

Fundamental Concepts in Adaptation Planning for Climate Change

Russell Jackson
NOAA Coastal Services Center

Climate Change in the Caribbean 2011: Puerto Rico
and the U.S. Virgin Islands
November 16, 2011

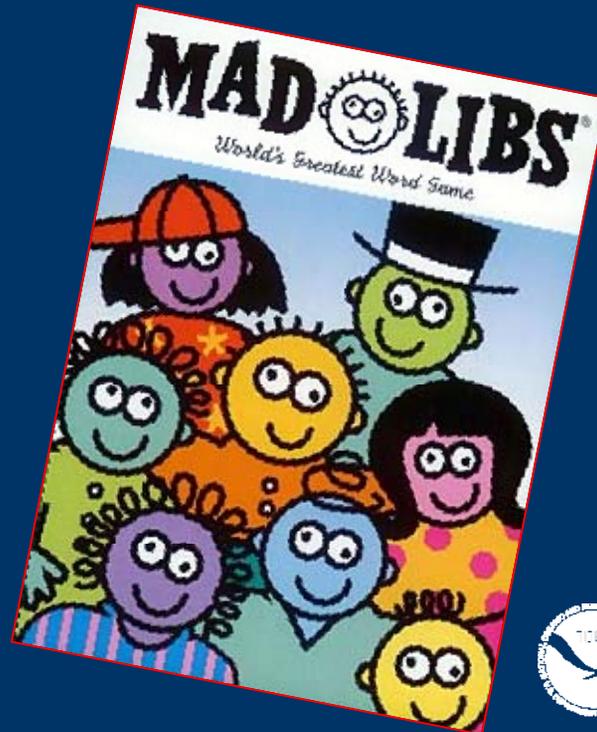


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What is Climate Adaptation?

Climate Adaptation is __ (one word) __

because _____ (few words) _____.



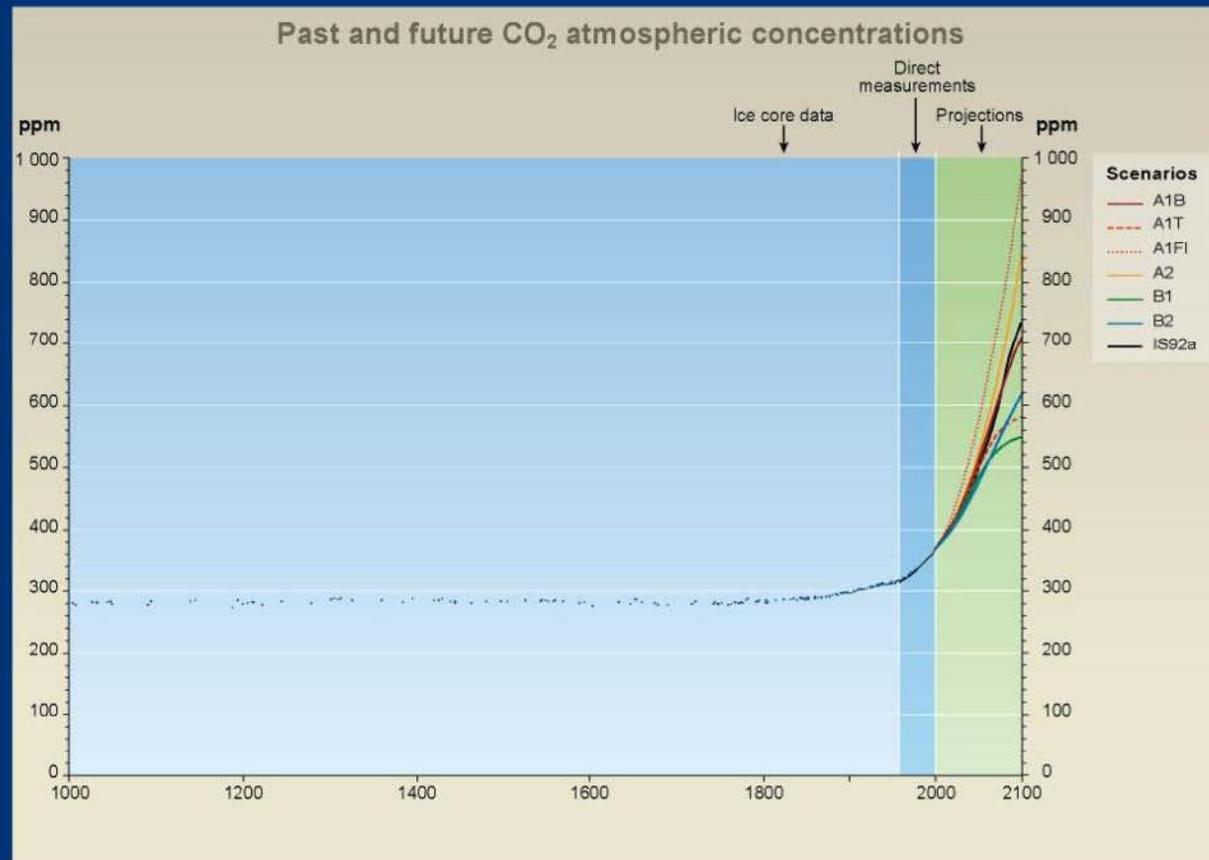
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Why should we care
about climate
adaptation?



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Humans Have a Dramatic Effect on Climate

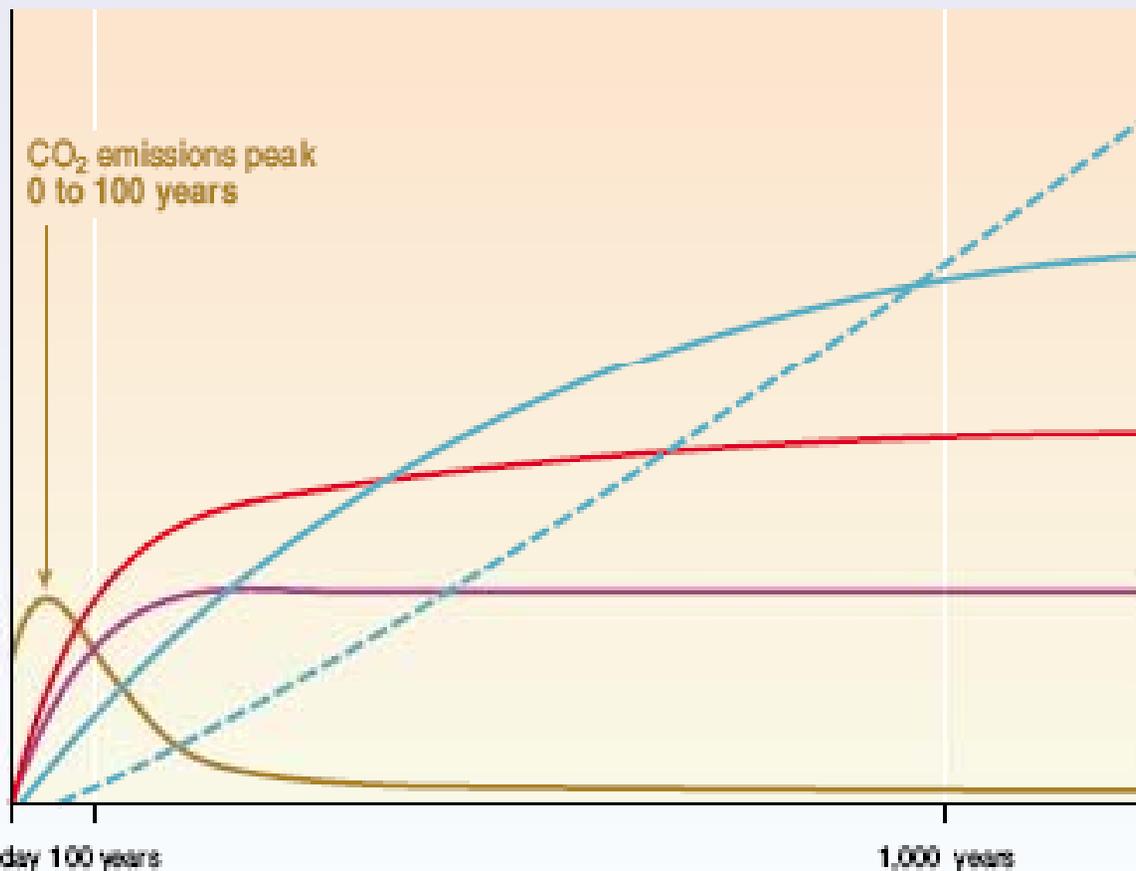


SYR - FIGURE 9-1a

Long-Term Effects

CO₂ concentration, temperature, and sea level continue to rise long after emissions are reduced

Magnitude of response



Time taken to reach equilibrium

Sea-level rise due to ice melting:
several millennia

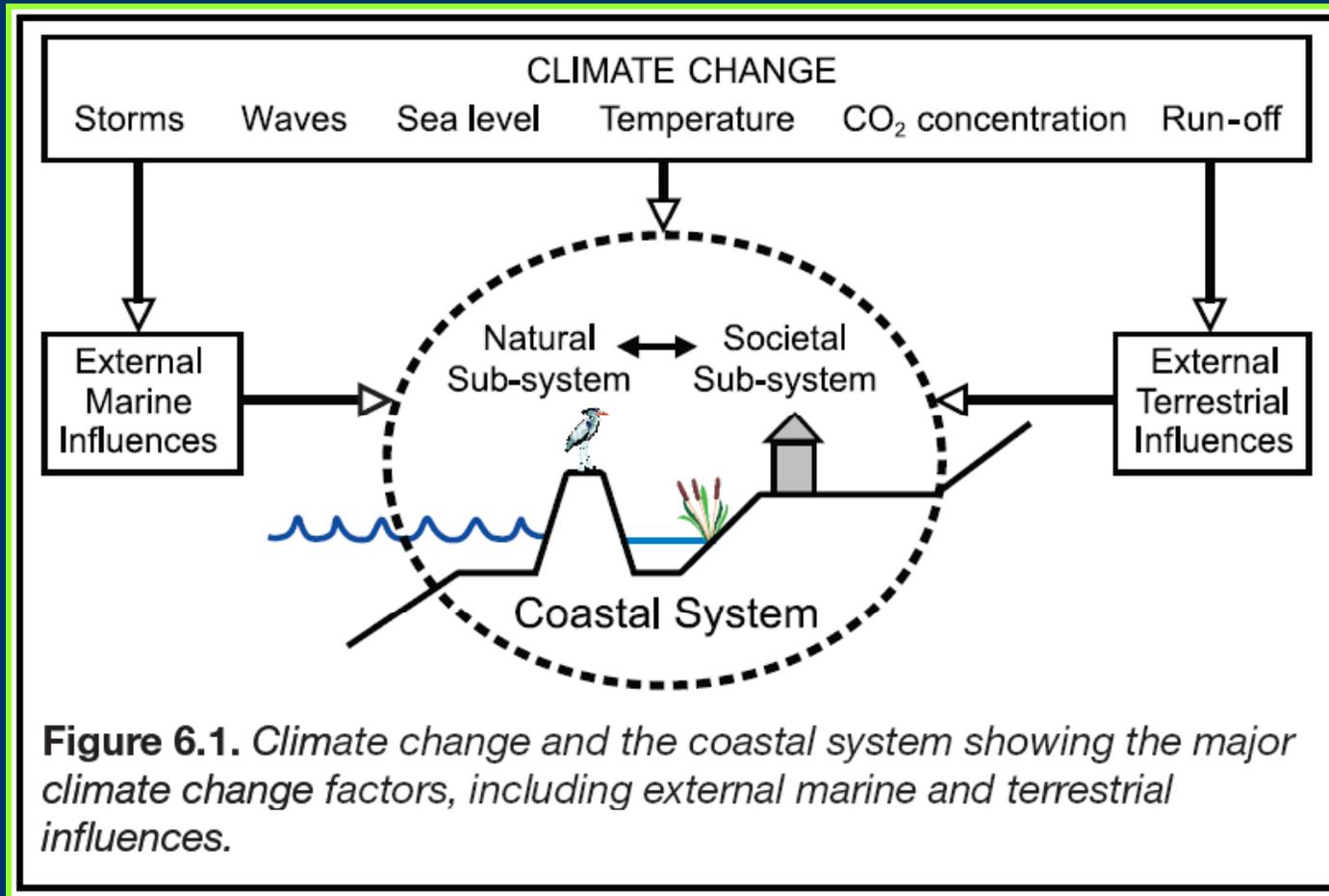
Sea-level rise due to thermal expansion:
centuries to millennia

Temperature stabilization:
a few centuries

CO₂ stabilization:
100 to 300 years

CO₂ emissions

A Coastal Management Perspective



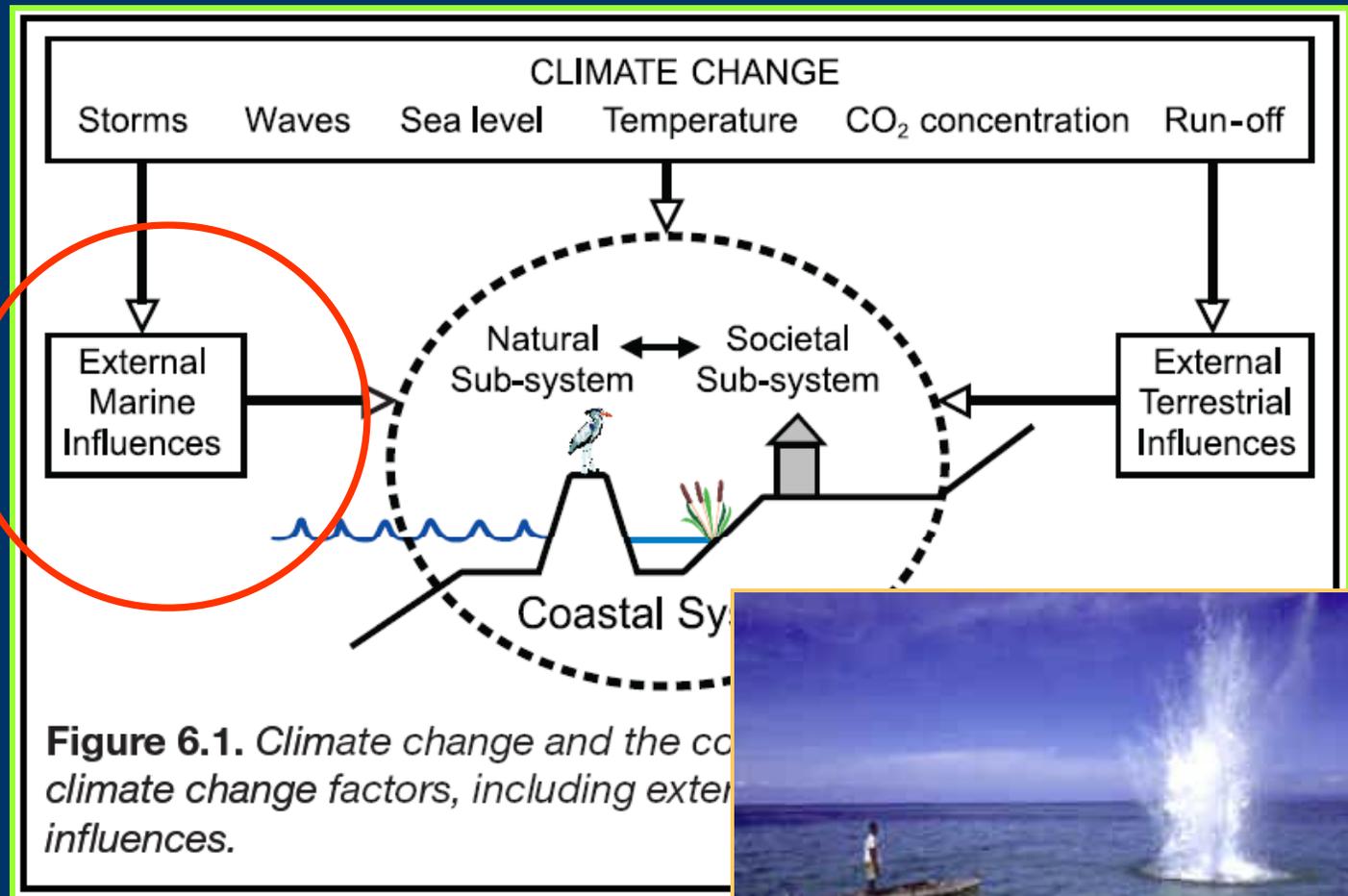
Source: Coastal systems and Low-lying Areas, WGII, FAR, 2007. Ch. 6, pg. 318.



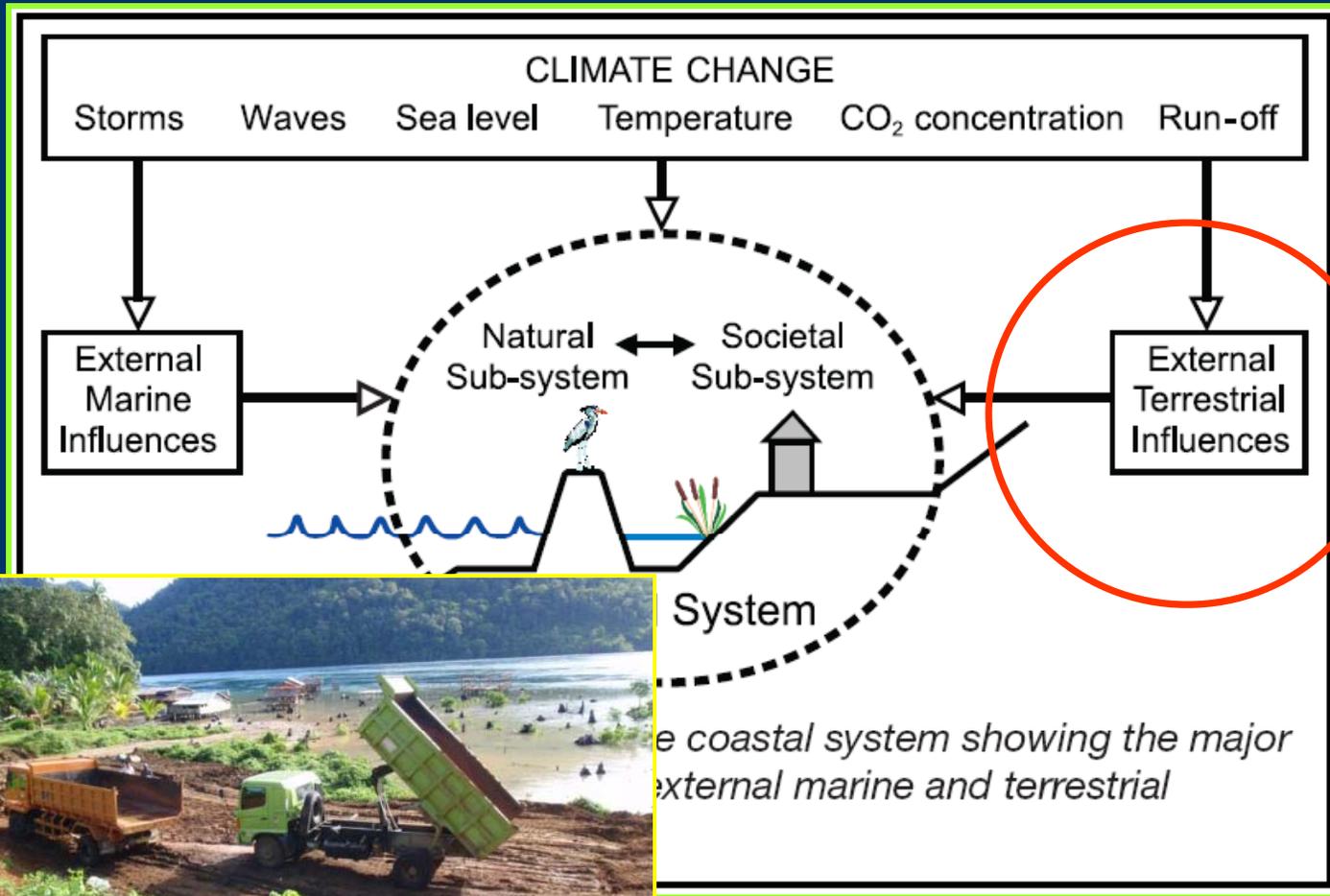
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A Coastal Management Perspective

- over-fishing
- illegal fishing practices
- marine debris
- vessel spills
- tourism impacts



A Coastal Management Perspective



- non-point source pollution
- coastal development
- sediment loads
- upland logging
- tourism impacts



A Coastal Management Perspective

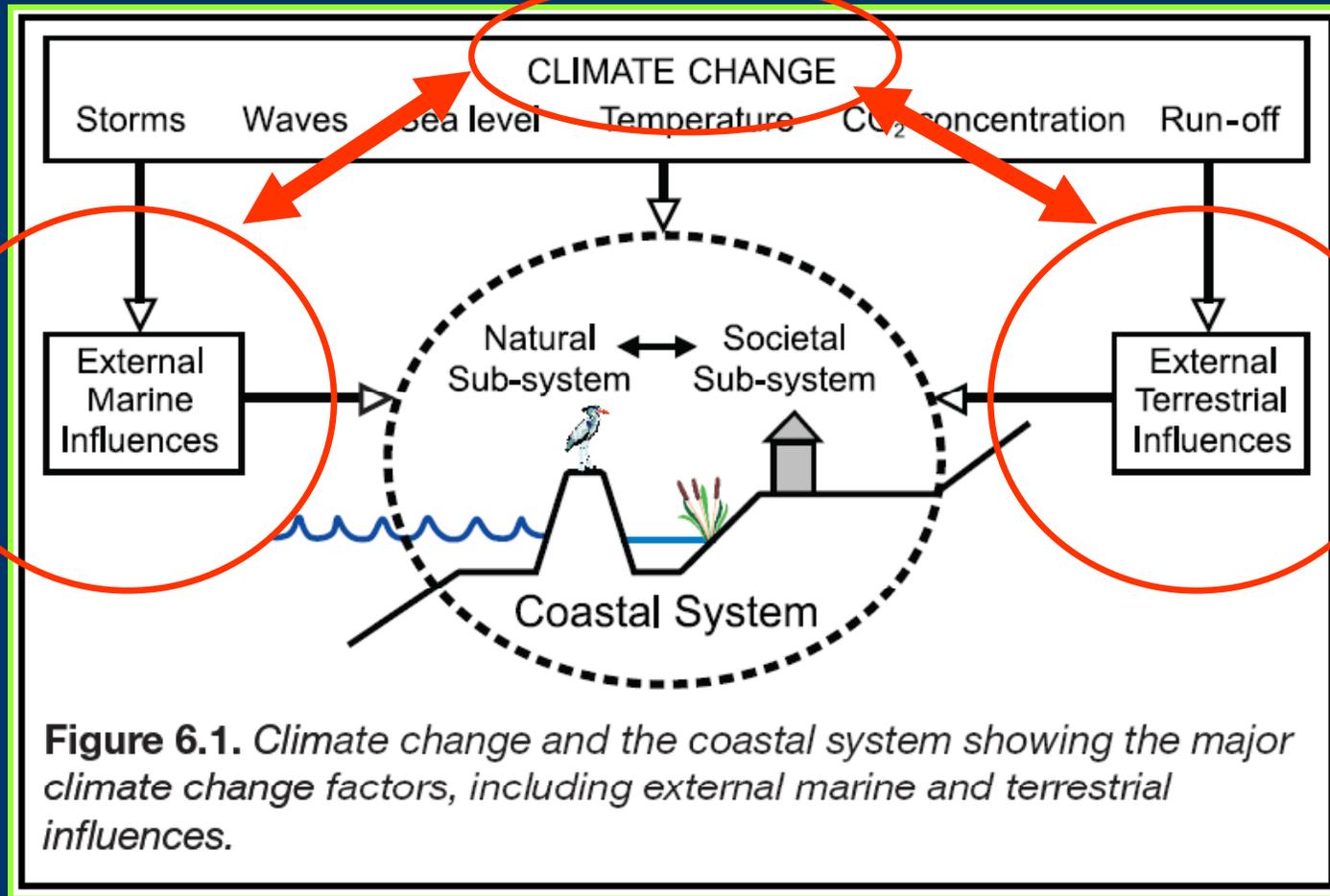


Figure 6.1. Climate change and the coastal system showing the major climate change factors, including external marine and terrestrial influences.

Source: Coastal systems and Low-lying Areas, WGII, FAR, 2007. Ch. 6, pg. 318.



Don't miss out on the latest
craze in confusing lingo bingo!



Climate Change
Adaptation

Climate Change
Mitigation

Hazard
Mitigation



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What is Climate Change Adaptation?

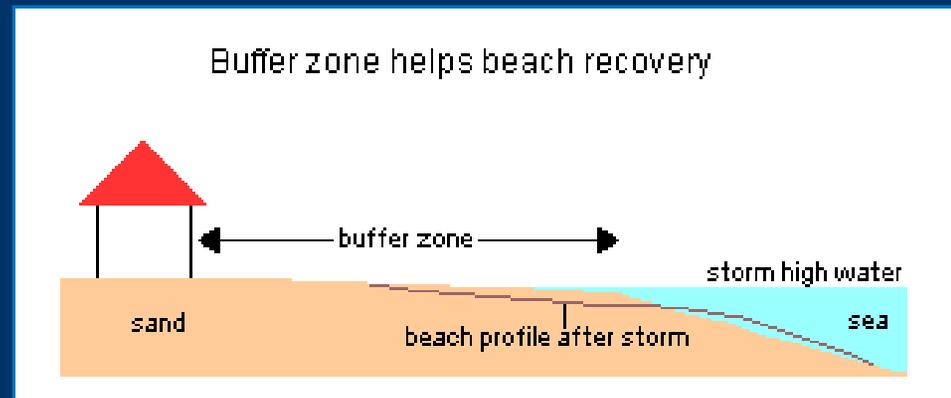
Measures to **reduce the vulnerability** of natural and human systems to climate change effects.

Structural



NOAA, 2010

Non-Structural

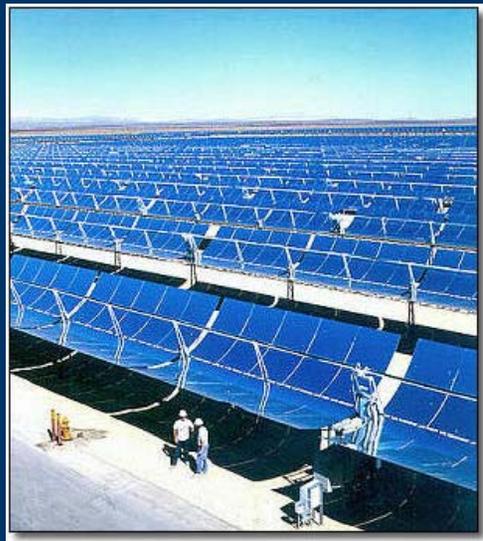


USAID, 2008
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What is Climate Mitigation?

“A [human-induced] intervention to **reduce the sources** or enhance the sinks of **greenhouse gases.**”

– (Intergovernmental Panel on Climate Change)



NOAA, 2010



DNREC, 2010

What is Hazard Mitigation?

“...any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards.”

–(Stafford Act)



FEMA, 2010



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USGS, 2010

The Climate Change Tug-of-War

Mitigation

“The advice to adapt is an obstacle to the correct political response, which is prevention.”

–(Al Gore, 1989).



Adaptation

“..... an irreversible change that will last for more than a thousand years,” – (Susan Solomon, NOAA, 2008)



Reactive Adaptation

Changes in policy and behavior that people and organizations adopt **AFTER** encountering climate change.



NOAA, 2010



EPA, 2010

The Focus - *Planned* Adaptation

Intentional, **proactive**,
and occurs at the societal level.



European Pressphoto Agency

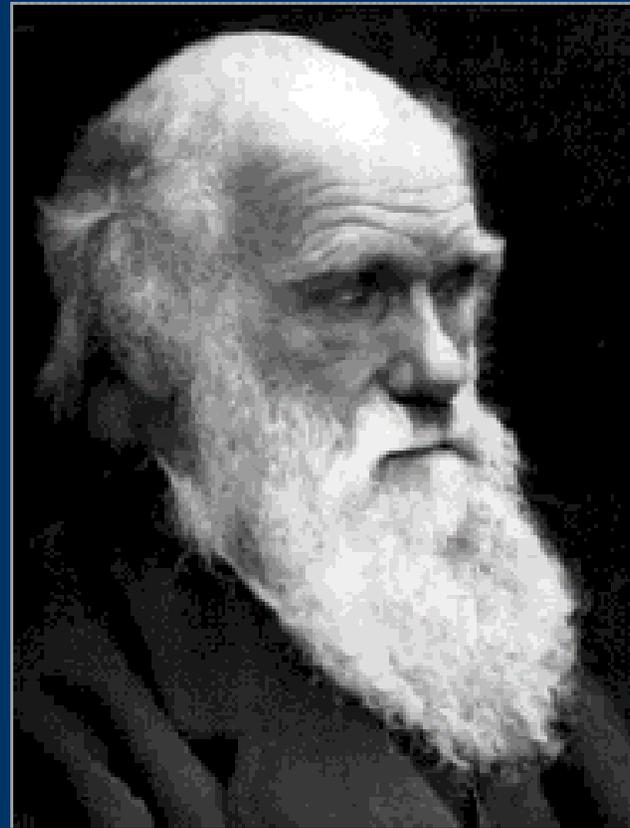


SaskAdapt 2010
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Theory of Evolution

Adaptation is the transformation in living organisms that allows them to live successfully in a changing environment

Climate change presents us with a changing environment to which we must adapt



Charles Darwin



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Adaptation Strategies

Avoidance: Prevent additional risk

Accommodate: Buy some time

Protect: Defend against the impact

Retreat: Get out of the way

Do nothing



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PWA, 2010

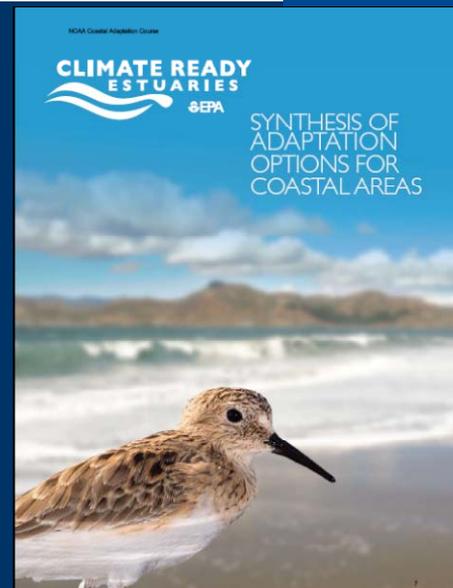
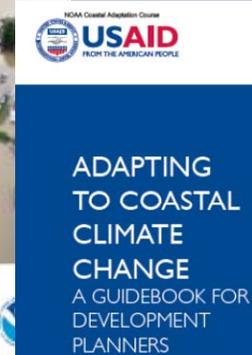
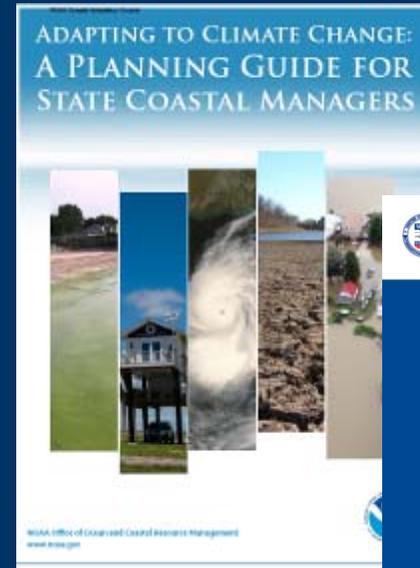
Seeing Your Toolbox through a Climate Lens



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Build upon Existing Tools

- Shoreline protection
 - Fisheries/livelihoods
 - Wetlands protection
 - CZM, MPA
 - Coastal setback
 - Integrated water mgmt
 - Habitat restoration
- & many others.....*



the American People through the United States Agency for International Development
Coastal Resource Center—University of Rhode Island (CRC-CRI) and International

ices Center
, AND TECHNOLOGY

What is Your Experience?

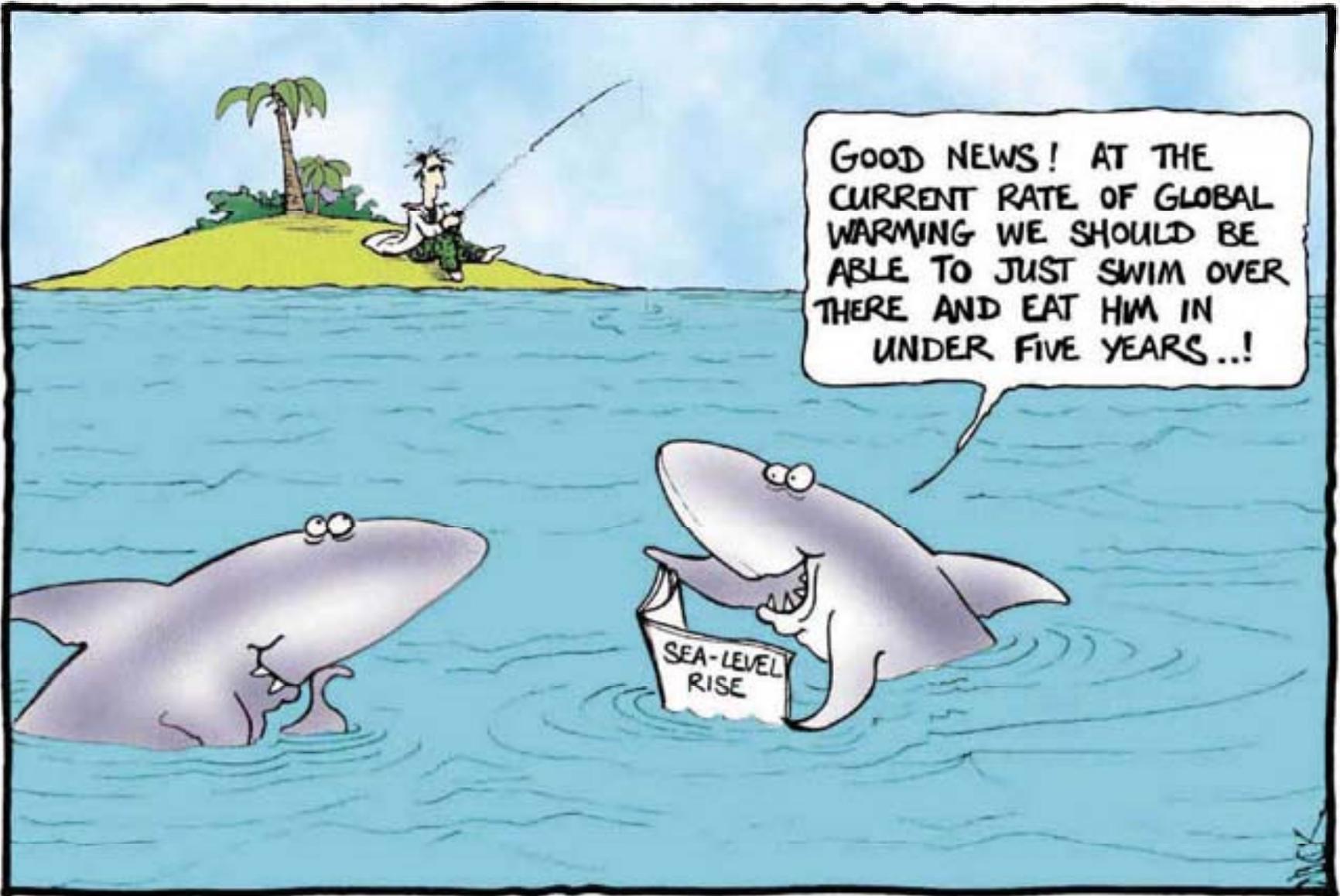


What is Your Experience?

Have You Seen a Mal-adaptation Lately?



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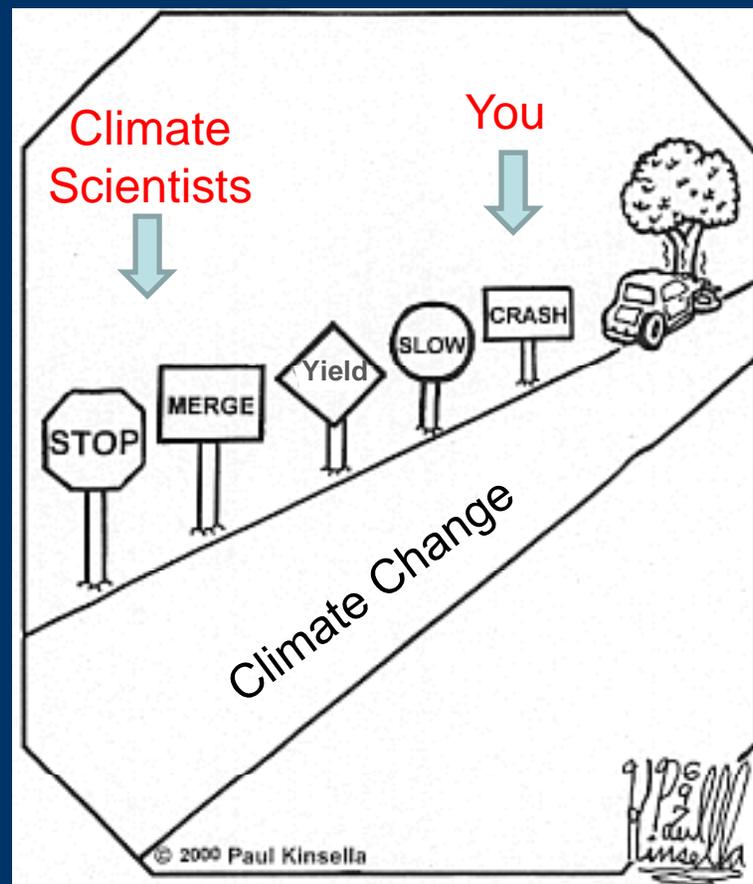


What does all
this really
mean to you?

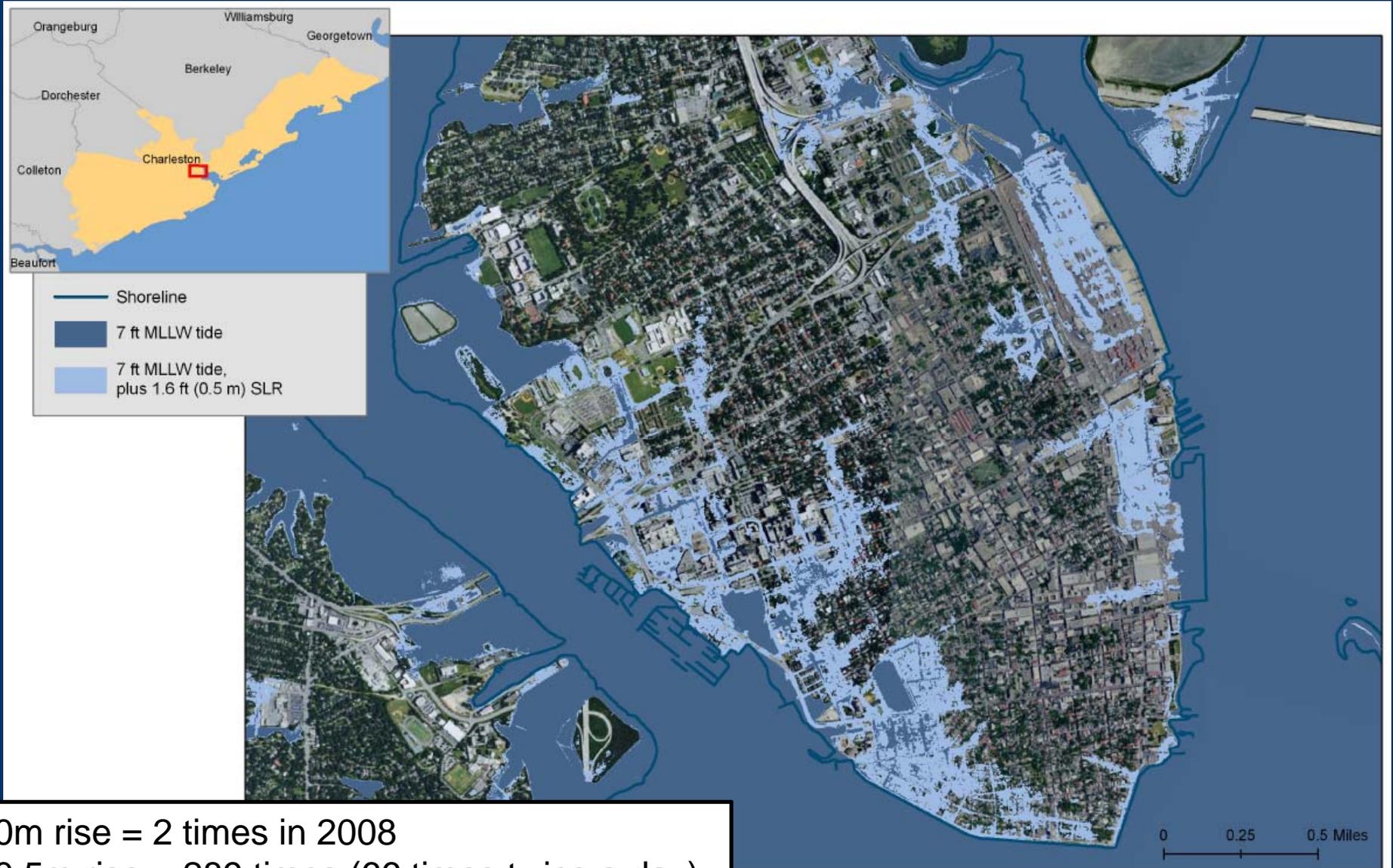


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Those closest to the action are farthest from the information...



Shallow Coastal Flooding SLR (Charleston, SC)



0m rise = 2 times in 2008

0.5m rise = 289 times (66 times twice a day)

THE DAILY NEWS

www.dailynews.com

THE WORLDS FAVORITE NEWSPAPER

- since 1879 -

Major Federal Study Determines That Low-lying Areas Will Flood!



NOAA announced today the results of a five year study to indicate which regions are susceptible to coastal inundation. In the face of sea-level rise, it can be shown that regions with low elevations will be the most at risk. This would include the coastal barrier

Normal everyday flooding conditions, such as shallow flooding downtown during high tides, will only worsen in the future. Experts would like local municipalities to consider the impacts while planning for the future.

"Consider this a call to arms for preparing for the future in

The reality is that no matter the scenario, sea level rise will make existing problems worse.



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And soldiers for *climate adaptation*



Surprise!

- You aren't just soldiers – you are on the front lines
- You are largely responsible for how resilient our communities become to climate change in the future

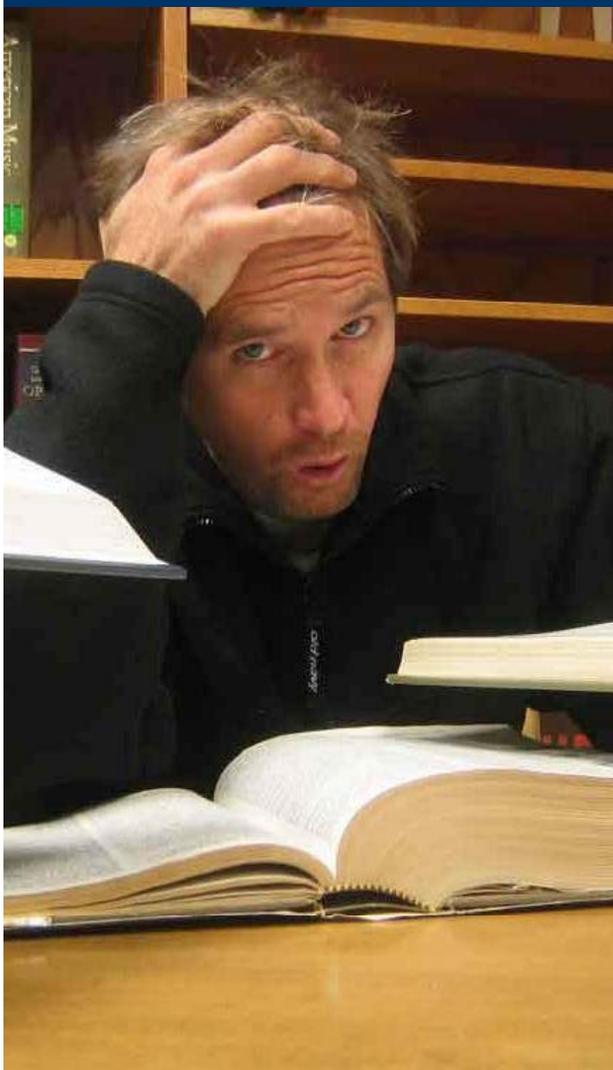


Now what?



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Guess what?
You need to know this stuff - study
time!



- **Climate change basics**
- **Anticipated impacts**
- **Climate mitigation & adaptation**
- **Information resources**



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Actions speak louder than words.



- **Systematically consider climate change vulnerabilities and risks**
- **Link community planning, infrastructure development, hazard mitigation, etc. to climate adaptation**



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Adaptation Planning is ...

Planning with the understanding that:

- History may no longer be a guide to the future
- We must prepare for change in built, human and natural systems
- We must be smart about what we build and where



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Adaptive Planning (cont.)

**“Planning backward from
2050, 2075, or 2100”**

**“Asking the Climate
Question”**



“The key is to listen to scientists, not politicians.”

– King County (WA) Executive Ron Sims,
US News and World Report, June 5, 2006



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If you think it's tough getting people to act in the face of hurricanes & floods, wait until you start talking to them about climate change



“No Regrets,” “Low Regrets,” and “Win-win” Actions are KEY



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Planning for Uncertainty

Look to implement

“No regrets” strategies

- Provides benefits now with or without climate change

“Low regrets” strategies

- Provide climate change benefits for little additional cost or risk

“Win-win” or “Co-benefit” strategies

- Reduce climate change impacts while providing other environmental, social, or economic benefits



No Regrets

- Improved drought planning
- Increased conservation planning
- Fixing leaks in water supply lines
- Better flood forecasting
- Implementing low impact development practices in areas already prone to stormwater management problems



Low Regrets

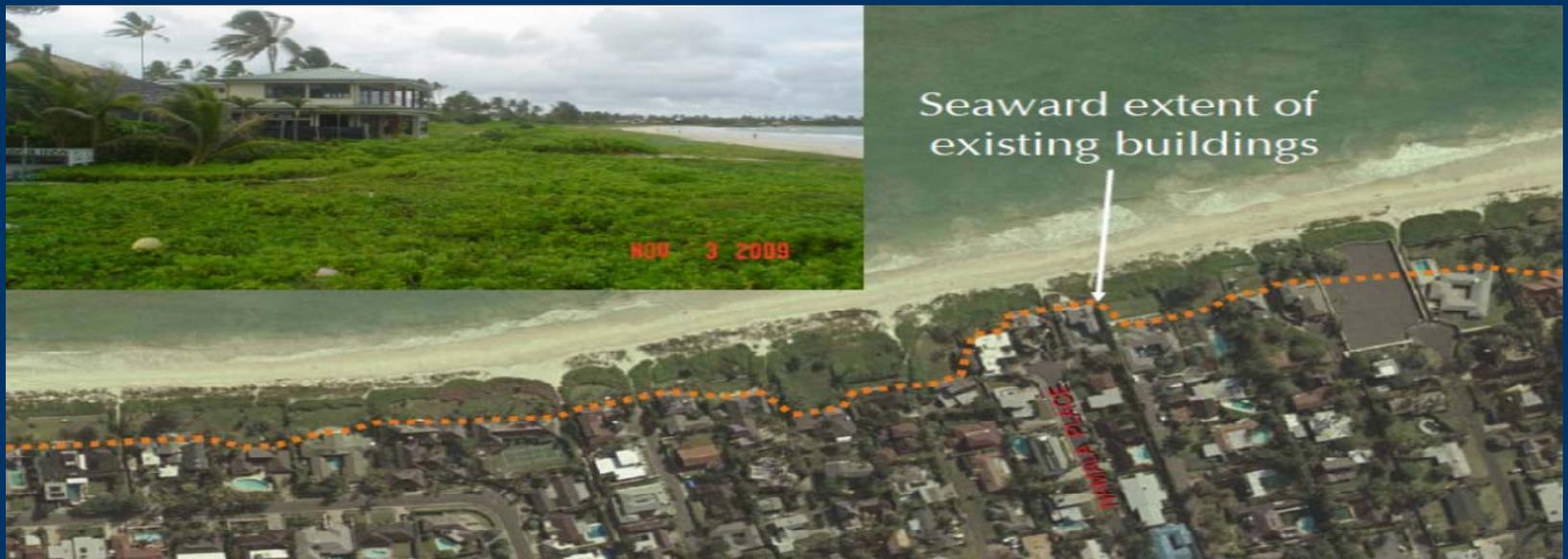
- To accommodate SLR - built 2 ft higher
- The plant's 9.5 mile, 24 foot diameter outfall tunnel should remain functional through 2050 despite the effects of SLR
- Less expensive to build at the higher height in the original design rather than trying to incorporate projective barriers in the future.



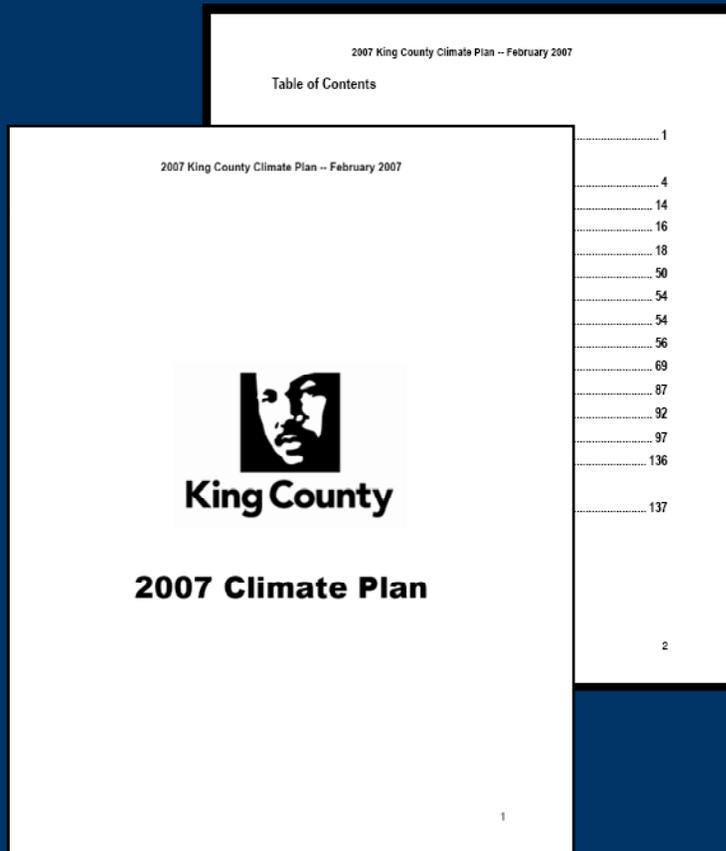
Boston Harbor
Deer Island Wastewater Treatment Plant

Win-Win

- Replacing small culverts with larger culverts that can handle a wide range of streamflows
 - can handle increased risk of high flow events and has co-benefit of improved salmon habitat
- Increased coastal setbacks
 - reduces coastal vulnerability while also allowing for nearshore habitat to move backwards in response to sea level rise



The 2007 King County Climate Plan



The Plan addresses...

- Climate science
- Public health, safety and emergency preparedness
- Surface water management, freshwater quality and water supply
- Land use, buildings and transportation infrastructure
- Economic impacts
- Biodiversity and ecosystems



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The 2007 King County Climate Plan

“King County plans will guide the region to [incorporate] preparedness for climate change impacts into all major investments...”

– King County Climate Plan

**Incorporate flexibility into
long-range planning**

**Develop adaptive capacity in built, human and
natural systems whenever practicable**



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The 2007 King County Climate Plan

King County's:

- Comprehensive Plan
- Flood Planning
- Wastewater Treatment Division asset management
- Transportation Infrastructure

have all been updated to build flexibility and resilience to climate change impacts



Low Impact Development at the Military Road S. at S. 272nd Street site, King County



Greenbridge, King County



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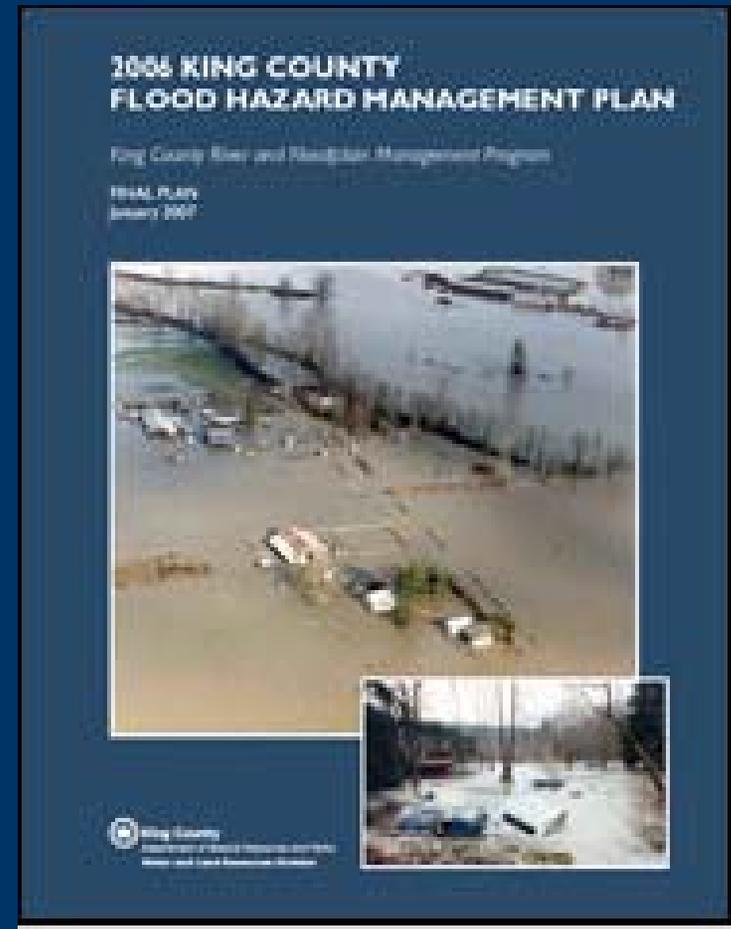
King County Flood Planning

Rather than wait for disaster to loom, Sims argued...

"Let's make the investments and prevent it."

That investment would amount to as much as... \$30 a year on a \$300,000 home. It would seem to be the cheapest insurance a homeowner could buy.

– *“Cheap Insurance,” Seattle P-I Editorial Board, July 2006*



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King County Flood Planning (cont.)



- Up to \$335 million to improve King County's system of 500 levees
- County purchase of most susceptible lands



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Vulnerability of Major King County Wastewater Facilities to Flooding from Sea-Level Rise



West Point Treatment Plant - Seattle, Washington



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Wastewater Treatment Division Planning Response

Develop strategies to manage wet weather impacts of climate change to the sewer system

- Identify wastewater facilities impacted by storm surge/sea level rise (above extreme high water)
 - Develop and conduct GIS based methodology combining sea level rise projections + storm surge, compared to facility elevations
 - Identify the impact threshold (problematic at what level)
 - Characterize the impact (on-site flooding, hydraulic, operational)



Wastewater Treatment Division Planning Response (cont.)

- Identify adaptive strategies for affected facilities (i.e., protective berms, armoring, relocation, etc.)
- Include findings in routine asset management improvements, capacity planning and facility design



Vulnerable Facilities Inventory Approach



- Used GIS to identify vulnerable areas along coast line (project area in white)
- Facilities subject to tidal and storm impacts
- 40 facilities included
- One Secondary TP, Three CSO TPs (red/orange)
- Pump stations (green)
- Regulator stations (blue)



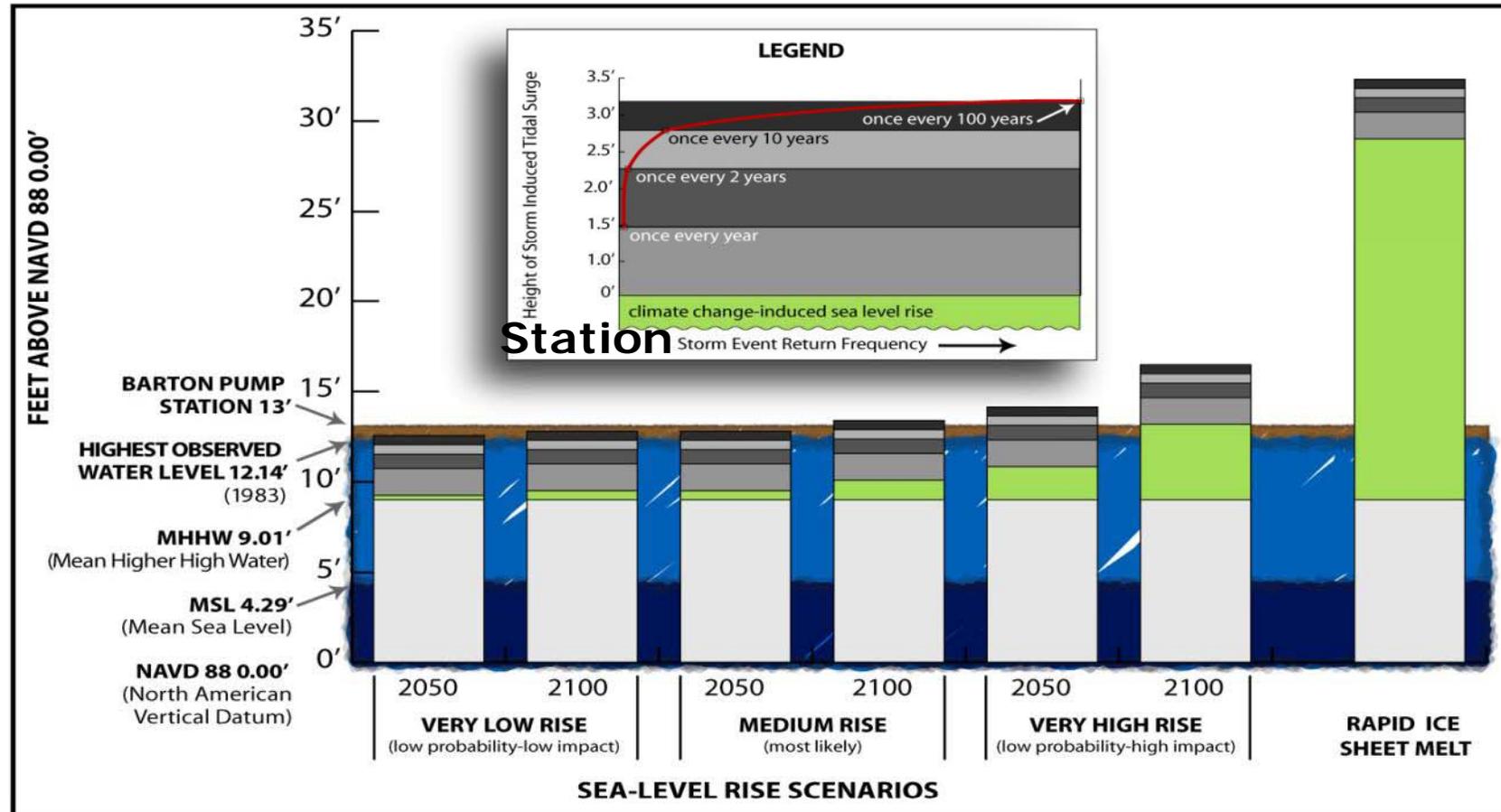
Summary of Results

Combined Sea Level Rise with Extreme Storm Events			Mote et al						
			2050 Low Level (<5% Likelihood)	2100 Low Level (<5% Likelihood)	2050 Medium Level (Most Likely)	2100 Medium Level (Most Likely)	2050 High Level (<5% Likelihood)	2100 High Level (<5% Likelihood)	Rapid Ice Sheet Melt Scenario
			3"	6"	6"	13"	22"	50"	20'
Zervas	No Event	-	0.25'	0.50'	0.50'	1.08'	1.83'	4.17'	20'
	Once a Year Event 100%	1.48'	1.73'	1.98'	1.98'	2.56'	3.31'	5.65'	21.48'
	Once every two years 50%	2.27'	2.52'	2.77'	2.77'	3.35'	4.10'	6.44'	22.27'
	Once every 10 years 10%	2.79'	3.04'	3.29'	3.29'	3.87'	4.62'	6.96'	22.79'
	Once every 100 years 1%	3.19'	3.44'	3.69'	3.69'	4.27'	5.02'	7.36'	23.19'

-  No facilities at risk of on site flooding.
-  Three facilities at risk of on site flooding
-  Five facilities at risk of on site flooding

-  Eight facilities at risk of on site flooding
-  Fourteen facilities at risk of on site flooding
-  30 or more facilities at risk of on site flooding

Barton Pump



Vulnerable Facilities Inventory Results and Recommendations



- Conduct terrain analysis of five lowest sites and West Point Treatment Plant.
- Raise elevation of Brightwater sampling facility and flow monitor vault sites.
- Raise weir height and install outfall flap gate for Barton Pump Station improvements.



Vulnerable Facilities Inventory Results and Recommendations

- **Conduct analysis of sea-level rise impacts on system hydraulics.**
- **Include sea-level rise as a planning factor for future projects.**
- **Review sea-level rise literature every five years and address in five year updates to conveyance system plan.**



King County Transportation Infrastructure

- New \$24 million Tolt Bridge spanning the Snoqualmie River has been built with longer spans than the previous bridge, increasing its capacity to withstand high flows and major flooding events
- More than 57 smaller "short span" bridges are planned to be replaced with wider span structures, allowing debris and floodwater to pass underneath without backing up river levels
- Culverts that will increasingly be at risk of chronic flooding and road failure, and would cause destruction of fish habitat during storm events – will be replaced with larger systems not only to prevent roads from failing, but also to improve fish passage



CENTER FOR ISLAND CLIMATE ADAPTATION AND POLICY

UNIVERSITY OF HAWAII'S SEA GRANT COLLEGE PROGRAM



SEA-LEVEL RISE AND COASTAL LAND USE IN HAWAII: A POLICY TOOL KIT FOR STATE AND LOCAL GOVERNMENT



CENTER FOR
ISLAND CLIMATE
ADAPTATION & POLICY



UNIVERSITY OF HAWAII AT HONOLULU
WILLIAM C. BISHOP MUSEUM
SCHOOL OF LAW

HAWAIIANUIAKĀEA
UNIVERSITY OF HAWAII



college of social sciences



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SUMMARY GUIDE to the SANCTUARY DRAFT MANAGEMENT PLAN



New species of anemonefish (*Amphiprion pacificus*) in Fagatele Bay. Photo by Doug Fenner

We welcome your comments on the draft management plan. Here's how:

E-mail: <http://www.regulations.gov>
click the "submit a comment" icon, then enter NOAA-NOS-2011-0243 in the keyword search

Mail: Fagatele Bay
National Marine Sanctuary
P.O. Box 4318
Pago Pago, American Samoa
96799

Fax: (684) 633-4195

Public Meetings:

Various locations throughout American Samoa during November 2011. See last page for details.

Written comments will be accepted at all meetings. Due to time constraints, oral comments must be limited to three minutes per individual.

Comments accepted through (postmarked by) Friday, January 6, 2012.

For information on how to get a copy of the Draft Management Plan please refer to the back cover of this guide.

New Sanctuary Plan Available for Public Comment

The NOAA Office of National Marine Sanctuaries is currently updating the management plan for the Fagatele Bay National Marine Sanctuary. To help you understand the sanctuary's new management plan and your opportunity to help shape it, this summary provides brief descriptions of proposed sanctuary actions and proposed revised sanctuary regulations, along with information on how to make your voice heard. This is your chance to comment on the future of your sanctuary, and the Office of National Marine Sanctuaries welcomes your input.



The Office of National Marine Sanctuaries and Public Participation

National marine sanctuaries are special areas of the marine environment set aside for long-term protection and conservation, and are part of our nation's legacy to future generations.

The Office of National Marine Sanctuaries has managed these special areas since passage of Title III of the Marine Protection, Research, and Sanctuaries Act of 1972, now called the National Marine Sanctuaries Act. For more than 35 years, the sanctuary system has engaged the public in helping to create new sanctuaries, develop resource protection strategies, address complex resource management issues and more recently, review and update sanctuary management plans. Marine areas managed within the National Marine Sanctuary System are shown in the map below.

NATIONAL MARINE SANCTUARY SYSTEM



Scale varies in this perspective. Adapted from National Geographic News.

Climate Change Action Plan

The primary objective of this action plan is to minimize and mitigate the impact from climate change events on coastal and marine ecosystems in sanctuary units.

<http://fagatelebay.noaa.gov>



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ADAPTATION AROUND THE GLOBE: A Brief Look at Adaptation Actions Around the World



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“Paradise almost lost: Maldives seek to buy a new homeland”
--The Guardian, UK, 10 November 2008



Photo credit: NASA/GSFC/METI/ERSDAC/JAROS
and U.S./Japan ASTER Science Team

- Maldives avg. height above sea level = 5ft.
- Much of nation likely submerged by 2100
- Country plans to divert tourism revenue towards purchase of land in another country
- Land in Sri Lanka, India, and Australia being considered for move



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The Micronesia Challenge



Photo credit: Karlyn Langjahr, Rock Islands, Palau

- 5 signatory governments
- Initiated in 2006
- Public commitment to conserve 1/3 nearshore waters and 1/5 land
- Land conservation to promote climate adaptability

- Healthy mangroves and reefs provide storm surge buffer
- Larger, diverse fish stocks create stock resilience
- Forest cover decreases erosion



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The Red Cross: Climate Relief in Vietnam

- Red Cross-funded planting of >50,000 acres of mangroves in Vietnam
- 100km protection for sea and river dykes
- Estimated benefit to 1.2 million people
- Cost to implement: \$1.1M; dyke maintenance reduction: \$7.3M
- Reduction of damage due to storm surge and sea level rise



Photo credit: International Federation of Red Cross and Red Crescent Societies
www.flickr.com/photos/ifrc/2478529236/in/set-72157604967716333/



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Rainfall and Food Availability in Zambia

- Region experiencing lowest rainfall in >10 years
- Tearfund (NGO) helped locals implement conservation farming techniques
- Minimum tillage, improved soil moisture
- Higher crop yields, improved crop diversity, gain food security
- Cost: \$500K over 5 years
- Benefit: >12,000 households



Photo credit: F. Sands, USAID

London's Response to Sea Level Rise: The Thames Barrier



Photo: Bill Bertram, 2008. Wikimedia Commons, <http://en.wikipedia.org/wiki/File:ThamesBarrierPano.jpg>

- 2nd largest flood barrier in world (>550 yards long)
- Pre-1990: 1-2 closures/yr.; post-1990: 4 avg. closures/yr.
- Closed on 14 consecutive tides in 2003
- By 2030, predicted 30 closures/yr.
- If SLR <1m, predicted 70 closures/yr. by ~2080

Bosham, West Sussex, England



http://en.wikipedia.org/wiki/File:Bosham_Low_Tide.JPG



http://en.wikipedia.org/wiki/File:The_pub_car_park.JPG



http://www.robertprice.co.uk/roblog/archive/2004/9/A_Visit_To_Bosham.shtml, Photo by Robert Price

Rising Waters in the Netherlands



Image courtesy NASA World Wind

Rising Waters in the Netherlands



Photo: www.biodiversity.ru/coastlearn/pp-eng/caseholland.html

- Maeslantkering storm barrier
- Main channel to Rotterdam harbor
- Expected to close once every 10 yrs.
- Cost to build: US\$570m



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Rising Waters in the Netherlands



- Dutch firms are pioneering amphibious architecture
- 26 built in Maasbommel, NL
- Can accommodate 13ft. rise in water table
- Will adaptations like this be seen more commonly in the future?

Dura Vermeer Home
Source: Dura Vermeer, The Netherlands
http://www.drijvendestad.nl/uk/project_info.asp?id=579



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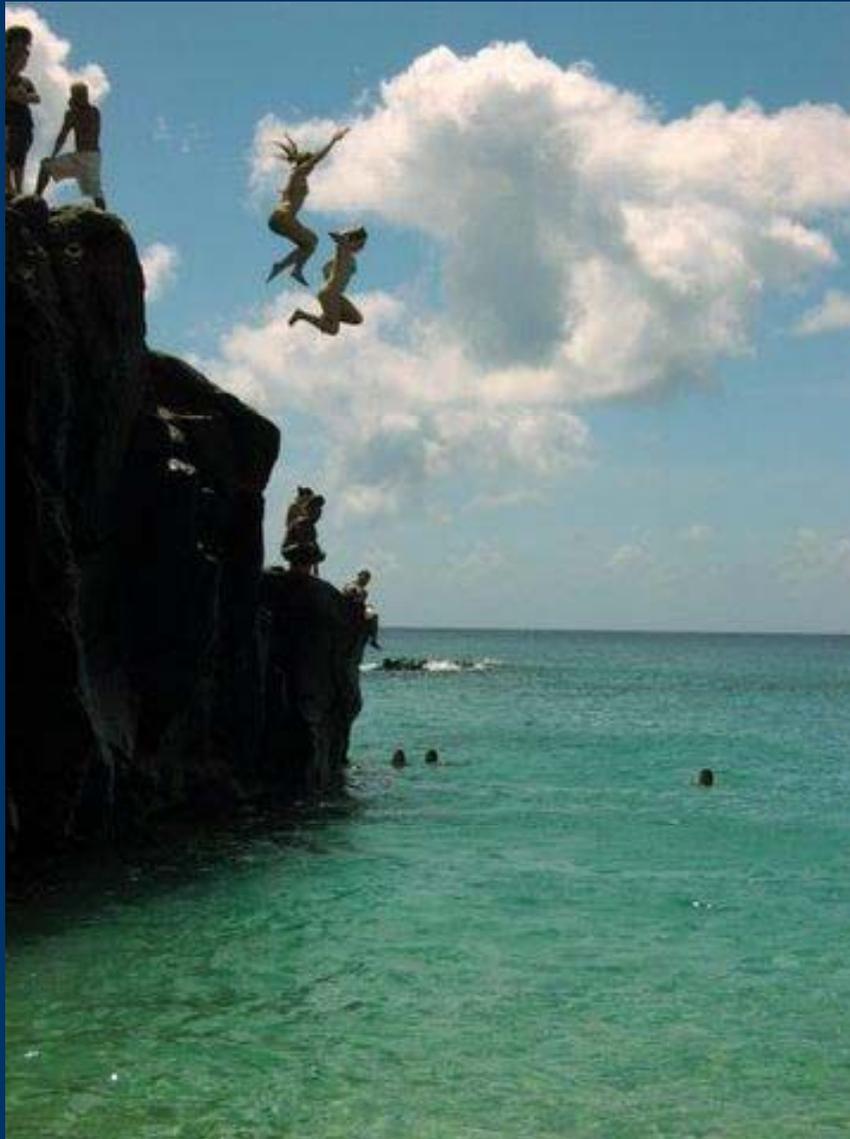
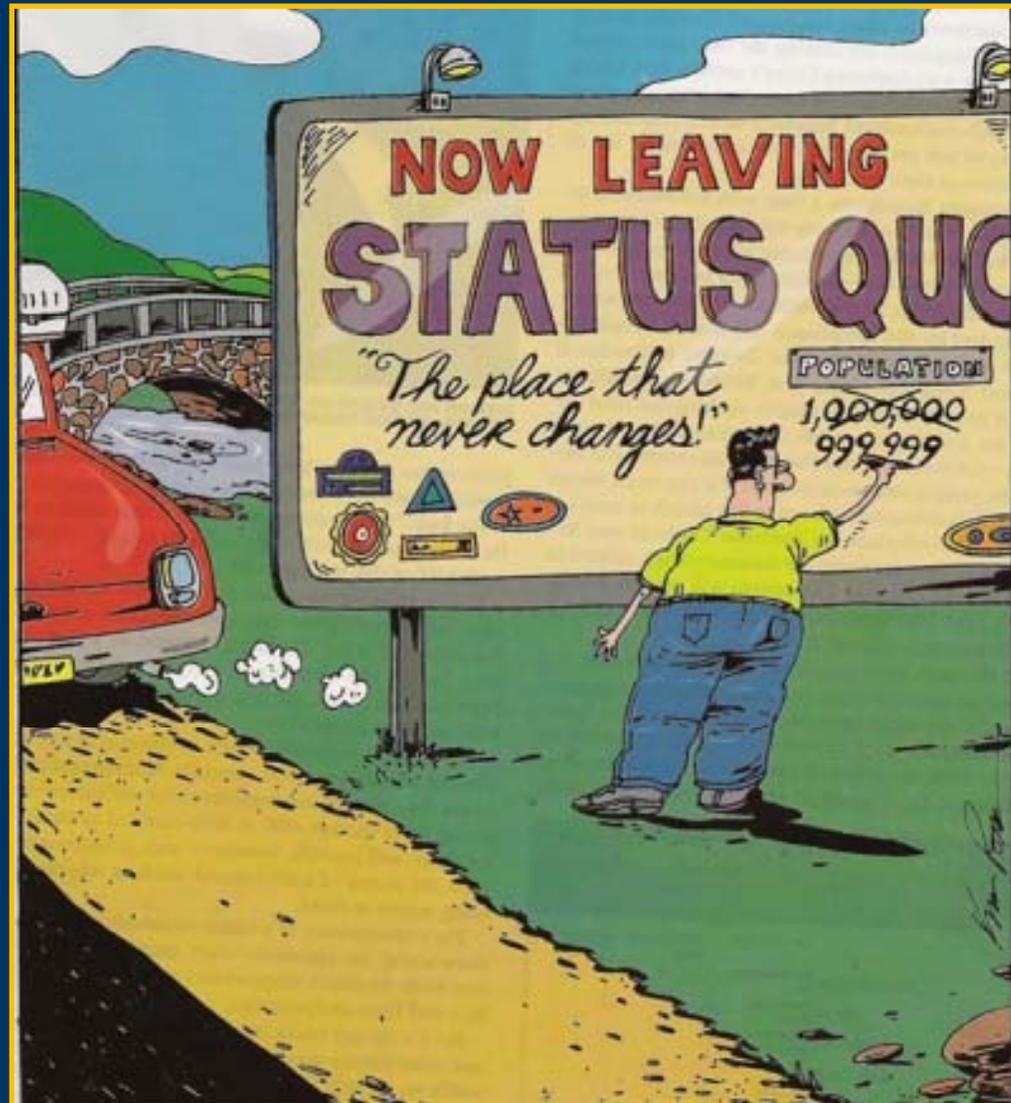


Photo credit: Karlyn Langjahr

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How will adaptation proceed in your neighborhood?



Thank You!

Contact:

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**Regional Program Manager / Coastal
Hazards Specialist**

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