America's CLIMATE CHOICES
AT THE NATIONAL ACADEMIES

Limiting the Magnitude of &
Adapting to

Future Climate Change

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http://americasclimatechoices.org

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Outline:

Background

What can we do to limit the magnitude of future climate change?

What can we do to adapt to the impacts of climate change?

The Request by the U.S. Congress to the National Academy of Sciences:

Congress called for the National Oceanic and Atmospheric Administration (NOAA) to execute an agreement with the NAS to:

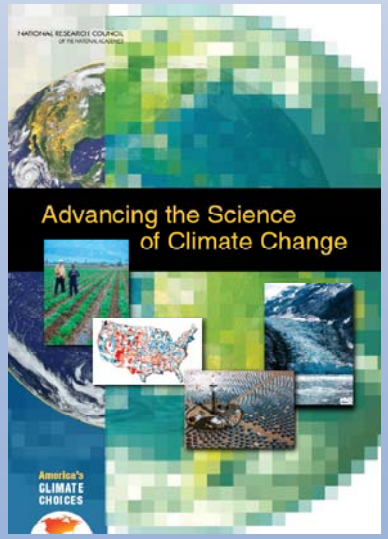
"…investigate and study the serious and sweeping issues relating to global climate change and make recommendations regarding what steps must be taken and what strategies must be adopted in response to global climate change, including the science and technology challenges thereof."

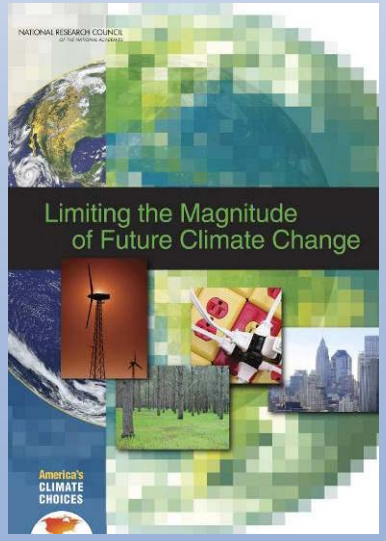
ACC Study Overview

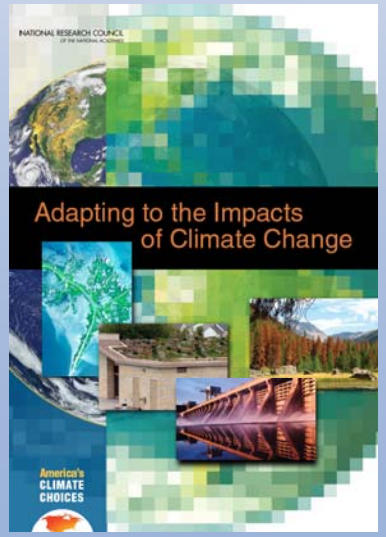
Four panels were convened to study and write reports on :

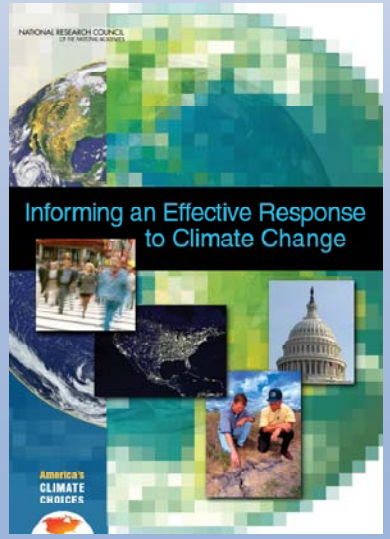
- **Limiting the Magnitude of Future Climate Change**
- **Adapting to the Impacts of Climate Change**
- **Advancing the Science of Climate Change**
- **Informing an Effective Response to Climate Change**

A *Committee on America's Climate Choices will release a Final Report* May 12, 2011





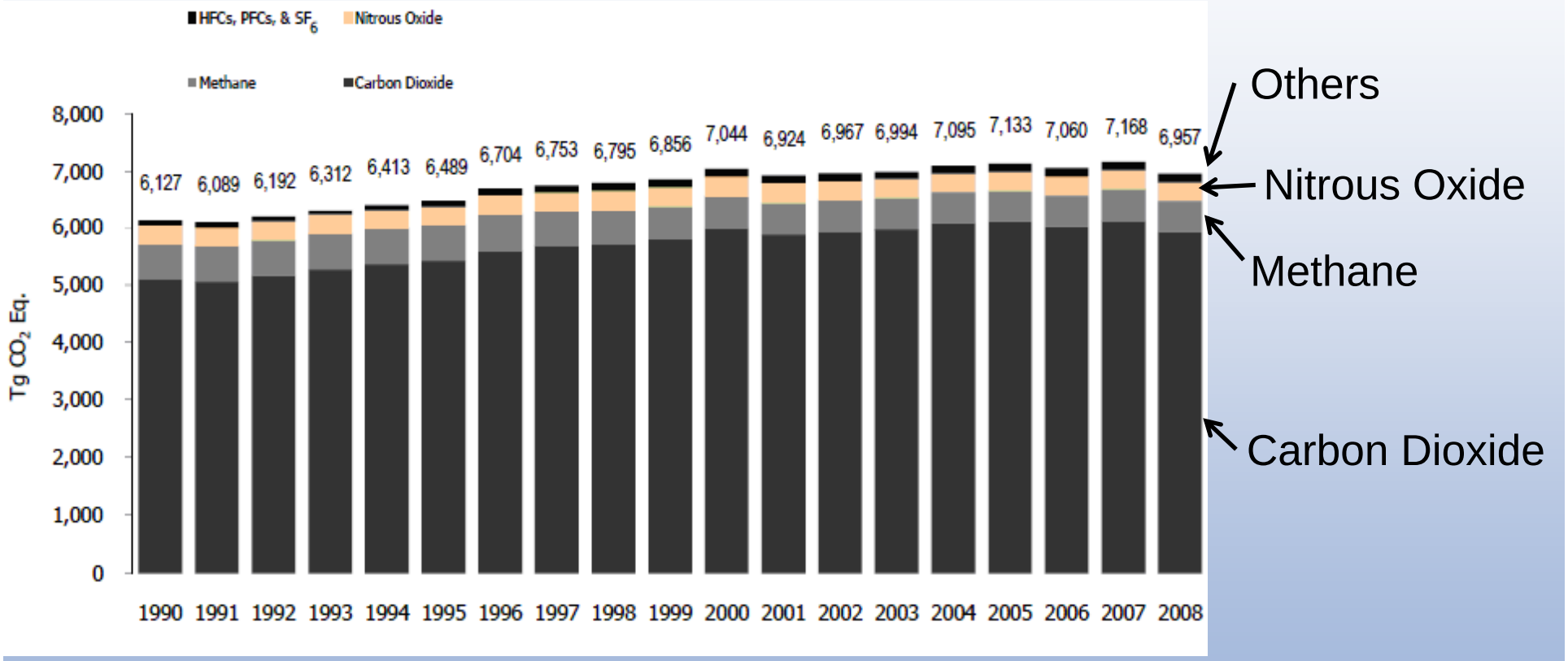




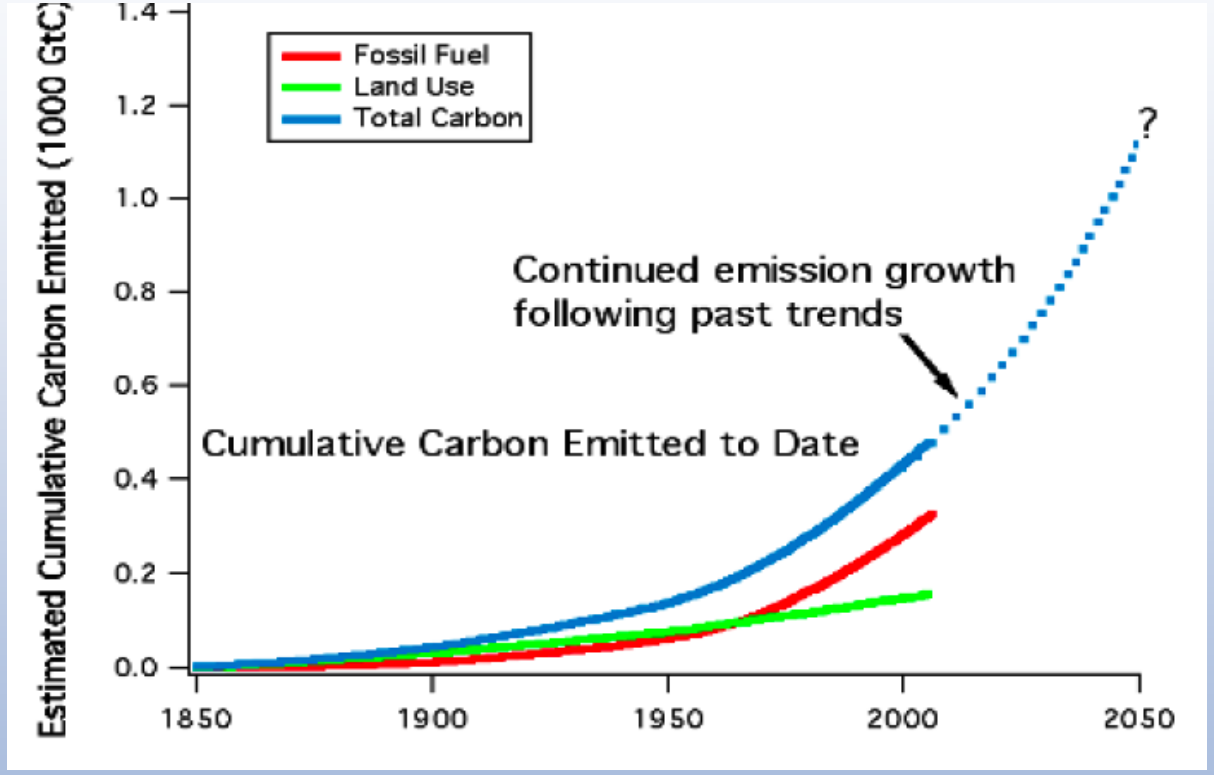
Why the National Academies?

- Reports from the National Academies are viewed as the “gold standard” in objective advice on matters related to science
- National Academy of Sciences (NAS) chartered in 1863 by Lincoln to provide advice to the Nation on science, engineering, and medicine.
- The National Research Council (NRC) is the operating arm of the NAS, NAE.
- NRC is a private, non-profit organization that convenes ad hoc committees of experts who serve pro bono
- Committees of experts are carefully chosen for expertise, balance, and objectivity
- All reports go through stringent peer-review and must be approved by both the study committee and the institution.

Carbon Dioxide is the Most Abundant Greenhouse Gas



Carbon Emissions Are Rising Rapidly



1. Carbon (in the form of CO_2) emitted into the atmosphere is increasing
2. Human activities are largely responsible for the increase in the atmospheric CO_2 concentrations

Setting Goals

Target: limiting global mean temperature increase (e.g., 2 deg, 3 deg)

What is a 'safe' amount of climate change?

↓

Target: limiting global GHG emissions (e.g. total global emission budget)

How does a given amount of greenhouse emissions translate into warming and other climate change impacts?

↓

Target: limiting U.S. GHG emissions (e.g. national emission budget)

What is a 'reasonable' share of U.S. emissions relative to the global target?

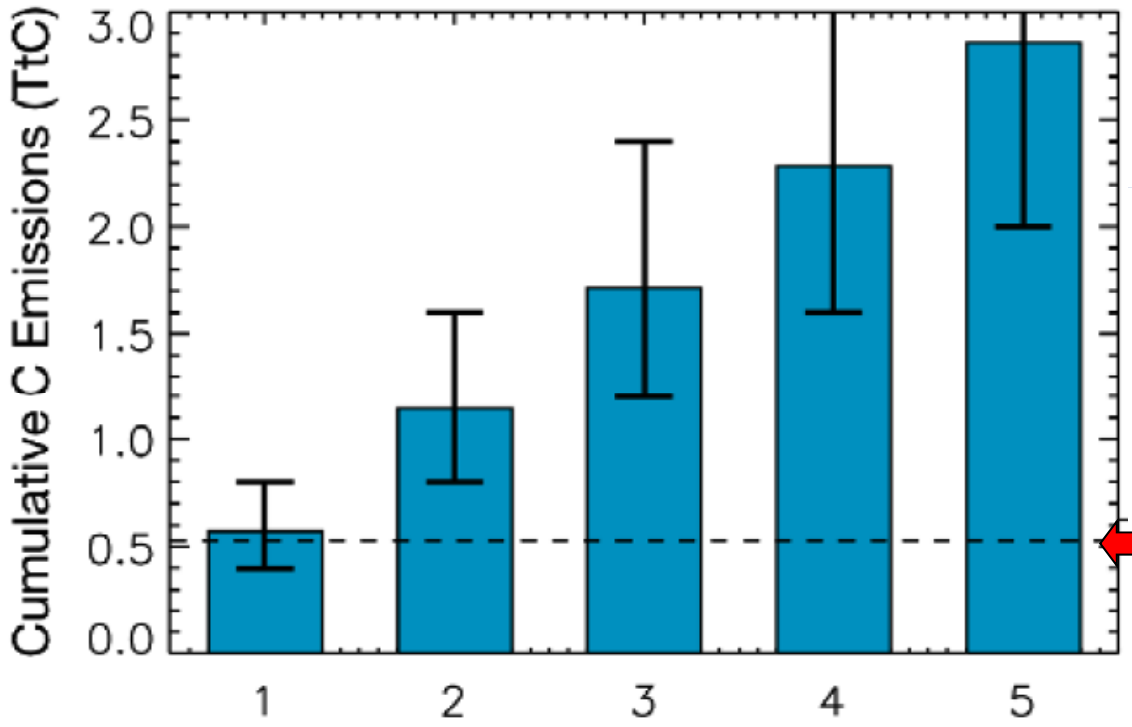
How Much Warming Is Too Much?

This requires value judgments. Not everyone agrees on how much risk we can tolerate as a society.

Because CO_2 stays in the atmosphere for a long time, most impacts may be irreversible for more than 1,000 years.

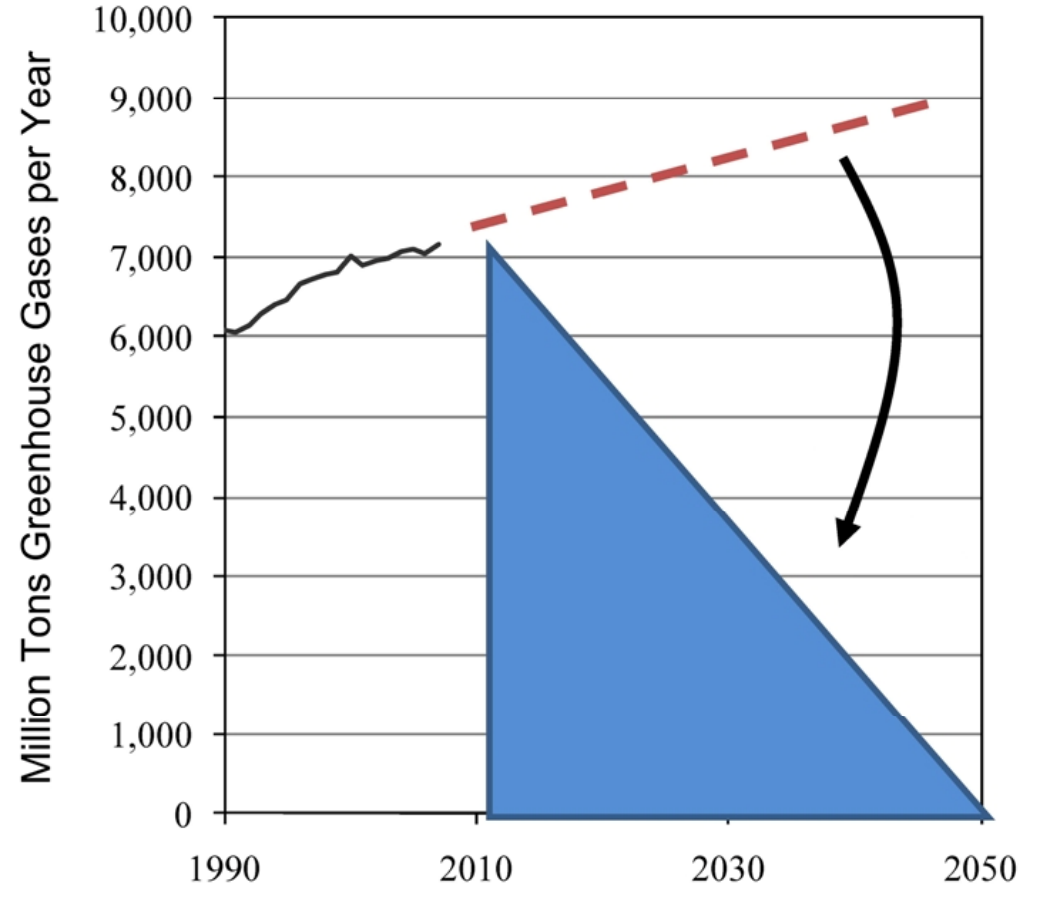
Thus, the majority of scientists and scientific reports suggest it is prudent to make sure we limit the amount of future climate change to a level that is "safe". There are debates about what this level really is.

More Carbon Means Rising Temperature



Emissions Budget

The U.S. goal could be set as the total amount of greenhouse gases emitted over a given period of time.

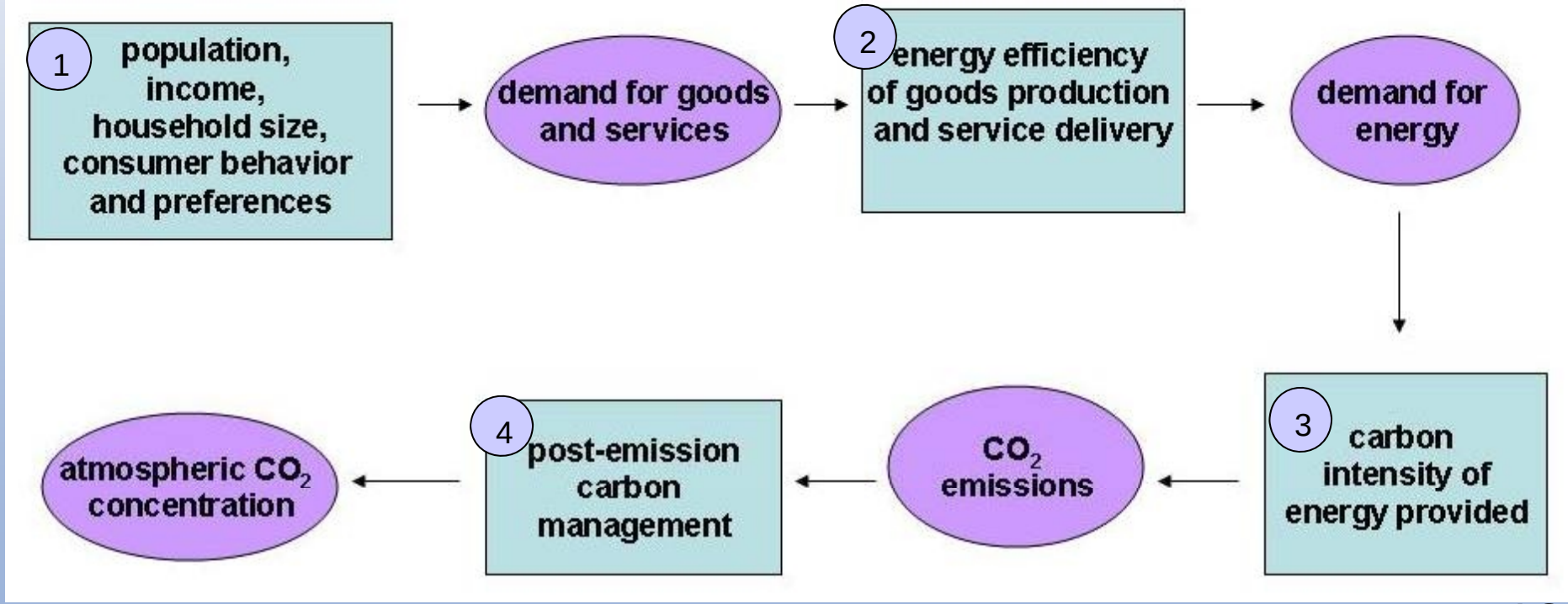


Under a "business as usual" scenario, total emissions might be ~330 billion tons from 2012-2050

Under a reasonably stringent budget, total emissions might be ~170 billion tons from 2012-2050

Options to Reduce CO_2 Emissions

1. Reduce demand for goods & services requiring energy
2. Improve the efficiency with which energy is used
3. Expand the use of low- and zero- carbon energy sources
4. Capture and sequester CO_2 directly from the atmosphere



Bottom Line

Achieving substantial U.S. emissions reductions could be technically possible, but will be very difficult.

For the electricity sector, existing clean energy options may be sufficient, but will need to be deployed as aggressively as possible.

For the transportation sector, expanding the use of ‘biofuels’ will not be sufficient.

Need to aggressively pursue all major near-term opportunities AND to support R&D for creating new options.

Recommendations

1. **Adopt an economy-wide carbon pricing system.**

2. **Complement the carbon price with policies to:**
   - advance energy efficiency and low-emission energy sources in the electric and transportation sectors;
   - establish the feasibility of carbon capture and storage and new nuclear technologies;
   - accelerate the retirement, retrofitting or replacement of emission-intensive infrastructure.

3. **Create new technology choices by investing heavily in research and crafting policies to stimulate innovation.**

Recommendations (continued)

4. **Consider potential equity implications when designing and implementing climate change limiting policies, with special attention to disadvantaged populations.**

5. **Establish the United States as a leader to stimulate other countries to adopt GHG reduction targets.**

6. **Enable flexibility and experimentation with policies to reduce GHG emissions at regional, state, and local levels.**

7. **Design policies that balance durability and consistency with flexibility and capacity for modification as we learn from experience.**

Take Home Messages:

A robust U.S. response to limit future climate change requires:

- Prompt, sustained efforts to reduce GHG emissions.
- An inclusive national framework for aligning the goals and efforts of actors at all levels.
- Adaptable management of policy responses.

Even with an aggressive response to limit CO_2 emissions not all impacts of climate change can be avoided.

How Can We Adapt to the Impacts of Climate Change?

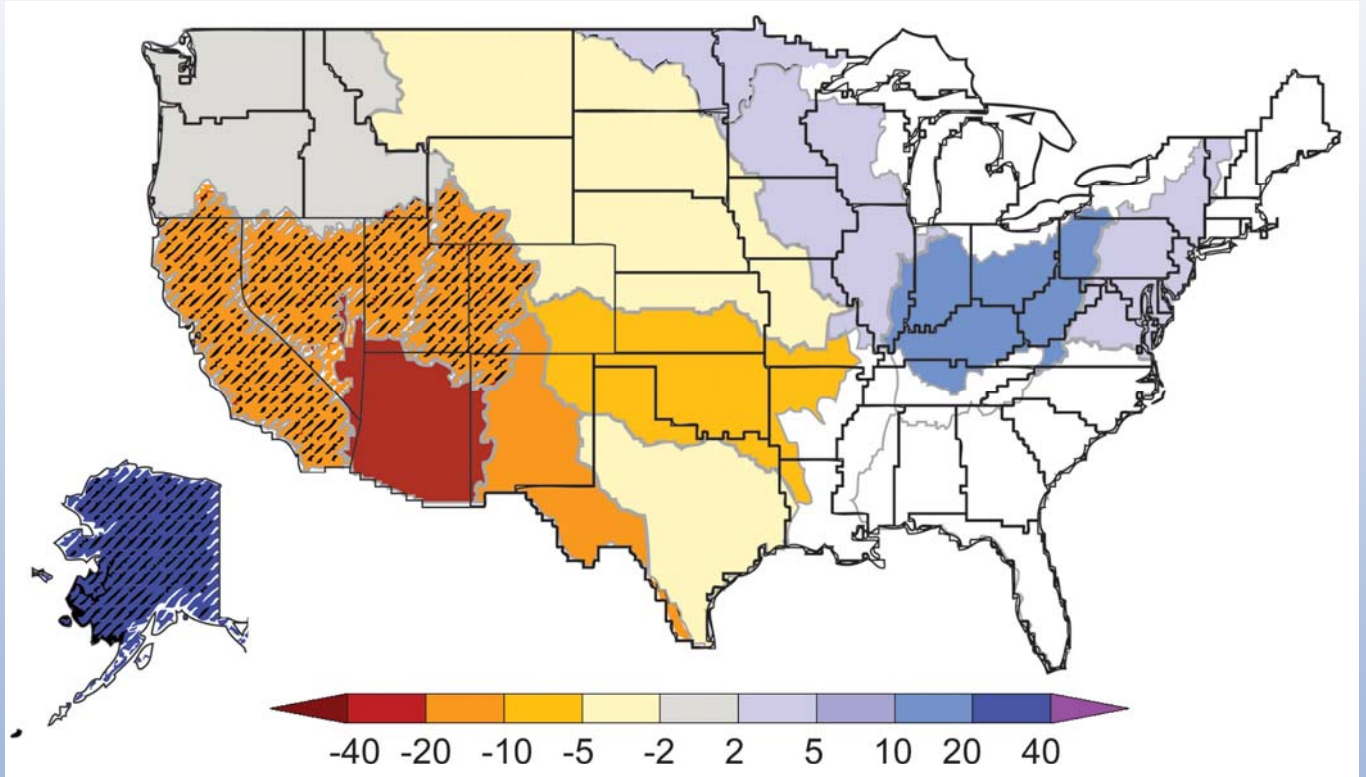
We know the climate is changing in the following way:

For each 1 degree (C) of global temperature increase we can expect the following changes:

- 5-10% changes in precipitation (rain or snow) across many regions
- 3-10% increases in rainfall during the heaviest precipitation events
- 5-10% changes in streamflow across many river basins
- 15% decrease in sea ice across the Arctic Ocean
- 5-15% reductions in the yields of crops as currently grown
- 200-400% increases in the area burned by wildfires in parts of the western United States

The Adaptation Challenge

… but the changes won't be uniform



Percent Changes in
Projected Annual Average Runoff

Source: USGCRP 2009

The Adaptation Challenge

… and each sector has different vulnerabilities

Sector	Examples of impacts due to a change in precipitation
Human health	Worried about more precipitation (e.g. floods and waterborne diseases)
Energy supply and use	Worried about less precipitation (e.g. Hydropower production is reduced; fossil fuel and nuclear plants production reduced due to increased water temperatures and reduced cooling water availability)
Ecosystems	Worried about less precipitation (e.g. water supply for endangered fish species)

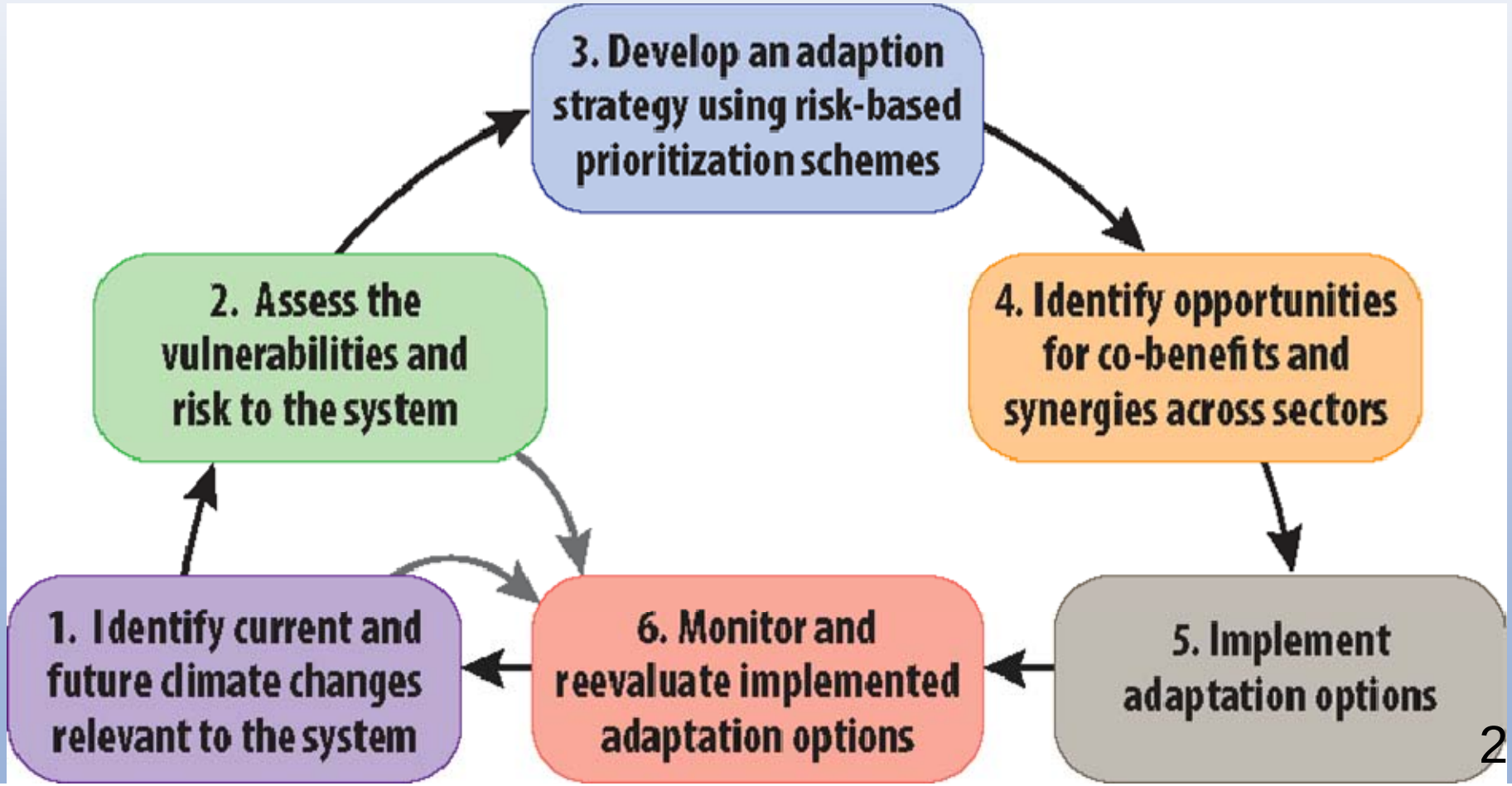
Source: Adapted from USGCRP 2009

The Adaptation Challenge

- **What makes sense is very context-specific**
- **Very limited knowledge of costs, benefits, potentials, and limits**
- **Limited evidence so far of effectiveness in reducing future climate change impacts**

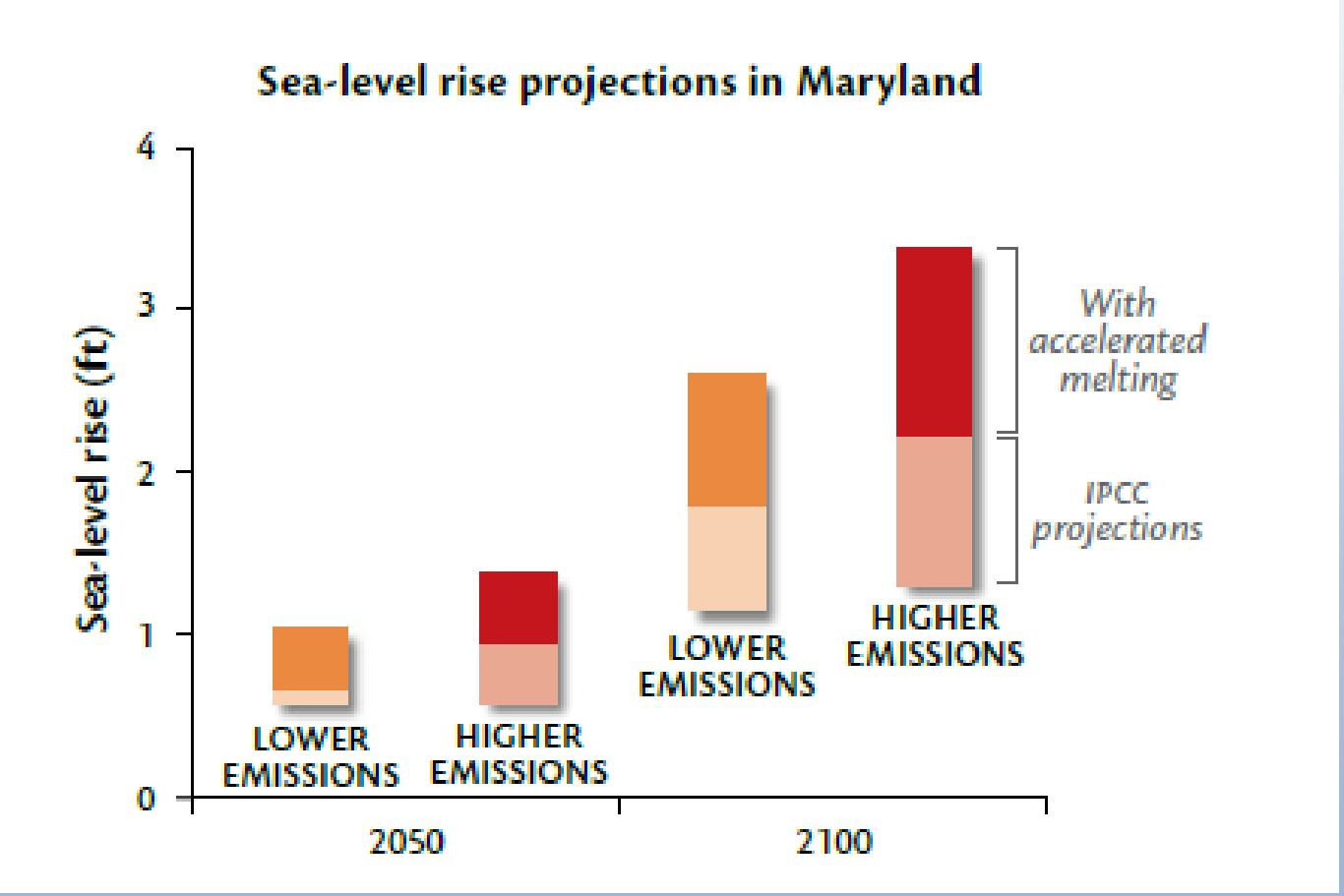
What Can We Do?

Adopt a risk management approach as a strategy for preparing ourselves for an uncertain future:



For example: Annapolis

Climatic Change of Concern:



Source: Maryland Department of Natural Resources

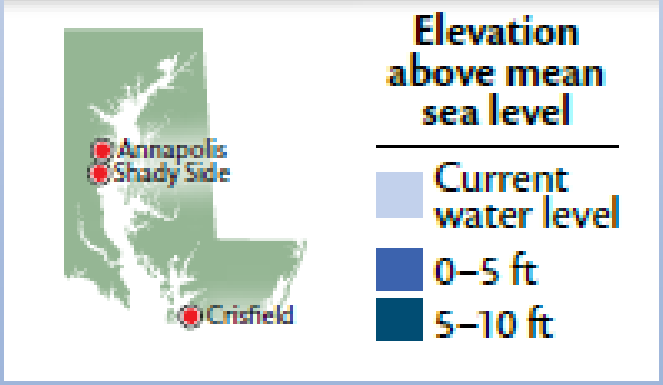
For example: Annapolis

Vulnerability of the System:

Maryland State House

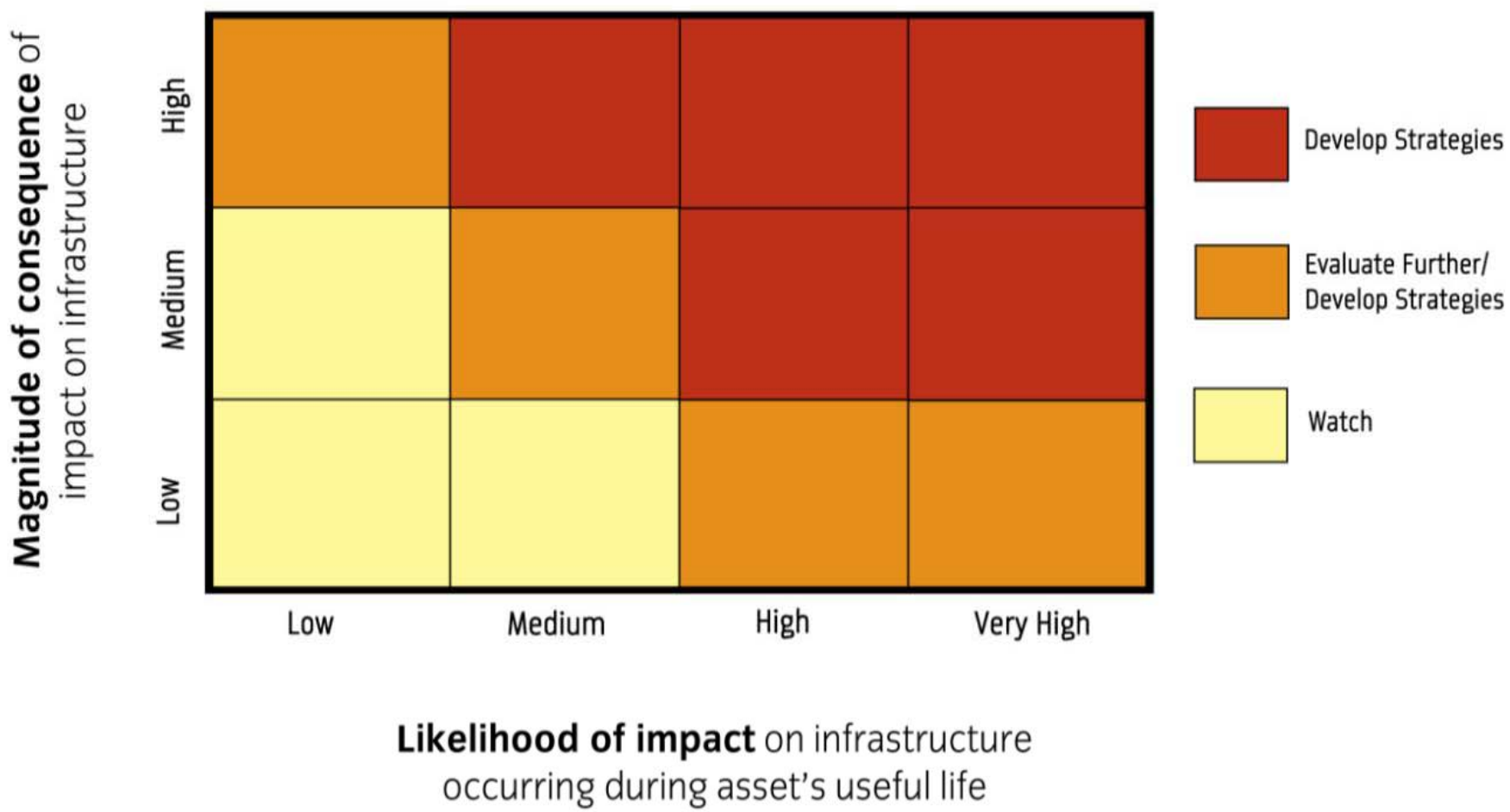
Naval Academy Visitor Center

Marriott Waterfront

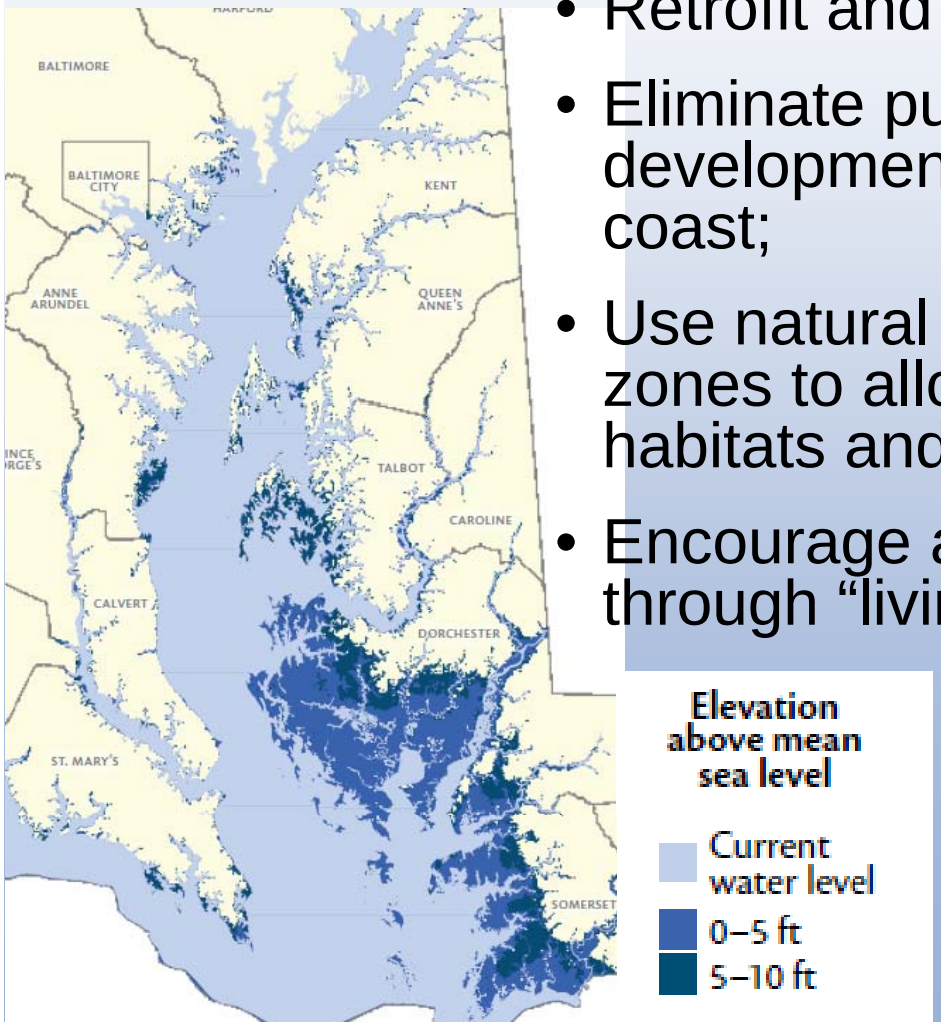


Source: Maryland Department of Natural Resources

Setting Priorities



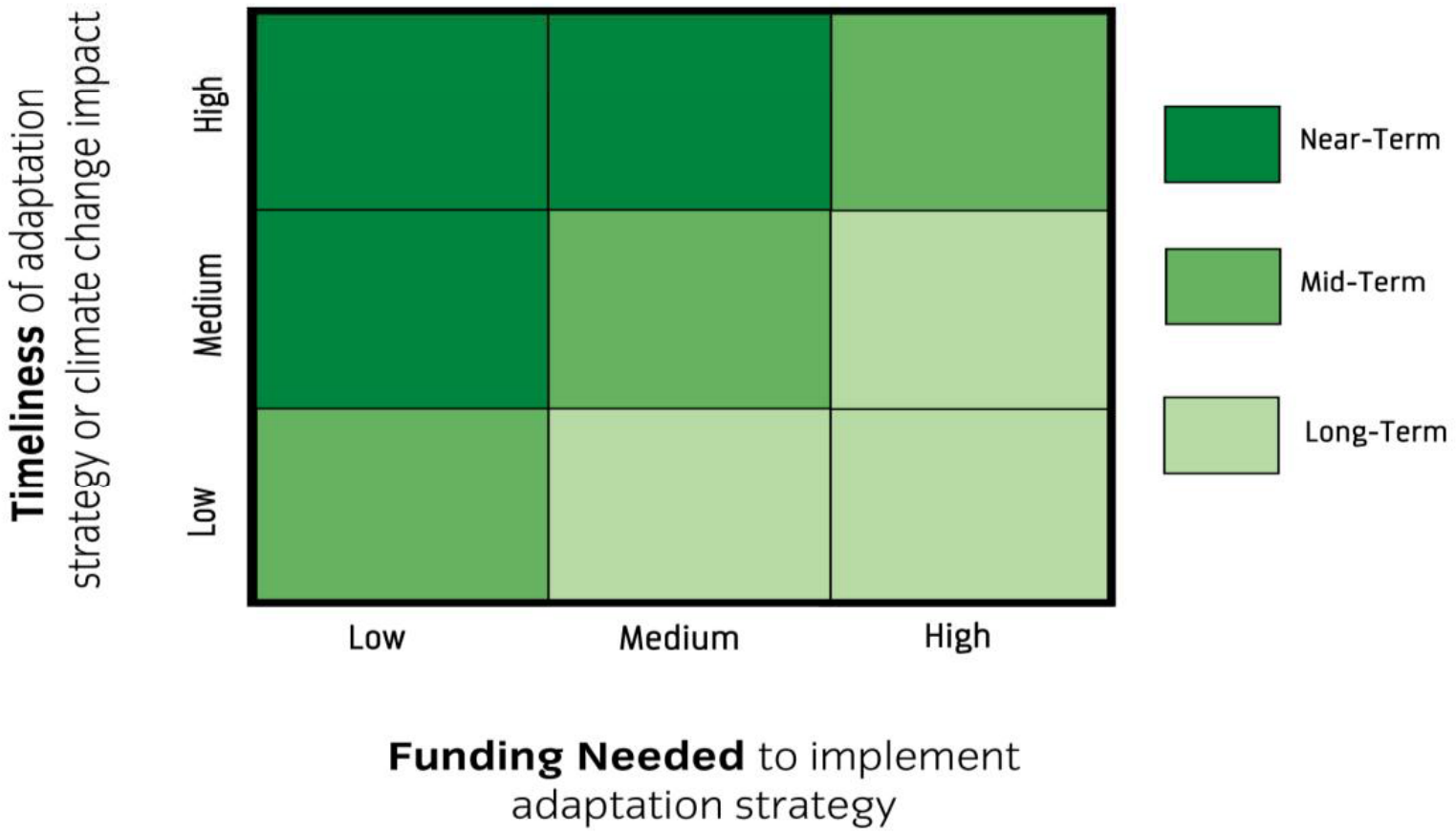
Examples of Options to Adapt to Sea-Level Rise



- Retrofit and protect public infrastructure;
- Eliminate public subsidies for future development in high hazard areas along the coast;
- Use natural shorelines, setbacks, and buffer zones to allow inland migration of shore habitats and barrier islands over time;
- Encourage alternatives to shoreline “armoring” through “living shorelines”; etc.

Choosing Adaptation Options

Identify Synergies and Trade-offs:

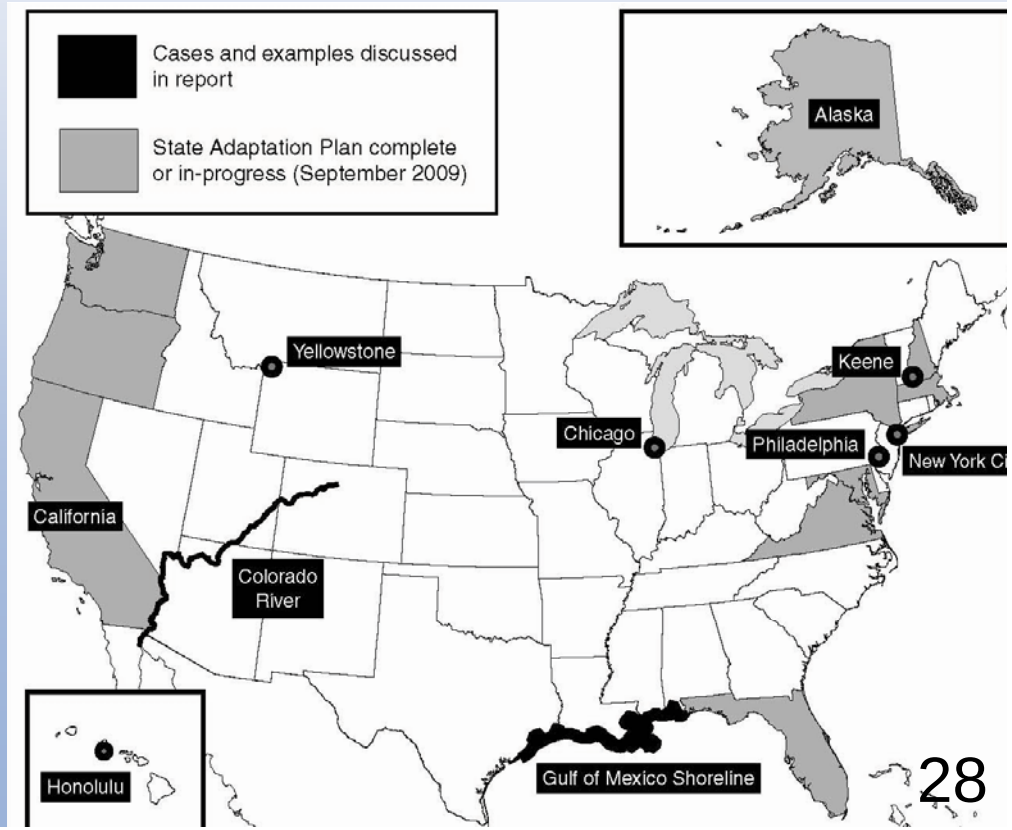


In the Short-Term, Adaptation Choices Likely to Reflect Options that

- Are easily deployed
- Focus on immediate risks that we care about
- Offer co-benefits for other objectives
- That have broad constituency support
- Reduce maladaptive policies and practices
- Avoid foreclosing future options

Implementation Barriers

- **Institutional Barriers**
- **Limited and Uneven Adaptive Capacity**
- **Resource Limitations**
- **Trans-boundary Issues**
- **Cross-sectoral Issues**



Recommendations

- **Develop a national adaptation strategy to overcome the barriers**

- **Combine grassroots-based, bottom-up adaptation efforts with a strong federal government commitment to adaptation**

- **Federal government facilitates coordination and knowledge exchange between the local efforts**

Main Conclusions

- **Climate is already changing. The magnitude of future changes depends on what choices we make today.**

- **Remaining uncertainty is not a reason to delay taking steps to limit greenhouse gas emissions or to adapt.**

- **The response to climate change needs to be viewed as an iterative process, which should *begin now* and from which we *learn by doing*.**

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For more information:

http://americasclimatechoices.org

For full report text online, free PDFs of report Summary and 4-page "report in brief", or to order copies:

http://www.nap.edu