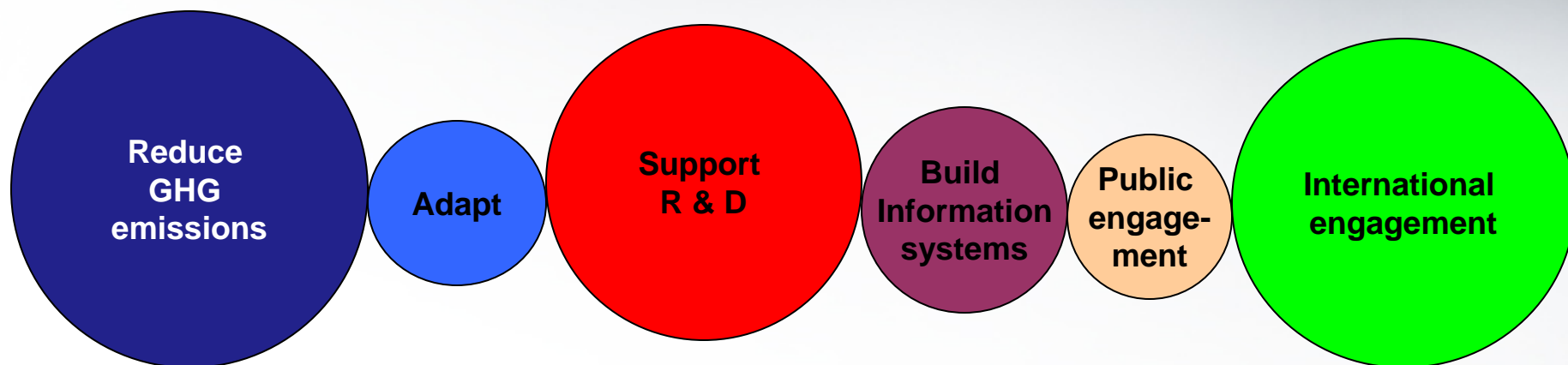




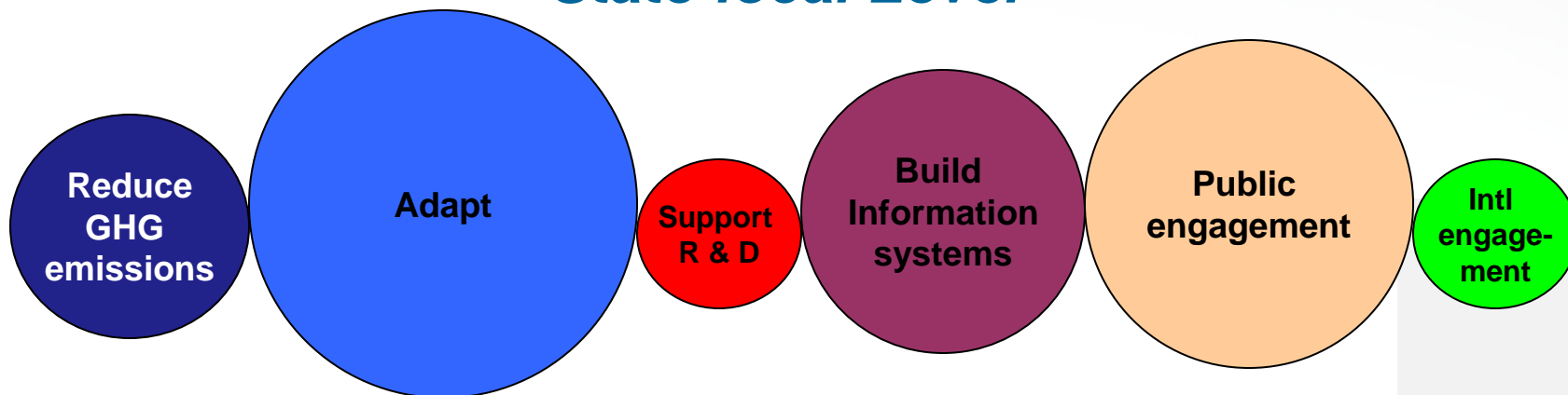
# Emphasis Depends on Level



## *Federal Level*



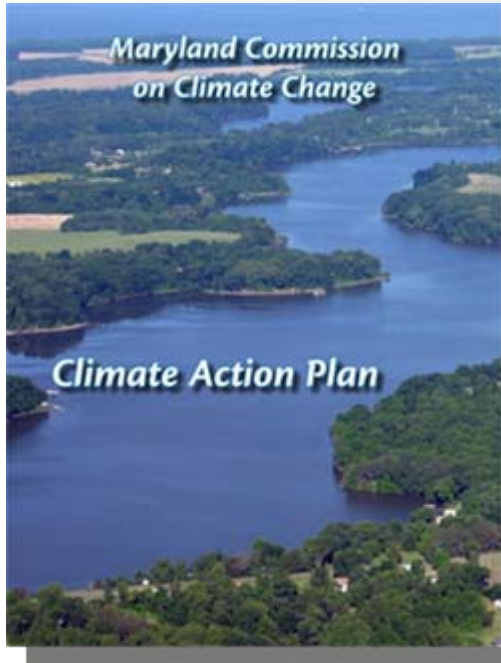
## *State-local Level*



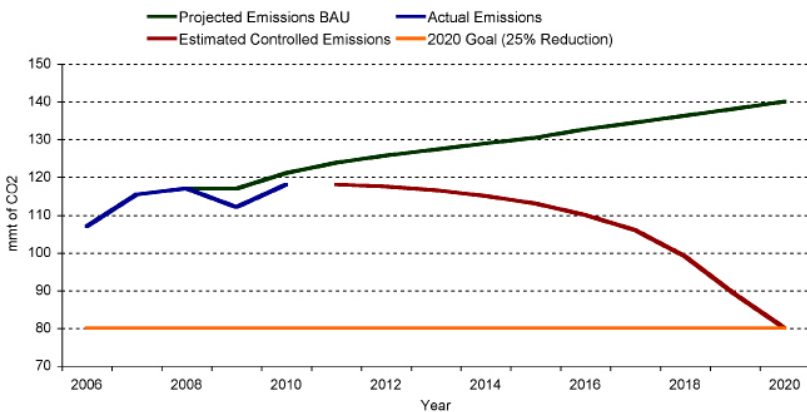
# Commission on Climate Change



- Comprehensive Climate Change Impact Assessment
- Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy
- Comprehensive Strategy for Reducing Maryland's Climate Change Vulnerability

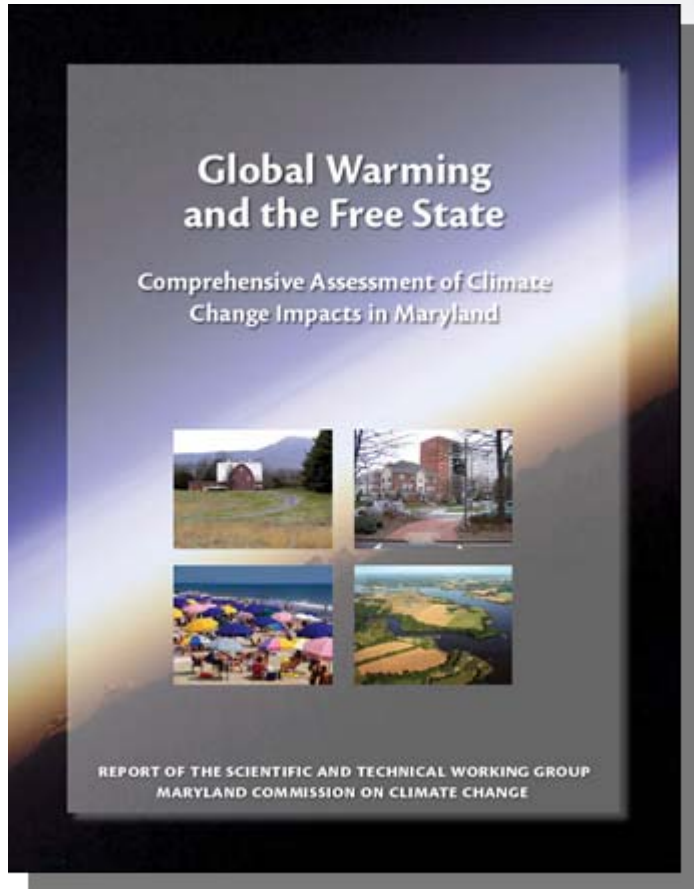


- ❁ State goals for reducing GHG emissions
- ❁ 42 policy options for achieving goals binned by effectiveness and feasibility
- ❁ Steps toward adaptation (integrated planning, vulnerable infrastructure, building codes, insurance, etc.)
- ❁ Greenhouse Gas Reduction Act of 2009 (25% reduction by 2020)



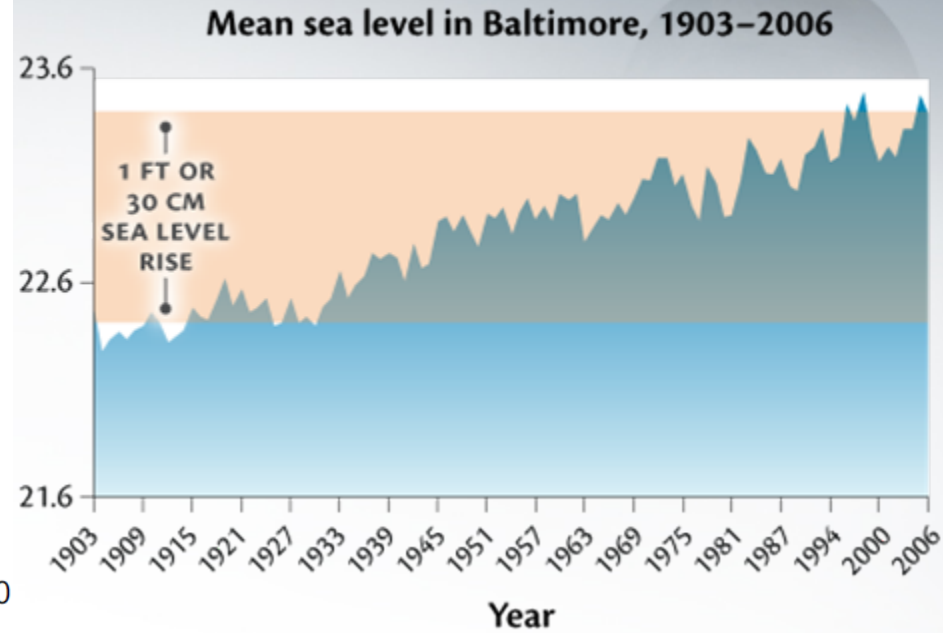
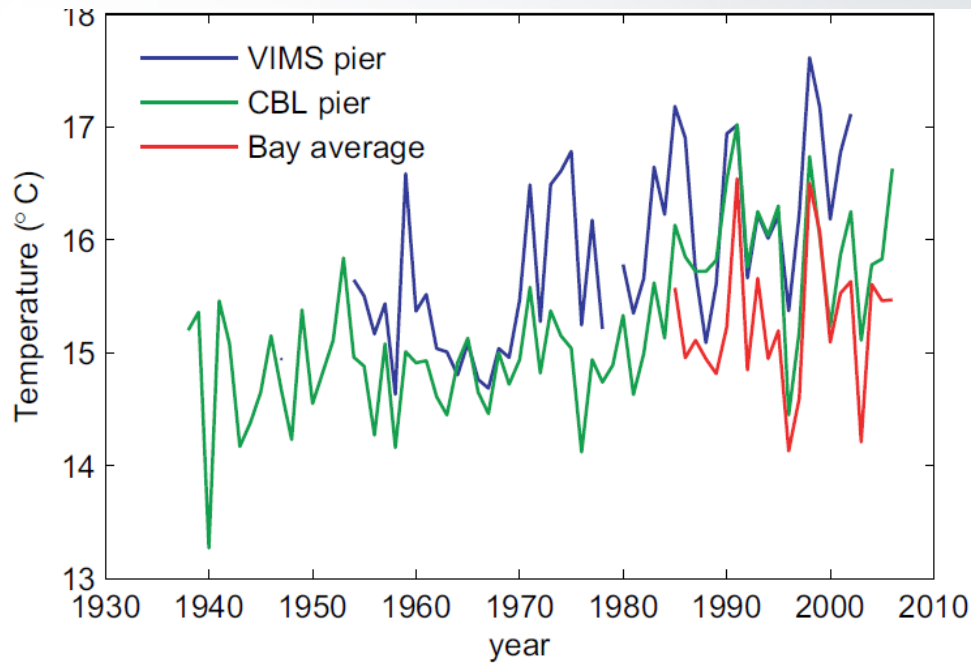


# Global Warming and the Free State



- Global warming **is already here**.
- Maryland's climate will be much warmer later in the century.
- Precipitation will very **likely increase during the winter and spring** but hotter temperatures are likely to create **drier conditions during the summer**.
- Sea level is likely to rise at least **twice as fast** as it did during the 20th century.
- Chesapeake Bay restoration will be made **more challenging** by climate change.
- Substantially reducing greenhouse gas emissions **is required to avoid** the most severe impacts in Maryland.

# Consequences Already Evident in the Chesapeake Bay

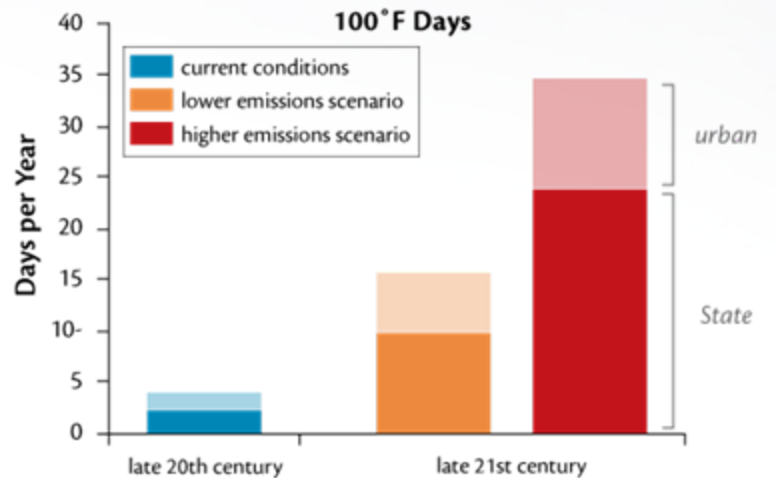
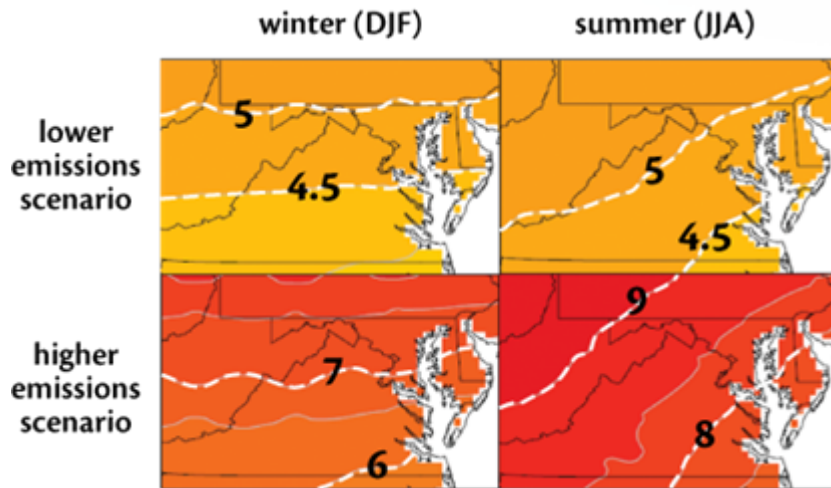
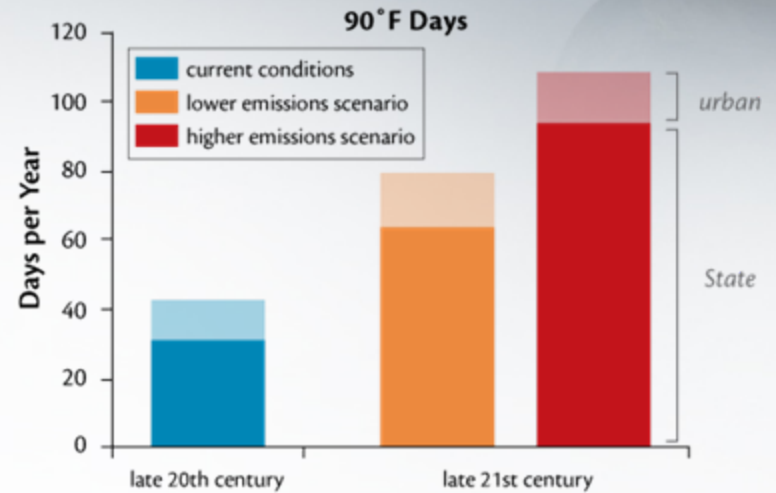
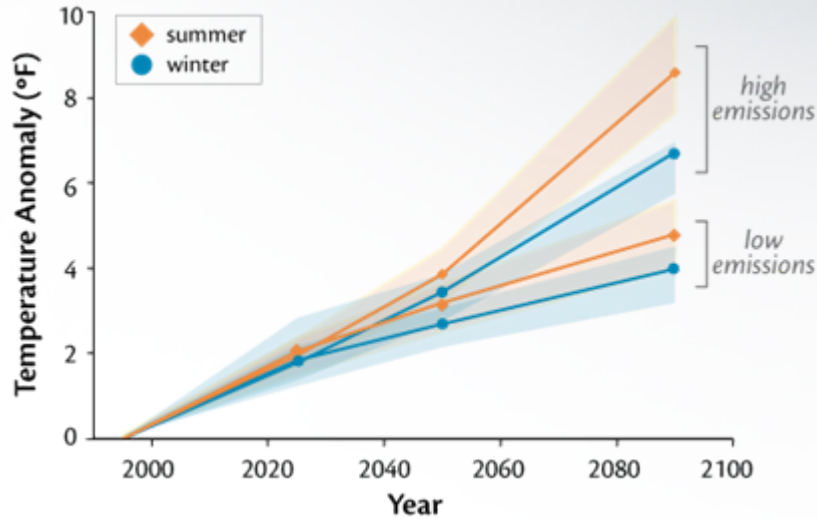


Chesapeake Bay has warmed by more than 2°F

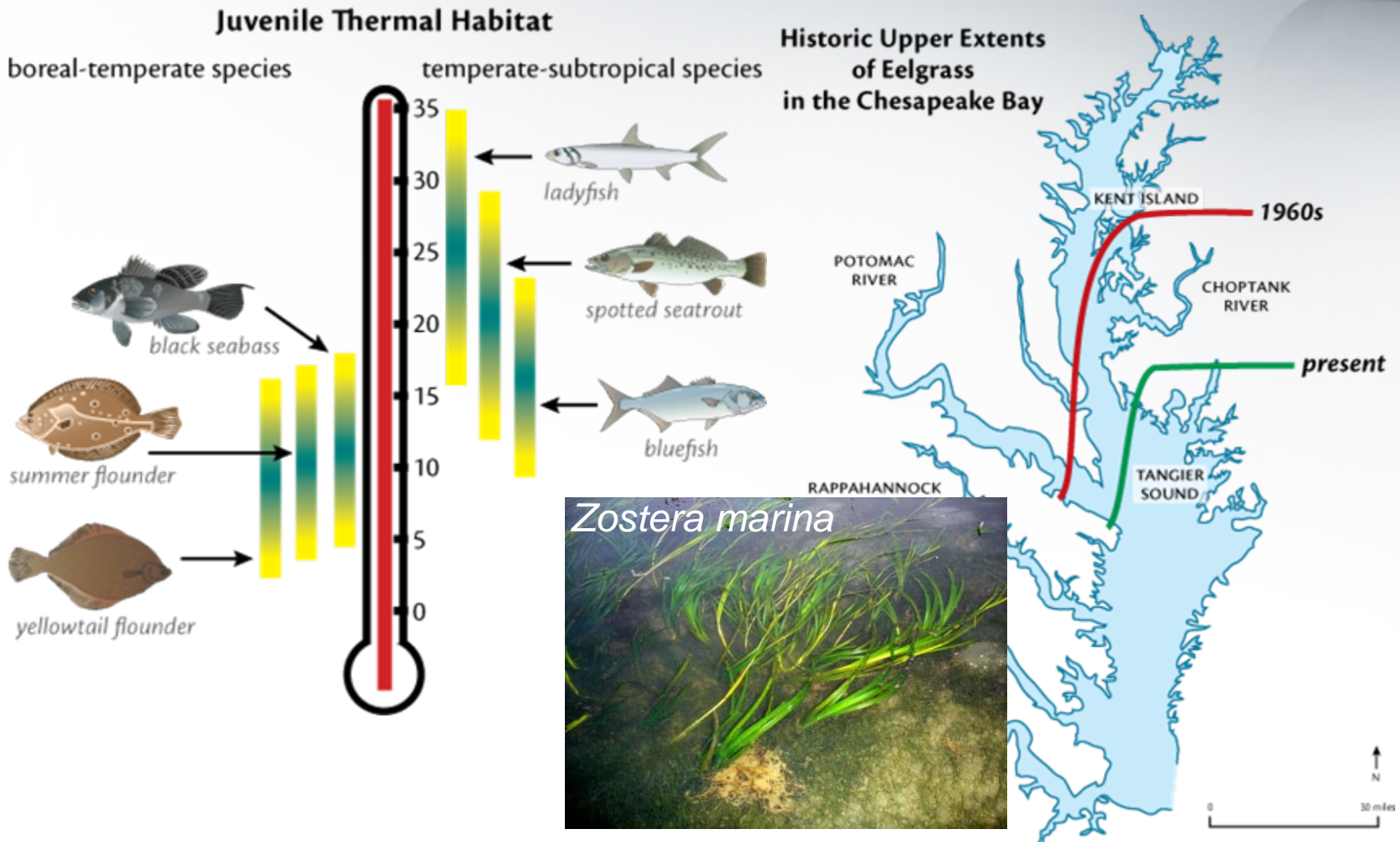
Sea level rose by more than one foot over a century

Najjar et al. 2010. *Estuarine, Coastal, Shelf Sci.* 86:1

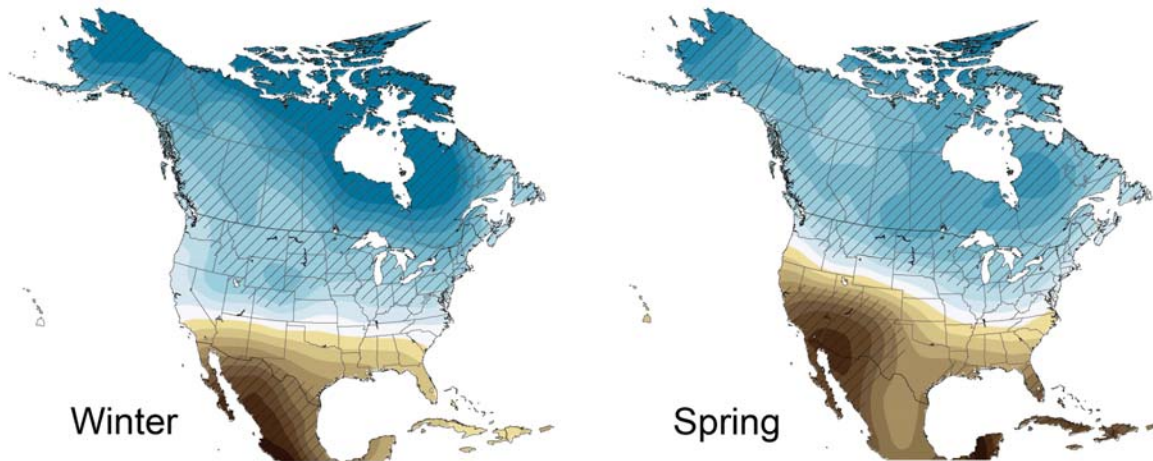
# Milder Winters, Much Hotter Summers



# The Warmer Chesapeake Bay



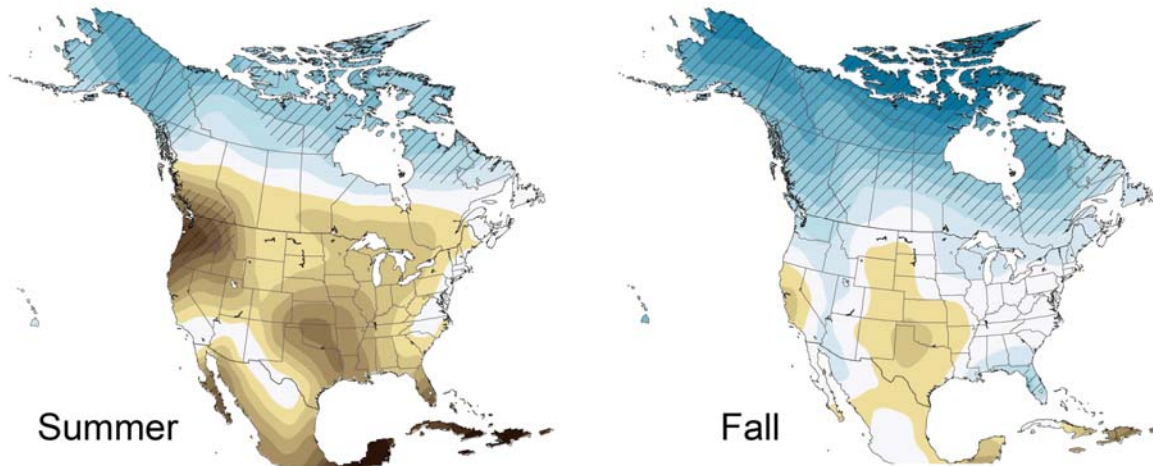
# Projected Changes in Precipitation



Winter

Spring

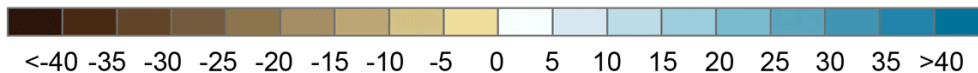
by 2080-90s



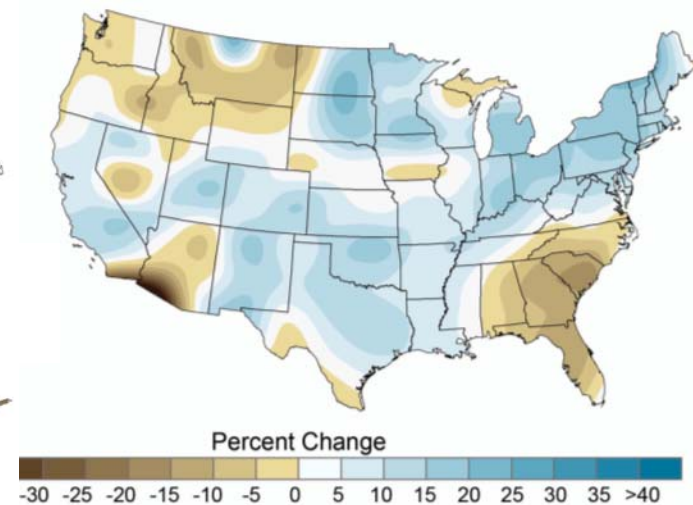
Summer

Fall

Percent Change



Observed annual change  
1950-2008



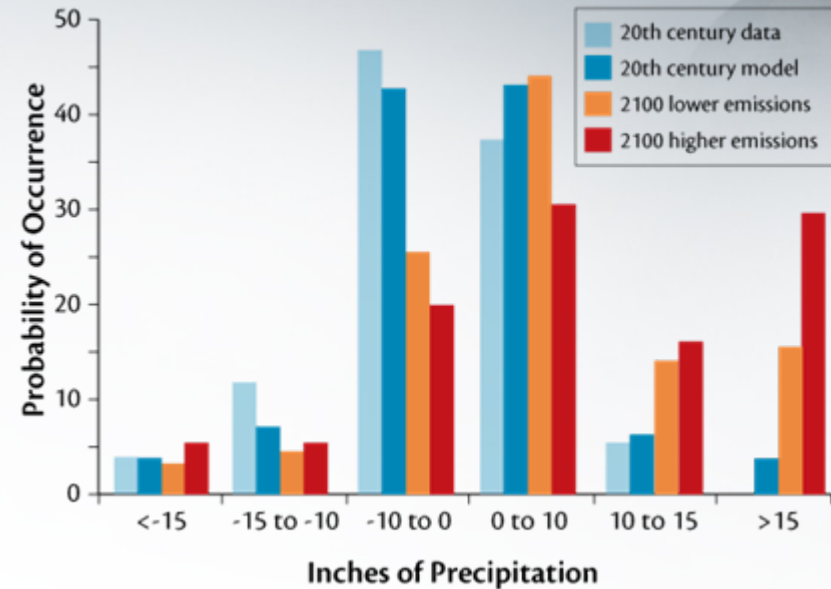
[www.globalchange.gov/](http://www.globalchange.gov/)

# Water Resources

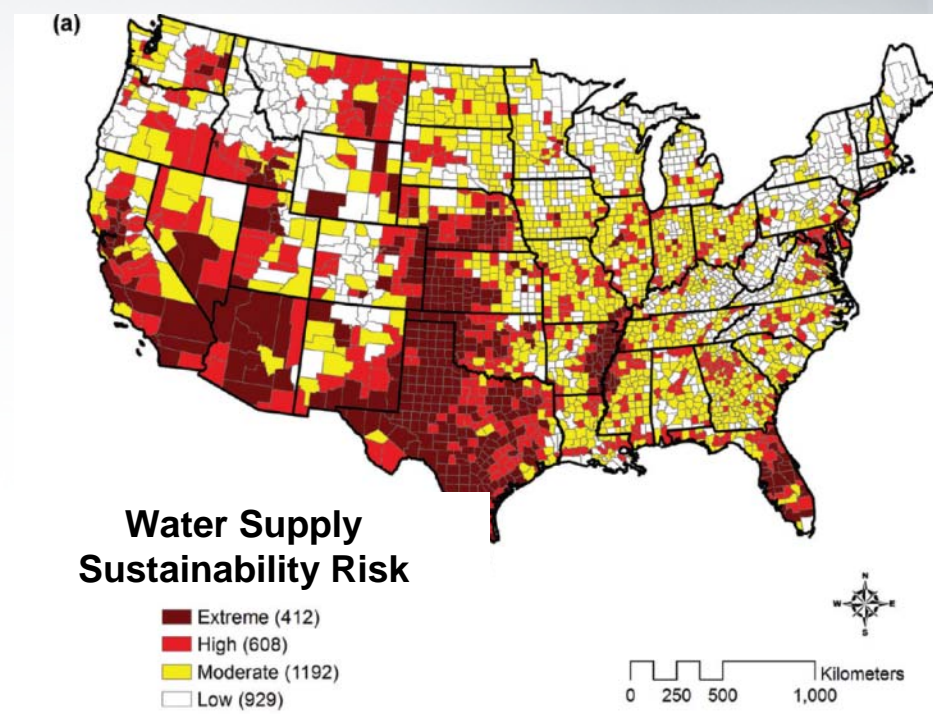
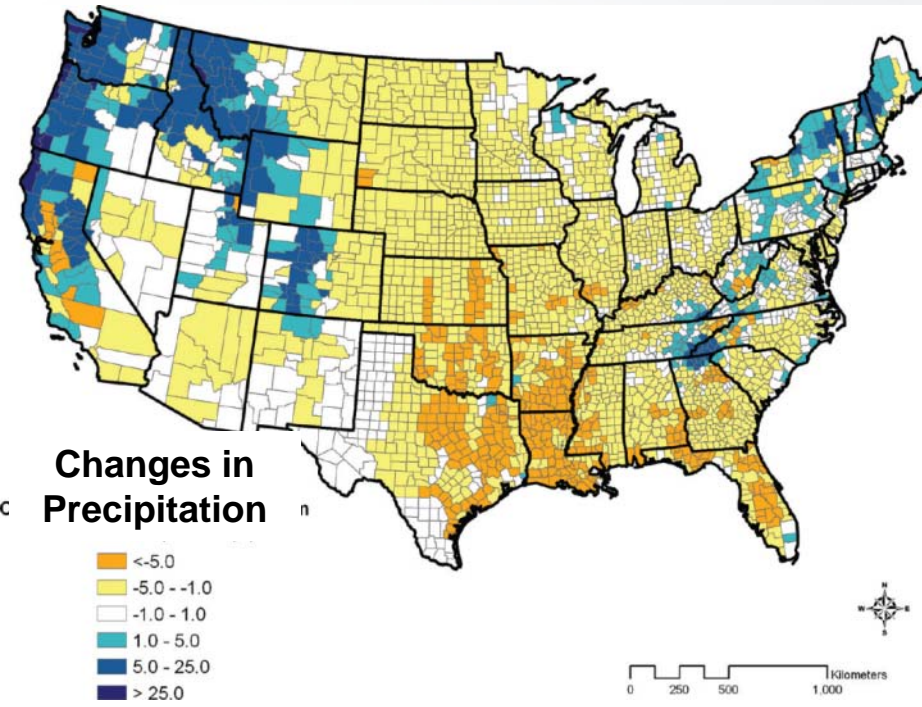


- ☀ Slightly more precipitation overall but mostly in winter & spring
- ☀ Summer droughts and downpours more frequent
- ☀ Soil moisture limiting agriculture; increased irrigation demand
- ☀ Baltimore supplies safe, Potomac River uncertain
- ☀ Will not alleviate overdraw of ground water

Two Year Precipitation Anomaly, Maryland



# Water in 2050?

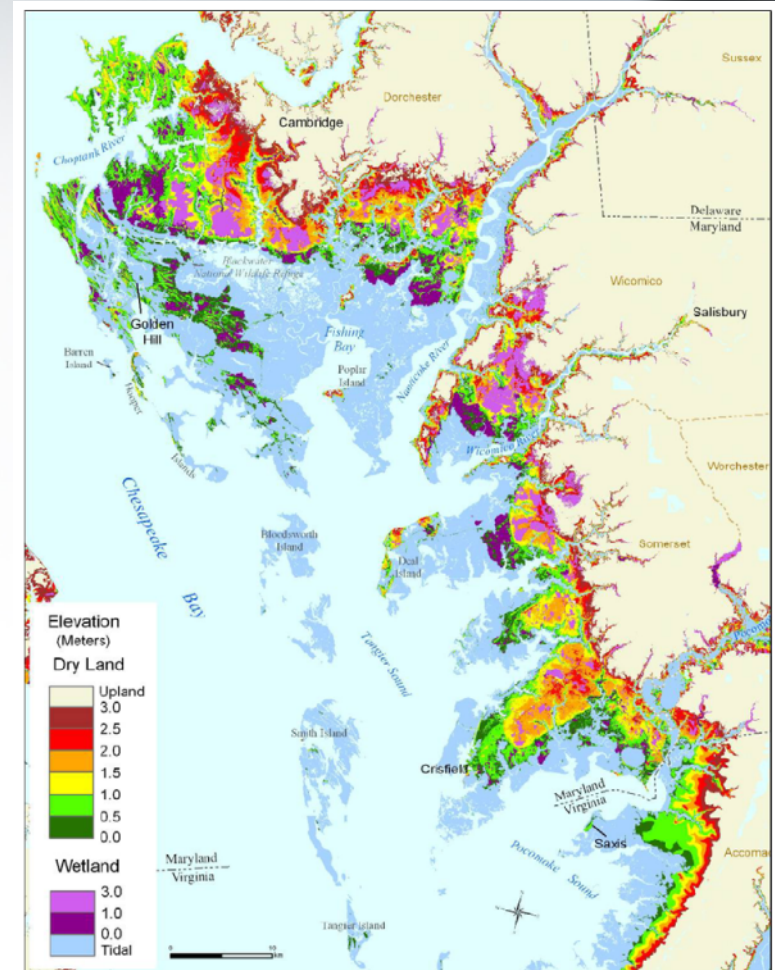
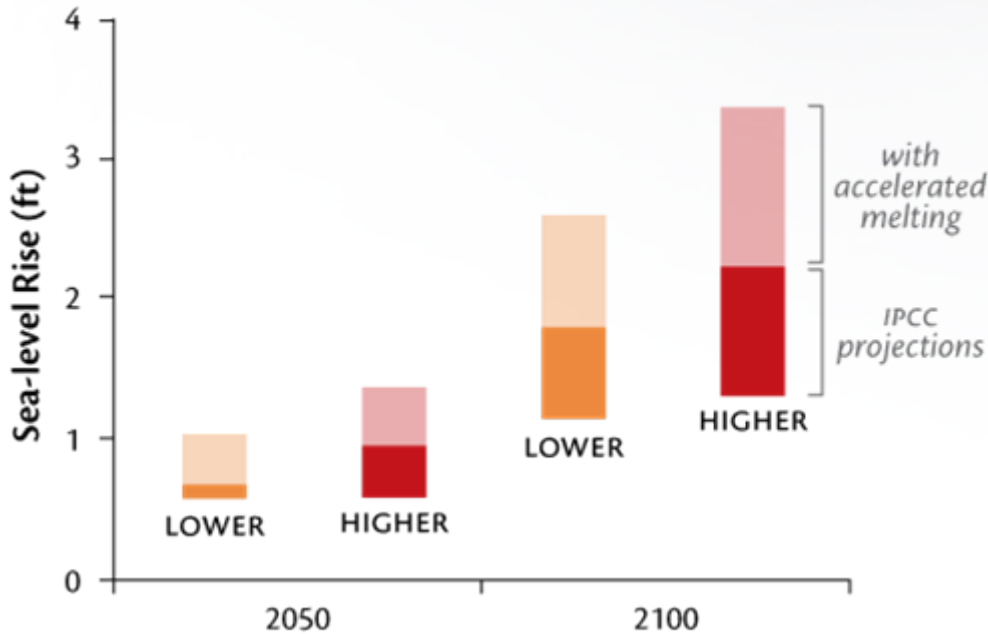


Roy et al. 2012 *ES&T*

# Sea-level Rise Will Redraw Map

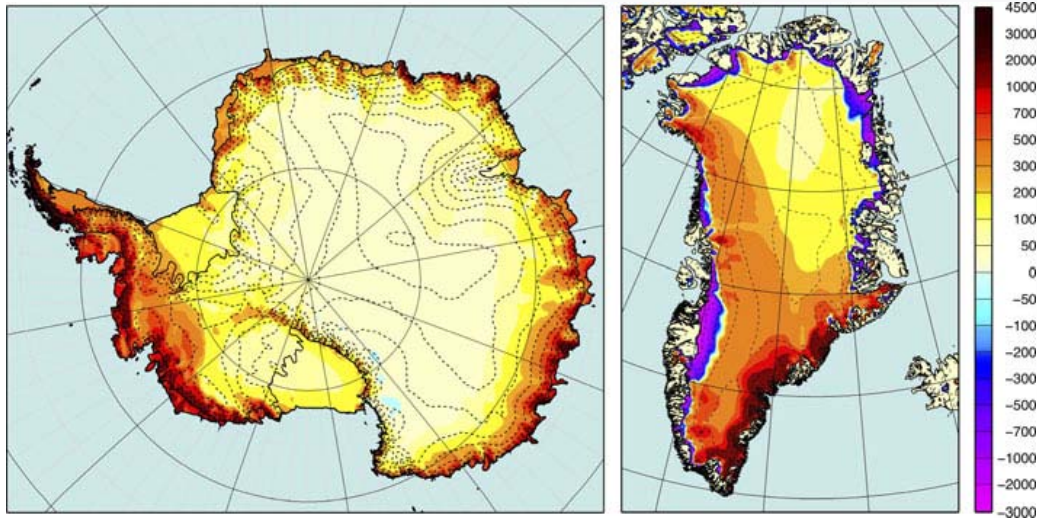


Sea-level Rise Projections in Maryland

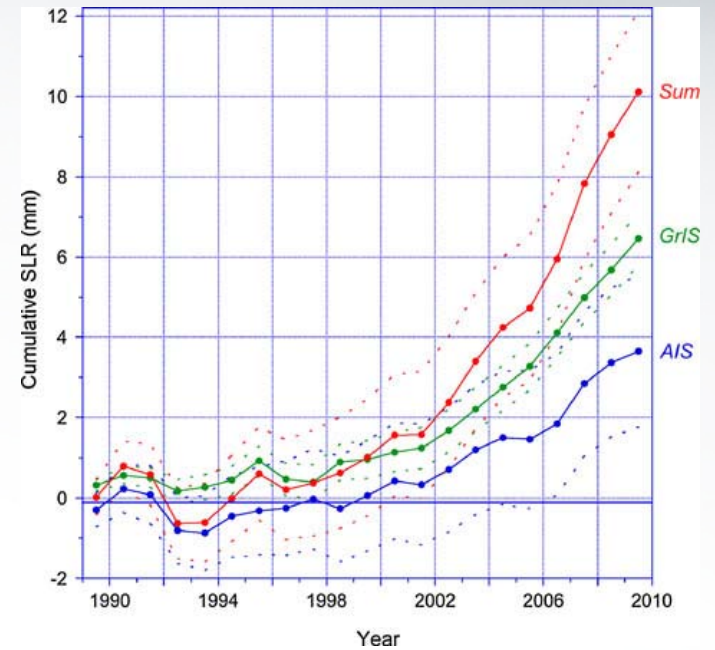




# Poles Matter



**Surface Mass Balance 1989-2009**



**Contribution to Sea Level Rise**

Van den Broeke et al. 2011 *Surv. Geophysics*

# Sector Based Adaptation



Affected Sectors	Climate Stressor	Climate Vulnerability	Adaptation Strategies
Water Resources	<ul style="list-style-type: none"> <li>• Changes in precip.</li> <li>• Extreme events</li> </ul>	<ul style="list-style-type: none"> <li>• Decreased water supply</li> <li>• Increased flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Create water markets</li> <li>• Improve flood control</li> </ul>
Bay/Aquatic Ecosystems	<ul style="list-style-type: none"> <li>• Sea level rise</li> <li>• Increased water temp</li> </ul>	<ul style="list-style-type: none"> <li>• Increased salinity</li> <li>• Habitat loss</li> </ul>	<ul style="list-style-type: none"> <li>• Install “living shorelines”</li> <li>• Protect critical habitat</li> </ul>
Human Health	<ul style="list-style-type: none"> <li>• Increased air temp.</li> <li>• Extreme events</li> </ul>	<ul style="list-style-type: none"> <li>• Vector-borne illness</li> <li>• Heat-related health effects</li> </ul>	<ul style="list-style-type: none"> <li>• Designate “cooling centers”</li> <li>• Vector-borne surveillance</li> </ul>
Agriculture	<ul style="list-style-type: none"> <li>• Changes in precip.</li> <li>• Sea level rise</li> </ul>	<ul style="list-style-type: none"> <li>• Drought</li> <li>• Salt-water intrusion</li> </ul>	<ul style="list-style-type: none"> <li>• Plant salt tolerant crops</li> <li>• Drought management</li> </ul>
Forest/Terrestrial Ecosystems	<ul style="list-style-type: none"> <li>• Changes in precip.</li> <li>• Increased air temp.</li> </ul>	<ul style="list-style-type: none"> <li>• Disease, Fire</li> <li>• Species shifts</li> </ul>	<ul style="list-style-type: none"> <li>• Fire mgmt. and control</li> <li>• Invasive species mgmt</li> </ul>
Growth & Infrastructure	<ul style="list-style-type: none"> <li>• Changes in precip.</li> <li>• Sea level rise</li> </ul>	<ul style="list-style-type: none"> <li>• Increased population growth</li> <li>• Increased flooding</li> </ul>	<ul style="list-style-type: none"> <li>• “Smart” site and building design</li> <li>• Retrofit storm water mgmt.</li> </ul>
Coastal Zone	<ul style="list-style-type: none"> <li>• Sea level rise</li> <li>• Extreme events</li> </ul>	<ul style="list-style-type: none"> <li>• Submergence of low-lying lands</li> <li>• Increased coastal flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Protect coastal infrastructure</li> <li>• Increase natural vegetative buffers</li> </ul>

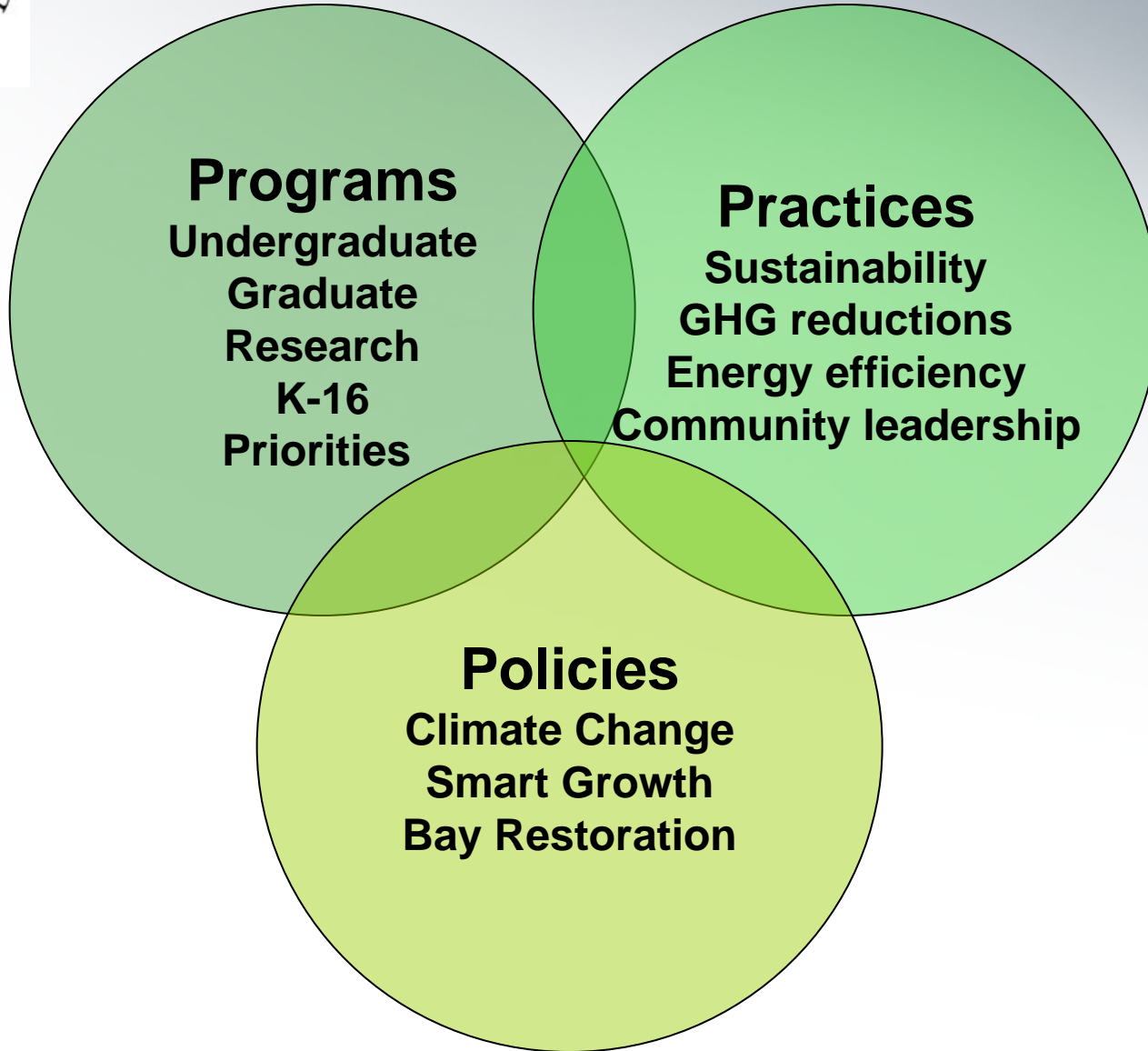
Scientific Assessment →

Adaptation: Phase I →

Adaptation: Phase II



# Environmental Sustainability





**Maryland and Delaware Climate Change  
Education Assessment and Research**

- K-12 Education (integrated with STEM, RTTT, Next-Generation Science Standards, and Environmental Literacy Requirements)
- Higher Education (sustainability literacy, pipeline)
- Informal Education (museums, aquaria, outdoor centers, media)

# Questions or Comments?

A photograph showing a flooded area with a white, two-story house and a utility pole. The water is calm, reflecting the sky and the surrounding landscape. The house has a dark roof and a chimney. The utility pole is on the left side of the frame. The background shows a line of trees and a clear sky with some clouds.

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