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Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

Effects of ocean warming on coastal ecosystems and resources

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High Level Conference on Climate Change Assessment and Adaptation in the Arab Region – Beirut, Lebanon – 26-28 September 2017

Contents

Poor acknowledgement of climate change, global warming and effects on marine ecosystems and services

Some basic facts

Suite of potential effects

Need for ecosystem approach as advocated by UNEP and others

Arab context: highly complex given diversity of ecosystems, approach, resources, geo-political features, geography.

Key issues in Arab region: water and food security, most (in some cases, all) population is coastal, volatility etc

Key Recommendations

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Relevance of marine ecosystems

Marine ecosystems are centrally important to the biology of the planet, yet a comprehensive understanding of how anthropogenic climate change is affecting them has been poorly developed.

Climate change - and some of its 'marine' implications - present increasing threats to marine ecosystems, the processes that control and affect them and, crucially, the people who depend upon them. Directly or indirectly.

Over 1 billion people depend on coral reefs alone.

Most people - in some cases all - live on or very near the coast and this is destined to increase.

Arab States are a prime example of this.

Climate change is already manifesting itself through very visible and tangible phenomena including enhanced or more frequent meteorological events (storms, hurricanes, coastal flooding and extreme rainfall) as well as visible effects on some ecosystems including coral reef bleaching.

We've known for a long time….

Scale of ocean warming is staggering, poorly understood nor communicated clearly

Ocean warming may well turn out to be the greatest hidden challenge of our generation

Most visible effects on coral reefs, but many more largely 'unknown'

Not a new problem!

1956 - meteorologist Carl-Gustav Rossby, the 'father' of ocean warming, speculated that over the course of a few centuries vast amounts of heat might be buried in the oceans or emerge, perhaps greatly affecting the planet's climate. He warned that "Tampering can be dangerous. Nature can be vengeful. We should have a great deal of respect for the planet on which we live ".

….And yet…….

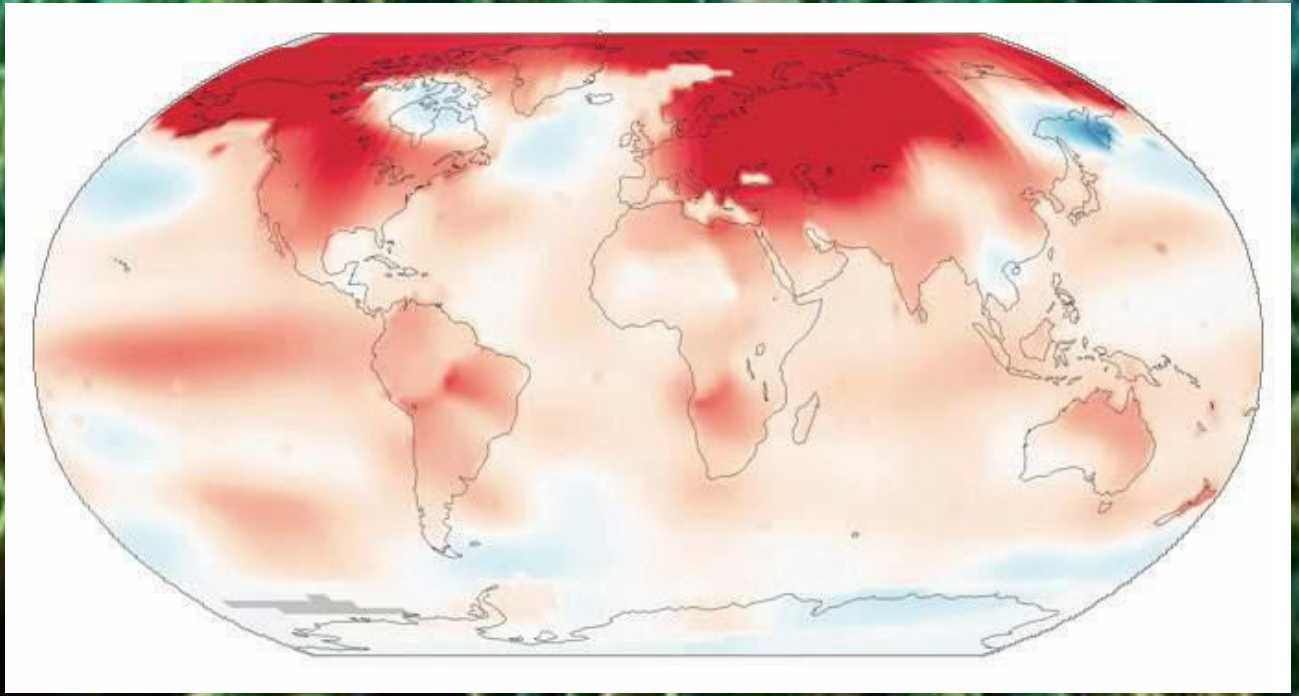
His theory has been borne out as the consequences of increasing human activities have indeed injected vast quantities of heat into the ocean, shielding humanity on land, in so doing, from the worst effects of climate change. This regulating function, however, happens at the cost of profound alterations to the ocean's physics and chemistry that lead especially to ocean warming and acidification, and consequently sea-level rise

Long-term studies of climate change in the oceans are rare by comparison to those on land

We spend more $ trying to reach Mars than looking at our own back yard - especially the wet one!

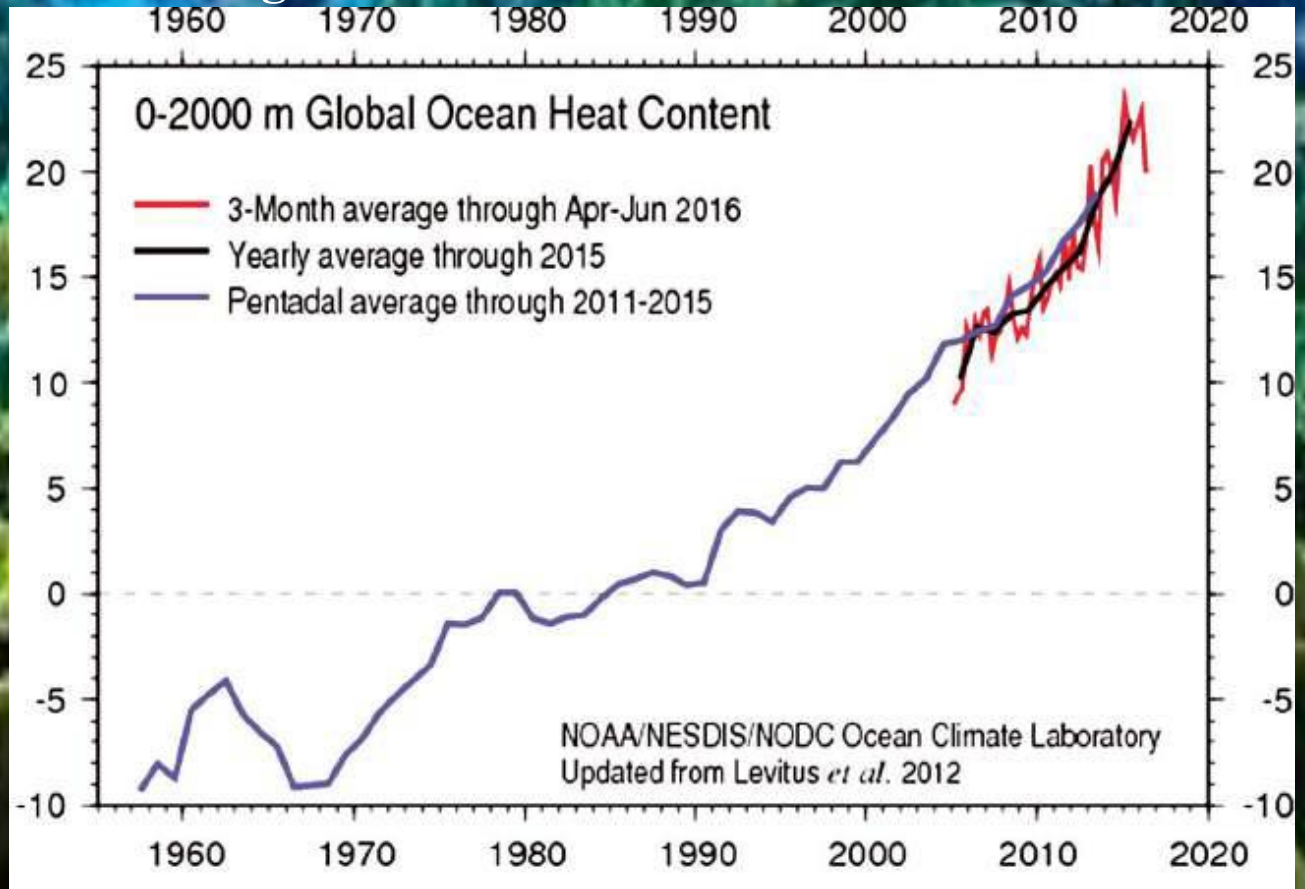
Some facts….

Annual global sea surface temperature anomalies from 1880 to 2015 with superimposed a linear trend (Base period 1951-1980), red positive, blue negative. From: http://www.ncdc.noaa.gov/cag/time-series/global/globe/ocean/ytd/12/1880-2016



Some facts….

The exceptional nature of the two record years for global SST and global temperatures in 2014 and 2015 in sequence and high likelihood that 2016 will also be a record year implies that the rise in global SST may be accelerating.



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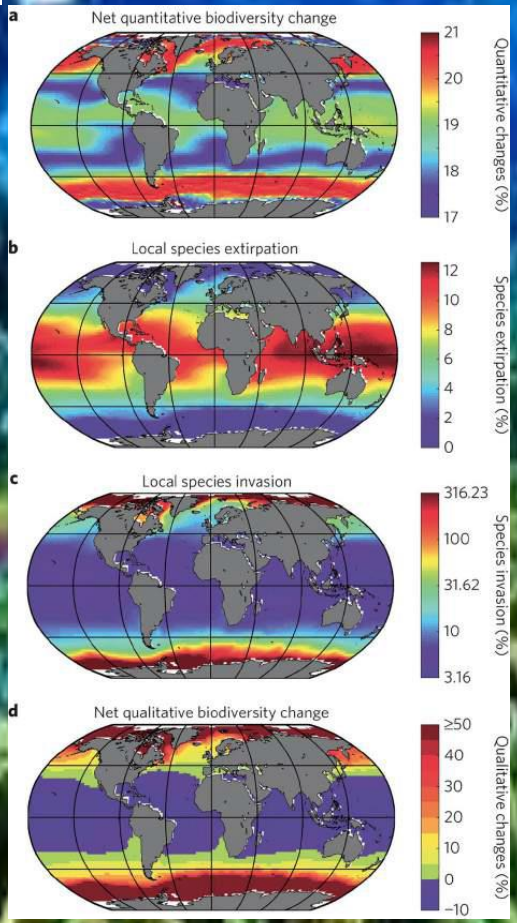

Expected sensitivity of biodiversity to a 2°C increase in temperature. a–c, Net quantitative changes in biodiversity (a), local species extirpation (b) and invasion c). d, Net qualitative biodiversity changes resulting from the difference between species invasion and extirpation. All changes are expressed as %a percentage. Based on Beaugrand et al. (2015).

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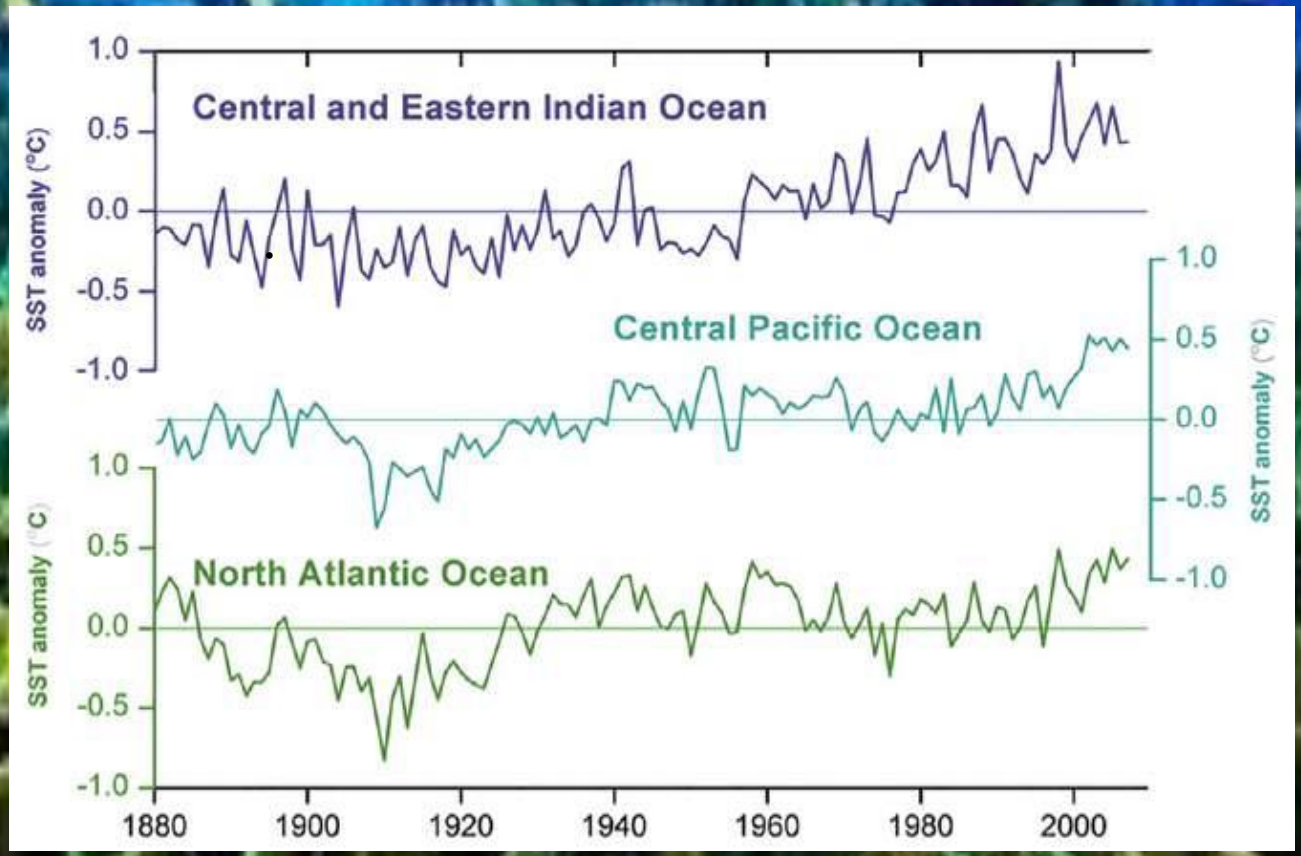
Some facts….



Arab region - key relevant features

Key features of the Arab Region

Highly varied geographically, climatically, ecologically, economically, socially (e.g. Atlantic, Mediterranean, Red Sea, RSA)

Considerable increase in CO2 emissions from energy consumption (per capita energy use)

Effects of ocean warming is highly diverse (flooding, ecological, water security, fisheries, climatic)

Water and food security are major issues

Most issues highly transboundary in nature (this is crucial for finding solutions)

Volatility is widespread albeit diverse

Transboundary efforts are being developed (EBM in ROPME Sea Area) - lessons learnt approach

Arab region differences need not be a hindrance but an opportunity! See ROPME EBM

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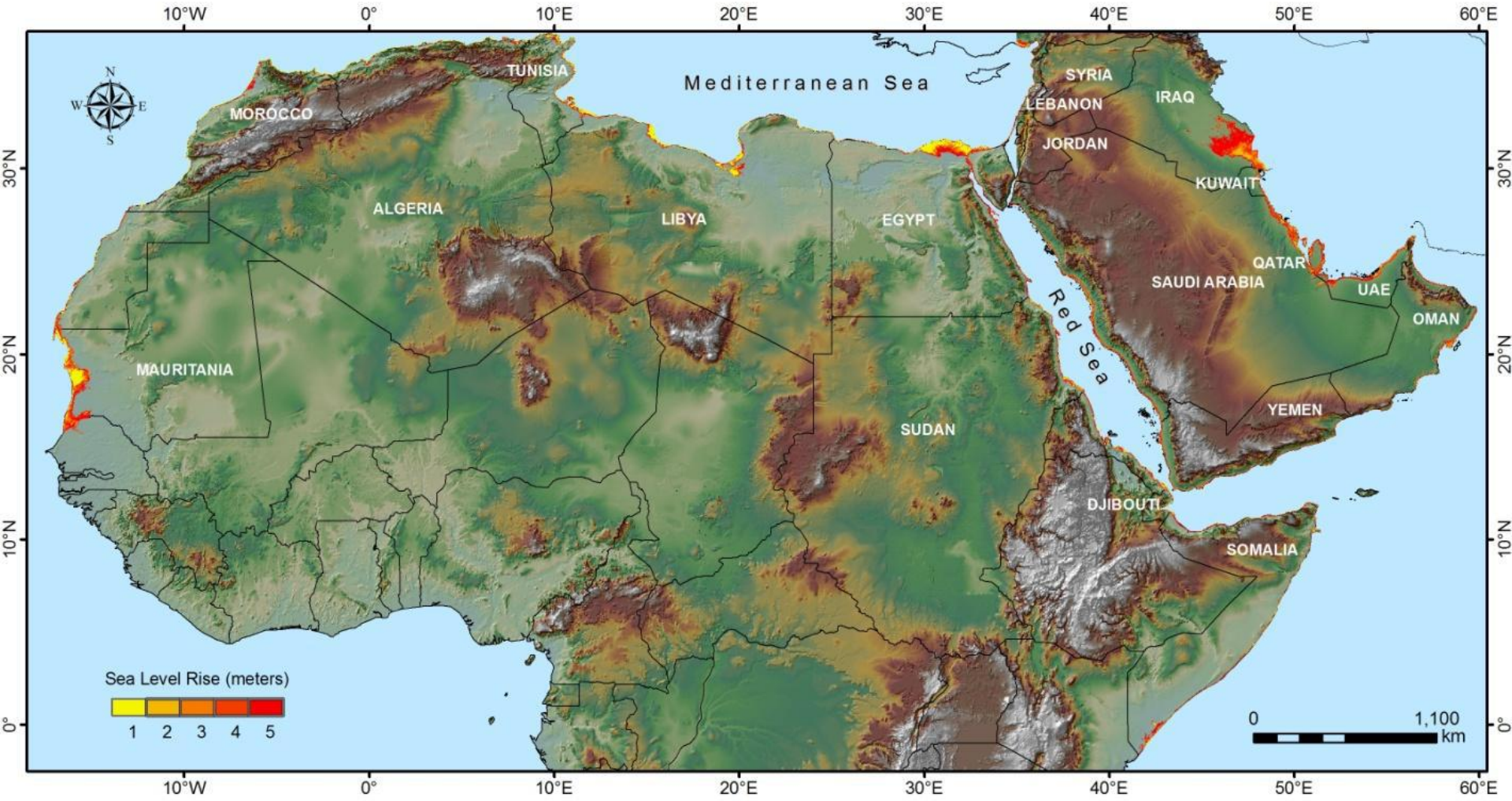
Overview of Arab region coastal areas most vulnerable to sea level rise



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Effects….

Suite of manifestations is increasingly complex and interactive and includes biogeographical, biodiversity, community size, species abundance ecological shift change including invasive species

ALL have effects on the benefits we secure from the oceans

Interactions remain poorly understood or unknown

Most effects of rising CO2 and consequent warming are highly negative and are known

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Table of Effects

Changes in heat storage	Increasing uptake of heat by the ocean Rising water temperatures at all depths Intensification of El Niño (ENSO) events
Changes in the strength/position of currents and heat transport.	Increased heat transport
Warming of adjacent land masses	Warmer land surface temperatures Melting permafrost Terrestrial vegetation changing Increased extent and magnitude of forest fires
Rising sea levels due to water heat expansion Temperature increases from melting ice sheets and glaciers	Permanent land inundation, coastal erosion, flooding from storm surges, salt water intrusion into aquifers, loss of coral atolls and islands.
A melting cryosphere (frozen world)	Melting and thinning of ice shelves Increasing Antarctic ice mass/sea ice Accelerated mass loss in Greenland Accelerating reduction of sea ice in the Arctic and Antarctica

Table of effects cont…..

Methane gas hydrate release	Potential release of methane to the atmosphere from seafloor
Intensification of the hydrological cycle	Higher SST reduce CO2 uptake from atmosphere and enhance atmospheric CO2
Deoxygenation	Reduced oxygen (O2) solubility in warmer water affecting bio-geo-chemical processes
Potential feedback from Ocean Acidification	Rising temperature reinforces Ocean Acidification with known consequences (biological and fisheries)
Potential slowdown of the Biological Pump	Current status unclear
Occurrence of more extremes in natural variability such as the El Niño/Southern Oscillation (ENSO) and weather events	Occurrence, frequency and severity of cyclones/hurricanes Changes in location/meandering of jet streams affecting downstream weather Landslides, collapses in fisheries coral bleaching and diseases, malnutrition and human migration Monsoons, forest fires and associated air pollution
Changes in biological processes at cellular to ecosystem scales	See below

Table of effects cont…..

On micro-organisms	Biogeochemical processes and food webs
On seaweed	Loss of habitat, loss of fisheries, loss of food source, less coastal protection
On seagrass beds	Loss of fisheries, recruitment habitat, sediment stabilization and carbon storage
On coral reefs	< 0.1% of sea floor, yearly provide ~US$9.8 trillion globally in social, economic and cultural services, habitat for >25% of marine fish species and over 1 bn jobs
On mangroves	Loss in fisheries, habitat, recruitment potential, erosion control
On deep water communities	Loss of carbon storage ability, release of frozen methane hydrate into atmosphere; biodiversity. The great unknown (see Rossby)

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Reefs: before and after

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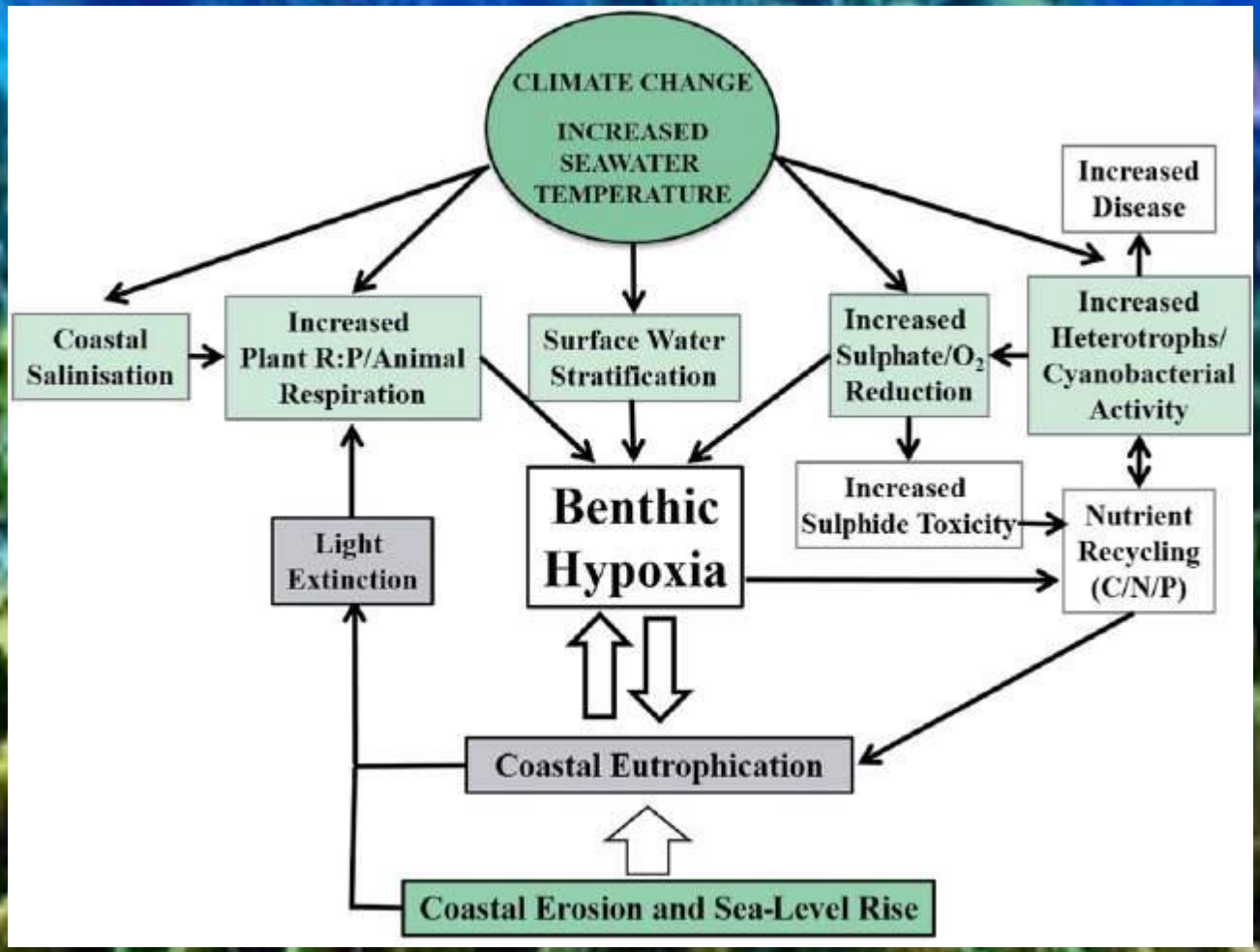
Interactions, interactions……



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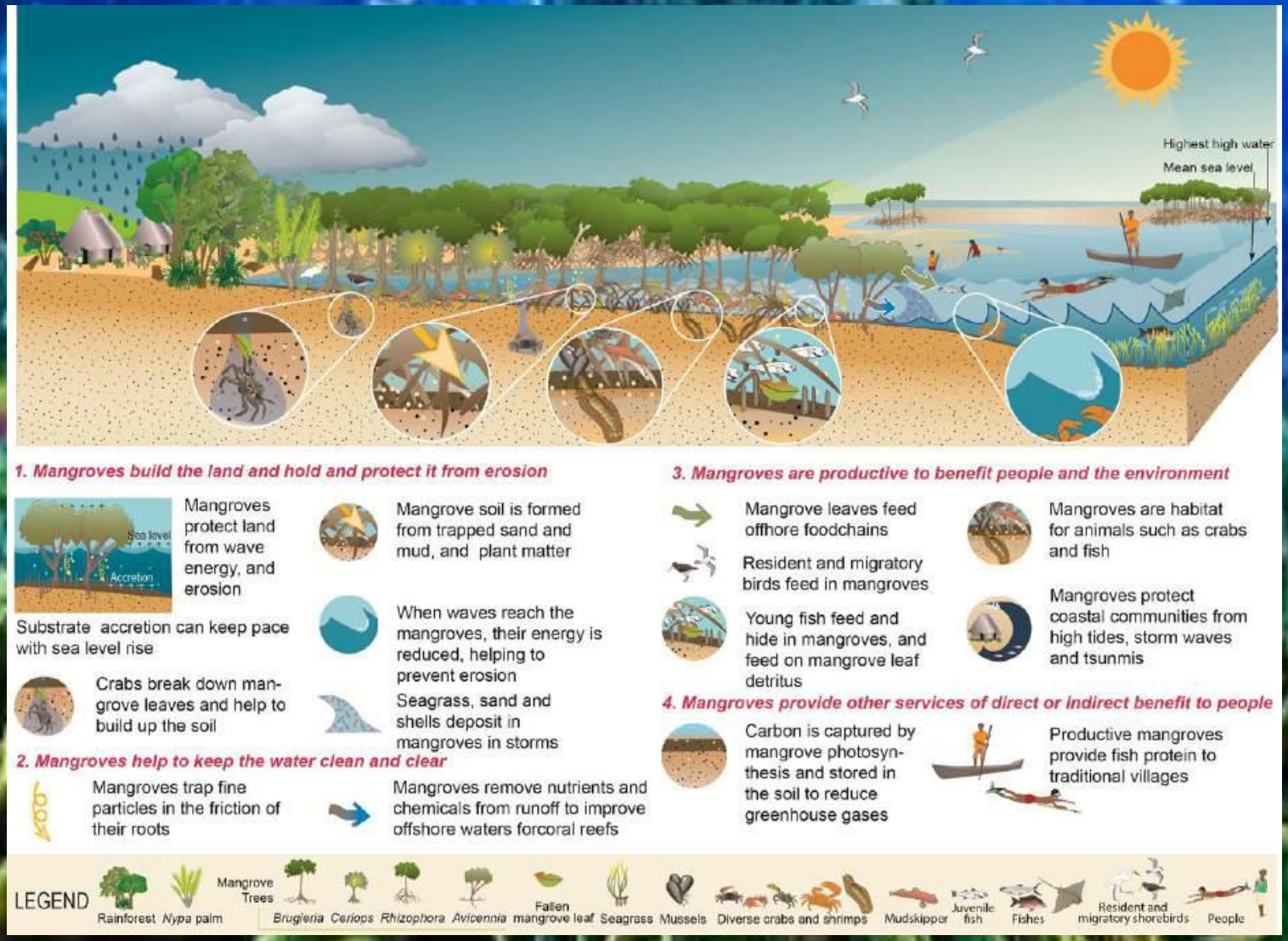
Interactions, interactions……



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Ecosystem based approach

Connectivity between ecosystems, and linkages between ecosystems and human well-being (taken from UNEP, 2011).

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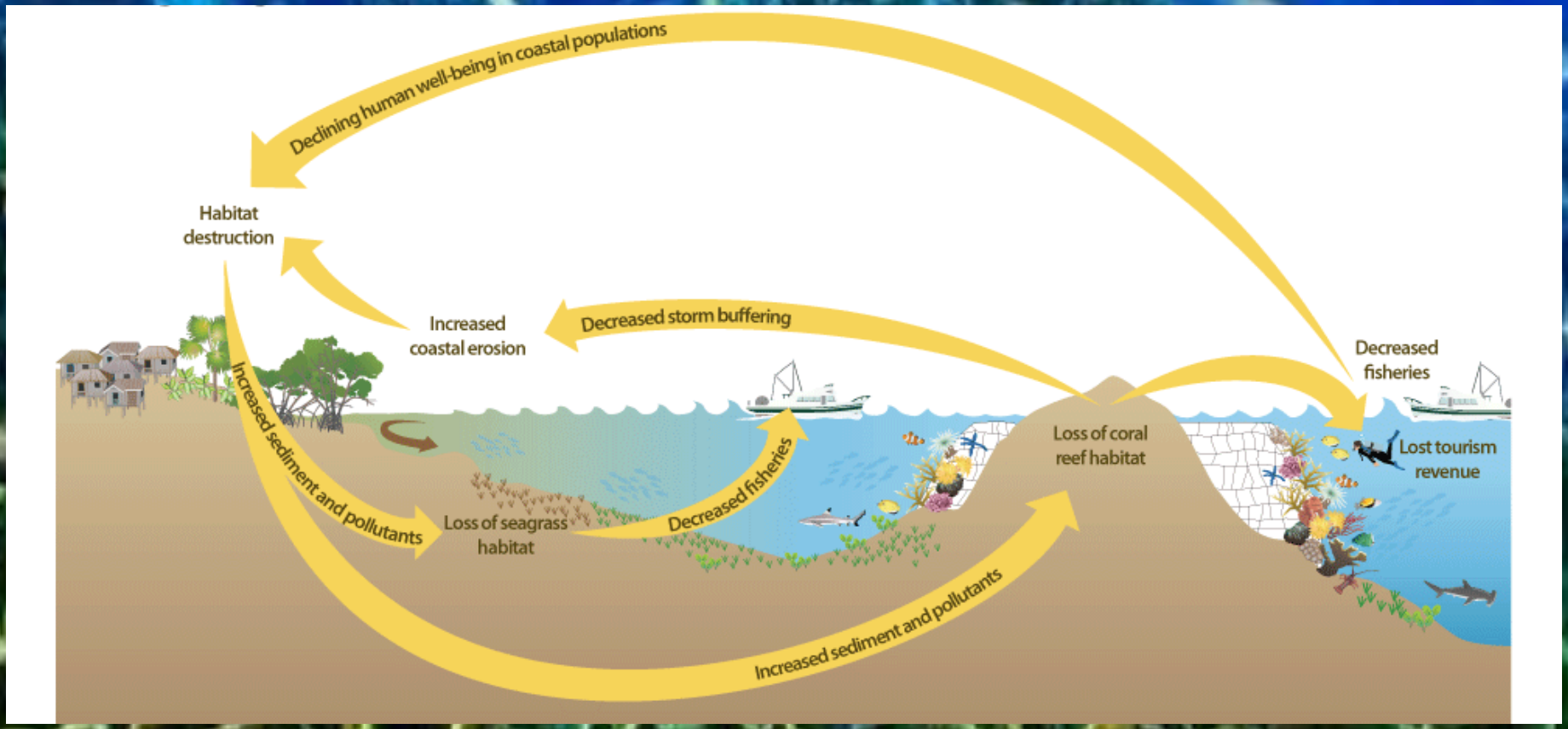
Ecosystem based approach



Ecosystem based interactions (taken from UNEP, 2011)

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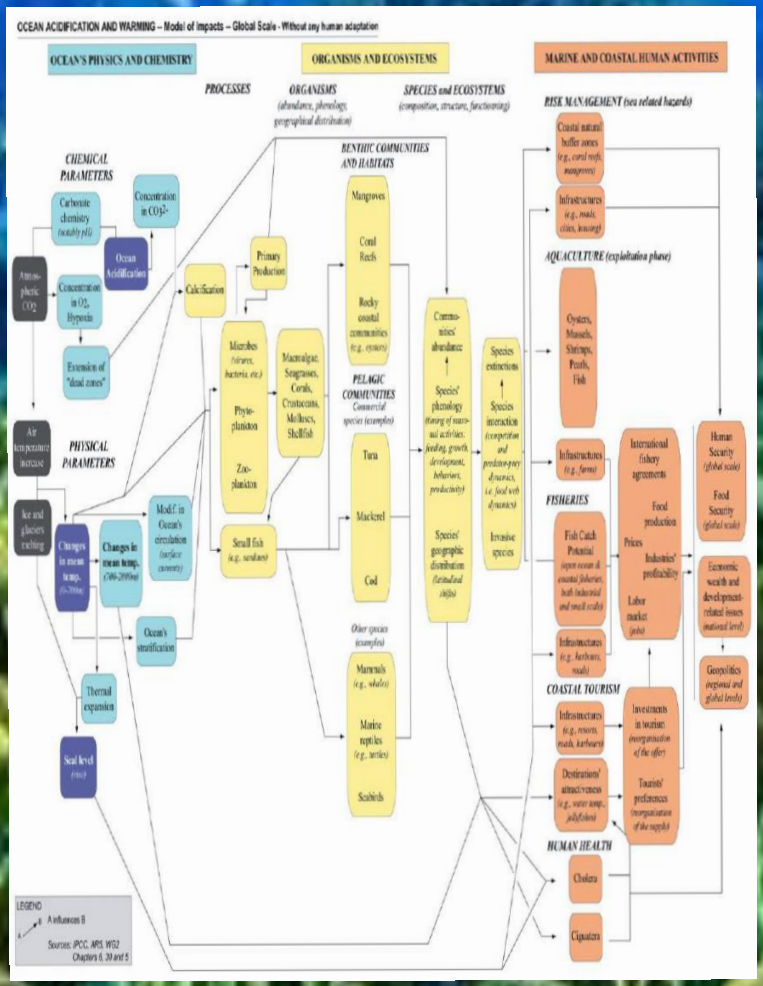
Ecosystem based approach



Contrasting risk of impacts to ocean and society from different anthropogenic CO2 emissions. Source: Gattuso et al (2015)

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Key recommendations for the regi

Build awareness at all levels of governance, society at large of the ecological and economic risks of climate change

Enhance capacity building and a concerted effort to strengthen the legal framework which underlies all effective environmental management

Enhance Stakeholder Engagement and role of the public

Enable NGO to raise awareness

Ensure international, regional and multilateral Conventions, treaties are endrorsed and implemented

Further improve research capacity and - crucially - data sharing

Develop further regional focal centres of excellence

Greater use of strategic, transboundary approach to development in its broadest sense

Adopt an ecosystem based approach to challenges of climate change and ocean warming

Engage with regional and international bodies dealing with relevant climate change issues

Invest in human resources via education and training on coastal and marine ecosystem

Address the needs of transboundary forms of conservation, fisheries management and monitoring reliable Develop transboundary approach to Ecosystem Service Valuation

Develop a more holistic approach towards agriculture, aquaculture and tourism sectors

Consider Blue Economy opportunitiesNeed for review of policies and tools towards a low-carbon economy

Adopt more efficient water and energy use; enhance renewable energy

Develop regional strategies for cumulative impacts of multiple stressors rather than climate change alone

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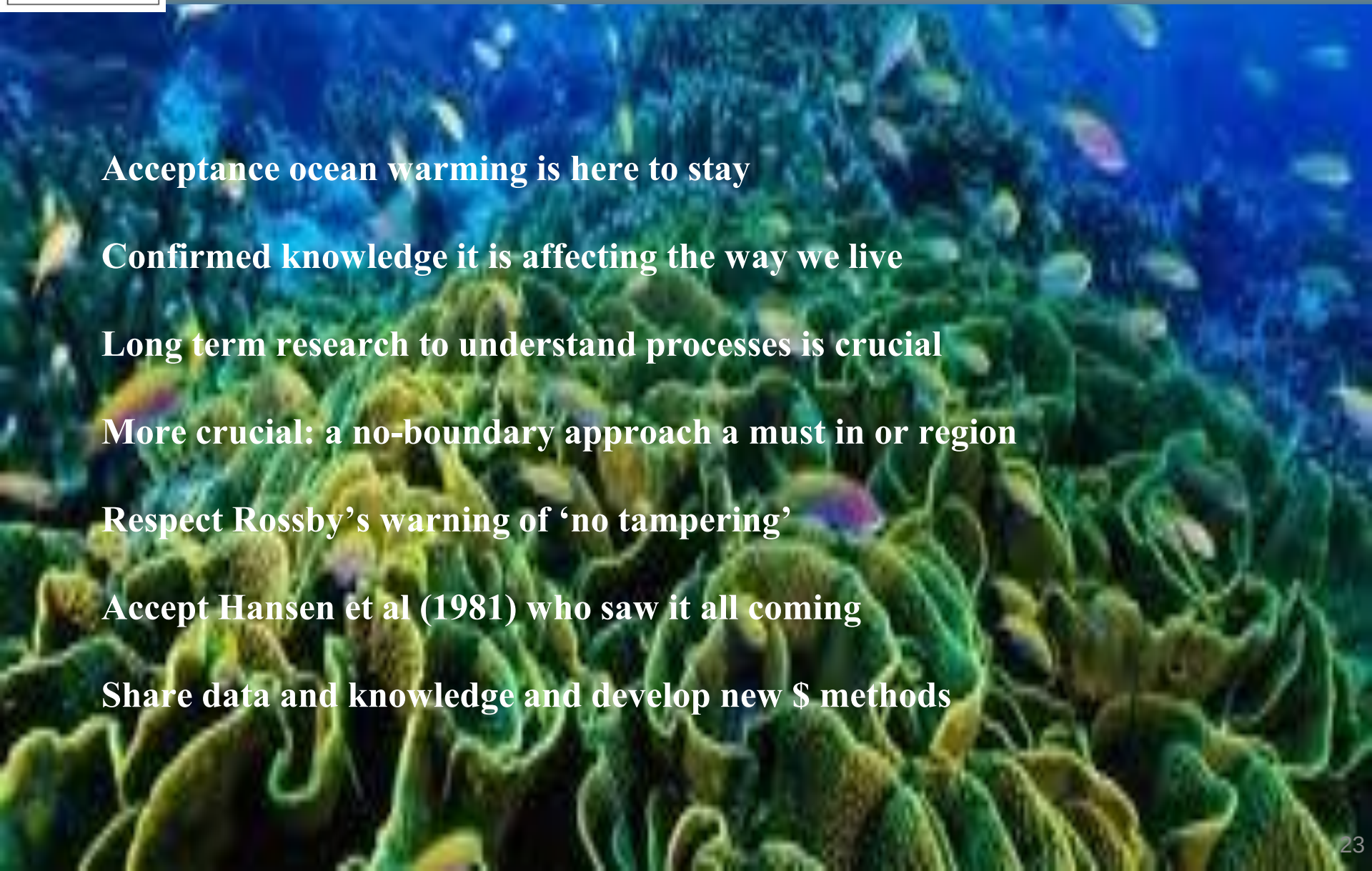
A few last thoughts



Acceptance ocean warming is here to stay

Confirmed knowledge it is affecting the way we live

Long term research to understand processes is crucial

More crucial: a no-boundary approach a must in or region

Respect Rossby's warning of 'no tampering'

Accept Hansen et al (1981) who saw it all coming

Share data and knowledge and develop new $ methods