CGE Hands-on training workshop on Vulnerability and Adaptation Assessments for the Latin America and the Caribbean Region
Asuncion, Paraguay, 14 to 18 August 2006

Day 3: Wednesday, 16 August

Impact, Vulnerability and Adaptation Assessment for Coastal Zones

Presenter: Dr. Robert Kay **9.45 – 10.45**

OVERVIEW

The objective of this session is to provide the participants with information on impact, vulnerability and climate change, and sea level rise on coastal zones including:

- A general discussion on the impacts of climate variability and climate change, and sea level rise on coastal zones and human settlement;

- Methods and tools to assess impacts, V&A relating to coastal zones and human settlement

OUTLINE

1. Drivers & impacts on coastal areas
2. Adaptation options
3. V&A tools & data sources
4. Integrating mechanisms
5. Conclusions

DRIVERS AND IMPACTS OF COASTAL CHANGE

Climate Change and Coastal Resources

Coastal resources will be effected by a number of consequences of climate change, including:

- Higher sea levels
- Higher sea temperatures
- Changes in precipitation patterns and coastal runoff
- Changed oceanic conditions
- Changes in storm tracks, frequencies, and intensities

Current Global Predictions of Sea Level Rise

- IPCC Third Assessment Report (TAR) range for global-mean rise in sea level is between 9 cm and 88 cm by 2100
- Change outside this range is possible, especially if Antarctica becomes a significant source
- There is a “commitment to sea level rise” even if atmospheric GHG concentrations are stabilized

Table 5.2. The main biophysical effects of relative sea level rise, including relevant interacting factors. Some factors (e.g., sediment supply) appear twice because they may be influenced by both climate and nonclimate factors (adapted from Nicholls, 2002).

Biogeophysical effect		Other relevant factors	
		Climate	Nonclimate
Inundation, flood and storm damage	Surge	Wave and storm climate, morphological changes, sediment supply	Sediment supply, flood management, morphological changes, land claim
	Backwater effect (river)	Runoff	Catchment management and land use
Wetland loss (and change)		CO_2 fertilization Sediment supply	Sediment supply, migration space, direct destruction
Erosion		Sediment supply, wave and storm climate	Sediment supply
Saltwater intrusion	Surface waters	Runoff	Catchment management and land use
	Groundwater	Rainfall	Land use, aquifer use
Rising water tables/impeded drainage		**Rainfall**	Land use, aquifer use

Biogeophysical Effects of Sea Level Rise

- Displacement of coastal lowlands and wetlands
- Increased coastal erosion
- Increased flooding (frequency and depth)
- Salinization of surface and groundwaters
- Plus others

•	Biogeophysical effect					
Sector	**Flood frequency**	**Erosion**	**Inundation**	**Rising water tables**	**Saltwater intrusion**	**Biological effects**
Water resources	•	•	✓	✓	✓	✓
Agriculture	✓	•	✓	✓	✓	•
Human health	✓	•	✓	•	•	✓
Fisheries	✓	✓	✓	•	✓	✓
Tourism	✓	✓	✓	•	•	✓
Human settlements	✓	✓	✓	✓	•	•

Ecosystem Loss

- Inundation and displacement of wetlands
  - e.g., mangroves, saltmarsh, intertidal areas
- Areas provide
  - Flood protection
  - Nursery areas for fisheries
  - Important for nature conservation
- Loss of valuable resources, tourism

Socioeconomic Impacts

- Loss of property and land
- Increased flood risk/loss of life
- Damage to coastal protection works and other infrastructure
- Loss of renewable and subsistence resources
- Loss of tourism, recreation, and coastal habitats
- Impacts on agriculture and aquaculture through decline in soil and water quality

RESPONDING TO COASTAL CHANGE (INCLUDING SEA LEVEL RISE)

Adaptation Methods

- **Retreat**
  - Managed retreat
  - Relocation from high risk zones
- **Accommodation**
  - Public awareness
  - Natural disaster management planning

- **Protect**
  - Hard options
    - Revetments, breakwaters, groins
    - Floodgates, tidal barriers
  - **Soft options**
    - Beach/wetland nourishment
    - Dune restoration

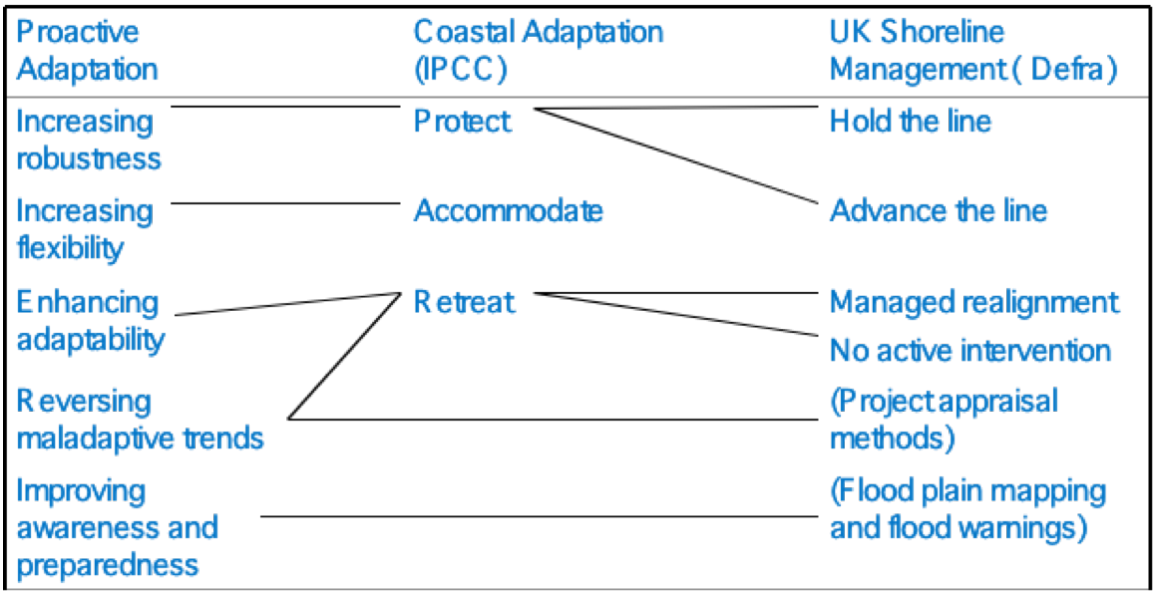
- **Example Approach to Adaptation Measures**

- Climate change predictions
  - Rise in sea level
  - Increase in number and intensity of tropical weather systems
  - Increase in severity of storm surges
  - Changes in rainfall

- **Coastal impacts**
  - Damage to property/infrastructure
  - Damage/loss of coastal/marine ecosystems
  - Destruction of hotels and tourism facilities
  - Increased risk of disease
  - Damage/loss of fisheries infrastructure
  - General loss of biodiversity
  - Submergence/inundation of coastal areas

- **Adaptation (retreat, protect, accommodate)**
  - Improved physical planning and development control
  - Strengthening/implementation of EIA regulations
  - Formulation of Coastal Zone Management Plan
  - Monitoring of coastal habitats, including beaches
  - Formulation of national climate change policy
  - Public awareness and education

Shoreline Management and Adaptation



TOOLS AND DATA SOURCES

Coastal Vulnerability Assessment

- Principles
- Older tools
- Top down
- Bottom up

Coastal vulnerability to climate change:

- The vulnerability of a coastal environment to climate change reflects the degree to which it is susceptible to adverse effects of climate extremes and climate variability.

- This vulnerability is a function of the exposure, sensitivity and adaptive capacity of a system to a variation in climate such that:

$$Vulnerability = f(E, S, AC)$$

In a coastal example:

E = character, magnitude and rate of sea level rise or intensified extreme events to which a coastline is exposed

S = degree to which property will be damaged by coastal flooding due to SLR

AC= ability of the shoreline to adjust to SLR to mitigating potential damages

- Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities or to cope with the consequences [Summary for Policy Makers (IPCC WG II]

Methods to Assess Impacts of Sea Level Rise

- Sea level rise & climate change scenarios
- Levels of assessment
    - Screening assessment
    - Vulnerability assessment
    - Erosion
    - Flooding
    - Coastal wetland loss
    - Planning assessment

- Three levels of assessment
  - Screening assessment (3-6 months)
  - Vulnerability assessment (1-2 years)
  - Planning assessment (ongoing)

Screening Assessment

- Rapid assessment to highlight possible impacts of a sea level rise scenario and identify information/data gaps
- Qualitative or semiquantitative
- Steps
  - Collation of existing coastal data
  - Assessment of the possible impacts of a high sea level rise scenario
  - Implications of future development
  - Possible responses to the problems caused by sea level rise

Step 1: Collation of Existing Data

- Topographic surveys
- Aerial/remote sensing images – topography/ land cover
- Coastal geomorphology classification
- Evidence of subsidence
- Long-term relative sea level rise
- Magnitude and damage caused by flooding
- Coastal erosion
- Population density
- Activities located on the coast (cities, ports, resort areas and tourist beaches, industrial and agricultural areas)

Step 2: Assessment of Possible Impacts of High Scenario Sea Level Rise

- Four impacts are considered
- Increased storm flooding
- Beach/bluff erosion
- Wetland and mangrove inundation and loss
- Salt water intrusion

Step 3: Implications of Future Developments

- New and existing river dams and impacts on downstream deltas
- New coastal settlements
- Expansion of coastal tourism
- Possibility of transmigration

Step 4: Responses to the Sea Level Rise Impacts

- Planned retreat (i.e., setback of defenses)
- Accommodate (i.e., raise buildings above flood levels)
- Protect (i.e., hard and soft defenses, seawalls, beach nourishment)

Barriers to Conducting Vulnerability Assessments

- Incomplete knowledge of the relevant processes affected by sea level rise and their interactions
- Insufficient data on existing physical conditions
- Difficulty in developing the local and regional scenarios of future changes
- Lack of appropriate analytical methodologies
- Variety of questions raised by different socio-political conditions

Beach Erosion

Bruun "Rule

$$R = G(L/H)S$$

where: $H = B + h^*$

- R = shoreline recession due to a sea-level rise S
- h* = depth at the offshore boundary
- B = appropriate land elevation
- L = active profile width between boundaries
- G = inverse of the overfill ratio

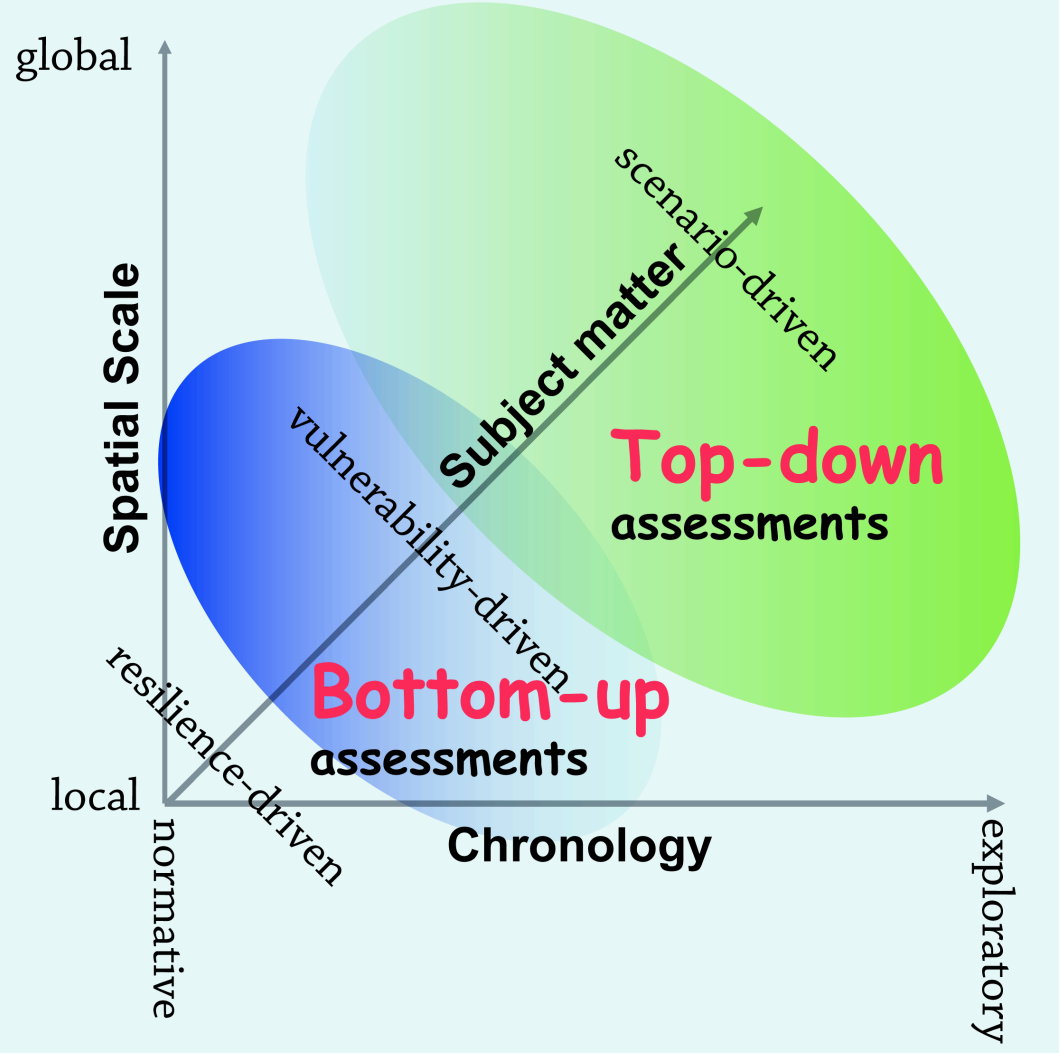
- Only describes one of the processes affecting sandy beaches
- Indirect effect of mean sea level rise
- Estuaries and inlets maintain equilibrium
- Act as major sinks
- Sand eroded from adjacent coast
- Increased erosion rates
- Response time – best applied over long timescales

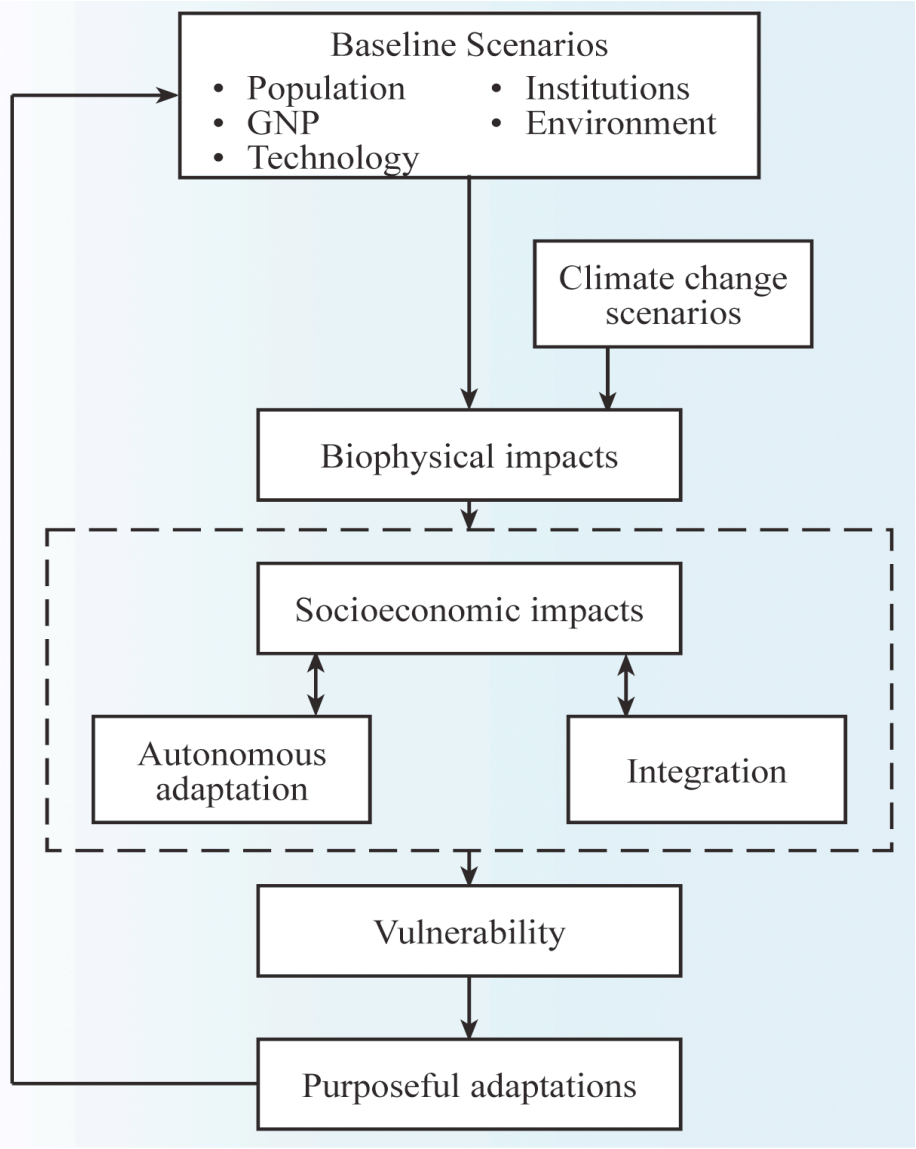
Flooding

- Increase in flood levels due to rise in sea level
- Increase in flood risk
- Increase in populations in coastal floodplain
- Adaptation
  - Increase in flood protection
  - Management and planning in floodplain

Models

- **Top Down**
  - DIVA: Dynamic and Interaction Vulnerability Assessment from DINAS-Coast Project
- **Older Models**
  - COSMO
  - RamCo
  - Common Methodology
- **Integrated Models**
  - **RegIS2 : Development of a metamodel tool for regional integrated climate change management**
- **Bottom-up approaches**





The IPCC "7-Step" Describing the Procedures involved in the "Top-down" Framework

- Define the problem
- Select the method
- Test the method
- Select scenarios
- Assess biophysical and socioeconomic impacts
- Assess autonomous adjustments
- Evaluate adaptation strategies

'Top-down' Frameworks applied in most V&A assessments to date

- Planning and institutional arrangements
- Capacity building initiatives
- Transfer of technologies and assessment

- Implementation mechanisms
- U.S. Country Studies Programme (http://www.gcrio.org/CSP/webpage.html);
- National V&A assessments as reported in the Initial National Communications (INCs) of NAI Parties (http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php);
- Assessments reported in the Third Assessment Report of the IPCCC (TAR) (http://www.grida.no/climate/ipcc_tar/wg2/index.htm)

'Bottom-up' Frameworks

- Enhancing local capacity
- Community and Private Sector assessment initiatives
- Incorporating traditional knowledge
- Community and Private-Sector implementation mechanisms
- Addressing near-term concerns
- Driven by issues identified through stakeholder consultations
    - Analysis to be conducted as deemed necessary
    - Application of "informal" analytical techniques

- UNDP Adaptation Policy Framework (APF);
- NAPA Guidance;
- UKCIP Risk, Uncertainty, and Decision-making Framework

UNFCCC approaches

- INCs: mostly top-down assessments
- NAPAs: Bottom-up
- SNC: UNFCCC User manual on the guidelines encourages the use of any approach for V&A assessment that suits the country (including APF, NAPA, etc).

Approach Selection

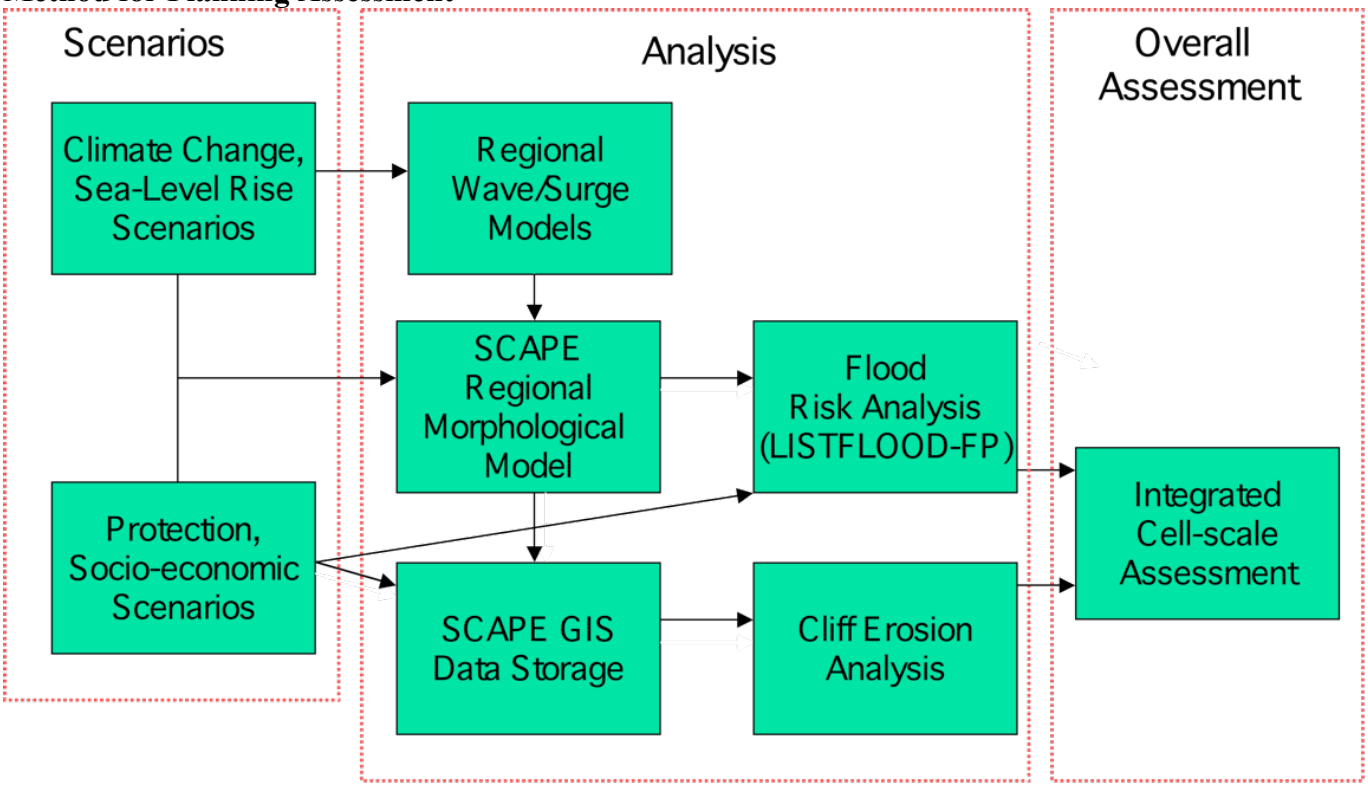
- Relative' vs 'absolute assessments'
- Pragmatic approach and selection
- Example selection criteria:
    - Type of coast
    - Management issues
    - Time/budget
    - Access to expertise & data
    - Integration into adaptation

Goals for Planning Assessment

- For future climate and protection scenarios, explore interactions between cliff management and flood risk within sediment sub-cell (in Northeast Norfolk)
- In particular, quantify
    - Cliff retreat and associated impacts
    - Longshore sediment supply/beach size

- Flood risk
- Integrated flood and erosion assessment

Method for Planning Assessment



SCAPE Model of Cliff Retreat (Norfolk, UK)

Data Sources

- IPCC Data Distribution Centre
- Sea level data
  - Permanent service for mean sea level
  - GLOSS – Global Sea-Level Observing System
- Remotely sensed data
  - Land Processes Distributed Active Archive Centre (NASA)
  - Shuttle radar topography mission

Integrating Mechanisms Integrated Coastal Zone Management (ICZM)

- Establishes institutions designed to overcome sectoral fragmentation
- Promotes harmonization & consistency of decisions, but does not supplant sectoral management
- Recognizes the distinctive, interrelated nature of watersheds, the coast, and ocean
- Establishes institutions designed to overcome sectoral fragmentation
- Promotes harmonization & consistency of decisions, but does not supplant sectoral management
- Recognizes the distinctive, interrelated nature of watersheds, the coast, and ocean

Scales of Coastal Management Plans

International	• Transboundary issues • Creating a common p urpose
Whole -of-jurisdiction [1]	• Ad ministrative arrangements • Setting national objectives and principles • Focus on prio rities
Regional	• Translating internationa l and national goals and objectives to local outcomes. • Aggregate local needs and issues to formulate national and internationa l prio rities and pro grams
Local	• Community involvement i n setting management options
Site	• Managing well defined problems • Tangible results o f all plannin g levels can be seen

CONCLUDING REMARKS

- Sea level rise could be a serious problem, but the uncertainties are large
- Impacts are strongly influenced by human choice
- Reducing GHG emissions reduces but does not avoid sea level rise impacts
- Preparing to adapt would seem prudent, in the context of multiple stresses and managing existing problems