The realities and opportunities of climate change for Florida

Intergovernmental Panel on Climate Change - IPCC

Most of the observed increase in globally averaged temperatures since the mid-20th century is ***very likely*** [>90% probability] due to the observed increase in anthropogenic greenhouse gas concentrations.

4th Assessment Report 2007

Joint science academies' statement: Global response to climate change

Climate change is real

There will always be uncertainty in understanding a system as complex as the world's climate. However there is now strong evidence that significant global warming is occurring[1]. The evidence comes from direct measurements of rising surface air temperatures and subsurface ocean temperatures and from phenomena such as increases in average global sea levels, retreating glaciers, and changes to many physical and biological systems. It is likely that most of the warming in recent decades can be attributed to human activities (IPCC 2001)[2]. This warming has already led to changes in the Earth's climate.

The existence of greenhouse gases in the atmosphere is vital to life on Earth – in their absence average temperatures would be about 30 centigrade degrees lower than they are today. But human activities are now causing atmospheric concentrations of greenhouse gases – including carbon dioxide, methane, tropospheric ozone, and nitrous oxide – to rise well above pre-industrial levels. Carbon dioxide levels have increased from 280 ppm in 1750 to over 375 ppm today – higher than any previous levels that can be reliably measured (i.e. in the last 420,000 years). Increasing greenhouse gases are causing temperatures to rise; the Earth's surface warmed by approximately 0.6 centigrade degrees over the twentieth century. The Intergovernmental Panel on Climate Change (IPCC) [illegible] global surface temperature to increase to between 1.4 centigrade degrees and 5.8 centigrade degrees above 1990 levels by 2100.

Reduce the causes of climate change

The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action. It is vital that all nations identify cost-effective steps that they can take now, to contribute to substantial and long-term reduction in net global greenhouse gas emissions.

Action taken now to reduce significantly the build-up of greenhouse gases in the atmosphere will lessen the magnitude and rate of climate change. As the United Nations Framework Convention on Climate Change (UNFCCC) recognises, a lack of full scientific certainty about some aspects of climate change is not a reason for delaying an immediate response that will, at a reasonable cost, prevent dangerous anthropogenic interference with the climate system.

As nations and economies develop over the next 25 years, world primary energy demand is estimated to increase by almost 60%. Fossil fuels, which are responsible for the majority of carbon dioxide emissions produced by human activities, provide valuable resources for many nations and are projected to provide 85% of this demand (IEA 2004)[3]. Minimising the amount of this carbon dioxide reaching the atmosphere presents a huge challenge. There are many potentially cost-effective technological options that could contribute to stabilising greenhouse gas concentrations. These are at various stages of research and development. However barriers to their broad deployment still need to be overcome.

Carbon dioxide can remain in the atmosphere for many [illegible] rates we will throughout the 21st century and beyond. Failure to implement significant reductions in net greenhouse gas emissions [illegible] in the future.

Prepare for the consequences of climate change

Major parts of the climate system respond slowly to [illegible] greenhouse gas concentrations. Even if greenhouse gas emissions were stabilised [illegible] today's levels, the climate would still change [illegible] it adapts to the increased emission of [illegible]. Further changes in climate are therefore [illegible] Nations must prepare for them.

The projected changes in climate will have [illegible] and adverse effects at the regional level [illegible] water resources, agriculture, natural ecosystems, human health. The larger and faster the change in climate, the more likely it is that adverse effects will dominate. Increasing temperatures are expected to cause [illegible] frequency and severity of weather events such as [illegible] waves and heavy rainfall. Increasing temperatures will lead to large-scale effects such as melting of ice [illegible] sheets (with major impacts on low-lying coastal areas throughout the world). The IPCC estimates that the combined effects of ice melting and sea-level rise [illegible] from ocean warming are projected to cause mean sea-level to rise by between 0.1 [illegible] between 1990 and 2100. In Bangladesh, a 1 metre sea-level rise would place about 6 million people at risk from flooding.

Developing nations that lack the infrastructure [illegible] to respond to the impacts of climate change are particularly affected. It is clear that many of the poorest people are likely to suffer the most from change. Long-term global efforts to create a more prosperous and sustainable world may be overtaken by changes in the climate.

The task of devising and implementing effective responses to the consequences of climate change requires worldwide collaborative inputs from a wide range of experts, including physical and natural scientists, social scientists, medical scientists, those in business leaders and economists.

Academia Brasiliera de Ciências, Brazil

Royal Society of Canada, Canada

Chinese Academy of Sciences, China

Académie des Sciences, France

Deutsche Akademie der Naturforscher Leopoldina, Germany

Indian National Science Academy, India

Accademia dei Lincei, Italy

Science Council of Japan, Japan

Russian Academy of Sciences, Russia

Royal Society, United Kingdom

National Academy of Sciences, United States of America

Adaptation

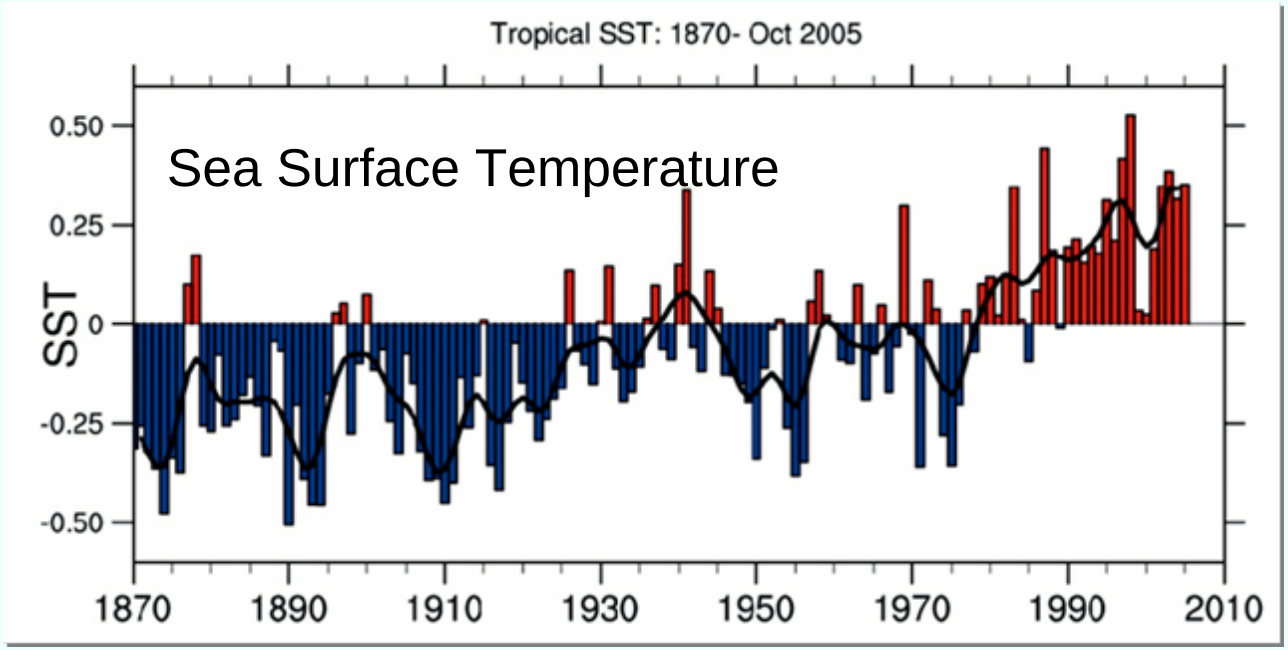
Mitigation

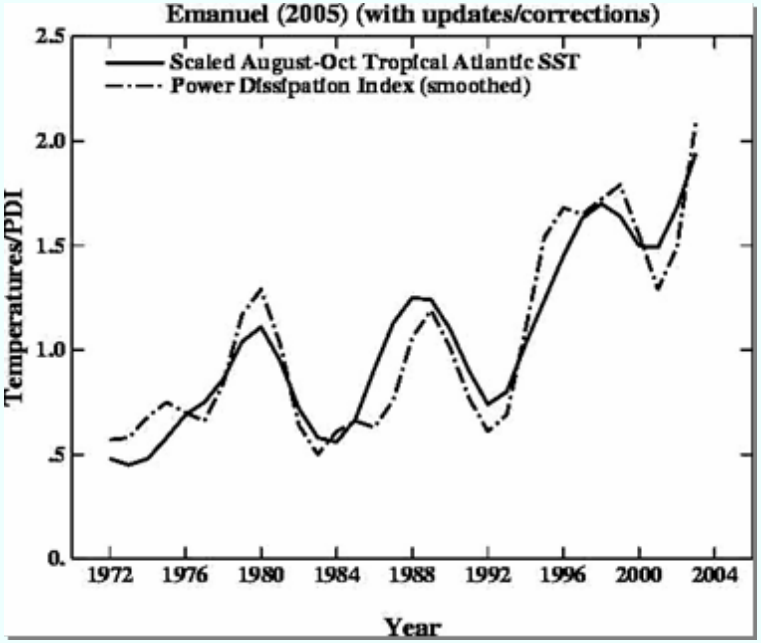
Designated authority -

The National Academies of Science & The IPCC

June 2005

Consequences: increased hurricane intensity

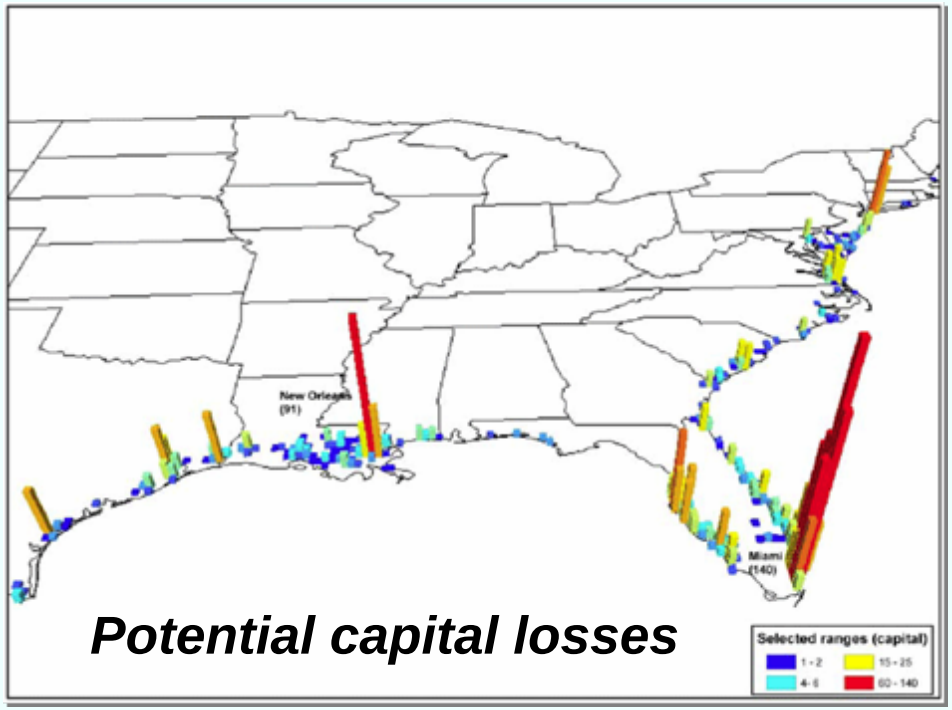




Annual power dissipation (PDI) by tropical cyclones compared to September sea surface temperature (SST). Emanuel [Nature, 2005; revised 2007]

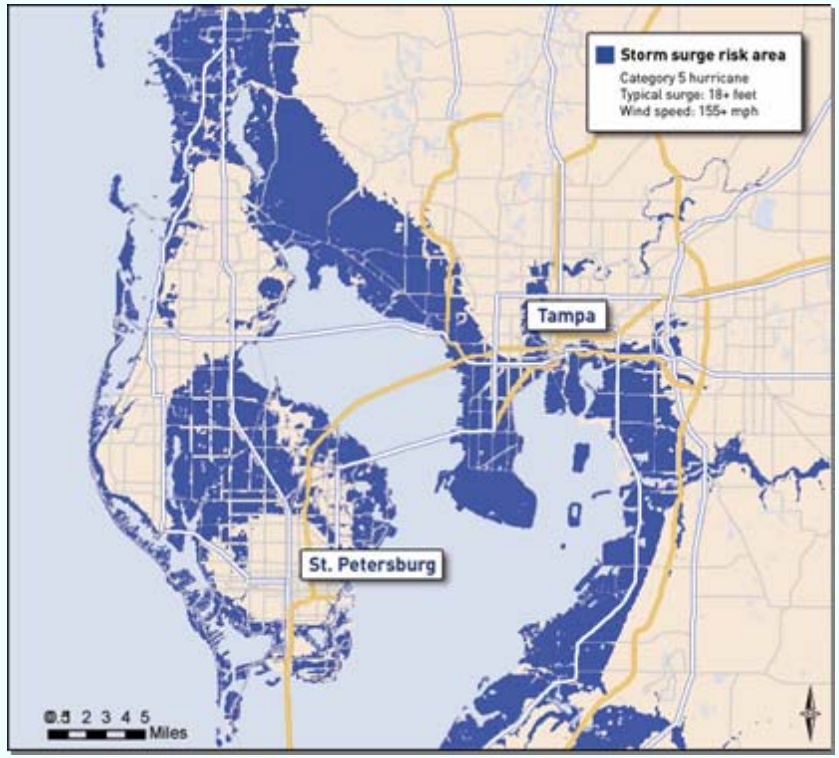
IPCC 4th assessment:
Stronger hurricanes “likely”

Florida vulnerability to hurricanes & storm surge



Potential capital losses

William D. Nordhaus. 2006. The Economics of Hurricanes in the United States. NBER 12813, 47pp.



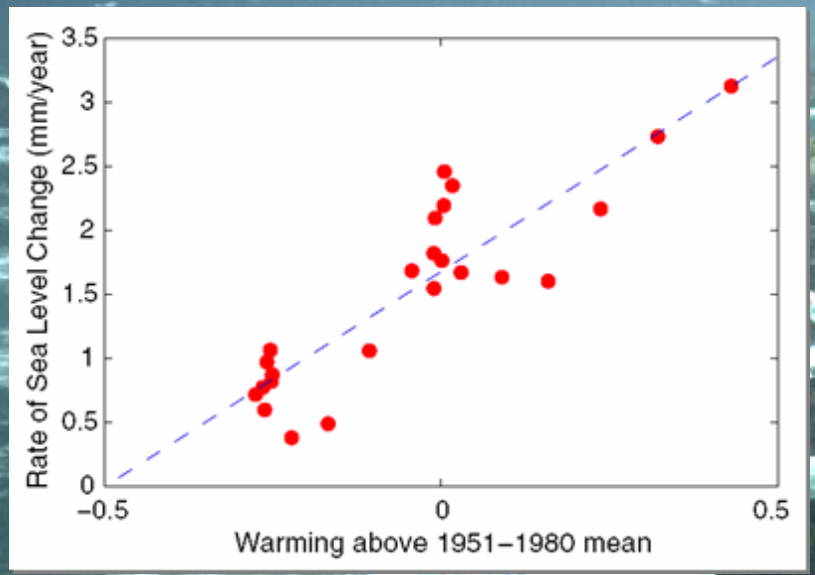
Storm surge - Tampa Bay

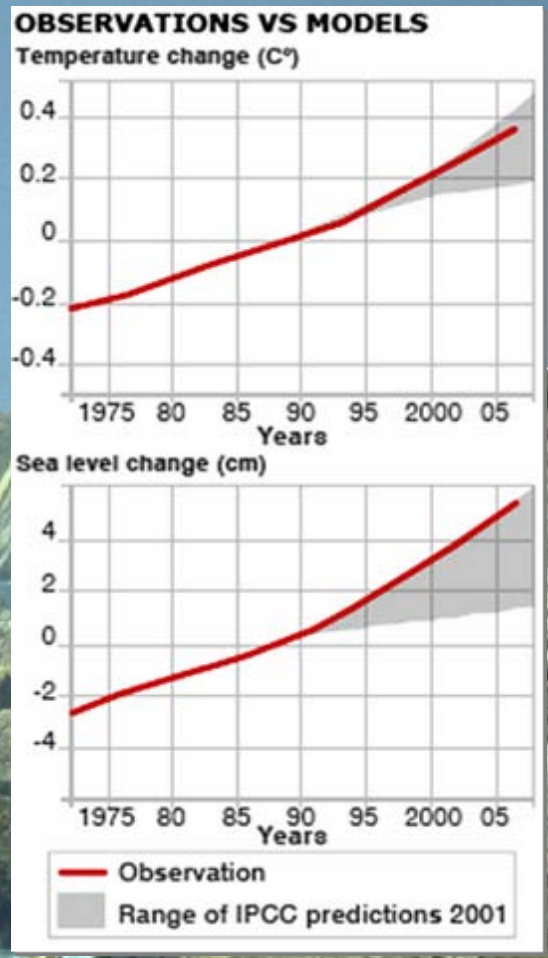
[The effects of global warming] ***"will emerge as if someone had subtly, but progressively, loaded a pair of dice."*** *- Kerry Emanuel 2005*

Stephen Mulkey 2007

Consequences: sea level rise

4th assessment: 7 - 23 inches by 2100, excluding effects of ice flow and carbon cycle feedbacks.





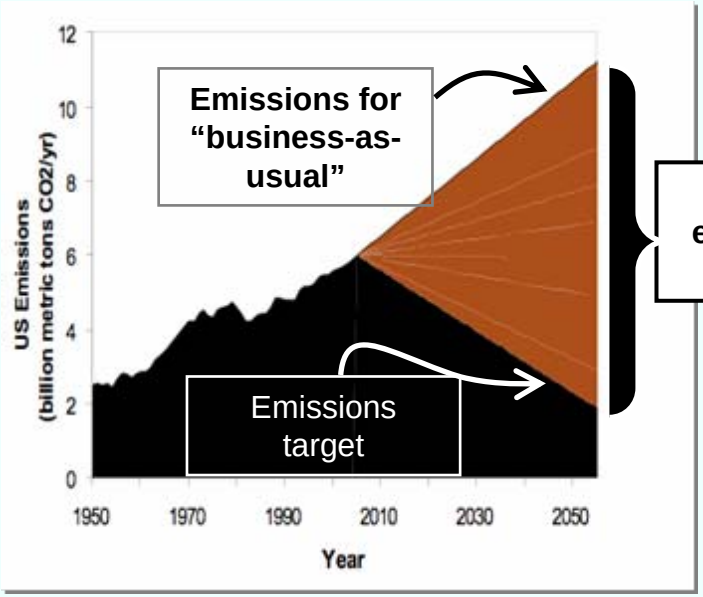
Bottom line: Up to 3 ft by 2100.

Source: Rahmstorf et al. *Science* 2007, Figure redrawn by BBC

Business as usual: expectations for Florida

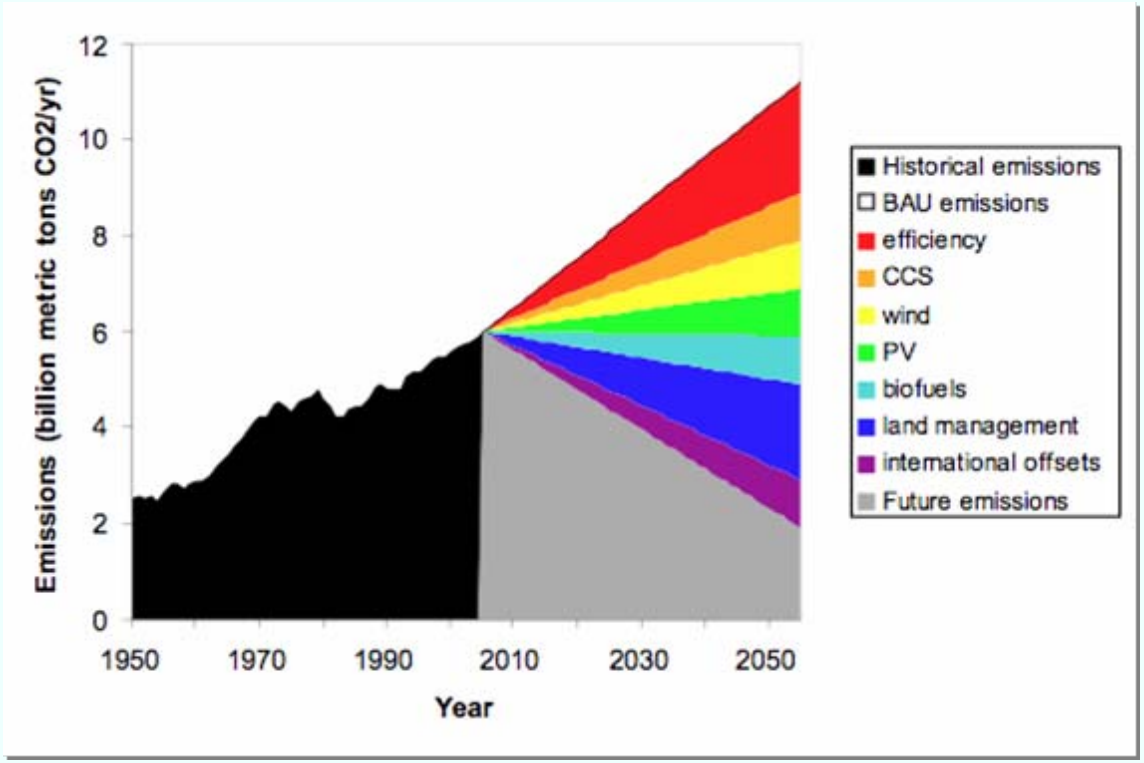
- Florida's coastal cities will be forced to make major expenditures for building seawalls and flood control structures.
- The rise in the temperatures will make Florida a less desirable place to live and will cause increases in heat stroke, emerging infectious disease, and other health problems.
- Florida will lose beachfront property and suffer much greater storm damage from higher storm surges and more powerful hurricanes.
- Insurance costs will soar and insurance companies will refuse to provide coverage in vulnerable areas.
- Agriculture in Florida may see a short term benefit but later will be hurt by longer periods of drought.
- Coral bleaching from warming and more acidic sea water will devastate sport and commercial fishing.
- Regional water shortages will increase; rationing more frequent and severe.
- Up to ??% of species committed to extinction - coastal habitats most affected.

Institute for Alternative Futures



Mitigation - Can we do it?

We need at least 7 wedges

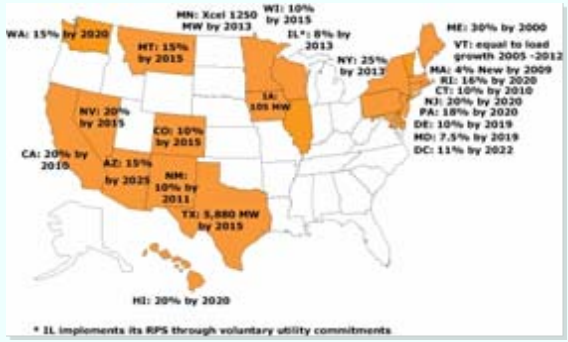


William Chameides

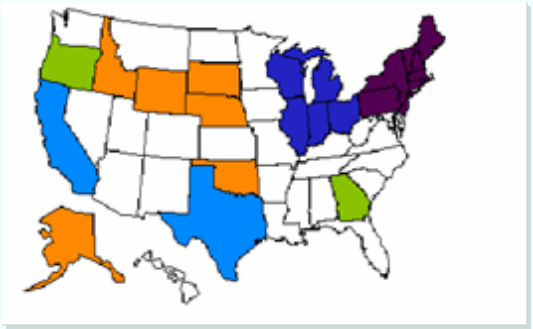
Responses among the states

GHG Emissions Targets

Climate Action Plans



Renewable Portfolios



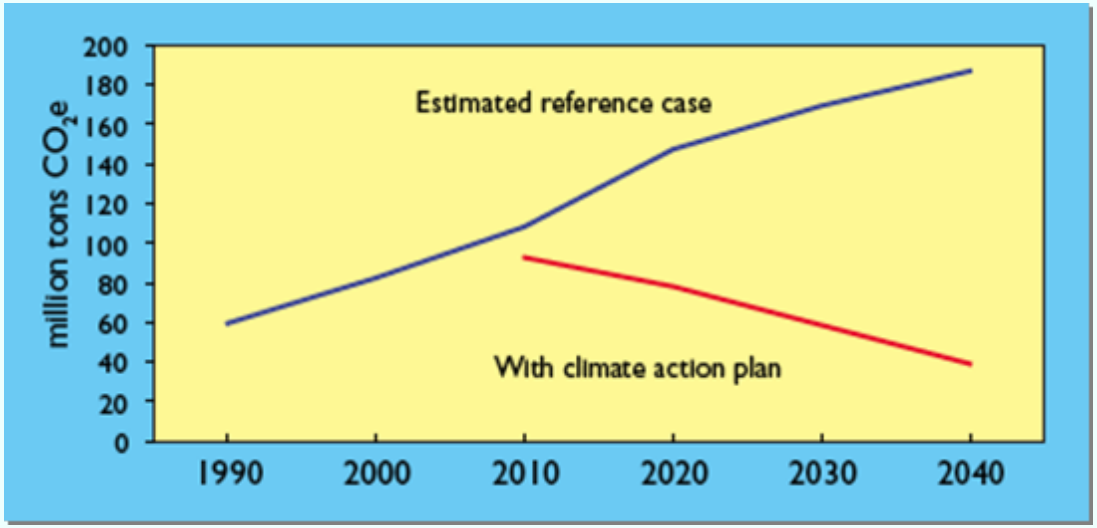
GHG Reporting Registries

Efficiency Standards

Regional Climate Initiatives

The costs of climate change for Florida are possibly the highest of any state

The Arizona climate action plan



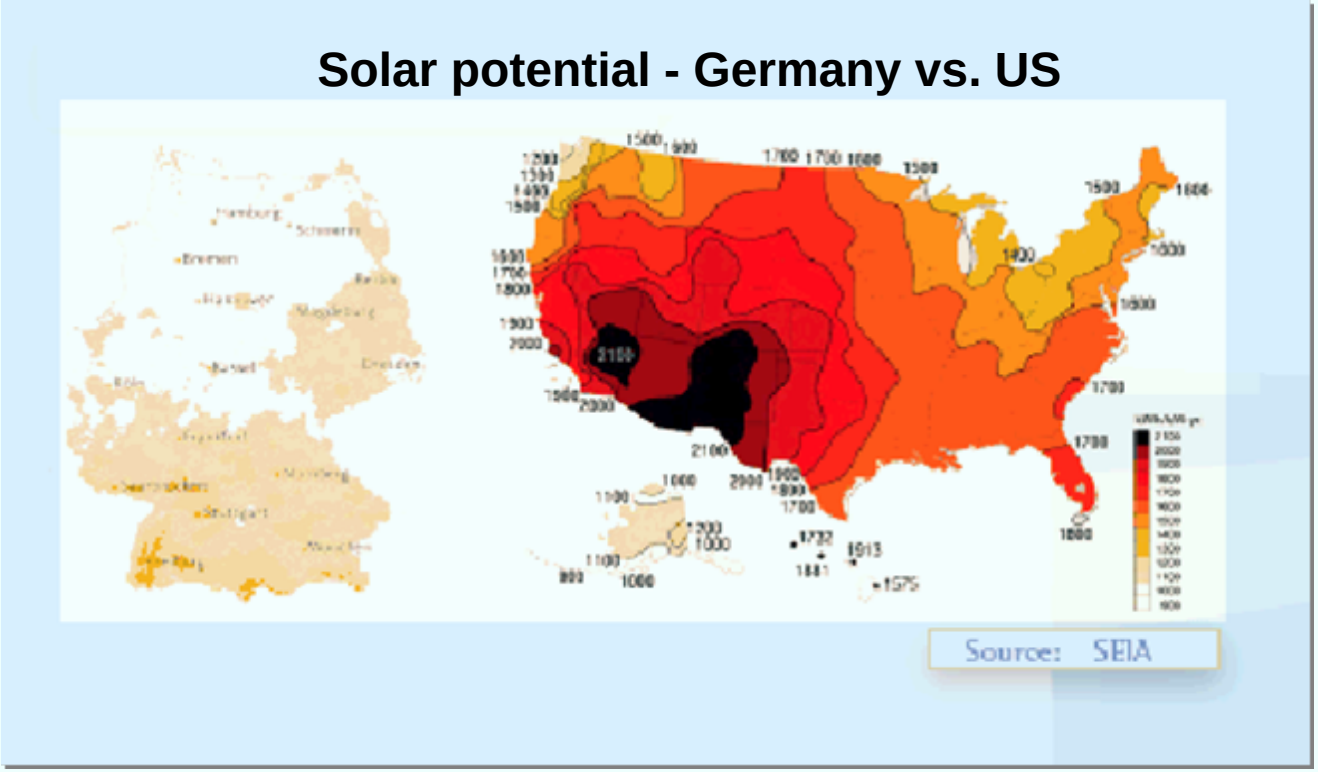
The Bottom Line

• The plan contains a portfolio of 49 recommendations that, if implemented, will **cut Arizona's GHG emissions almost in half by 2020** and provide **$5.5 billion** in net savings to the economy. **(Center for Climate Strategies)**

• **One third** of Florida's energy needs can be met by efficiency and renewables by 2023 and save about **$60 billion.** **(ACEEE, 2007)**

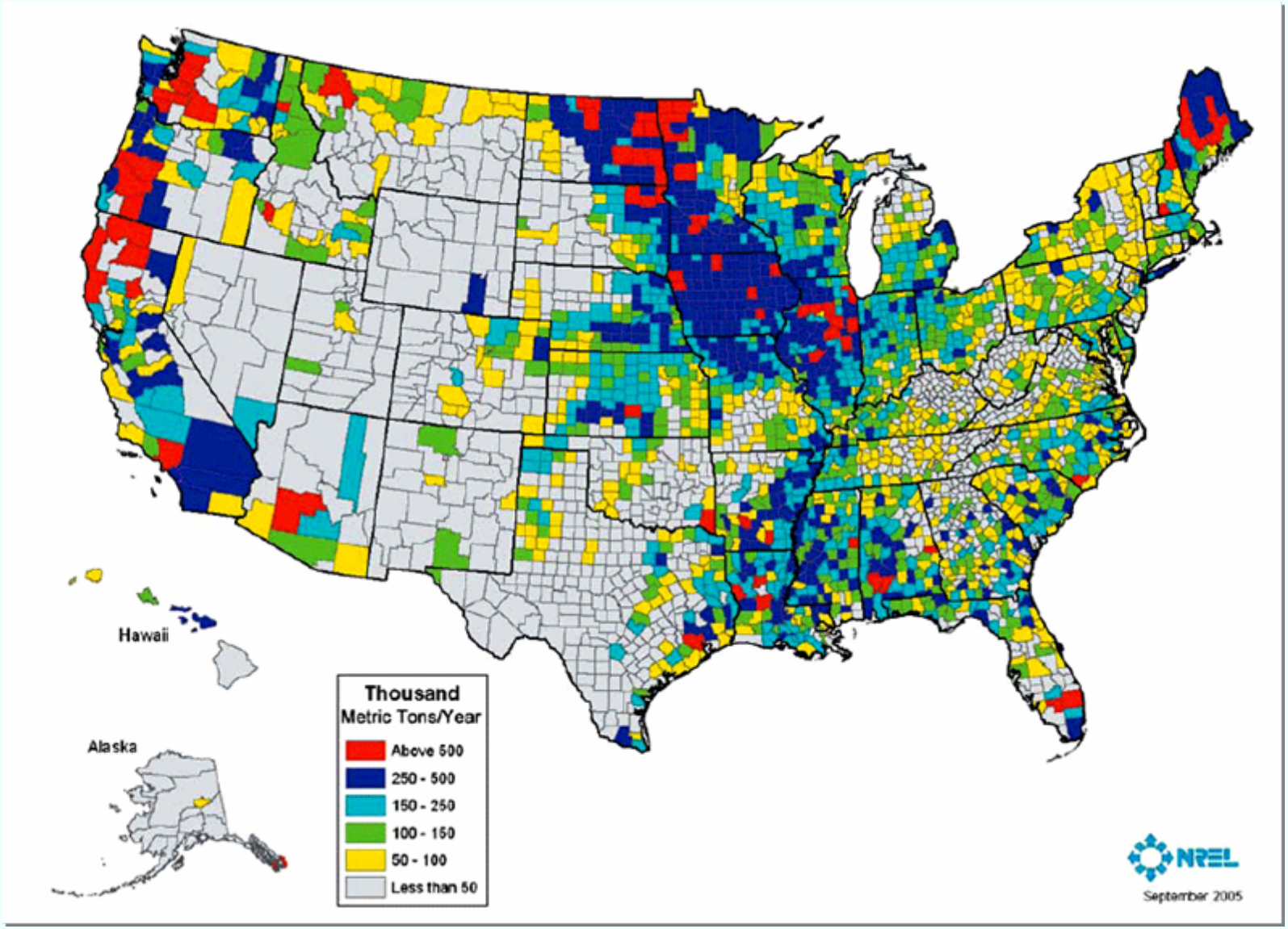
Opportunity: solar thermal & photovoltaic

52% of US solar exports go to Germany
Germany installations = 8 times US installs

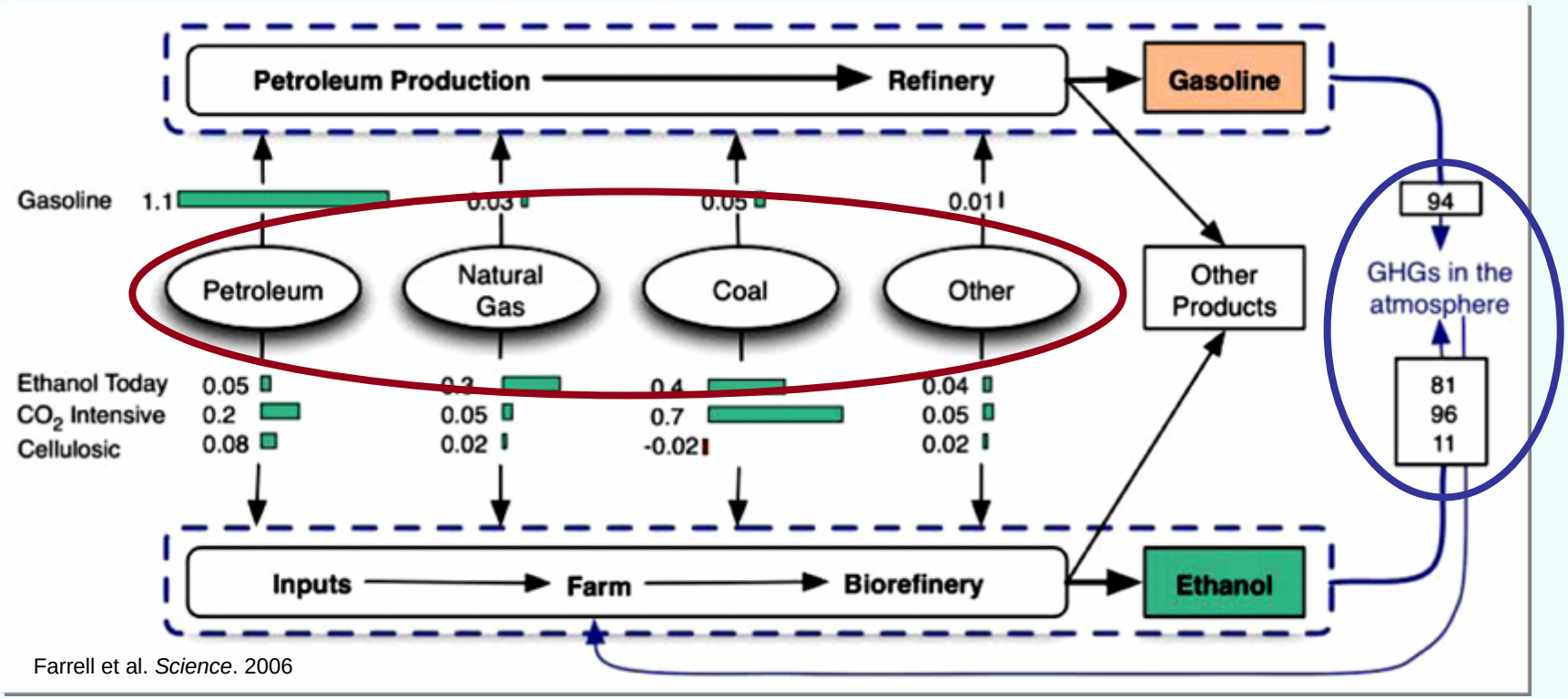


Of 40 states with net metering programs, only Florida and Illinois do not have statewide standards and incentives.

Opportunity: biofuels & biomass

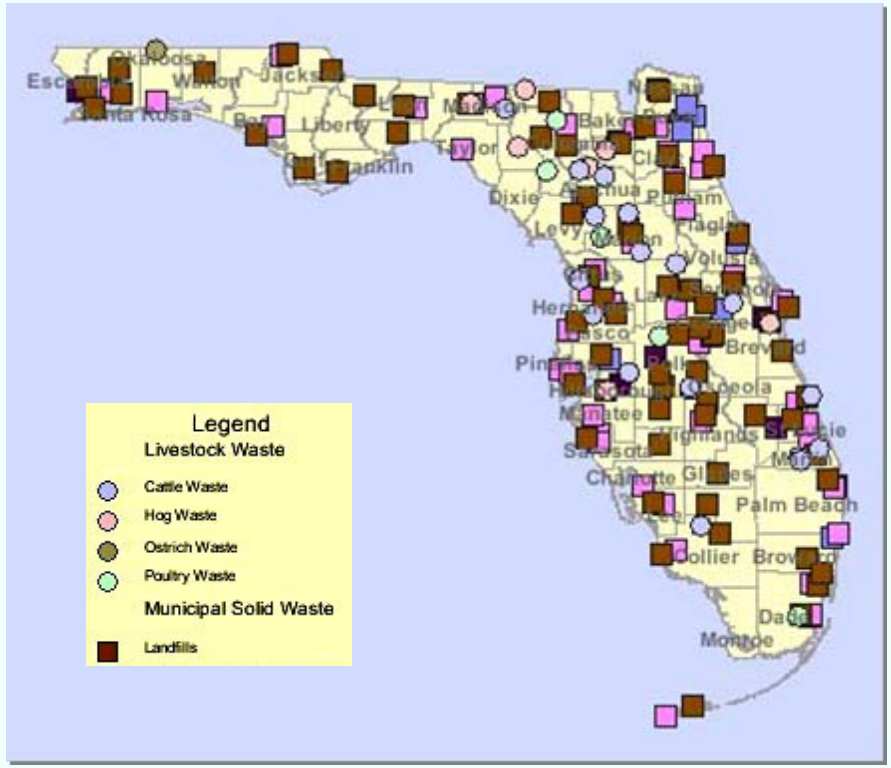


Cautions about ethanol



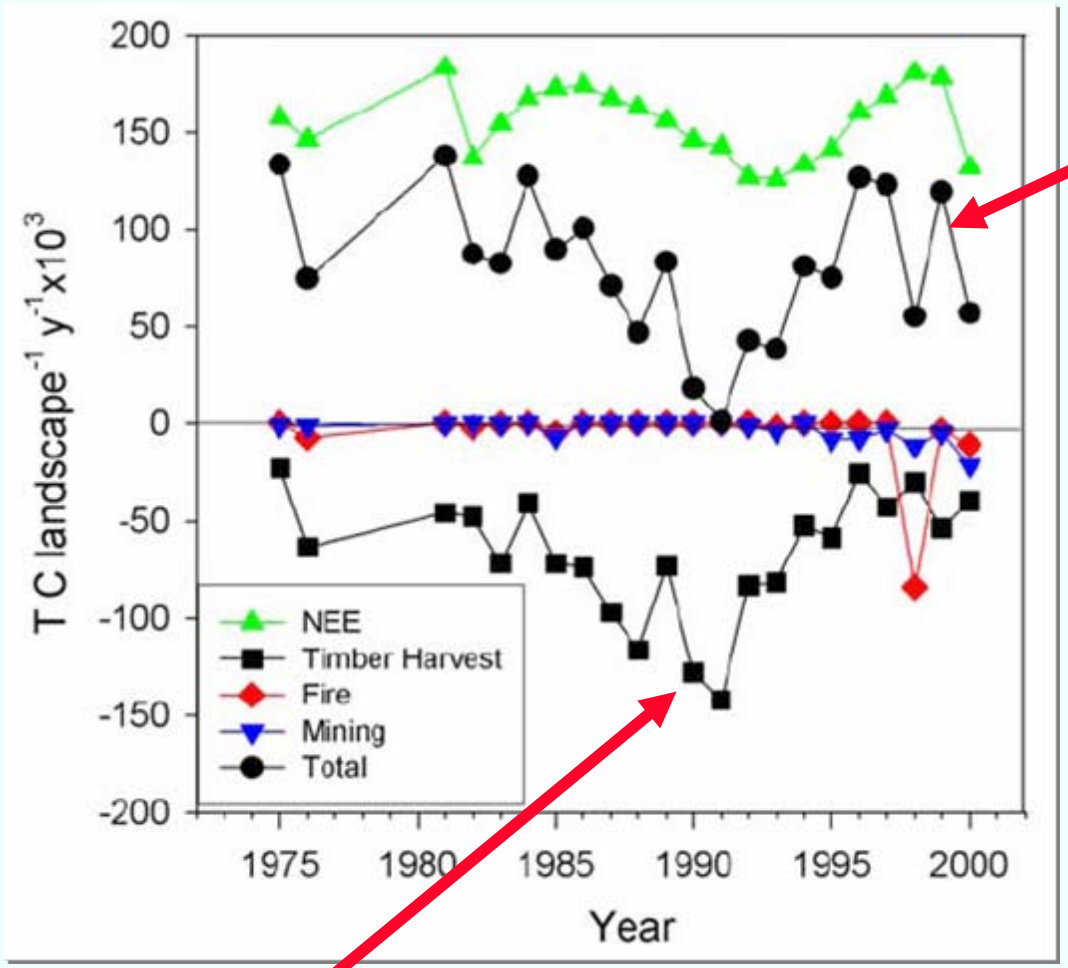
- Lifecycle carbon emissions must be known
- Production process must be transparent & accountable
- Cellulosic ethanol has yet to be mass produced
- Environmental and water use consequences

Opportunity - energy from waste



Less CO_2 is produced from power generation with methane.

Opportunity: industrial forests of the Southeast as carbon sinks

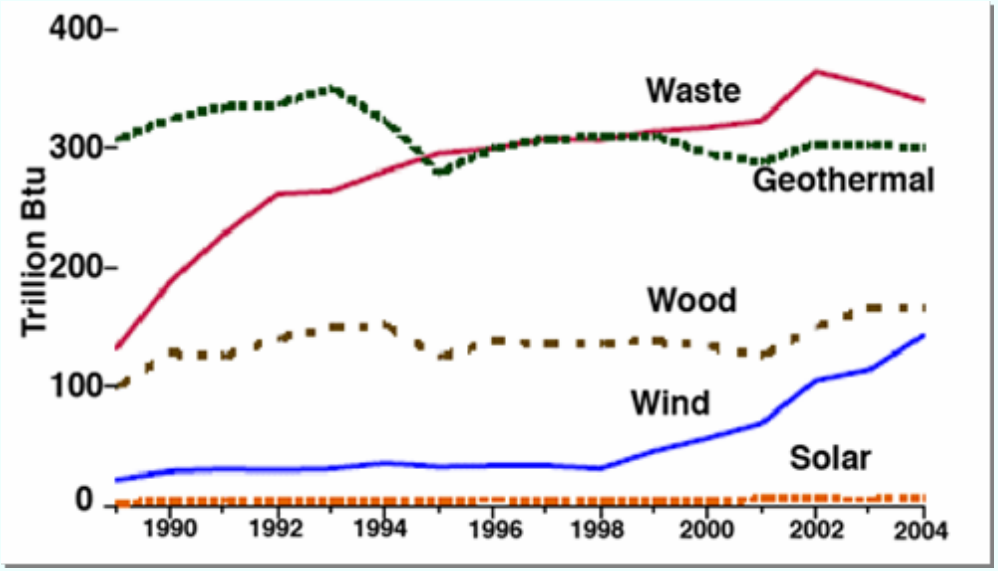


Total landscape carbon uptake as determined by growth, harvest, fire, and phosphate mining.

Carbon budget analysis is essential for assessing mitigation potential of Florida forests.

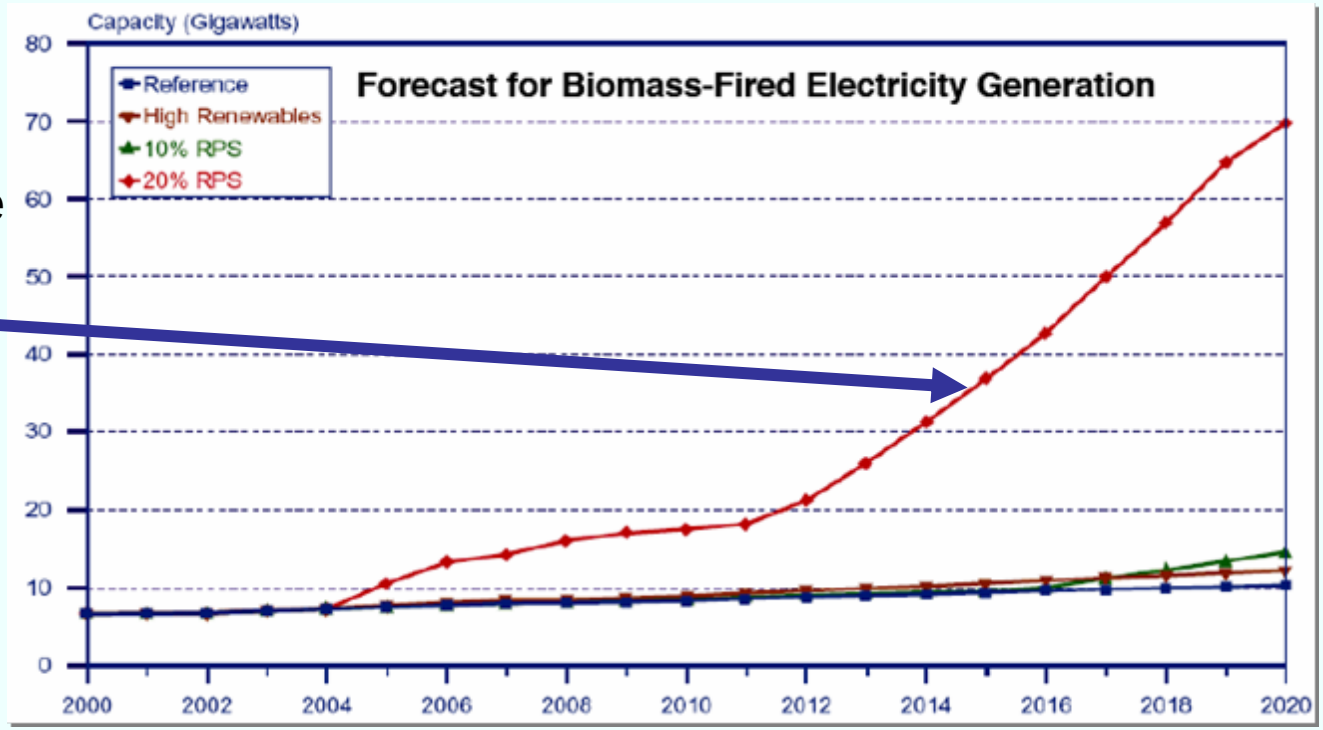
Harvest for fuel?

Binford et al. 2006. J Geophys Res.



Opportunity: woody biomass as fuel

With 20% Renewable Portfolio Standard, biomass use would increase 10-fold



Source: USDOE/EIA 2002; Haq, 2003

Net emissions of Electric Power Plants: Comparison of Biomass and Fossil Fuels

Pollutant	Woody Biomass	Coal	Heavy Oil	Natural Gas
Sulfur dioxide (lbs/ton)	0.08	39	157	
Nitrogen Oxide (lbs/ton)	1.5	21	47	
Carbon Dioxide (lbs/million BTU)	0*	225	174	117

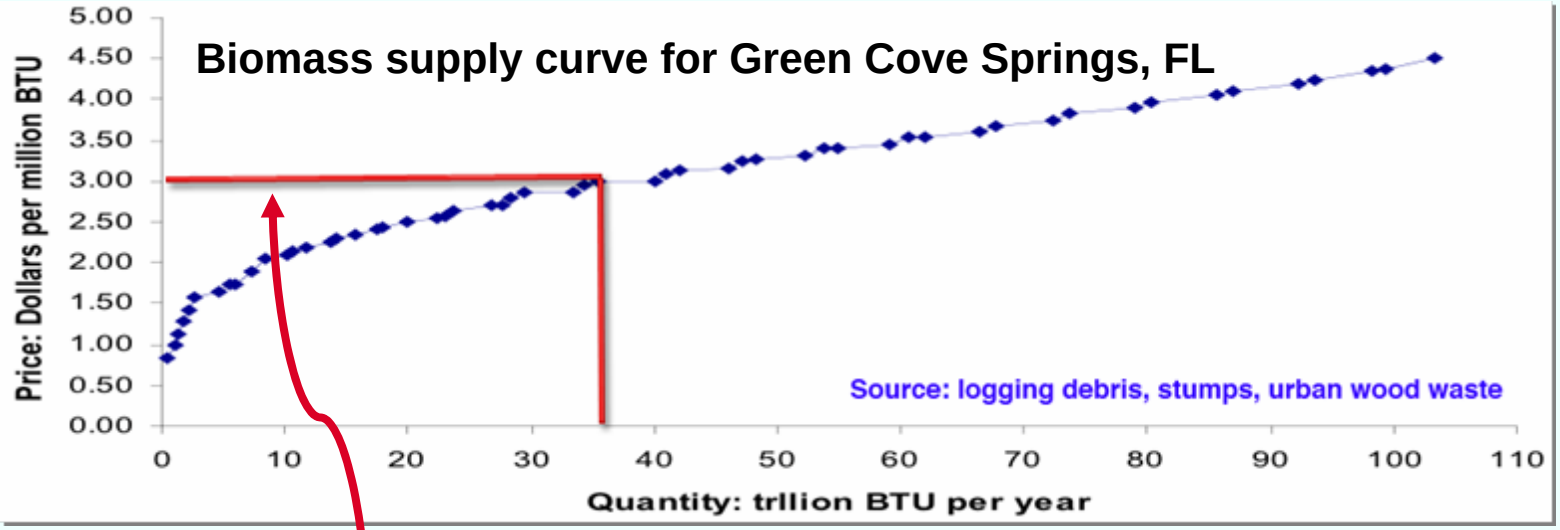
***Assumes wood grown and harvested for this purpose**

Concerns:

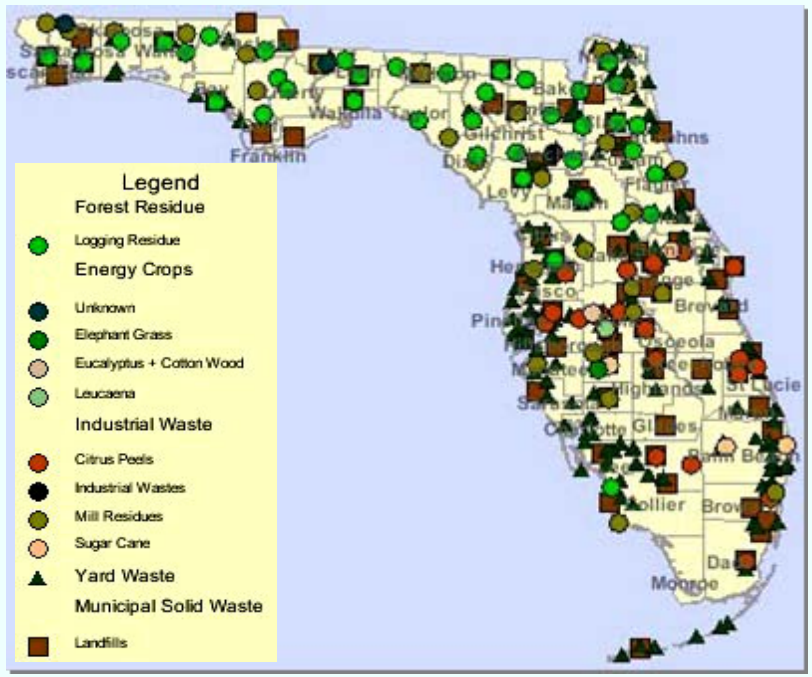
- ***Large scale land conversion to non-native species***
- ***Fire***
- ***Fossil carbon use in production and transport***

Source: USDOE/EIA, Power Technologies Data Book, 2003

How much energy could we get from wood?



At a price competitive with coal, this would supply half of the power produced by a medium size plant such as the one in Gainesville, FL.



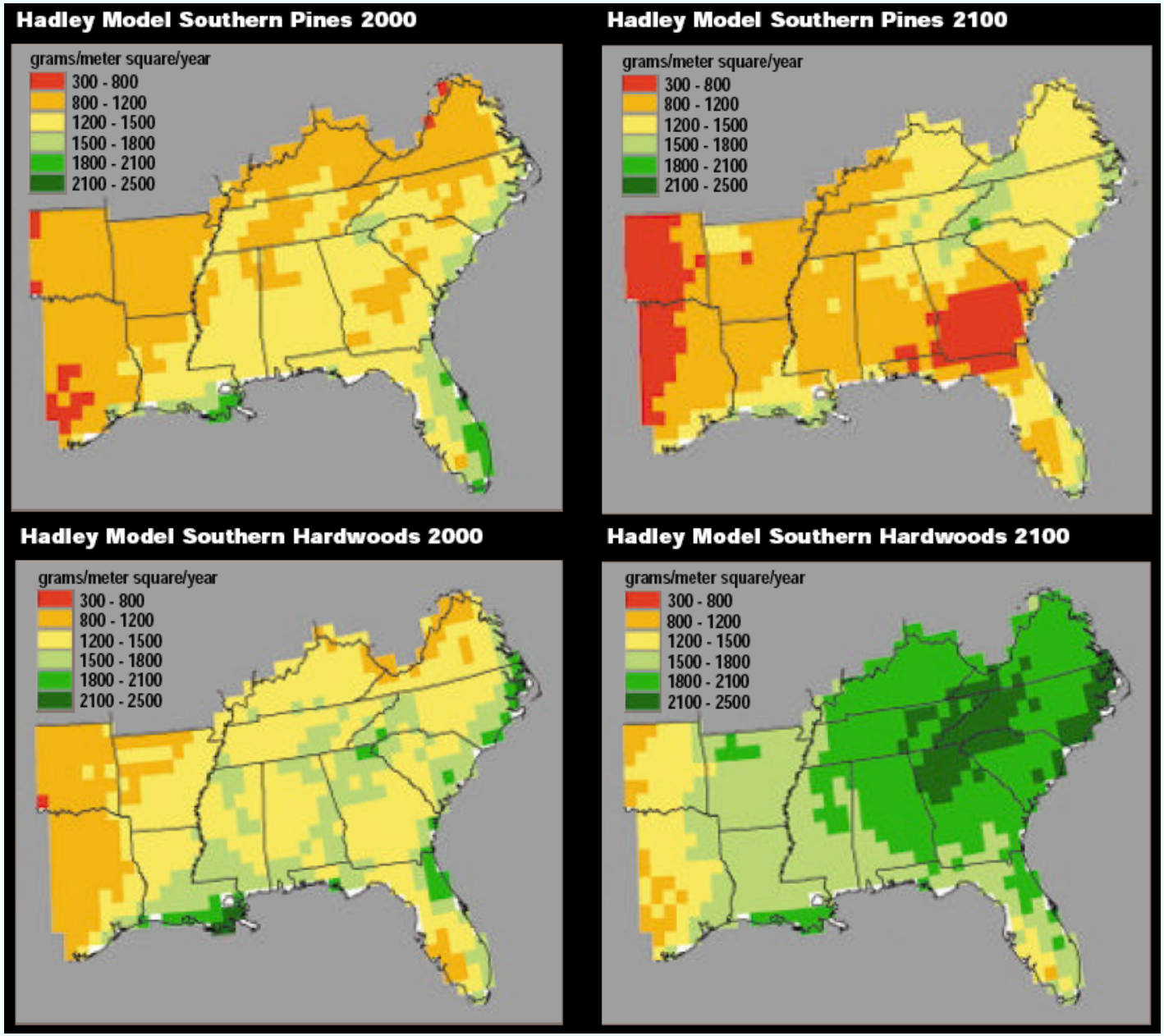
Matt Langholtz, UF/IFAS

Adaptation - coping with climate change

"Climate change is the biggest market failure in history" - Sir Nicholas Stern

- Adaptation is essential because of the warming already in the pipeline.
- Adaptation will not be a smooth or cost-free endeavor.
  - ✓ Will require substantial investments based on imperfect foresight.
  - ✓ Adaptation will be more difficult with more rapid or greater climate change.
- Managed systems will fare better than natural systems.
- Proactive approaches are more likely to avoid or reduce damages than reactive responses; requires periodic reassessments.
- Data and technological innovation are keys to adaptation

Regional changes in net primary productivity



Proactive adaptation for Florida

Agriculture - Reduced crop production in SE - precision agriculture with drip irrigation - new varieties of crops - conservation tillage; pest control.

Forestry - Anticipate changes in productivity & species composition - enhance the role of forests in carbon sequestration & fuel production.

Water resources - Extensive reserve capacity to regulate regional water scarcity - protect & enhance the Floridan aquifer.

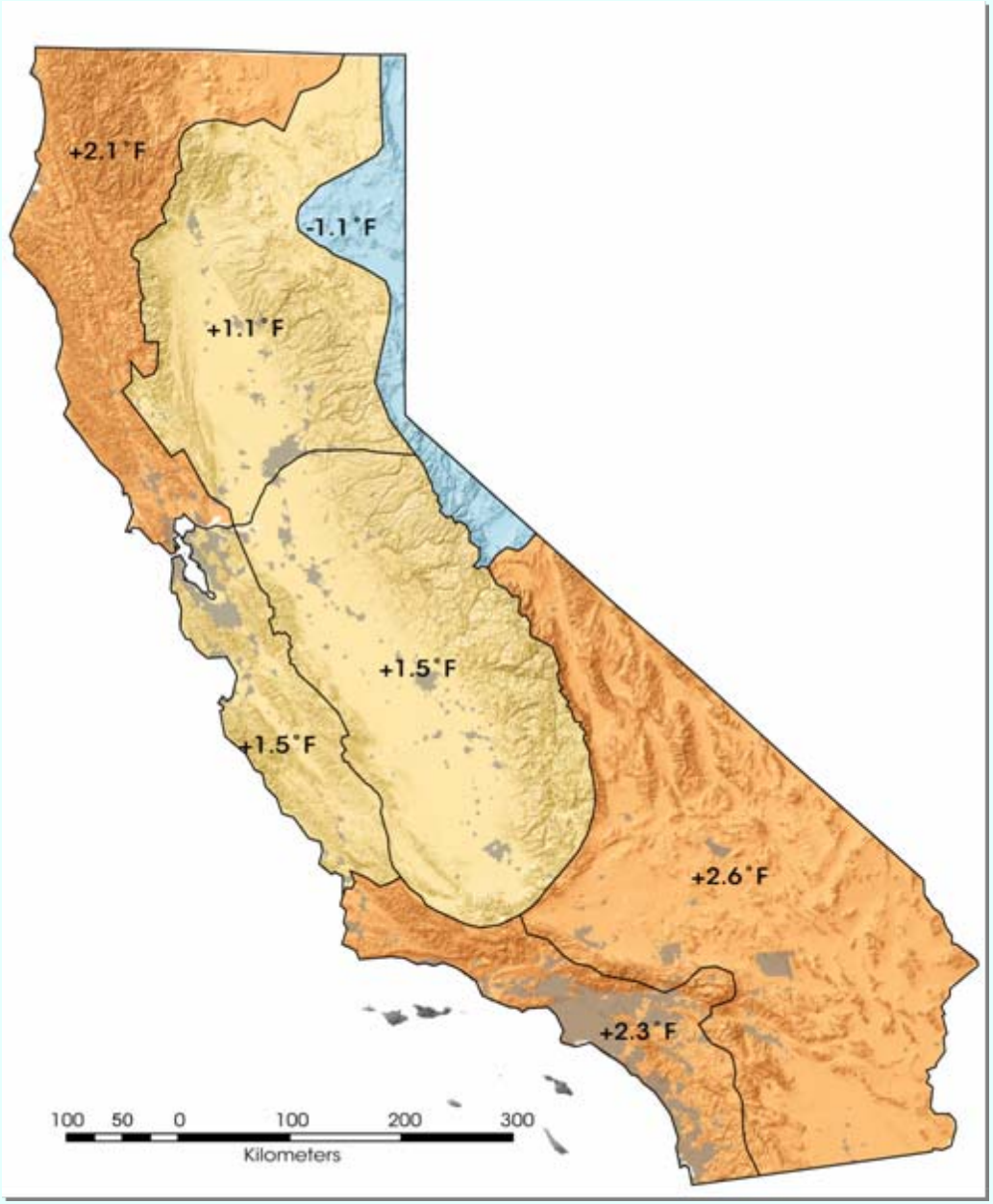
Sea level rise - Improve coastal elevation data - coastal land use planning; decide what to abandon.

Coastal ecosystems - Plan for shift in distribution of mangrove and salt marsh ecosystems - impacts on fauna.

Human health - Public health planning for emerging infectious diseases and heat related illness.

Hurricanes - Hurricane hardening & new coastal building codes - improved evacuation routes.

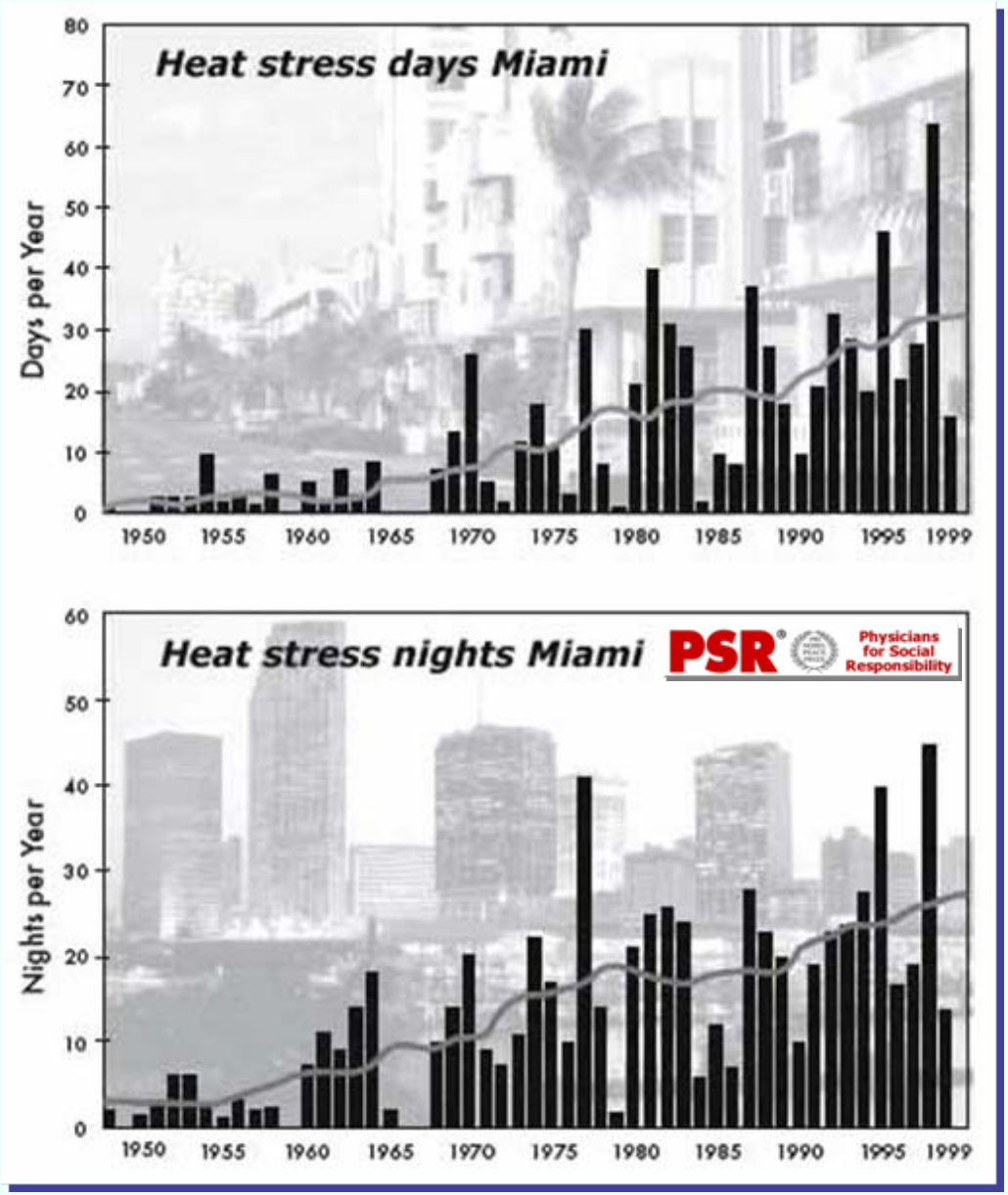
Land use - blending mitigation and adaptation



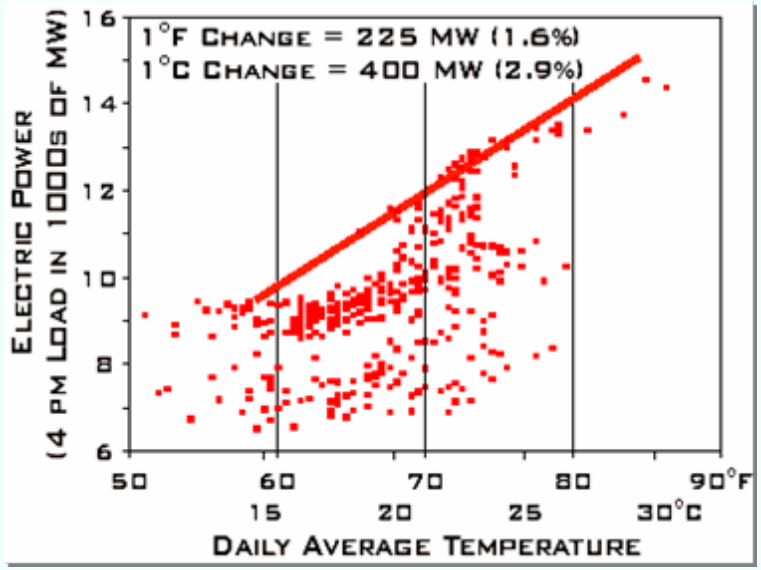
California land use amplifies warming

- **Warming - 50% due to gobal warming; 50% due to land use change**
- **Large urban areas warmed 2-5 times more than the state mean 1950-2000.**

LaDochy et al. 2007. IJC.



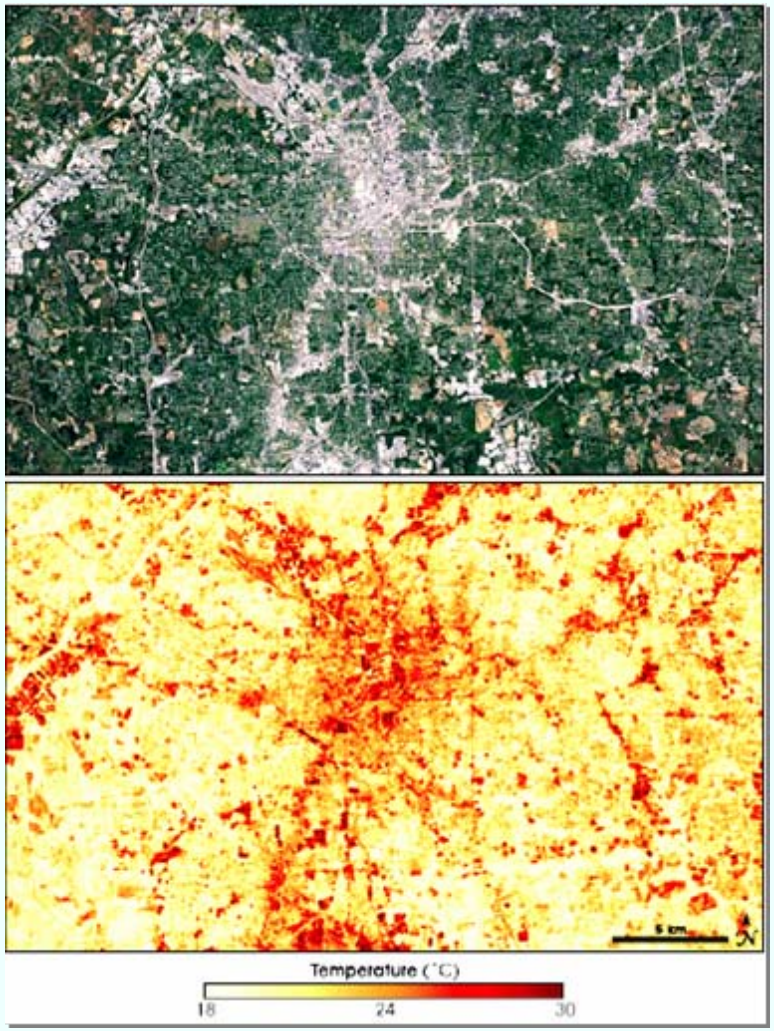
Urbanization - implications for energy conservation



Peak load as function of temperature

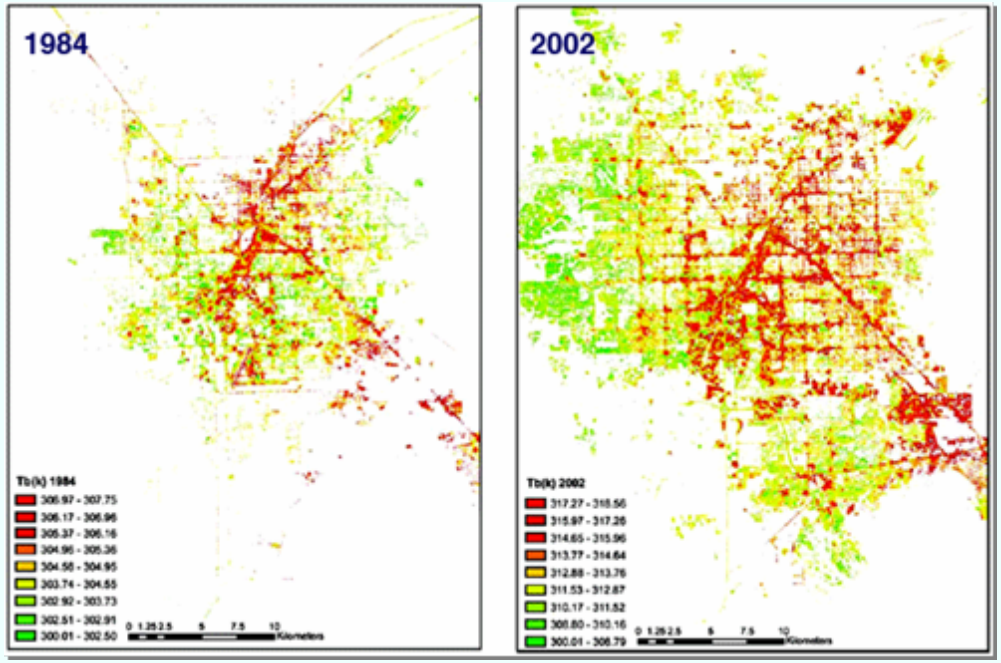
Buildings use up to 48% of our total energy budget.

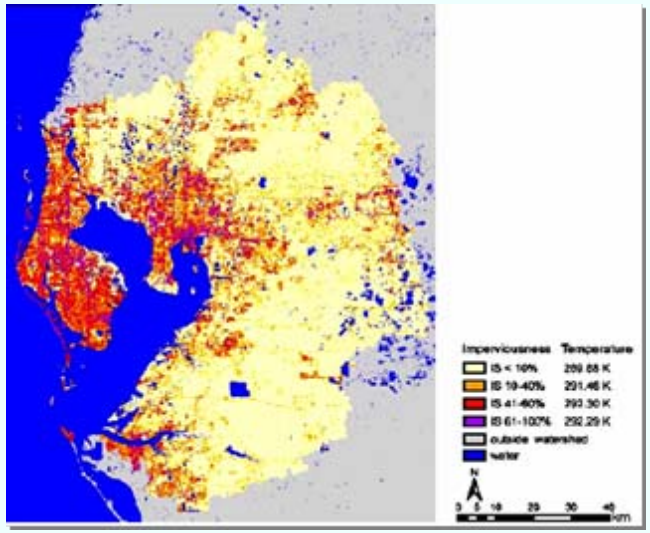
Impervious surfaces cost energy



Atlanta 26 Sept 2000; NASA

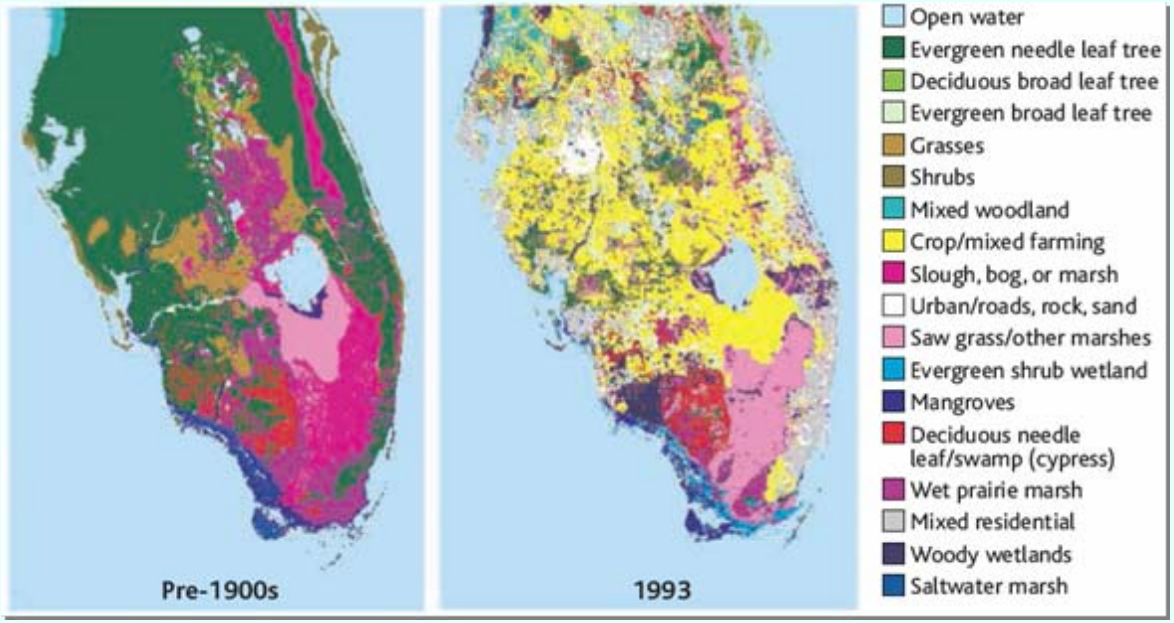
Las Vegas suburbs are cooler





Tampa Bay area impervious surfaces

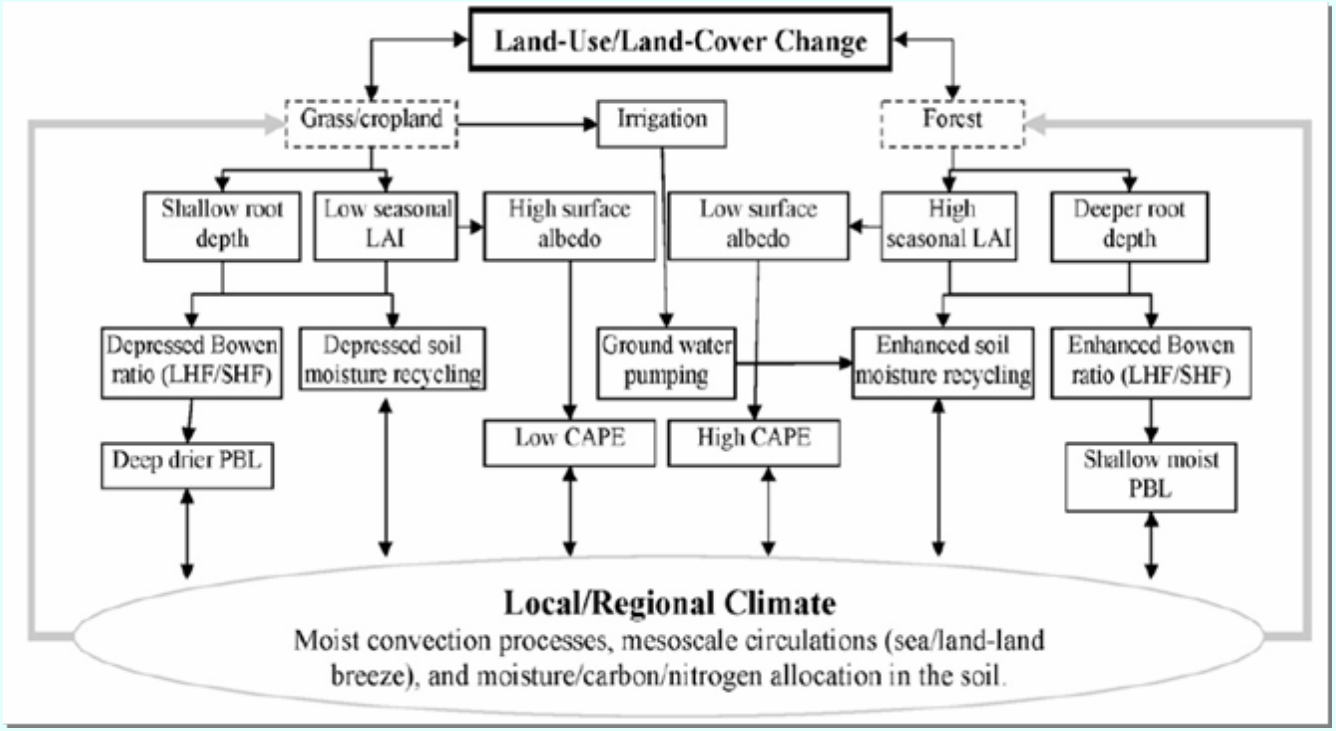
Xian & Crane. 2006. Remote Sens Env



Land use impact on mesoscale climate

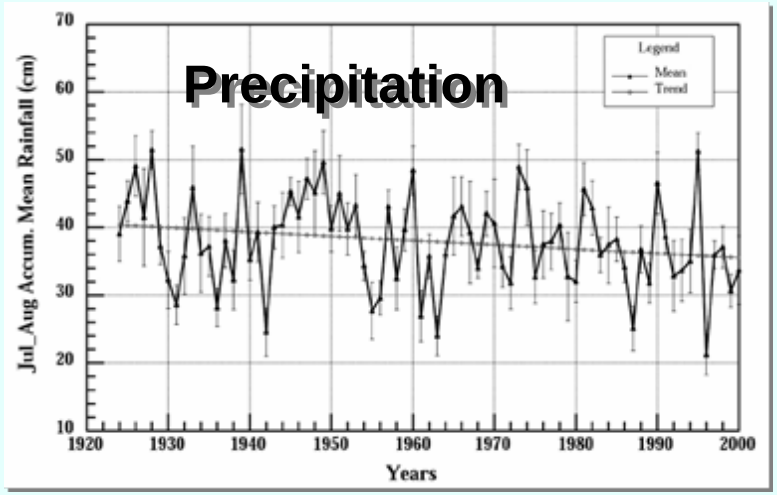
Major effects:

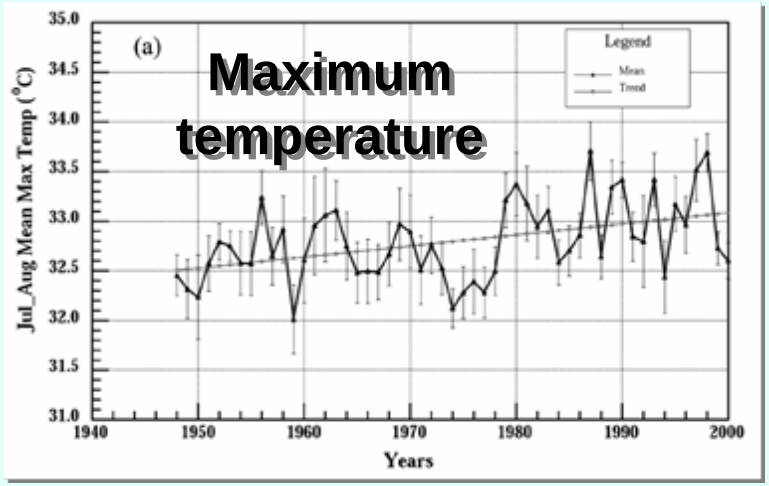
1. **Long wave radiation**
2. **Potential evapo-transpiration**
3. **Boundary layer & convective processes**

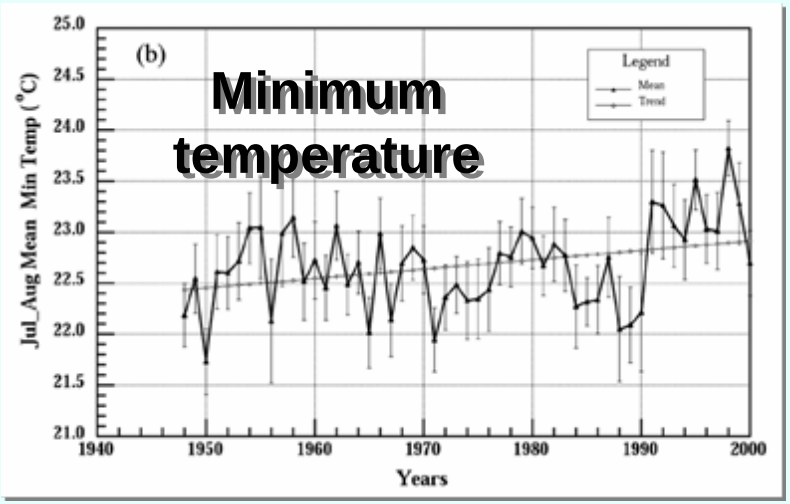


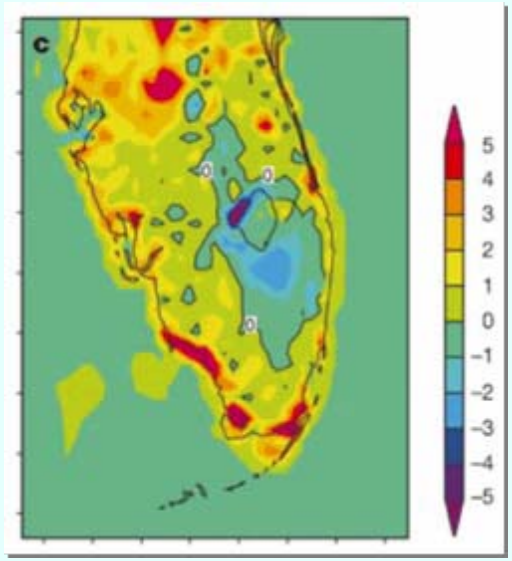
Pielke, R. A. *Science*. 2005

Land use impacts on south Florida climate







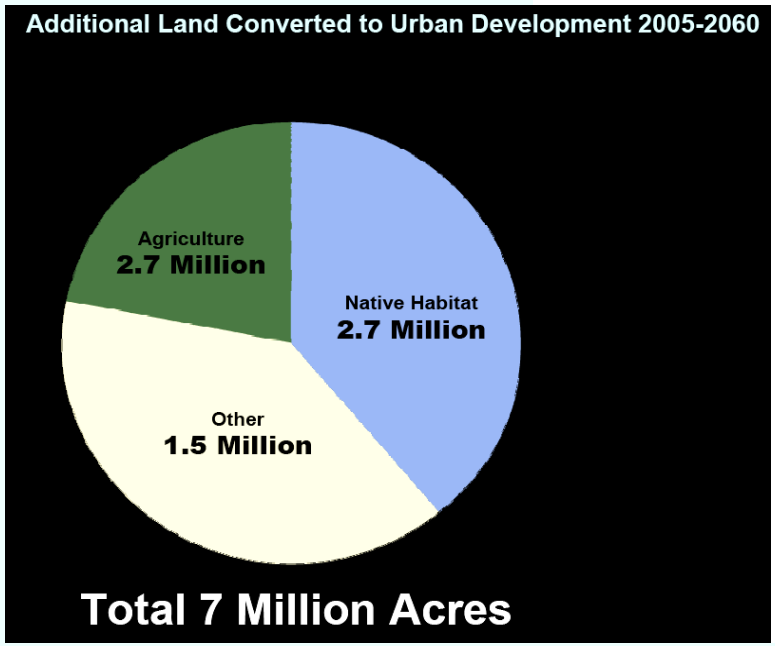


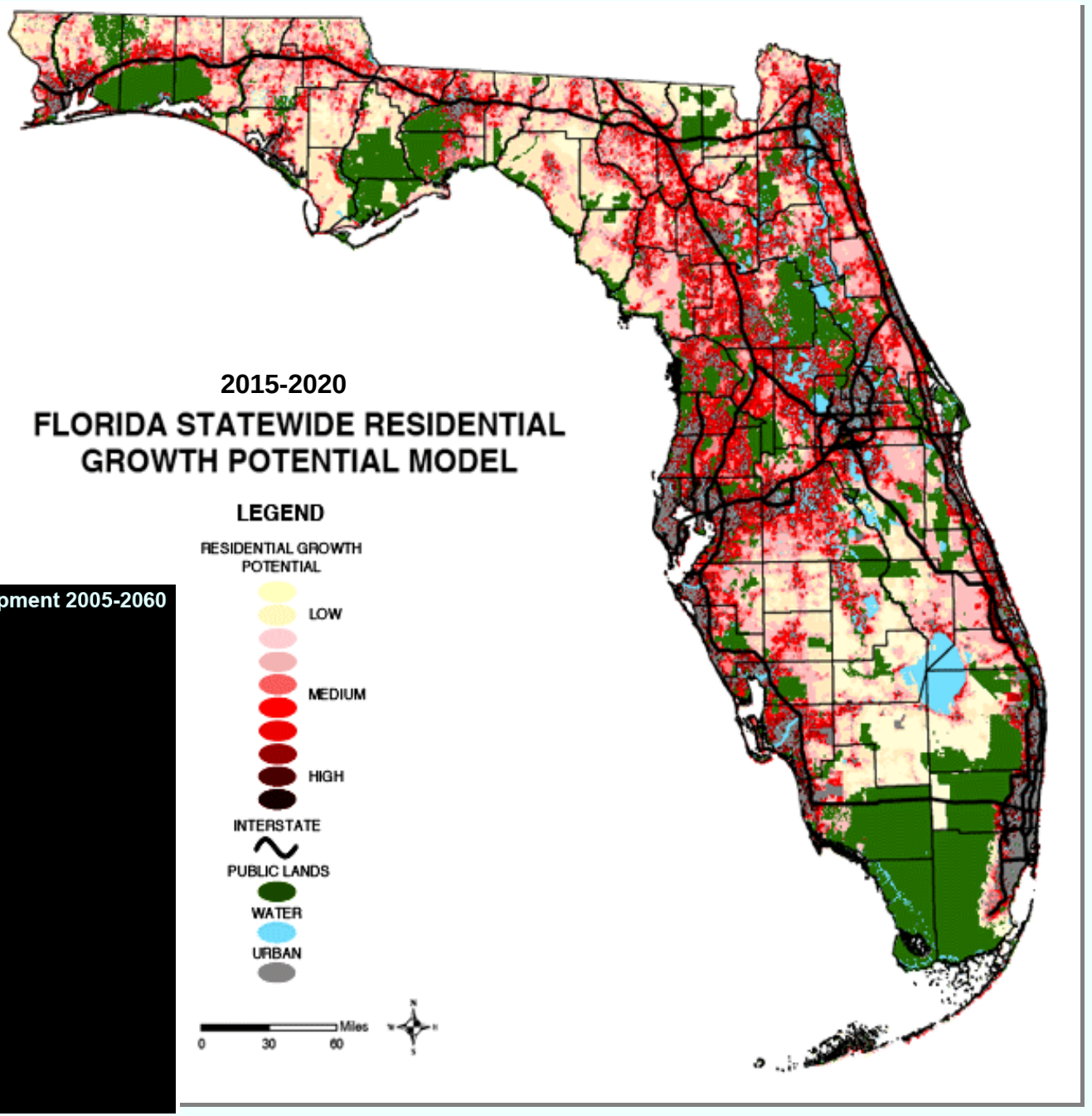
Minimum temperature anomaly due to land use.

Marshall et al. 2005. Monthly weather review.;
Pielke, RA, Sr.et al. 2007. Ag For Met.

Marshall et al. Nature 2003

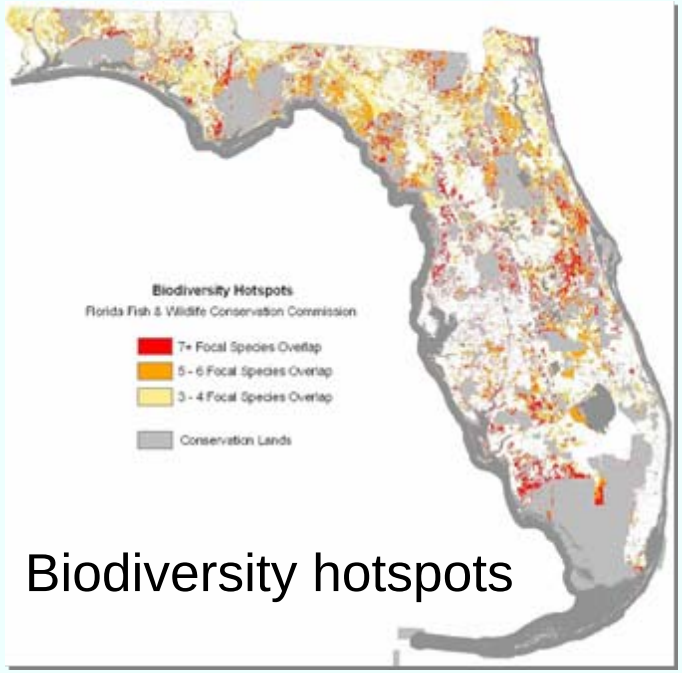
Our problem is obvious



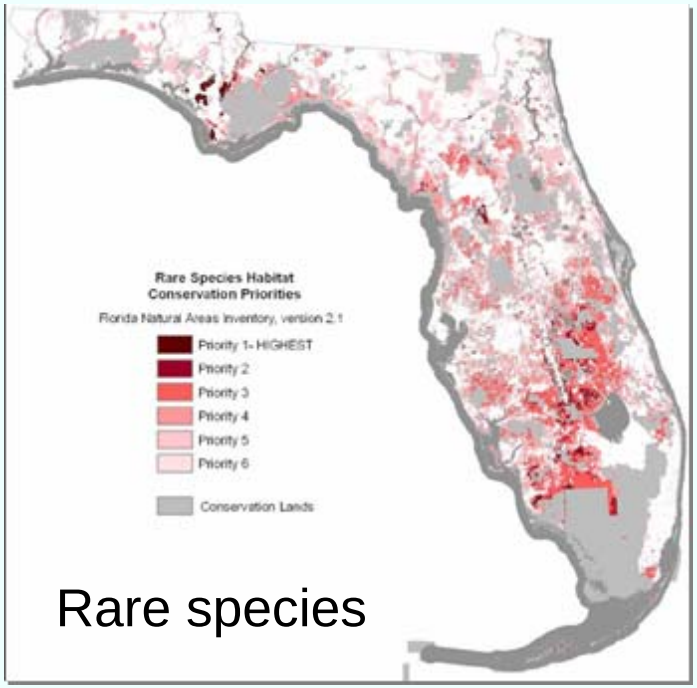


Critical lands

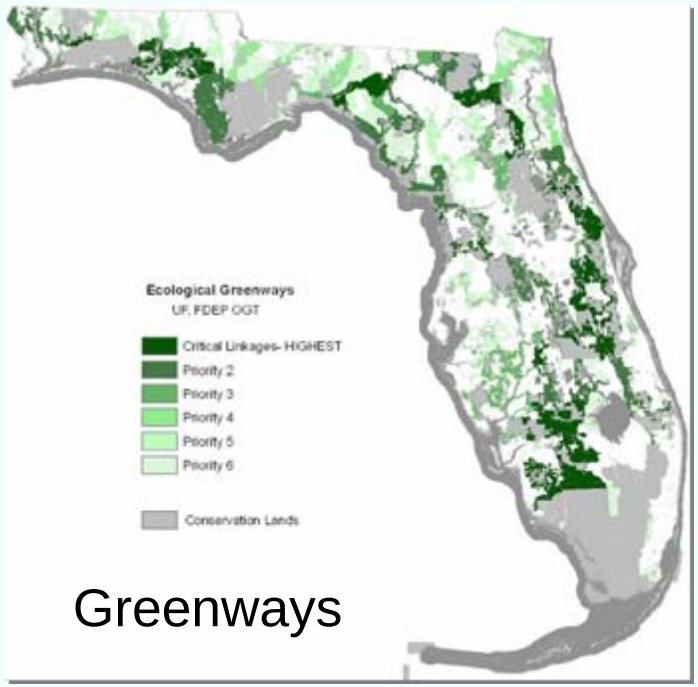
Strategic habitats



Biodiversity hotspots

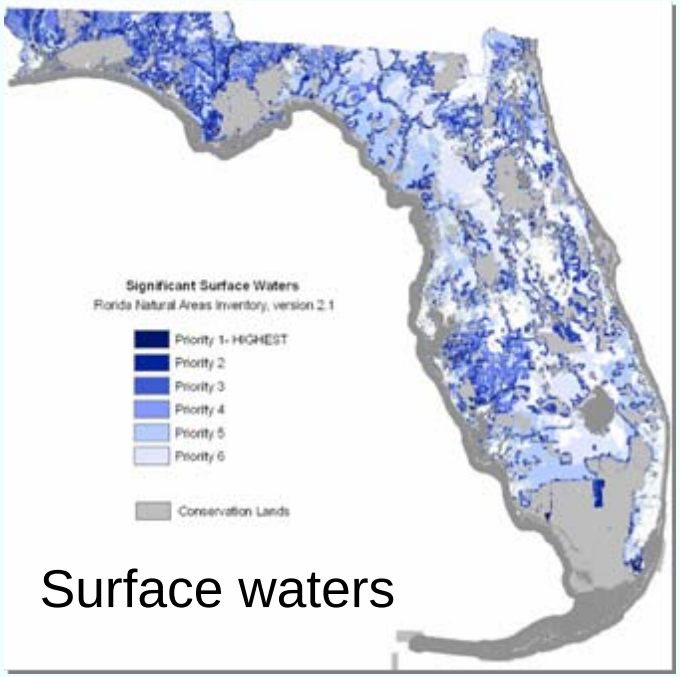


Rare species

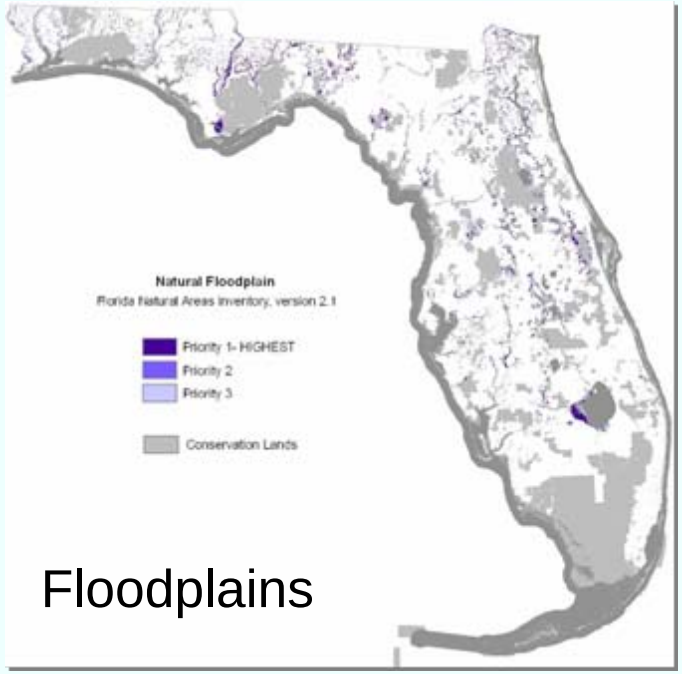


Greenways

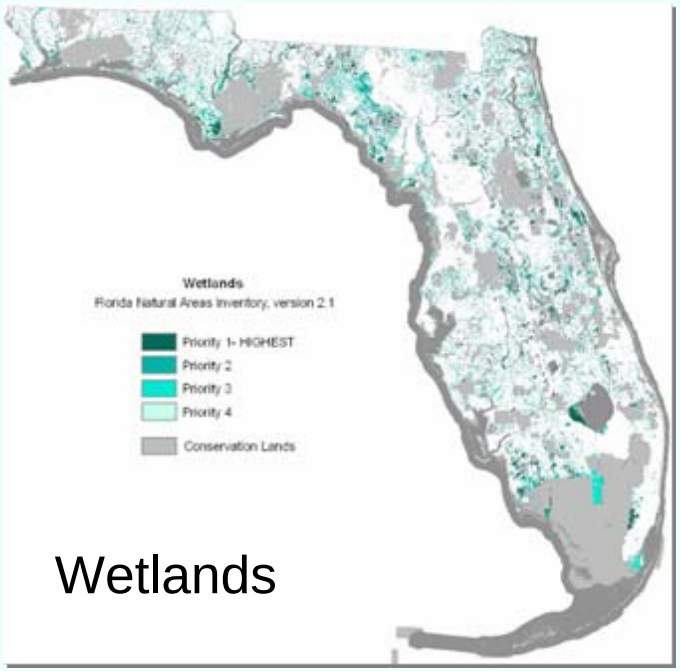
Source: CLIP; FNAI & UF Geoplan



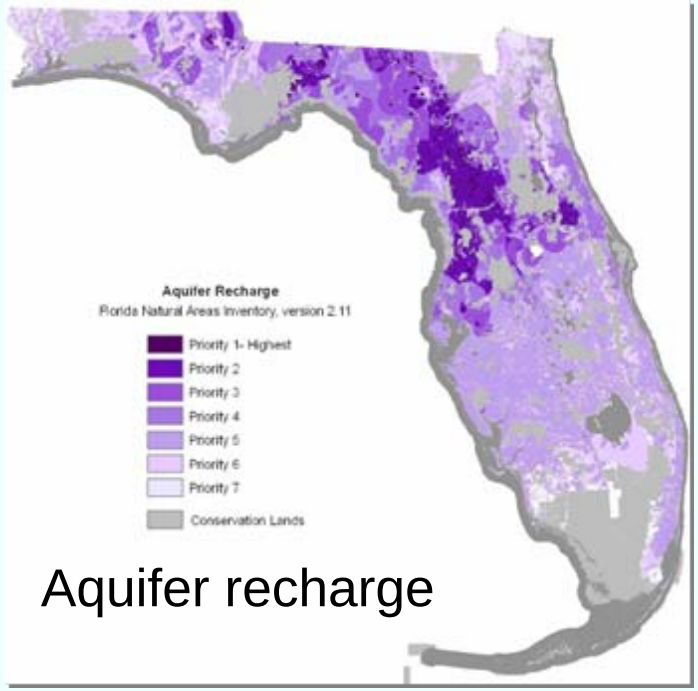
Surface waters



Floodplains



Wetlands

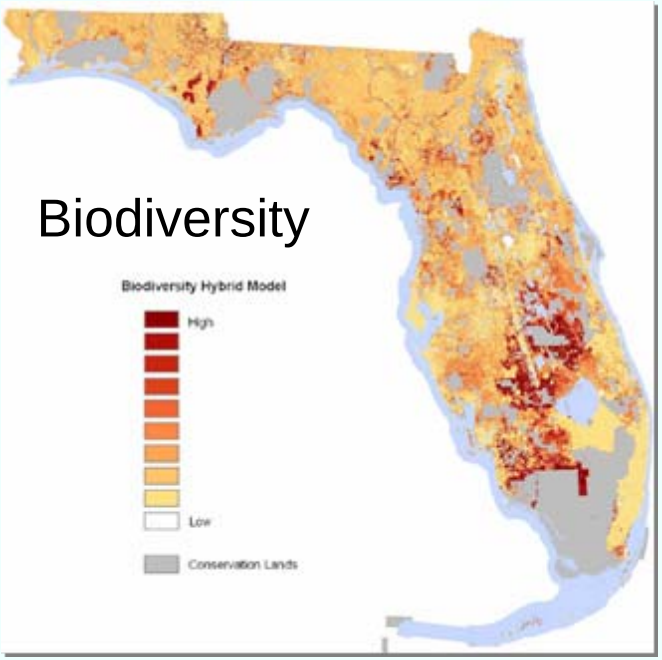


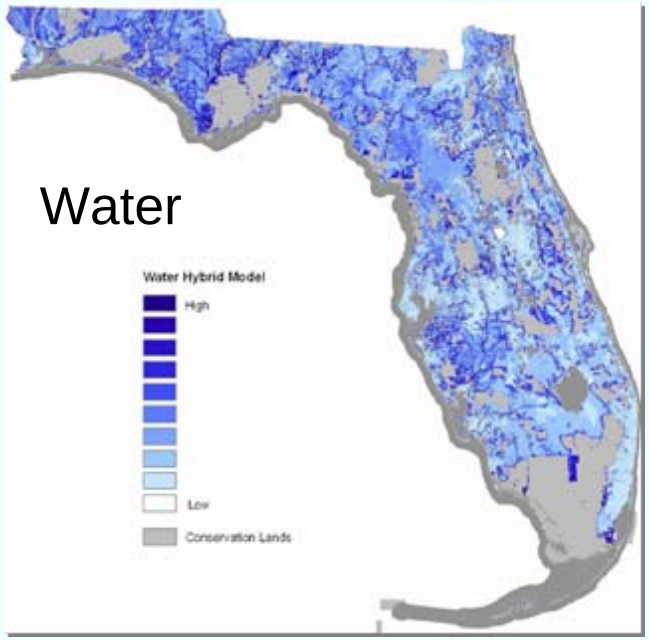
Aquifer recharge

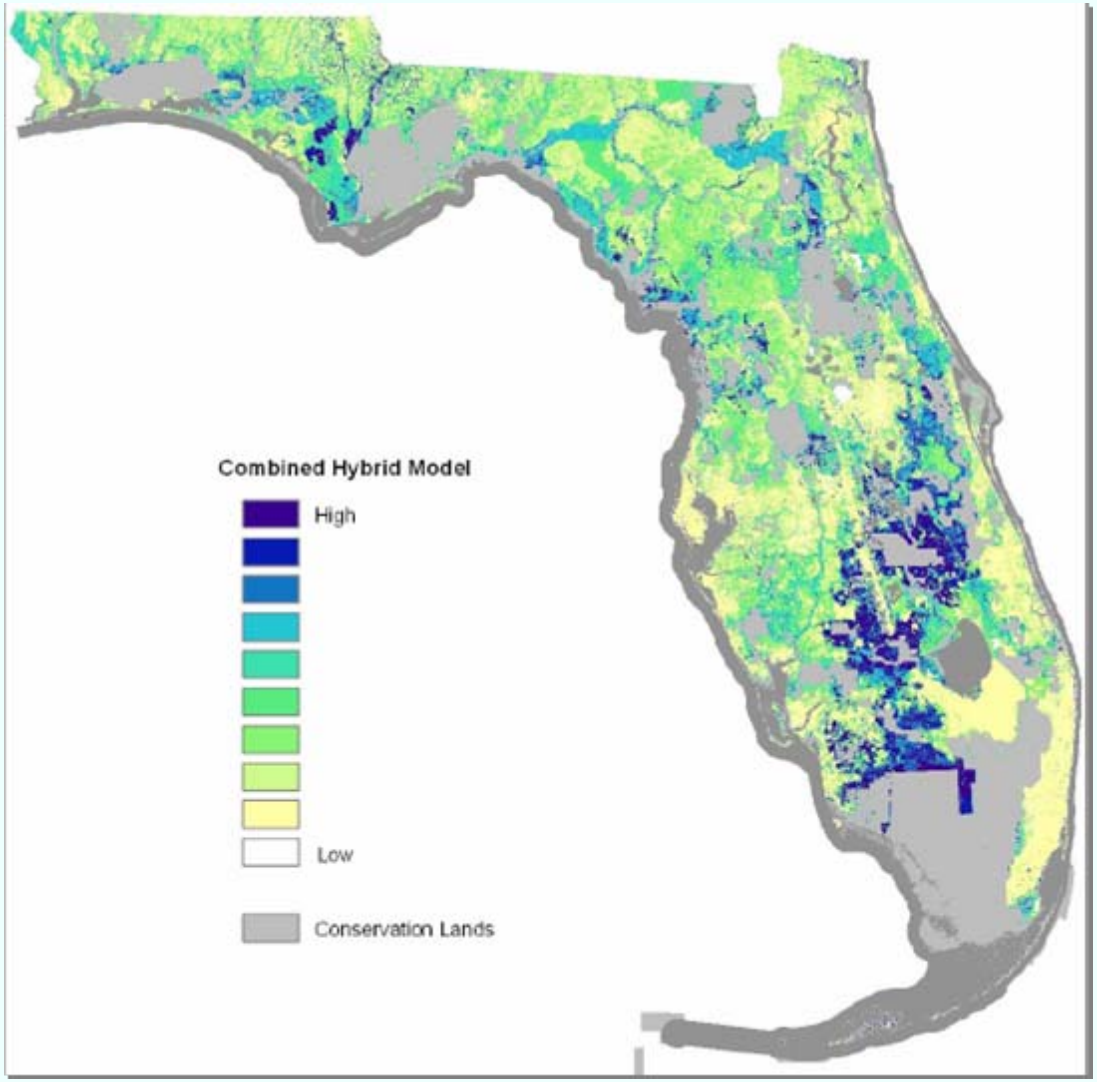
Critical waters

Source: CLIP; FNAI & UF Geoplan

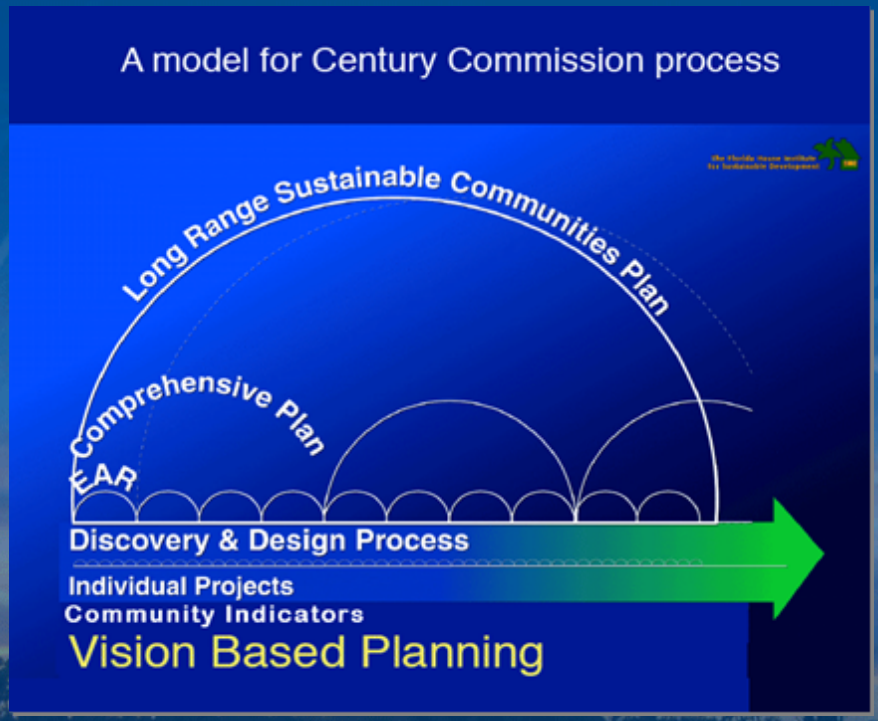
Florida Critical Lands and Waters







Scenario modeling for Florida's future



Concept from The Florida House Institute

IPCC 4th Assessment:

- **Sustainable development can reduce vulnerability to climate change.**
- **Climate change can slow progress toward sustainable development.**