Mainstreaming Climate Change Adaptation in Coastal Management Practice in Small Islands

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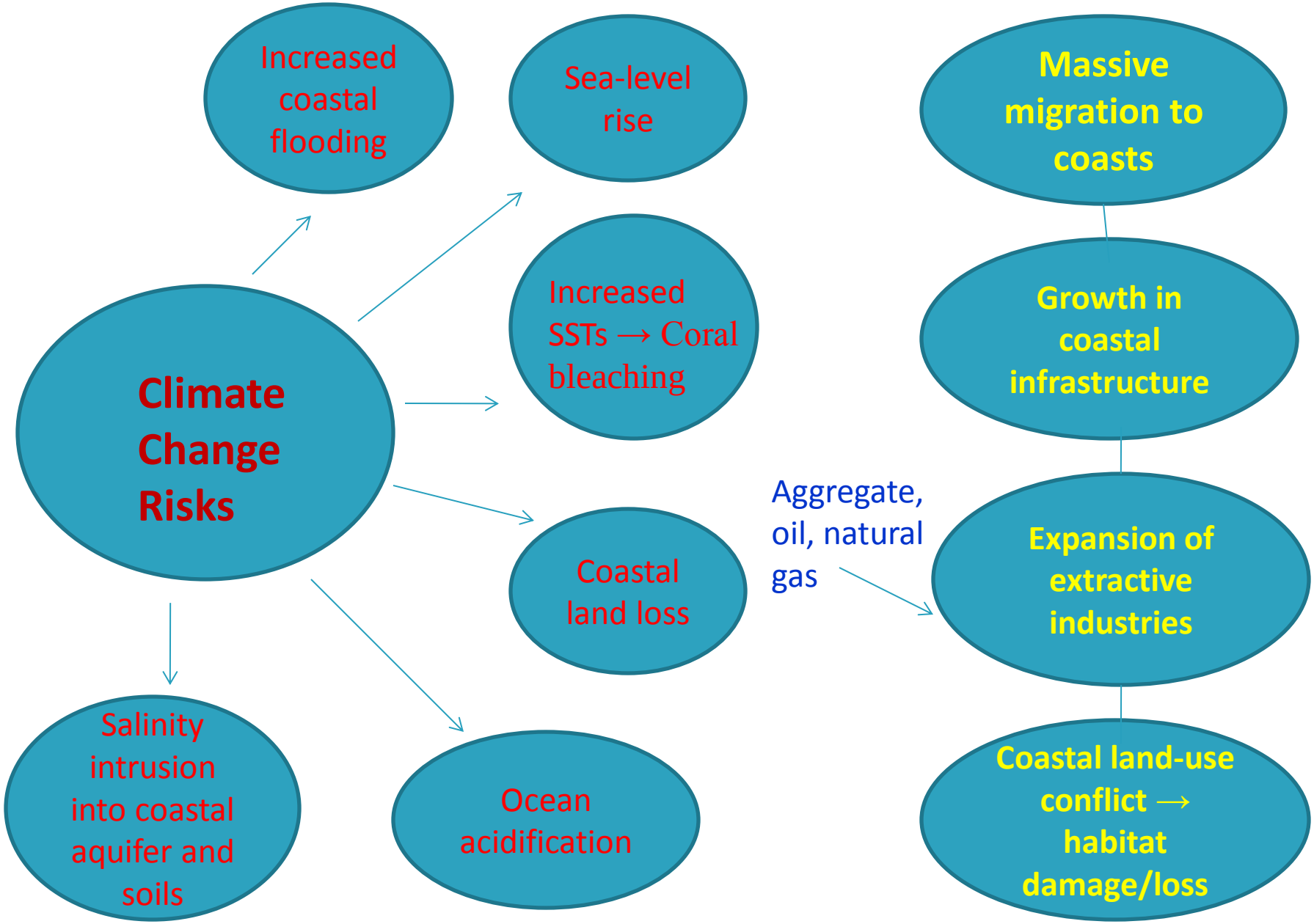
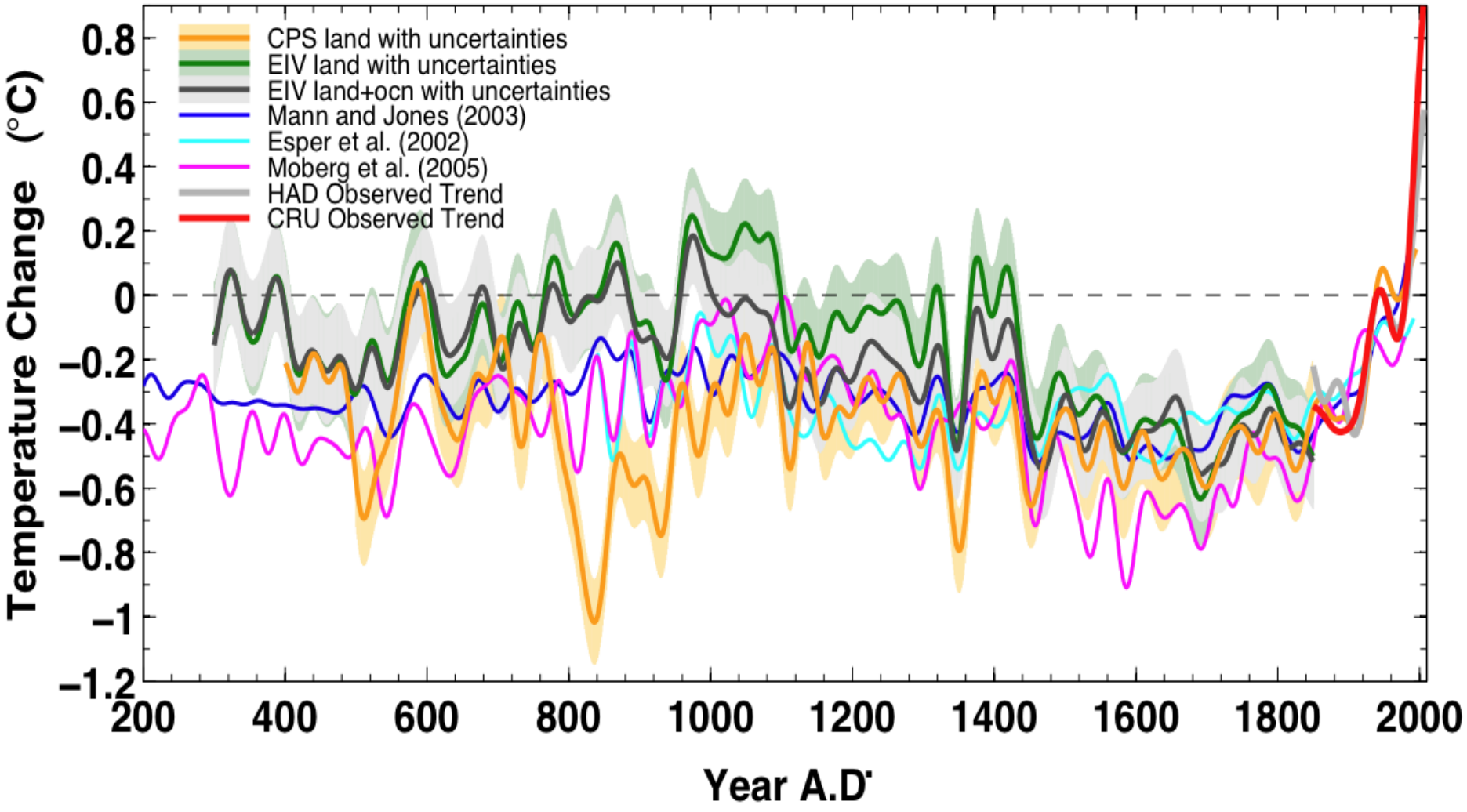
Development challenges add complexity to risk…

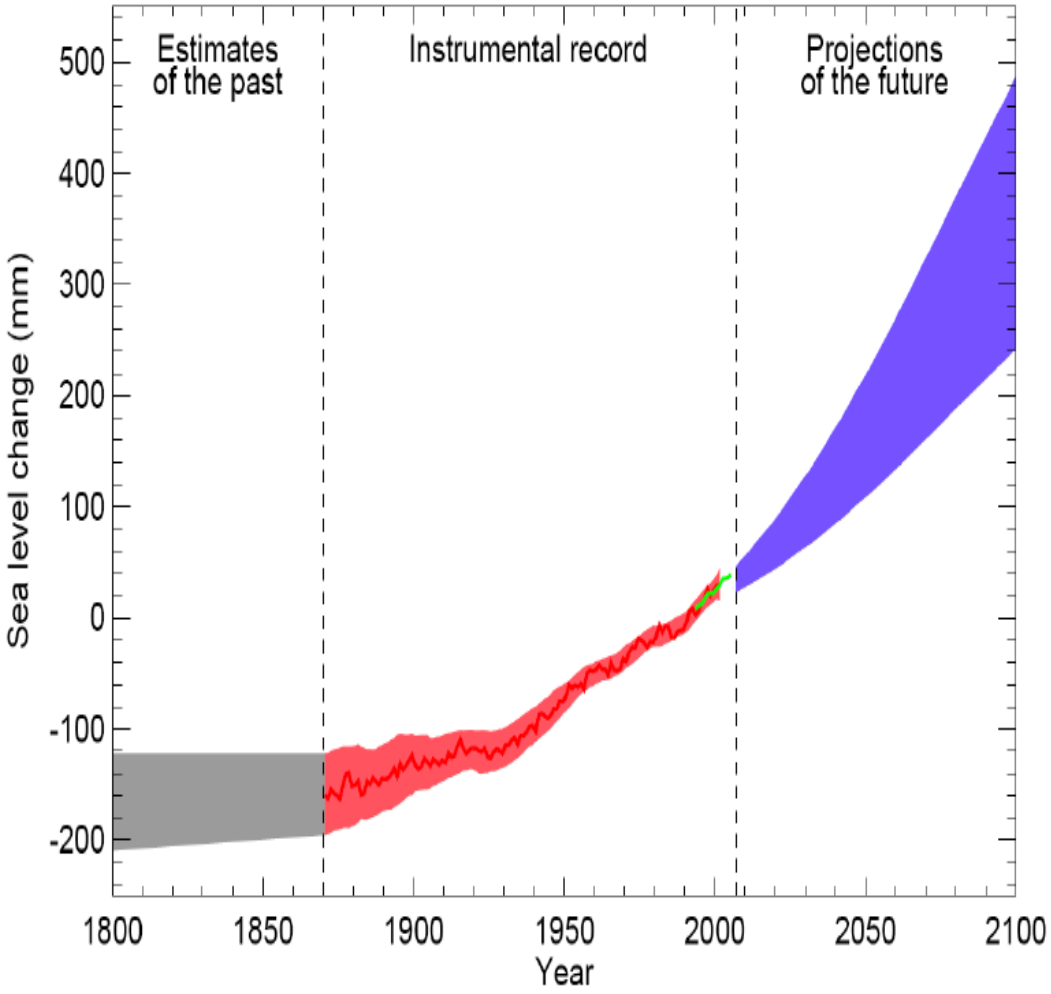


Temperature Change (Reconstructed) for Northern Hemisphere Since 2000 AD



Source: Copenhagen Diagnostics, 2009

Sea Level Rise Projections



- **IPCC AR4 projected a maximum sea level rise of 59 cm higher than the Pre-Industrial mean.**

- **Current projections are that by the end of this Century, global sea levels could be as much as 1.5 m higher than the Pre-industrial mean.**

How Would Climate Change Affect Wave Energy?

- *Wave Energy* (*E*) is proportional to the a*mplitude* (α) of wave
- α is also partly controlled by wind speed (*V*)

Climate change signals?

↑ ^{0}T (air & sea) →

(a) Thermal expansion

(b) Melting of land ice

↓

H_2O Depth

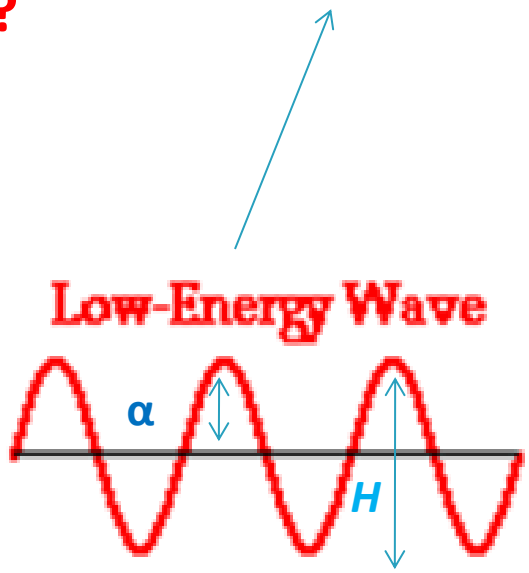
(c) Increasing wind speed?

(d) Pressure gradient change?

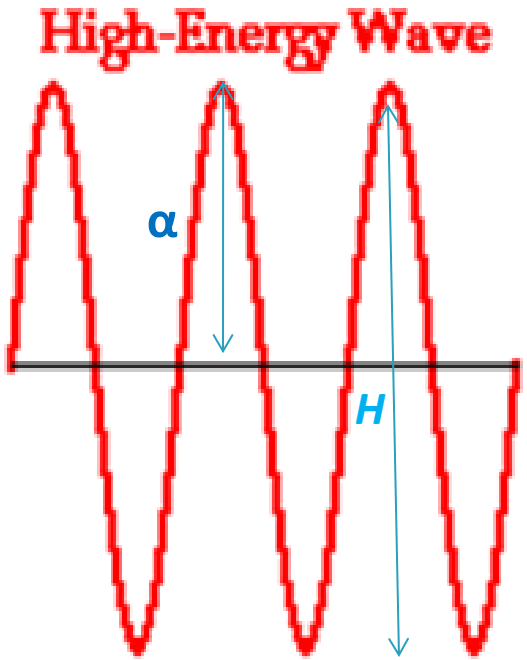
↓

Higher wave energy?

Example → sheltered leeward coasts



Example → exposed windward coasts



- As a general rule, *E* increases *exponentially* with increasing *V*
- *E* also increases with *water depth* (*d*)

Wave Energy

- Energy (*E*) is the total of *kinetic* and *potential* energy in the wave → measure of capacity of the wave to perform '*work*' along the coast:

$$E = \sum E_k + E_p$$

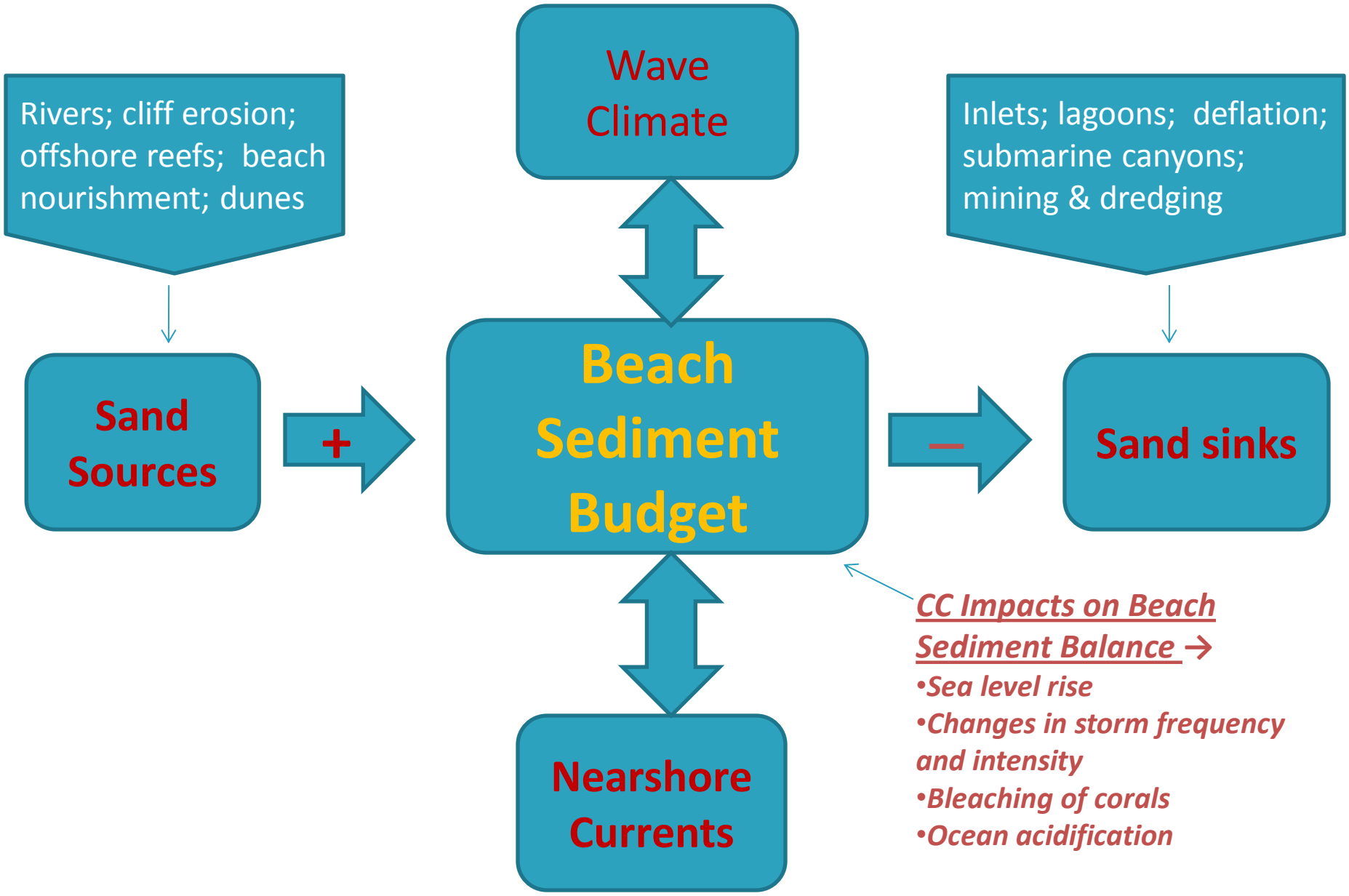
Erosion/transport/deposition

- *Water depth* (*d*) and wave height (*H*) are also important controls on wave energy.
- The total energy in a wave is proportional to the square of the wave height ∴ 2 X *H* increases *E* by a factor of 4.

  Example:
  - If energy in a wave of *H* = 4m = 1200 cal/m^2 ocean surface
  - Energy in a wave of *H* = 8m = 4800 cal/m^2 ocean surface

- Recall that *E* increases <u>exponentially</u> with increasing wind speed.
- IPCC AR4 projects 5-10% increase in maximum hurricane wind intensity by 2050's.

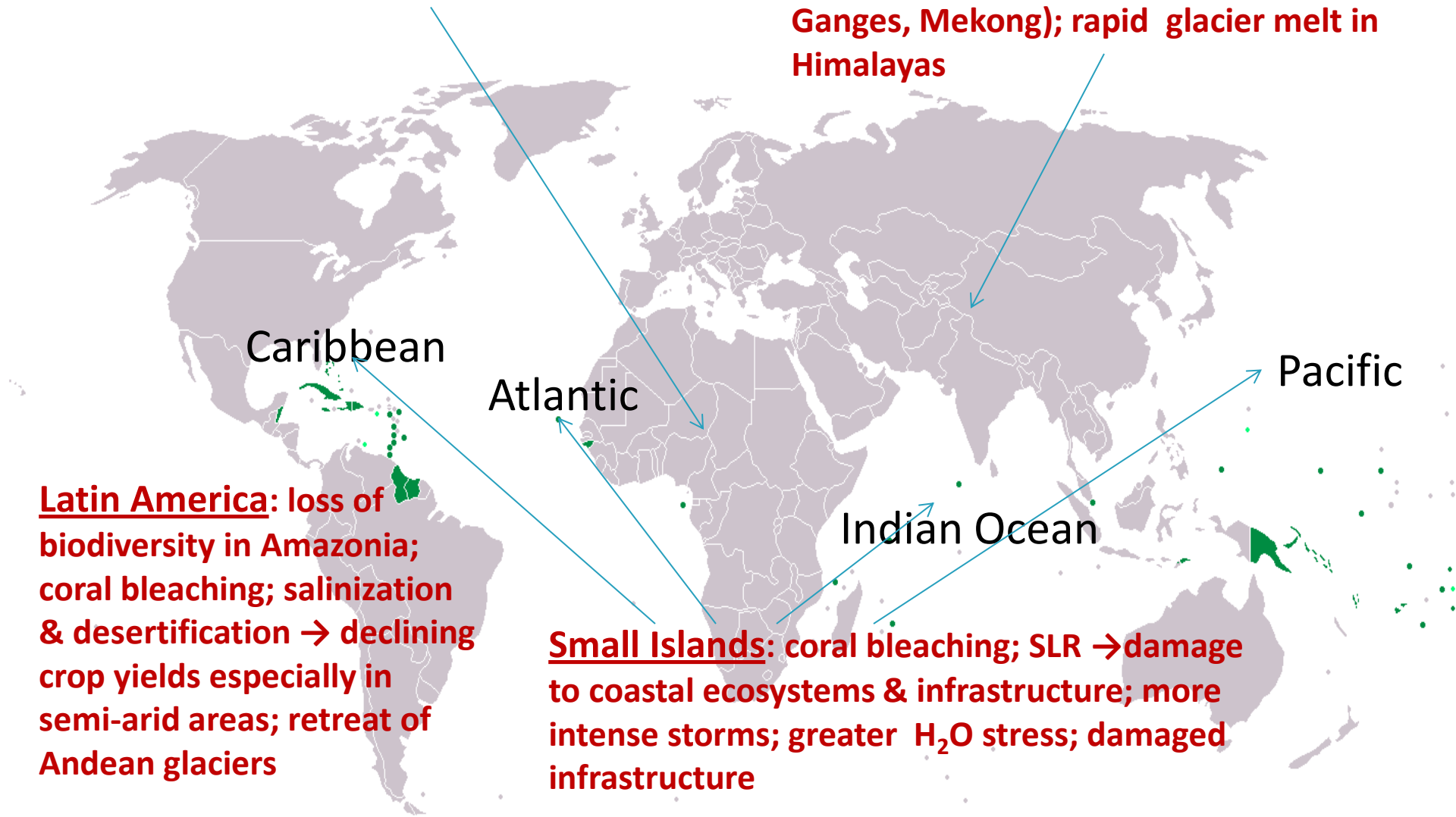
Beach Sediment Balance $= \sum [Q_{source\ 1} + Q_{source\ 2} + \ldots Q_{source\ n}] - \sum [Q_{sink\ 1} + Q_{sink\ 2} + Q_{sink\ n}]$



Regions of Highest Risk (IPCC AR4, 2007)

Africa: increasing H_2O scarcity & food insecurity; biodiversity loss in East- and South Africa; higher malaria incidence in highlands of East Africa

Asia: lower crop yields in central and southern areas by 2050s; increased H_2O scarcity in east and south-east; higher incidence of flooding in mega-deltas (e.g. Ganges, Mekong); rapid glacier melt in Himalayas

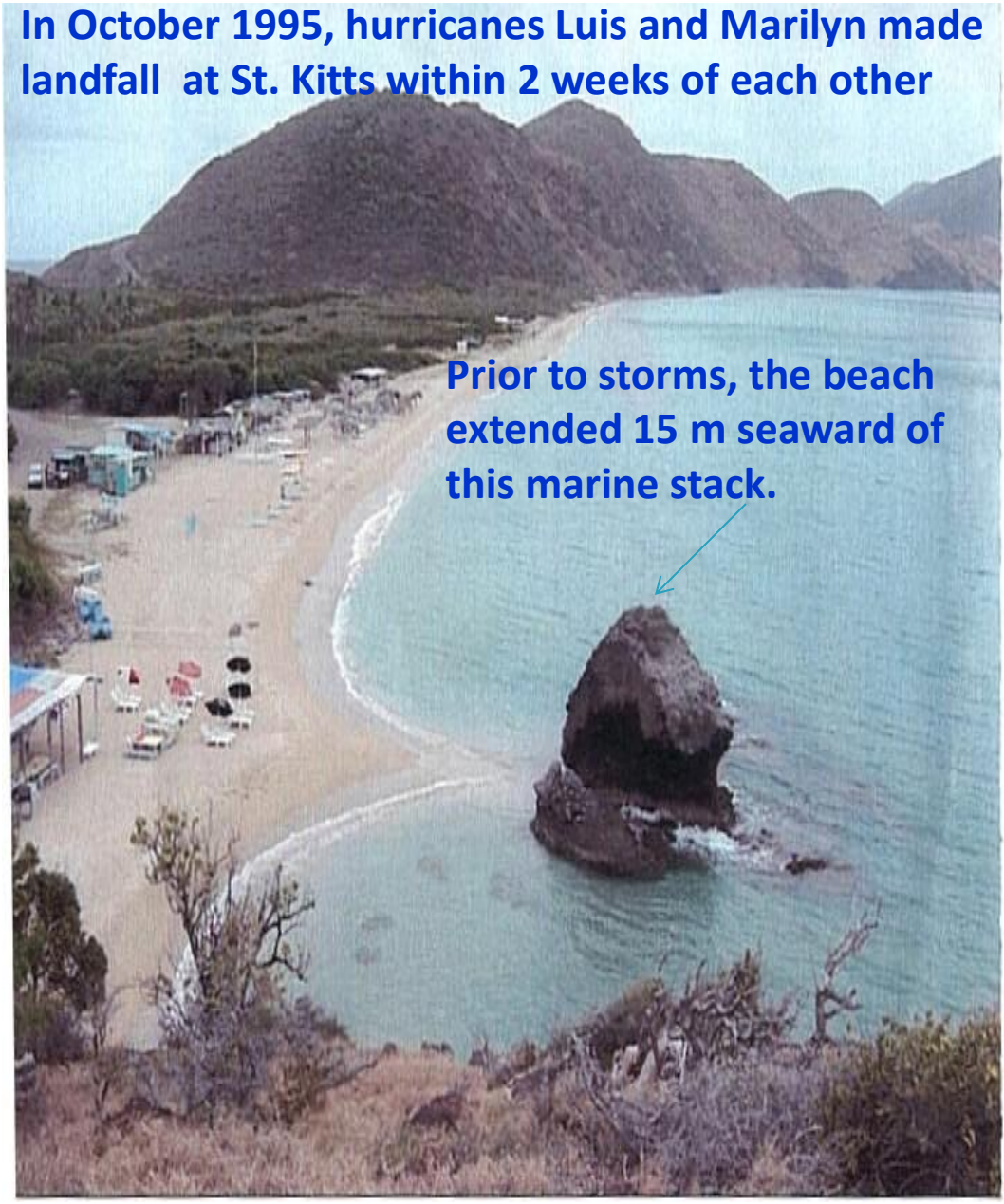


Latin America: loss of biodiversity in Amazonia; coral bleaching; salinization & desertification → declining crop yields especially in semi-arid areas; retreat of Andean glaciers

Small Islands: coral bleaching; SLR →damage to coastal ecosystems & infrastructure; more intense storms; greater H_2O stress; damaged infrastructure

Water Level Changes and Coastal Erosion

- *Accelerated beach erosion* will pose challenges for low-lying SIDS. While some present-day erosion is man-induced (*sand mining*, *reef degradation*), studies show that SLR can be a major contributory factor.
  - Higher H_2O Levels → Higher Wave Amplitude → Increased Wave Energy = More Coastal Erosion
  - Vulnerability assessments for various Caribbean islands (e.g. Barbados, Guyana & Grenada) show that elevated sea levels amplify coastal erosion.

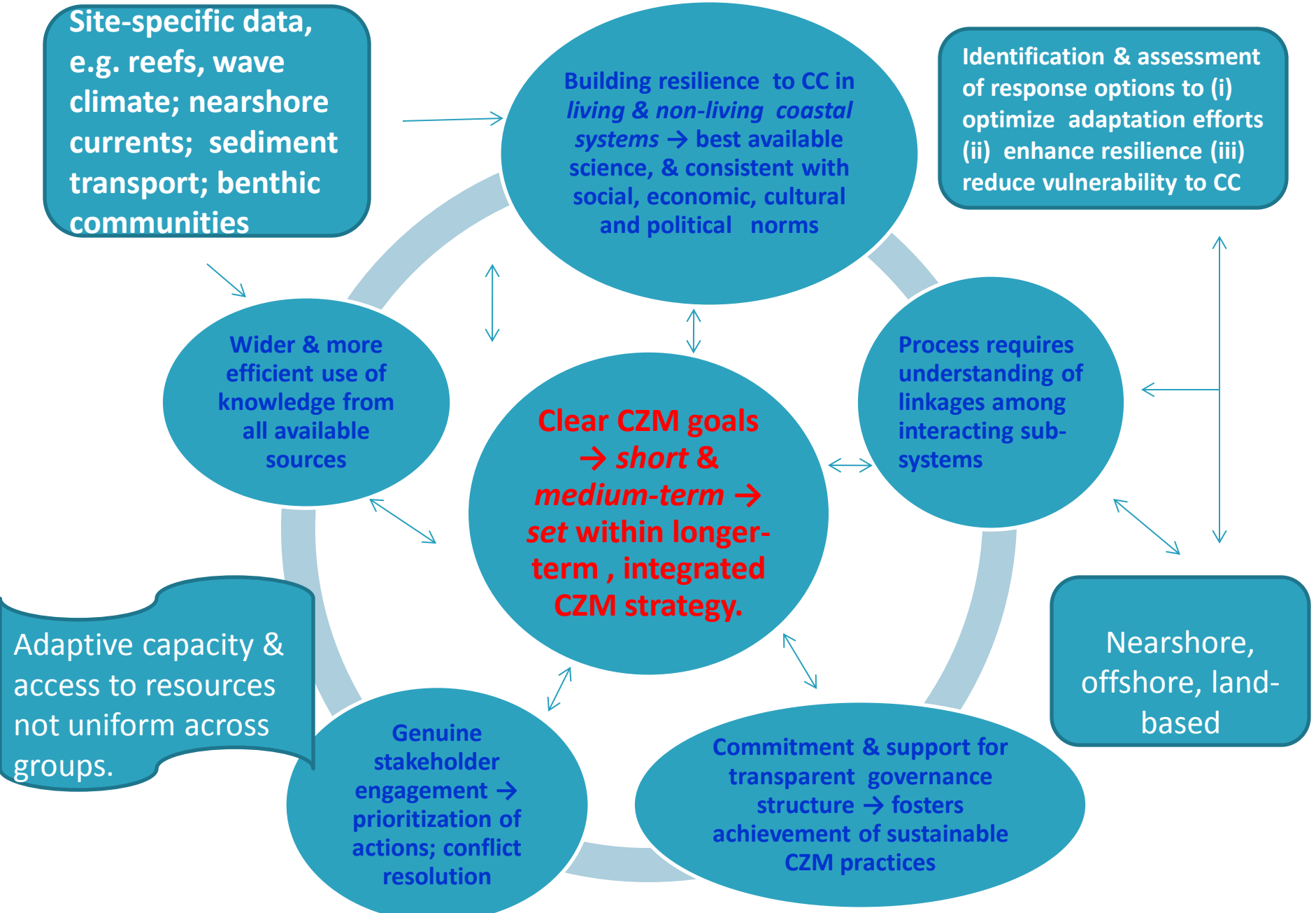


Will Corals Be At Serious Risk?

- Bleaching of corals triggered by high SSTs –at current GHG emission rates bleaching could become an annual event by 2025-2050.
- At 560 ppm CO_2 some corals likely to stop growing → little $CaCO_3$ accumulation.
- 14-30% decline in calcification rates by 2050

'*Cultural Assets*' Are Also At Great Risk

Laying the Foundation for Mainstreaming CC in ICM



Managing in the Face of Uncertainty

- Resource constraints dictate that it impossible to fill all knowledge & information gaps at once → prioritization:
  - Allows greater focus on research that help us to better define the really key concepts relating to vulnerability of coastal systems to CC, e.g. *risk, sensitivity.*
  - In regions such as the Caribbean, where *adaptive capacity* is considered low →risk and sensitivity are vital considerations in making decisions about future vulnerability, likely impacts and response strategies.
  - The extent to which mainstreaming of adaptation can be effectively achieved will be partly dependent on how well we can (i) quantify and (ii) represent *risk* and *sensitivity* in the CZM decisions we make.

'*No Regrets*' Measures are Integral to Mainstreaming

Example : Implementation of adequate *coastal setback* limits:

- **Provide effective buffer between the sea and the backshore;**
- **Ensure a minimum swash area → facilitates an uninterrupted cycle of shoreline advance and retreat. Important because:**

✓ **Wide beach is best mechanism for efficient absorption, reflection and dissipation of incident wave energy**

✓ **A wide swash zone renders the beach less susceptible to scour from extreme events**

- **Stringent application of setbacks is known positive factor in natural beach recovery after storms, swells, etc.**
- **Setbacks constitute a form of *risk reduction* → provide defense/protection from incident waves.**

Advancing the Process of Mainstreaming

***Tipping point*:**
A critical threshold at which even a small amount of change can qualitatively alter the dynamics, equilibrium or development of a system

System Failure

Collapse

Tipping points have great policy relevance. CC pushing systems towards critical thresholds rapidly

Monitoring & Early Warning Systems can help detect imminence of critical thresholds

Some ecosystems already near upper limit of their critical thresholds, e.g. corals, mangroves

Quantitatively small changes can overwhelm existing critical thresholds

Transient changes in climate already adversely affecting the Caribbean → occurring concurrently with rapid social & economic changes
→ *multiple stresses* will co-evolve in non-linear ways, increasing the probability of abrupt rather than slow, onset change , i.e. 'surprises'.

Mainstreaming can be a 'hedge' against the effects of such highly probable, but unpredictable *non-linearities*.

Identification of Strategic Entry Points in Planning Process

Set goals at different scales → short-, medium- and long-term ; national, sector & subnational

Evaluate national & local capacities →needs, barriers, coping strategies, knowledge base etc

CC impacts strongly felt at local level ; livelihoods affected →**mainstreaming must link directly with local conditions**.

Allocate resources → finance, information, personnel, equipment & technology, regulatory and legal support, etc.

Inclusive process: *agreed goals* → based on equity, gender, consideration of most vulnerable groups

Evidence-based measures →apply information from all sources, including local knowledge

Tracking Progress → Monitoring

Indispensable element of mainstreaming → Are strategies working? Are objectives being met? Are there barriers that were not previously identified? What adjustments need to be made?

Thank You

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