

# Water: Key Issues

Joint International Conference  
Karlsruhe Institute of Technology,  
The US National Academies, and the German Academy  
of Sciences Leopoldina

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Pacific Institute  
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# Focus

- Water and Climate Adaptation
- Water and Climate Mitigation (Energy Connections)
- The Concept of Peak Water
- Sustainable Solutions

# Adapting to Climate Change is Unavoidable



# Climate and Water Conclusions

- The scientific evidence that humans are changing the climate is increasingly compelling.
- Complex impacts affecting every sector of society, including, especially, water resources, are now unavoidable.
- In many cases and locations, there is compelling scientific evidence that climate changes will pose serious challenges to water systems.

# What Can We Expect for Water from Climate Change?

- A hotter world.
- Uncertain changes in precipitation, but overall intensification of rainfall.
- Dramatic changes in snowfall and snowmelt dynamics and runoff *timing*.
- Rising sea-level with impacts on groundwater aquifers and delta ecosystems.
- Uncertain impacts on extreme events, though extreme events – both floods and droughts – may be more of a problem.



Increased  
air temperature

## Climate Change Effects on Water Resources

Total precipitation may increase or decrease



More precipitation as rain than snow  
due to higher temperatures

Less snowpack

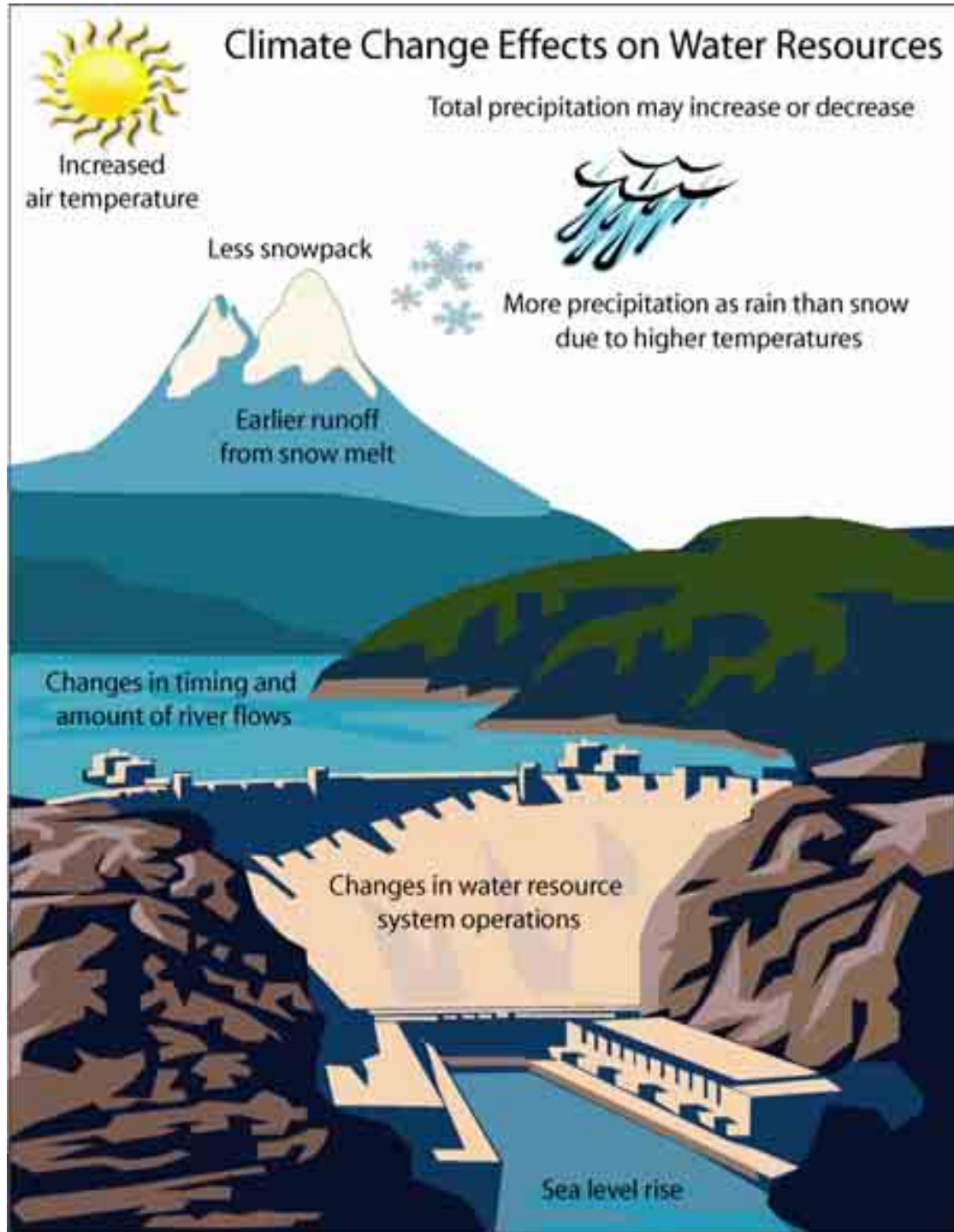


Earlier runoff  
from snow melt

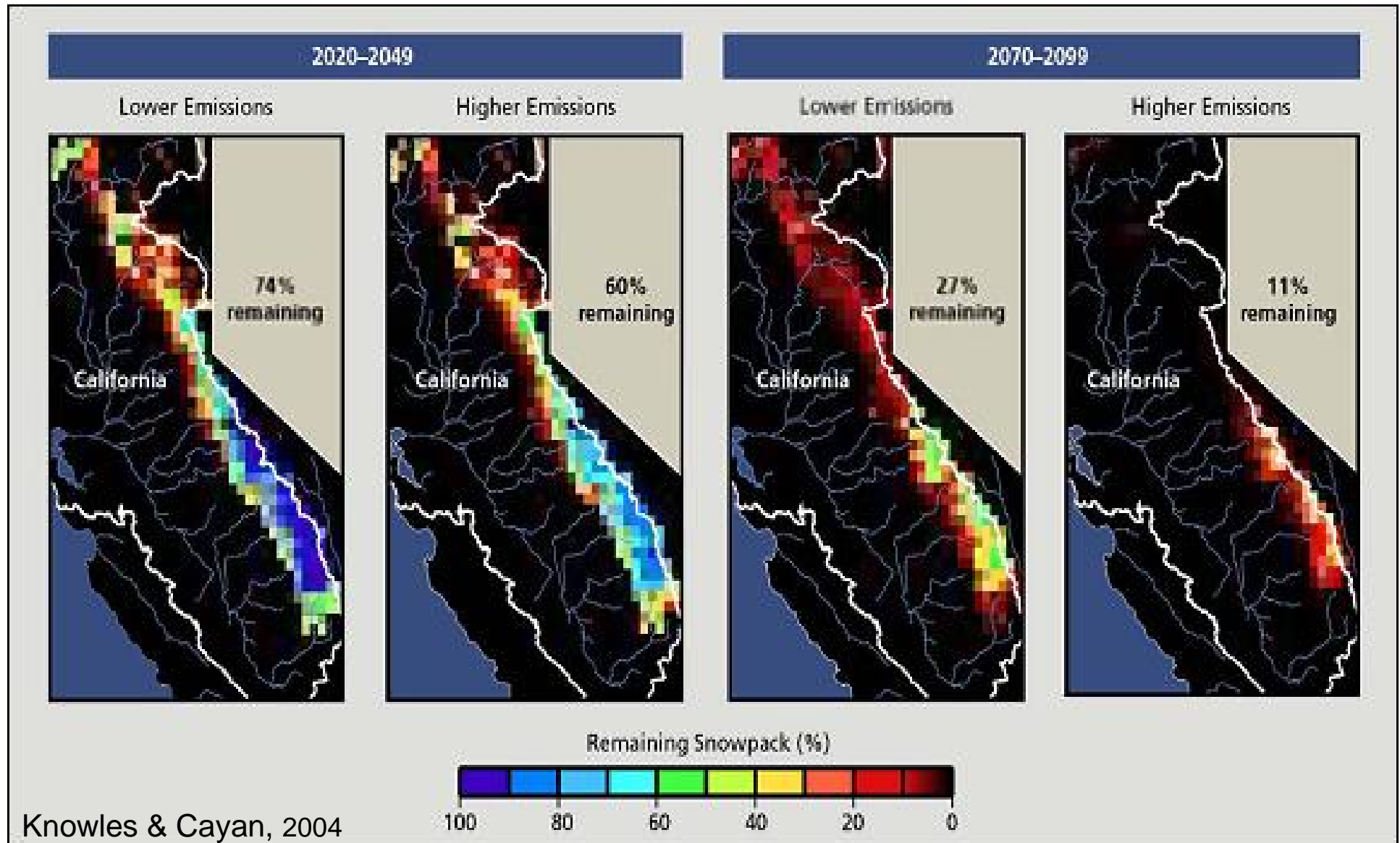
Changes in timing and  
amount of river flows

Changes in water resource  
system operations

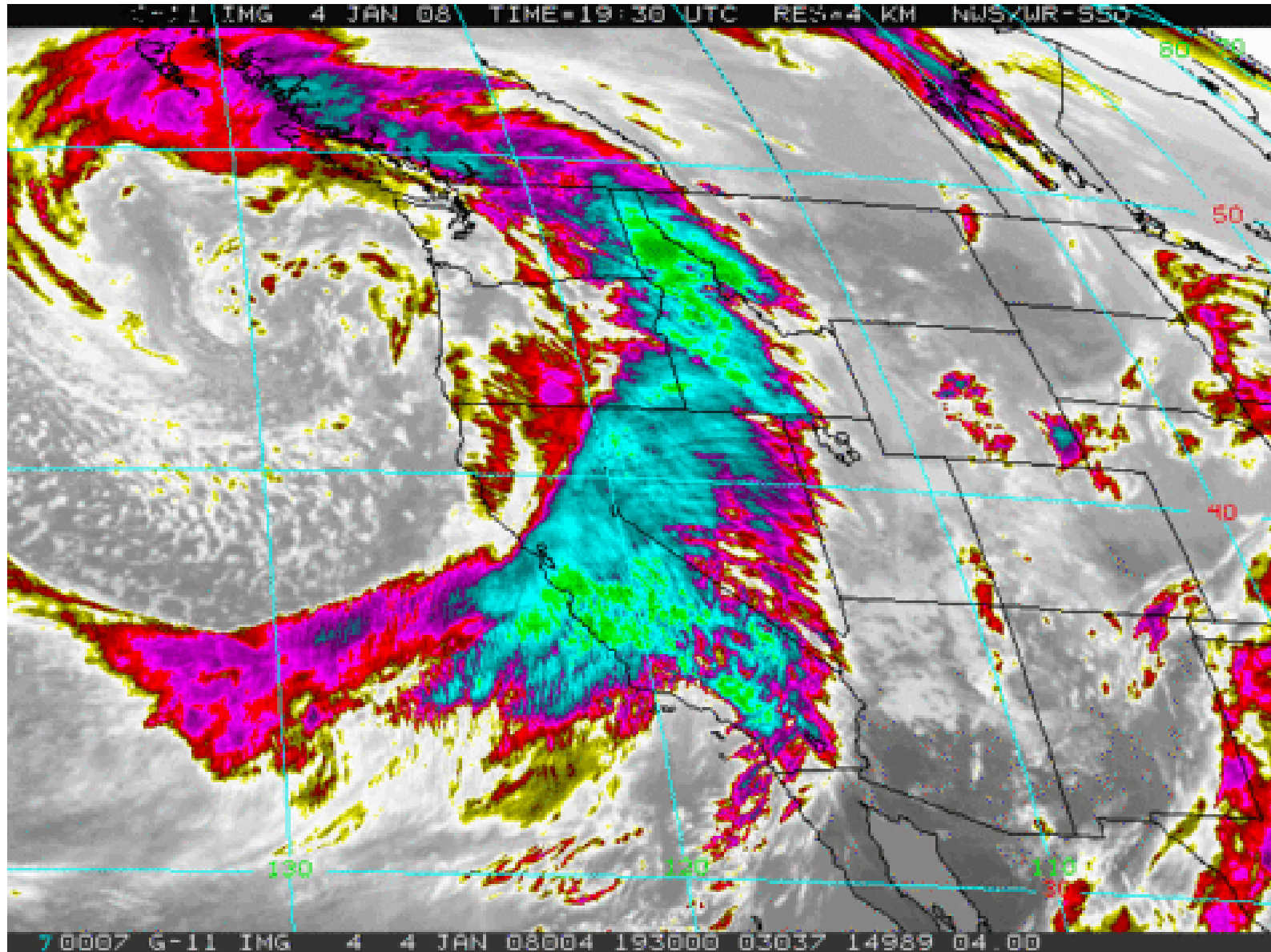
Sea level rise



# Snowpack Will Shrink

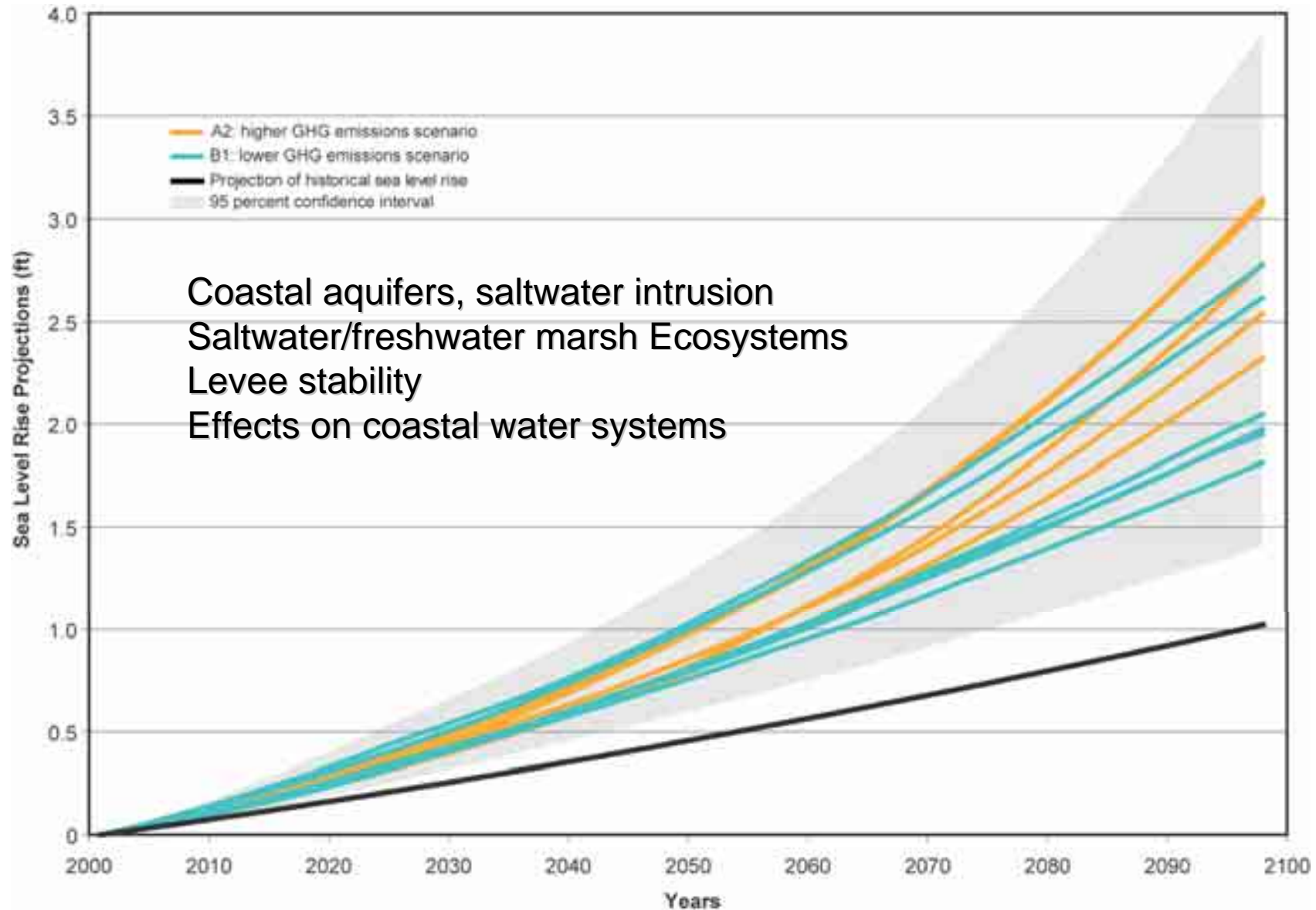


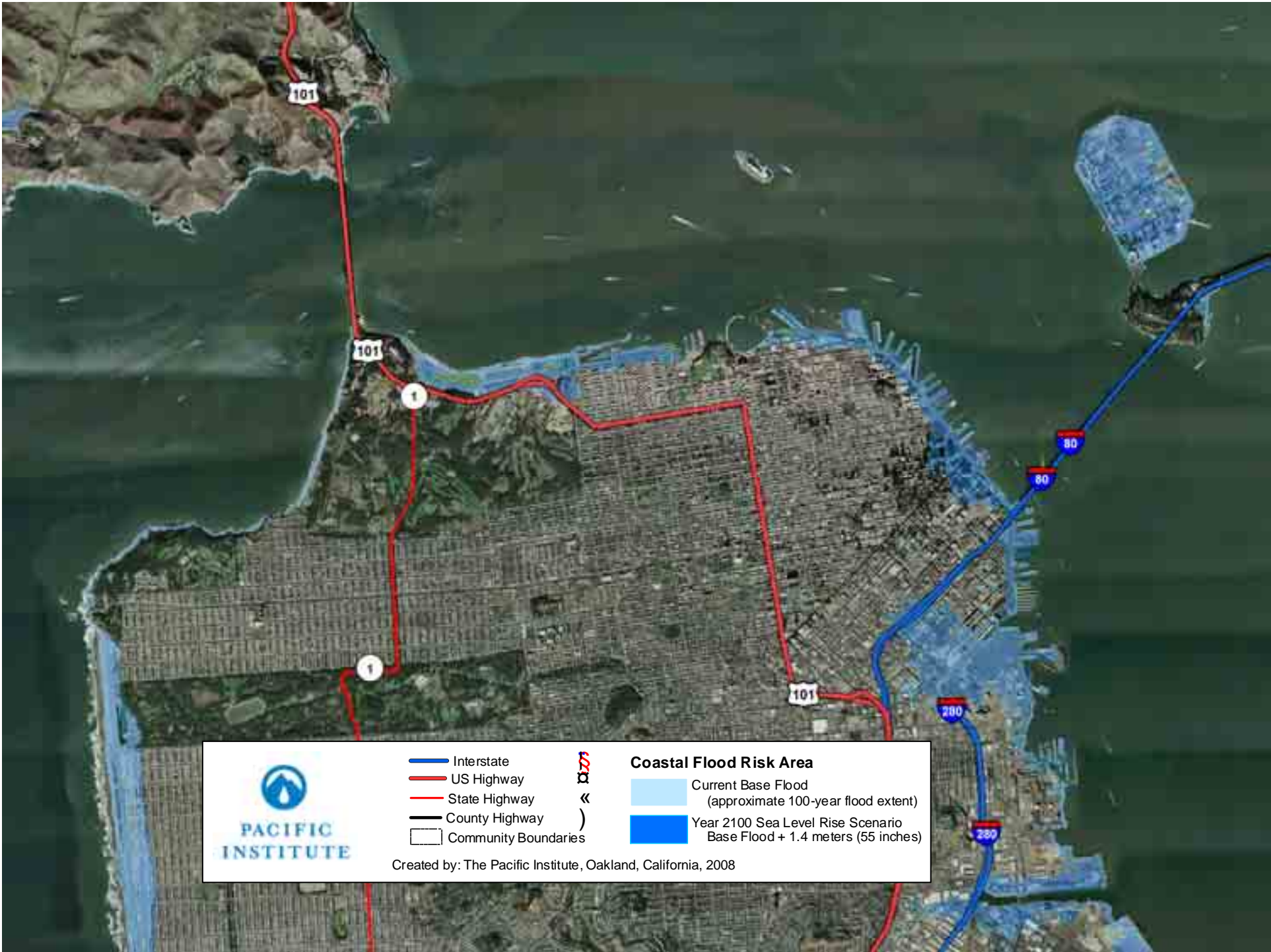
# Extreme Events are Critical












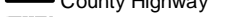
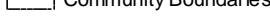




# Sea-Level Rise is Unavoidable





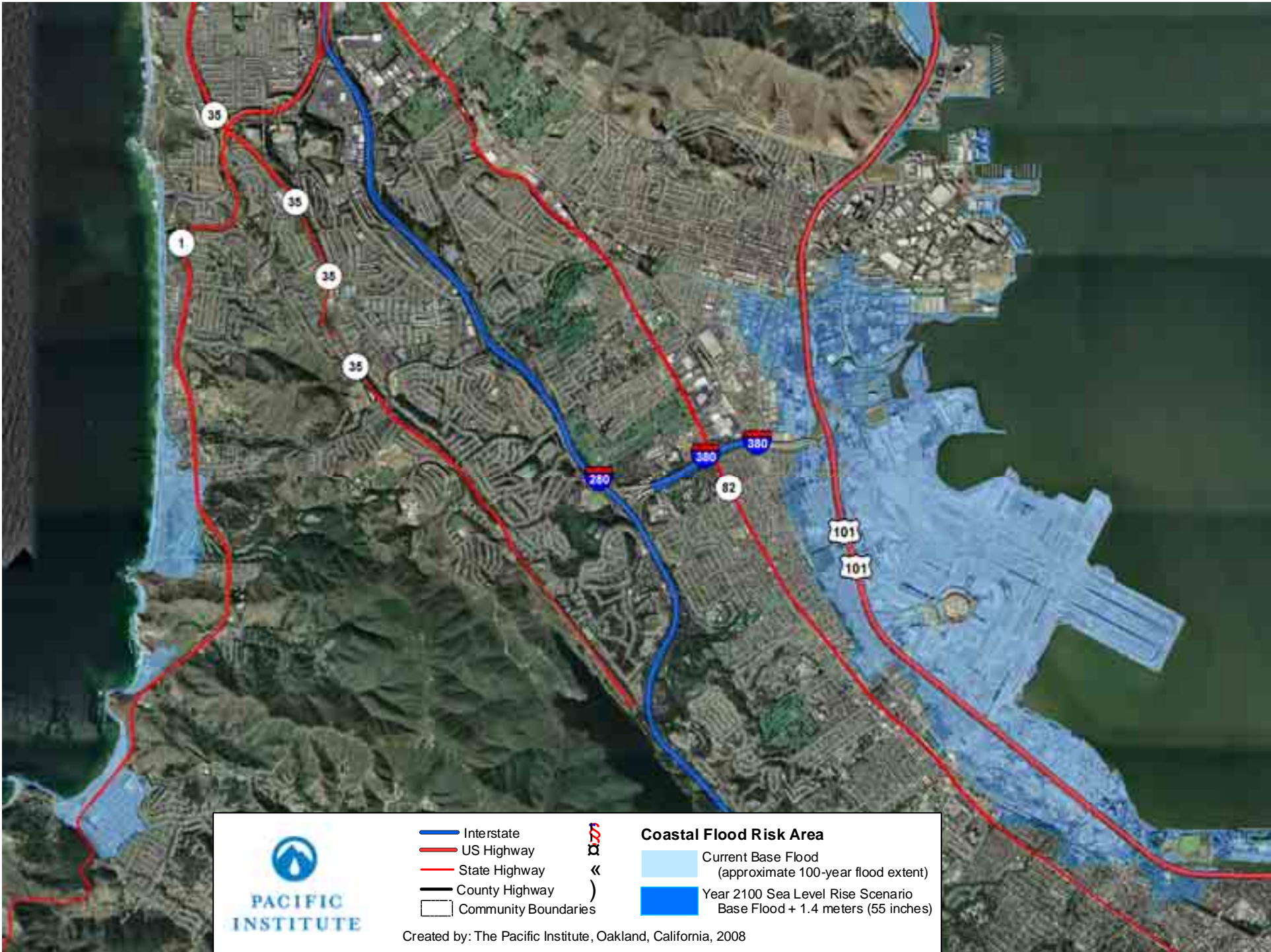
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|---|---|---|--|--|
| <br><b>PACIFIC INSTITUTE</b> |  Interstate            |      | <b>Coastal Flood Risk Area</b>   |  |
|   |  US Highway            |   |  Current Base Flood<br>(approximate 100-year flood extent)                |  |
|   |  State Highway         |   |  Year 2100 Sea Level Rise Scenario<br>Base Flood + 1.4 meters (55 inches) |  |
|   |  County Highway        |   |  |  |
|   |  Community Boundaries |   |  |  |













Created by: The Pacific Institute, Oakland, California, 2008

# Ocean Beach, San Francisco

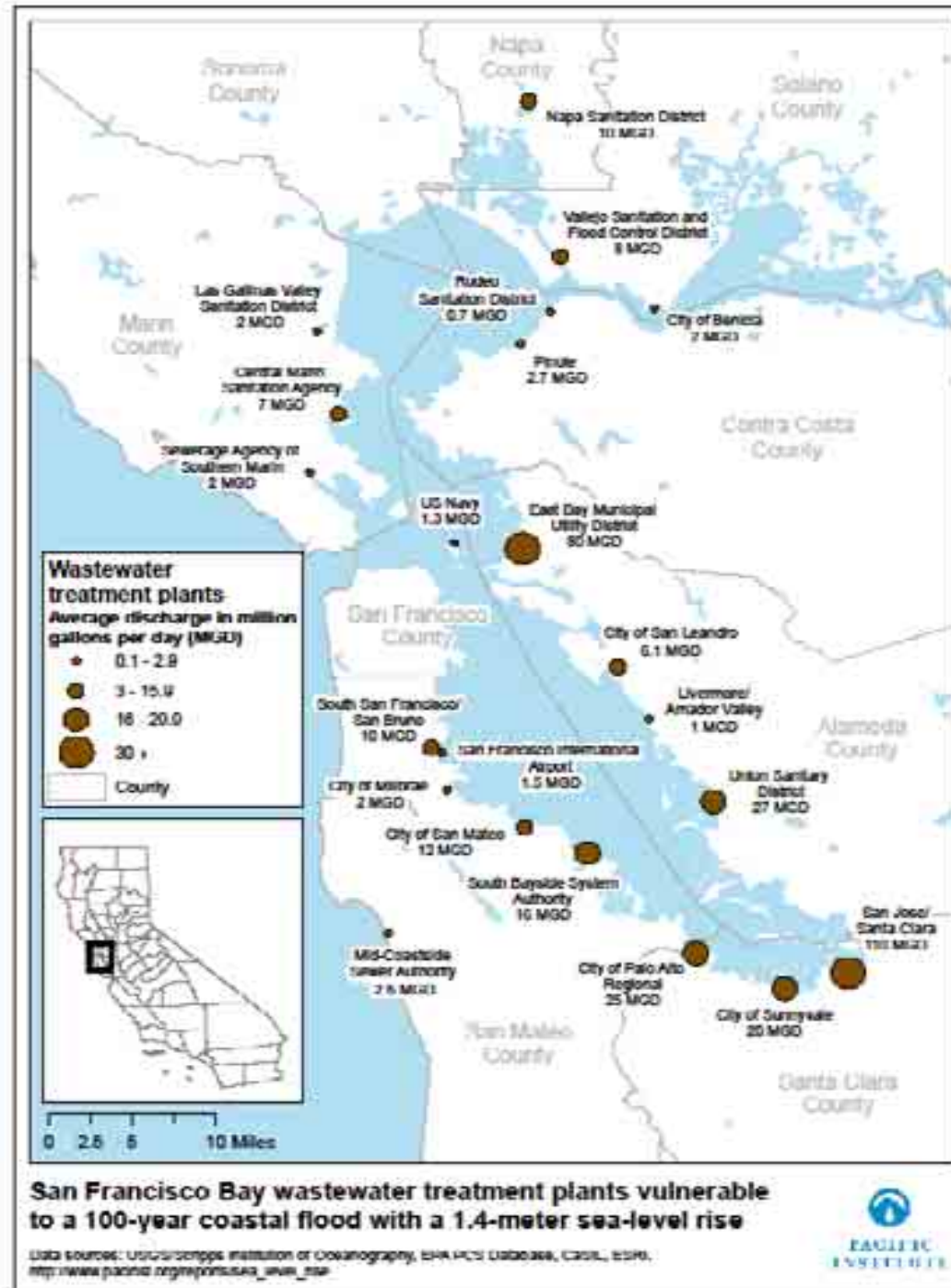


Source: [californiacoastline.org](http://californiacoastline.org)



|   |  |   |  |
|---|--|---|--|
|  |  Interstate           |  )<br> )<br> )<br> )<br> ) | <b>Coastal Flood Risk Area</b>   |
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Created by: The Pacific Institute, Oakland, California, 2008



Heberger et al. 2009. The Impacts of Sea-Level Rise on the California Coast. Pacific Institute, California

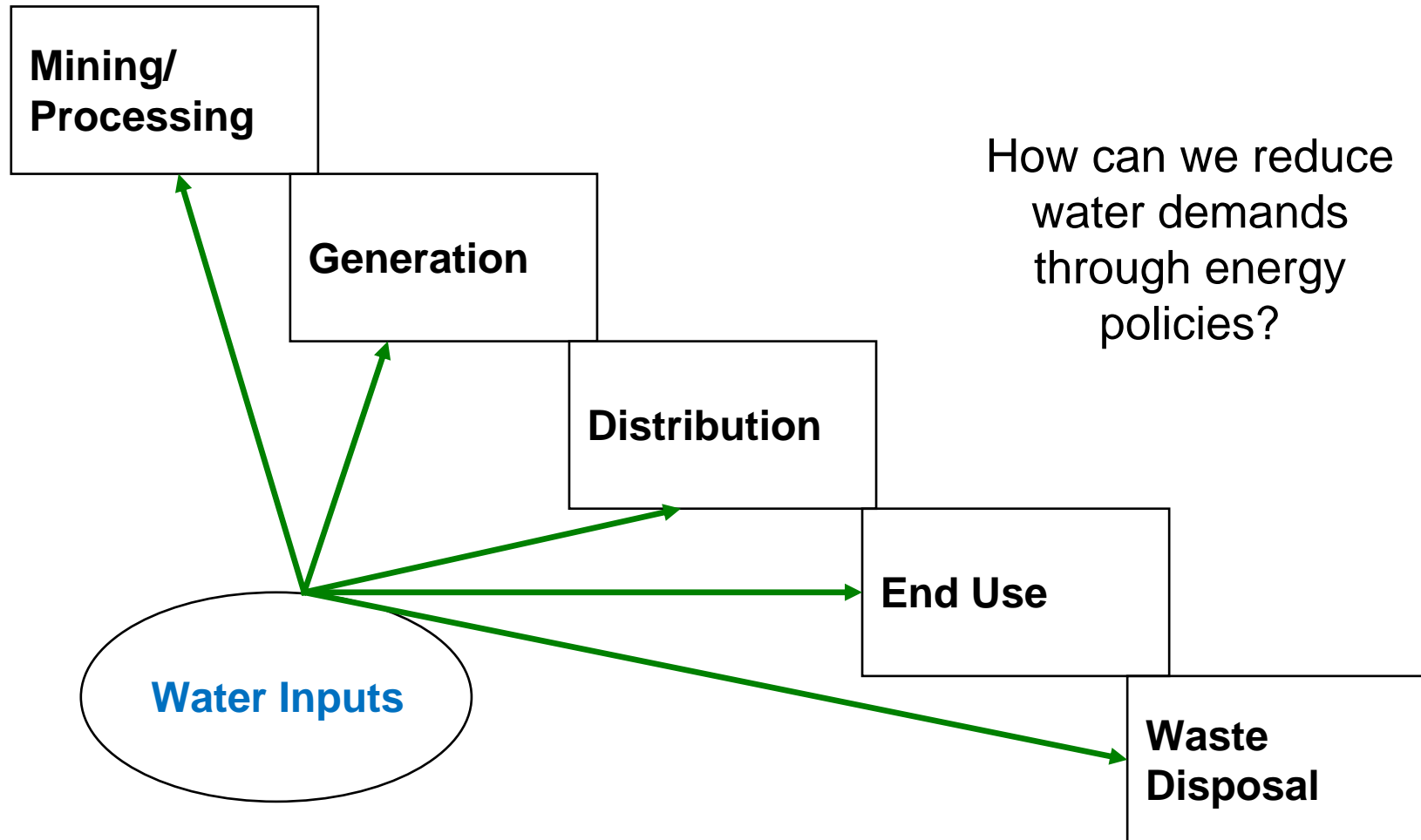
# Adaptation Strategies

- Integrate and coordinate mitigation and adaptation measures
- Review the advantages and disadvantages of *existing* water policies that help adaptation.
- Explore ways to incorporate adaptation into planning processes
- Develop and test adaptation strategies:
  - Economic
  - Technological
  - Institutional
  - Regulatory
  - Educational

# Water and Energy Links

- Water use and energy use are closely linked.
  - Energy production uses and pollutes water.
  - Water use requires significant energy.
- Limits to each are beginning to affect the other; Yet energy and water issues are rarely integrated in policy.
- Considering them together offers substantial economic and environmental benefits.
- The reality of climate change affects policies in both areas.

# The Energy Cycle Requires Water

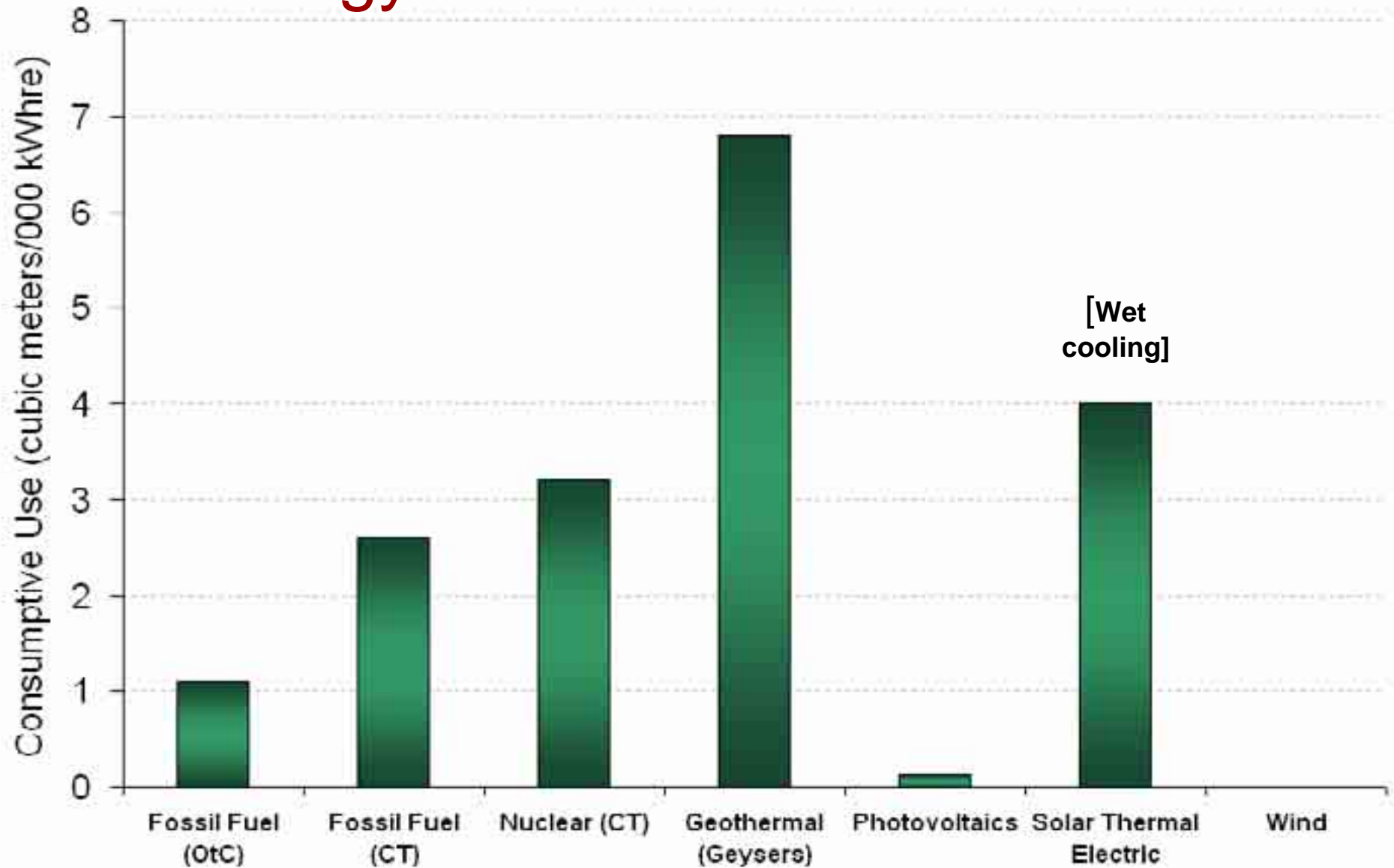




# Substantial Water is Required for the Production of Energy

- The largest withdrawal of water in the United States is for power-plant cooling.
- Most cooling water is not “consumed.”
- In arid and semi-arid regions, power-plant water demand can be substantial.
- Far more water is required for nuclear and fossil-fuel energy systems than for most renewables, depending on cooling system type.

# Energy Source Water Intensities

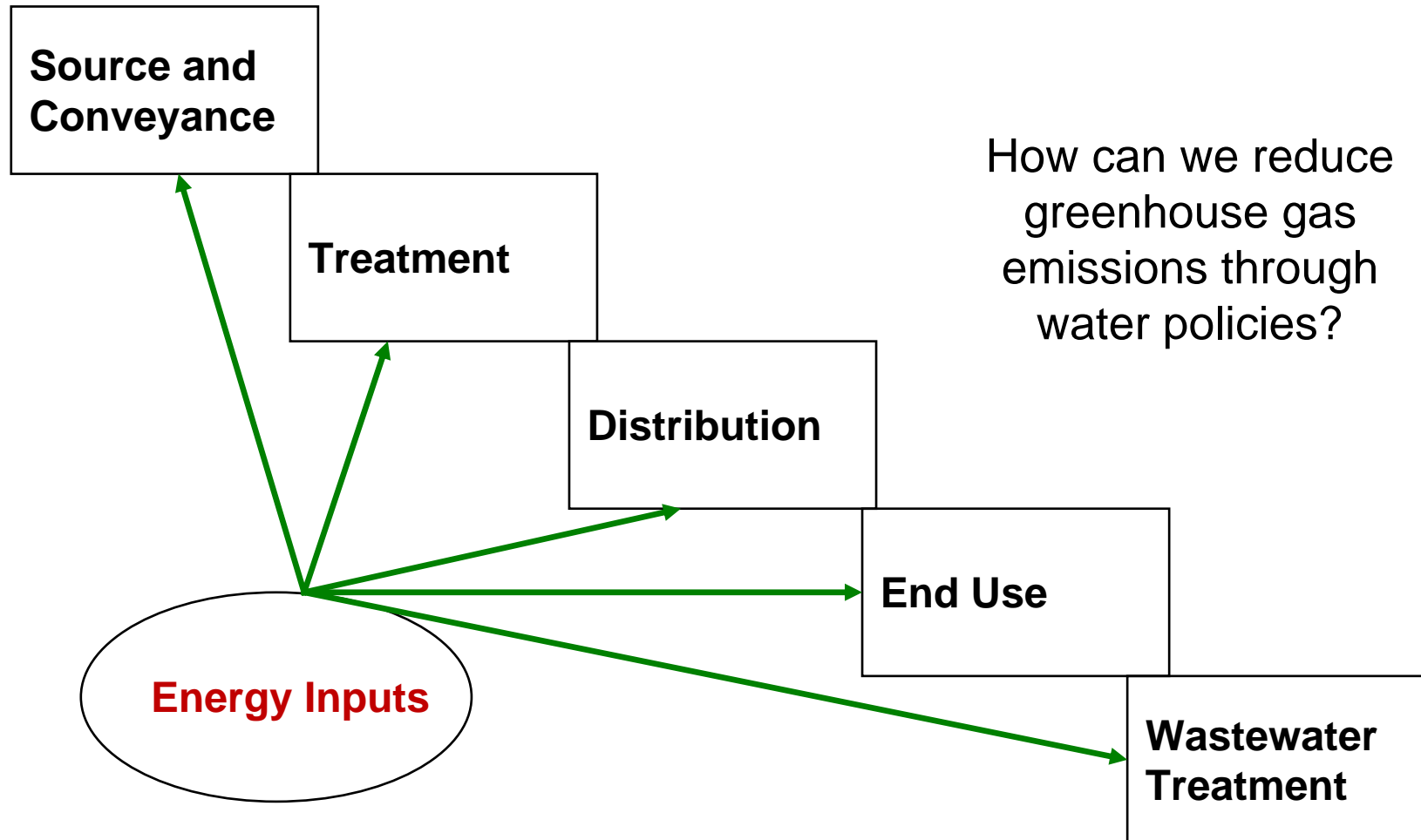


Source: P.H. Gleick, The World's Water, 2002  
(Island Press, Washington DC)

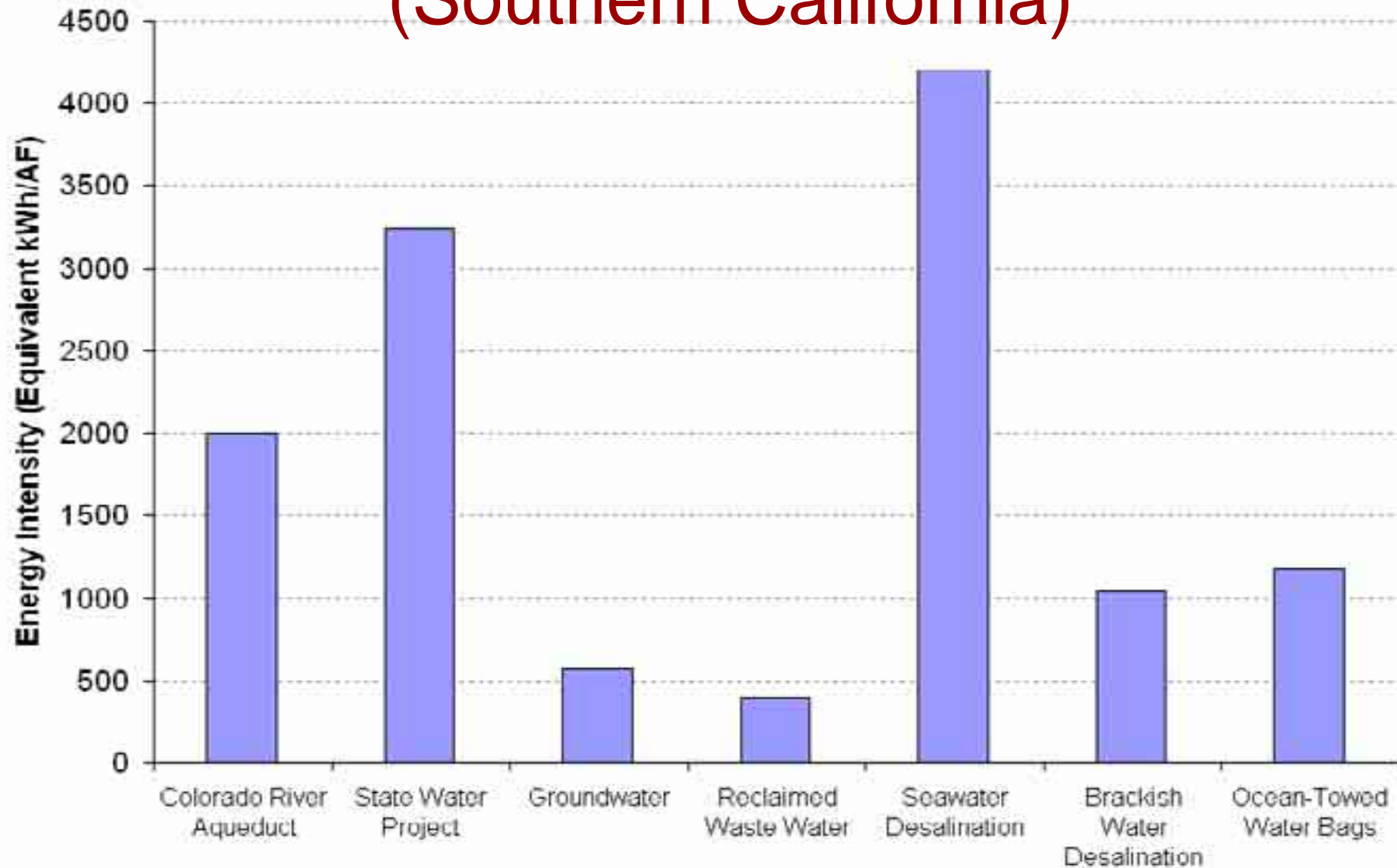
# Central Solar Thermal Can be Water Intensive



# The Water Cycle Requires Energy



# Water Supply Energy Intensities (Southern California)



Source: Pacific Institute, "Energy Down the Drain," 2004

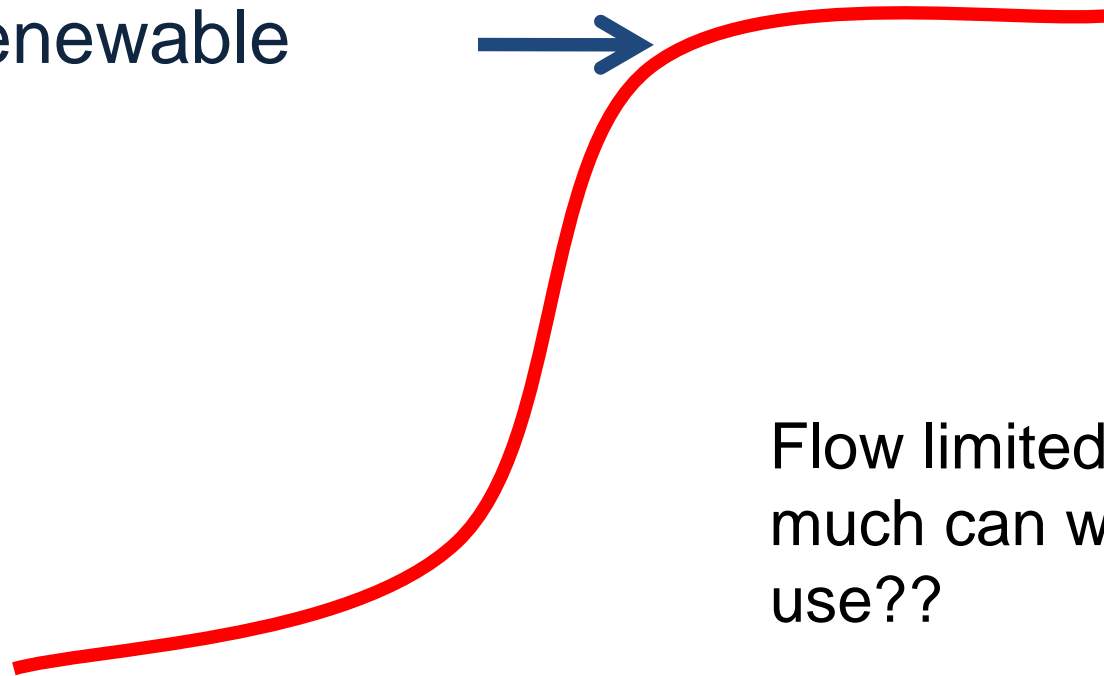
“Peak Water”

# Water Has Renewable and Non-Renewable Characteristics

- Non-renewable resources are “stock” limited.
- Renewable resources are “flow” limited.
- Water uniquely exhibits characteristics of both: overall renewable but with some fixed, non-renewable stocks.

# Peak Renewable Water

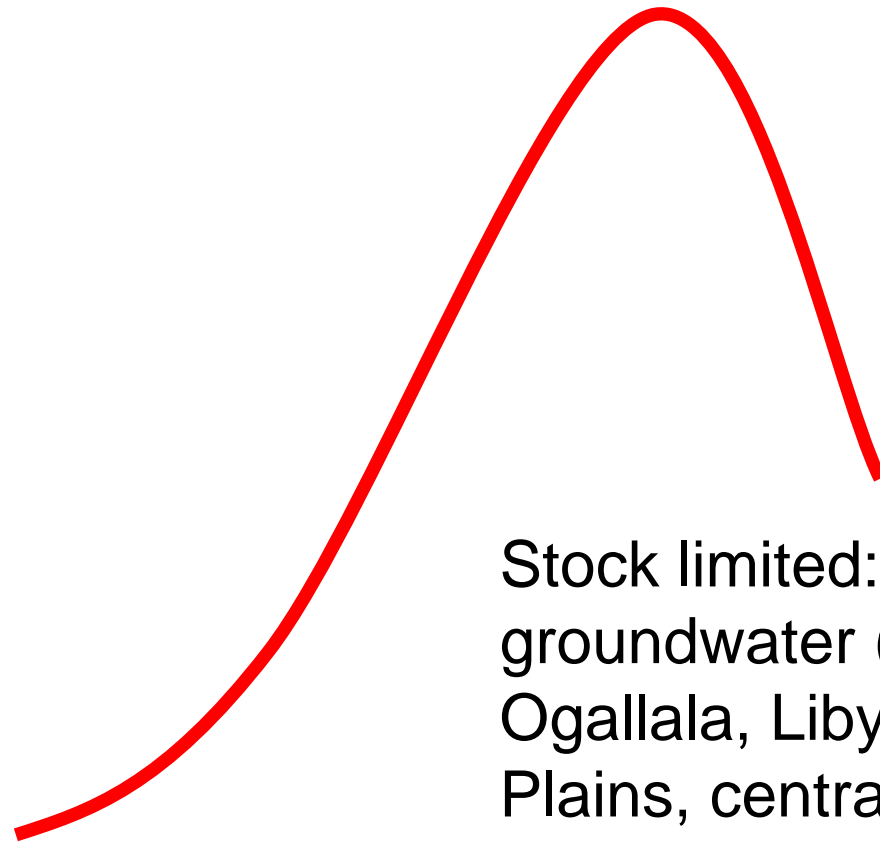
Total Renewable  
Supply



Flow limited: But, how  
much can we actually  
use??

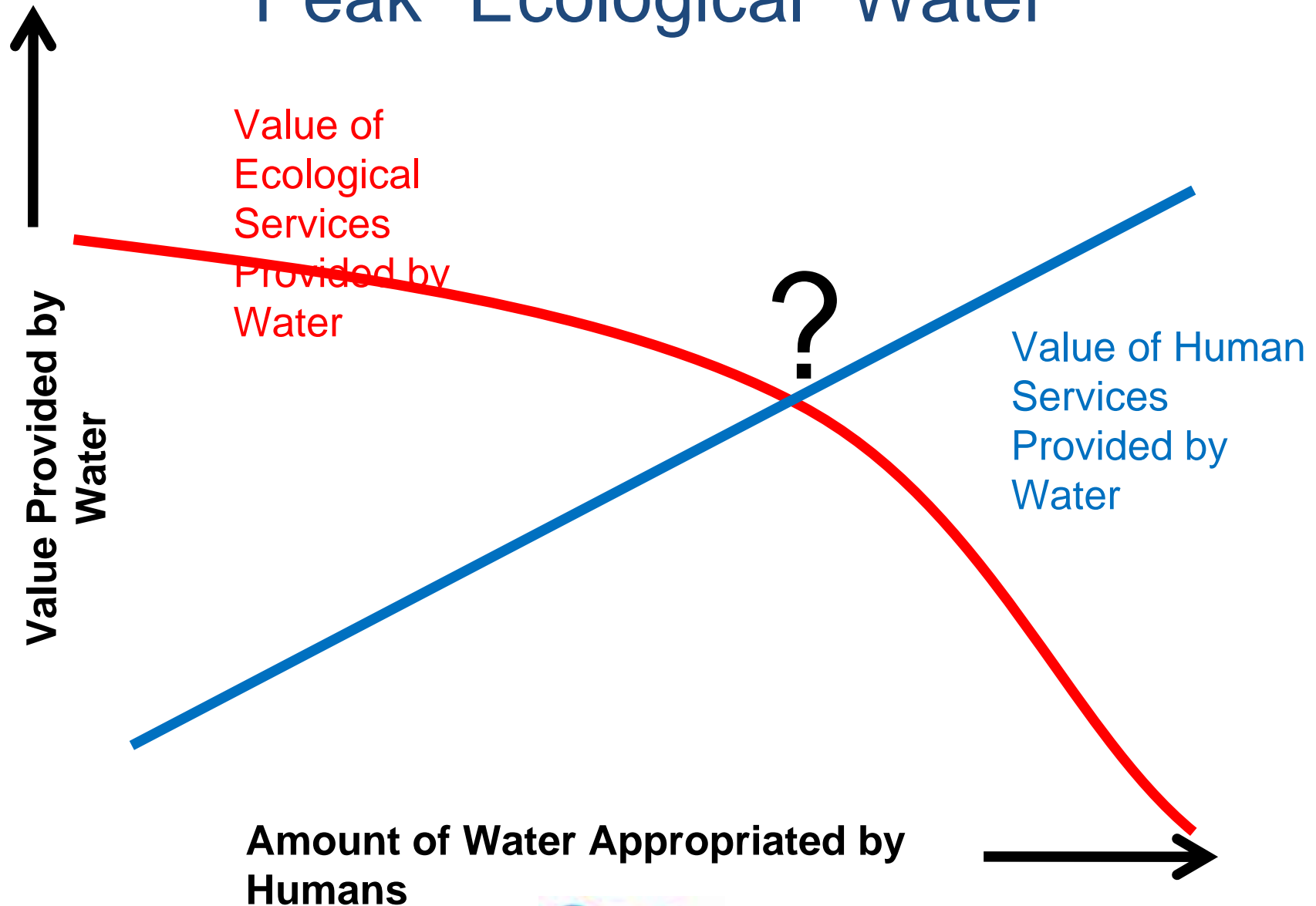


# Peak “Non-Renewable” Water

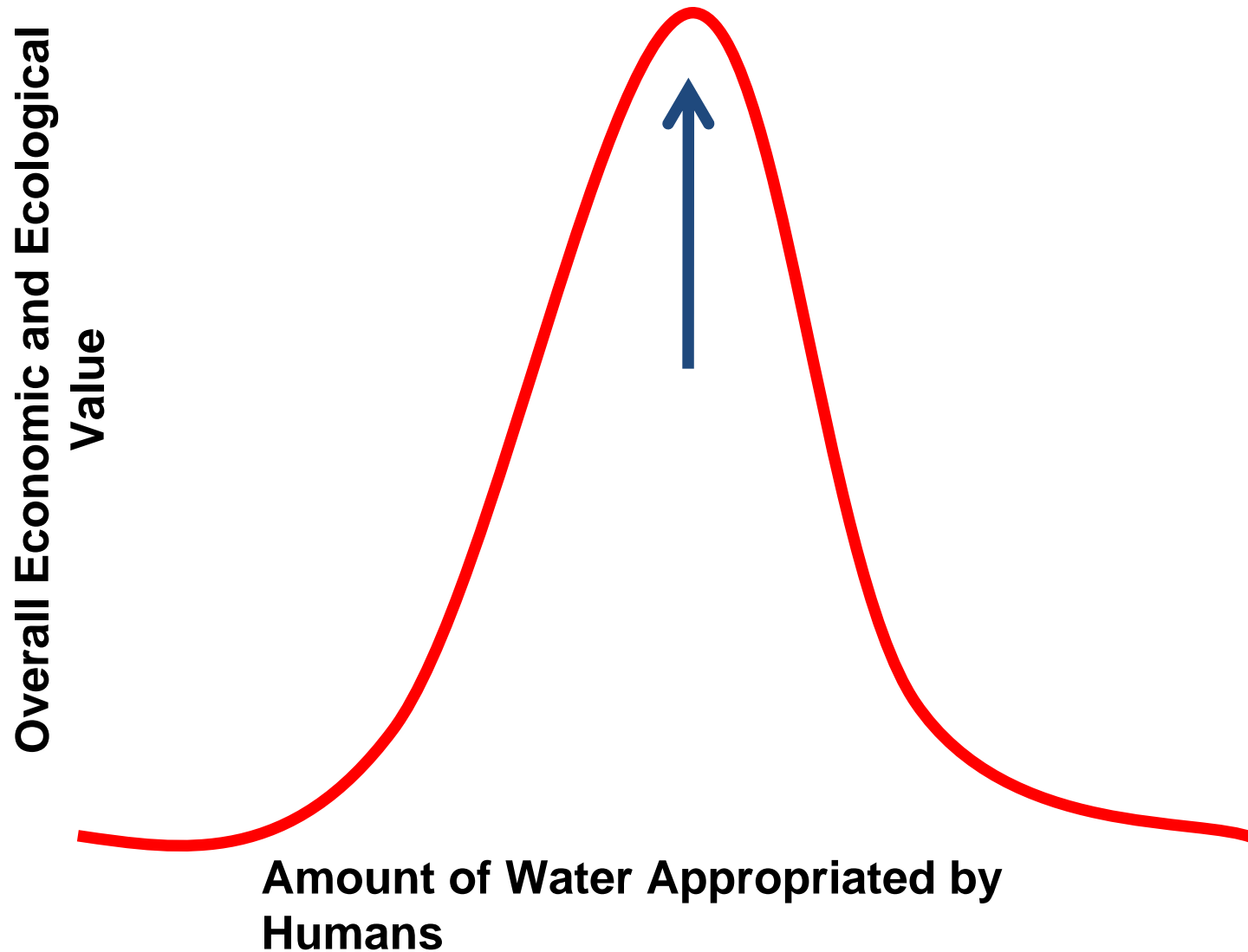


Stock limited: Such as fossil groundwater (Central Valley, Ogallala, Libya, North China Plains, central India...)

# Peak “Ecological” Water



# Peak “Ecological” Water



# What Does Peak Water Mean?

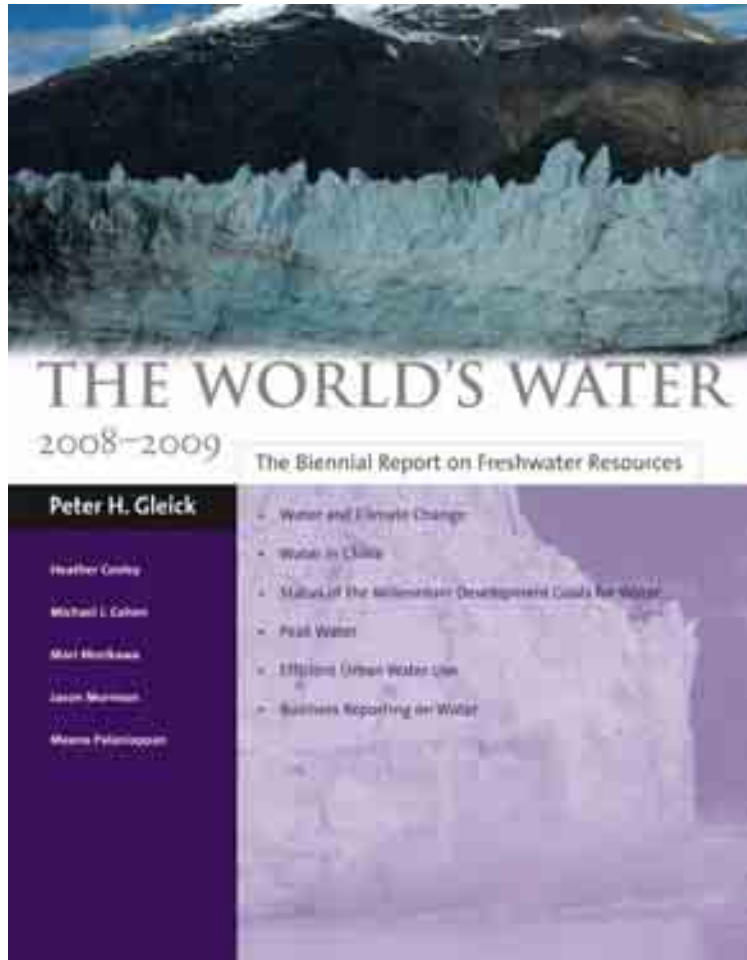
- We'll never “run out” of water overall. It is (mostly) renewable.
- Where water is “non-renewable” we *are already* running into stock constraints.
- We *are already* running into “flow” limits that are a combination of natural and economic constraints.
- We *are already* hitting (or exceeding) peak “ecological” water limits.

# Moving Toward Sustainable Solutions

- Develop new supply, but to higher standards.
- Expand and improve infrastructure.
- Improve water-use efficiency, reduce demand.
- Create stricter standards for water quality.
- Enforce those standards.
- Use proper pricing and markets.
- Improve and expand public participation.
- Fix and update water institutions

# Conclusions

- Climate change and water are closely linked, through energy.
- We will never “run out” of water, but
  - We are past the point of both peak water and “peak ecological water” in many regions.
- Sustainable solutions exist, but require new approaches and changes to old approaches.



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