

# Effects of climate change on planet ocean, IPCC 5th assessment report and beyond

---

## Decision making under uncertainty

UNFCCC Art. 2:

.....prevent dangerous anthropogenic interference....

.....allow ecosystems to adapt naturally...

.....ensure that food production is not threatened...

.....enable economic development to proceed in a  
sustainable manner

H.O Pörther

AR5 WGII CLA CH. 6, Ocean Systems,

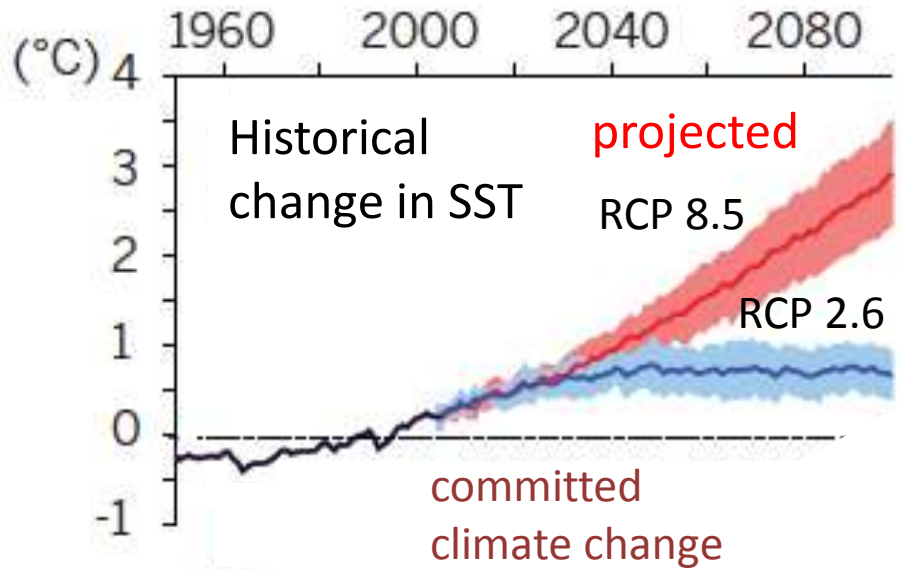
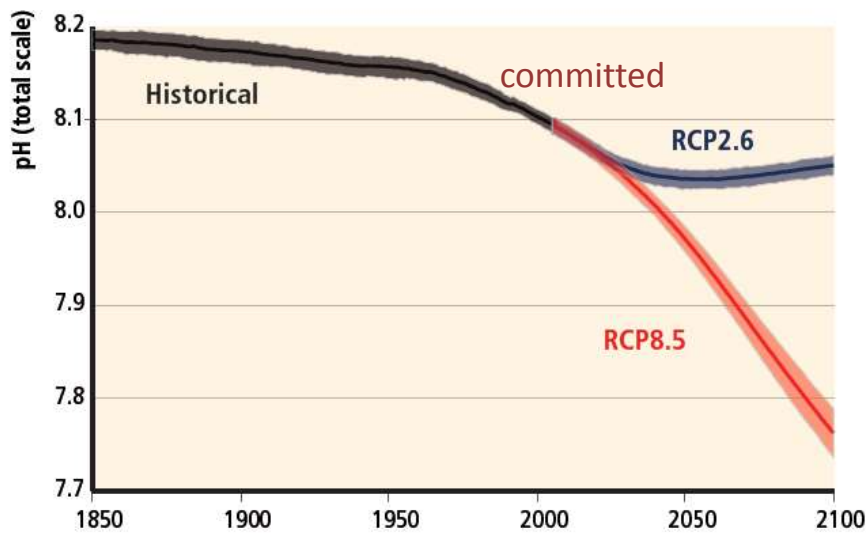
ocean products in TS and SPM, CC-Boxes, Synthesis Report

Co-Chair WGII AR6

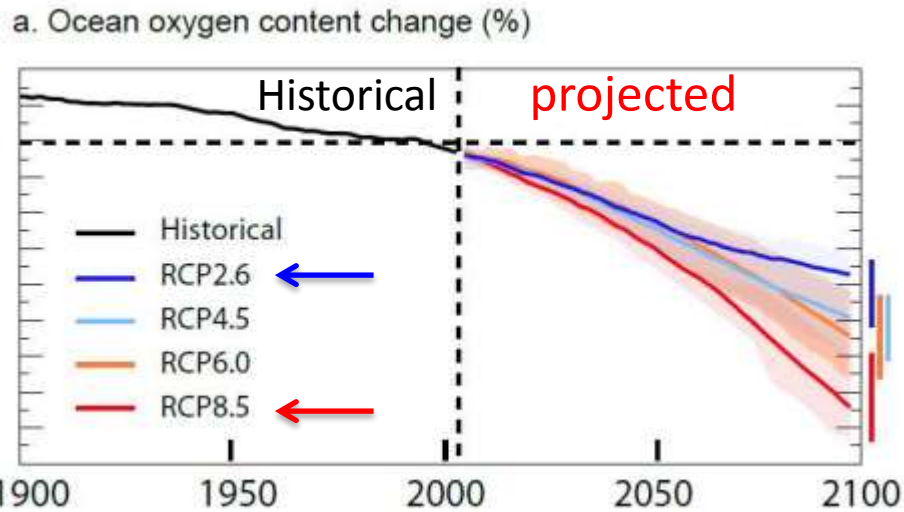
According to emission scenarios oceans are: **... warming**

**...acidifying**

Historical → Projections



**... losing oxygen**



CMIP5 model runs



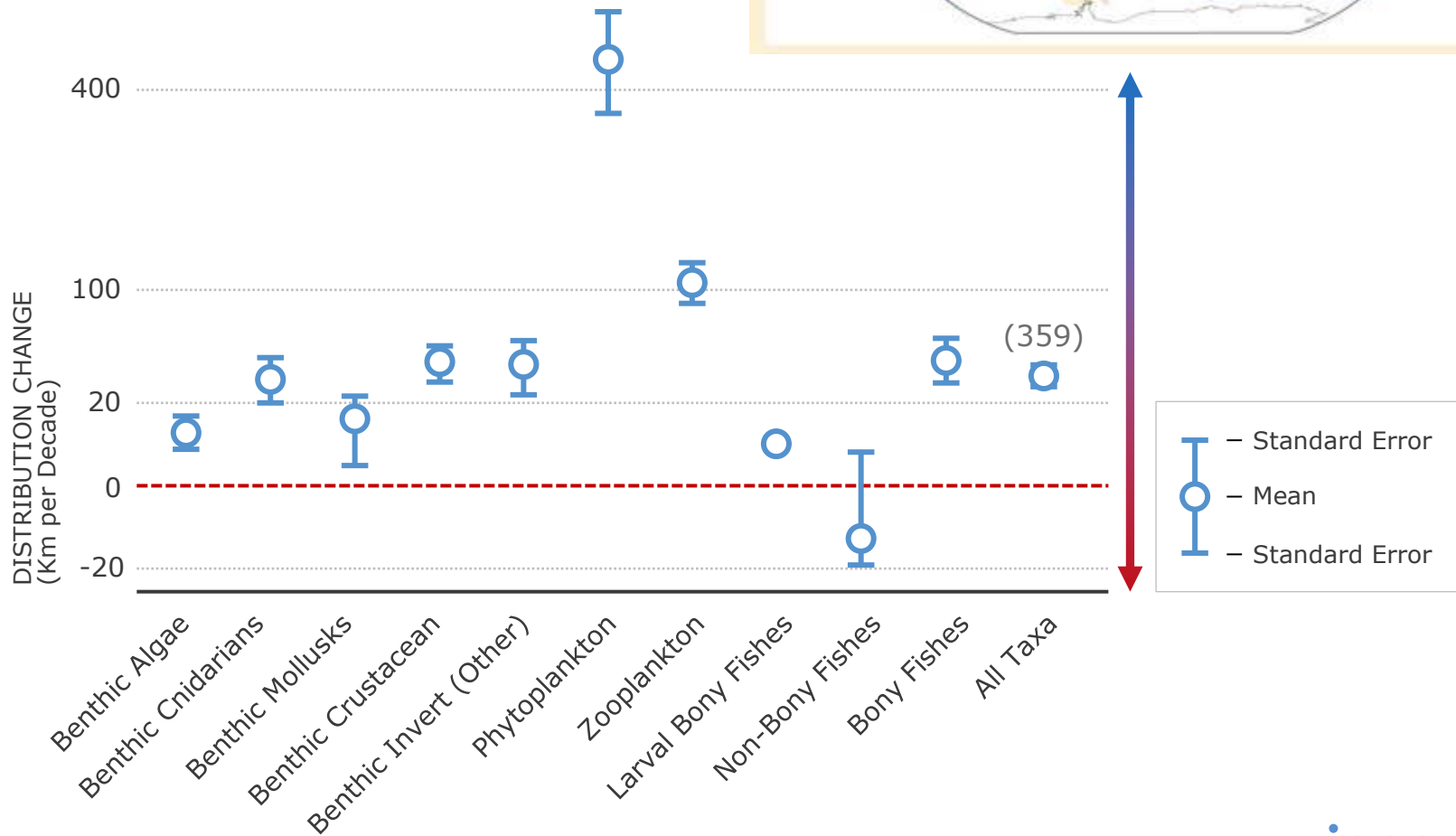
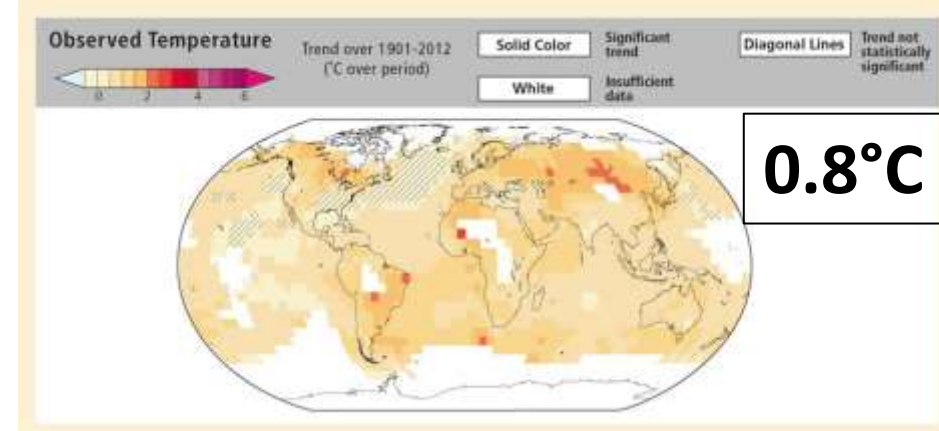
WGI Figure 6.30



Gattuso et al., 2015

# OBSERVATIONS

## World-wide marine species displacements due to climate change

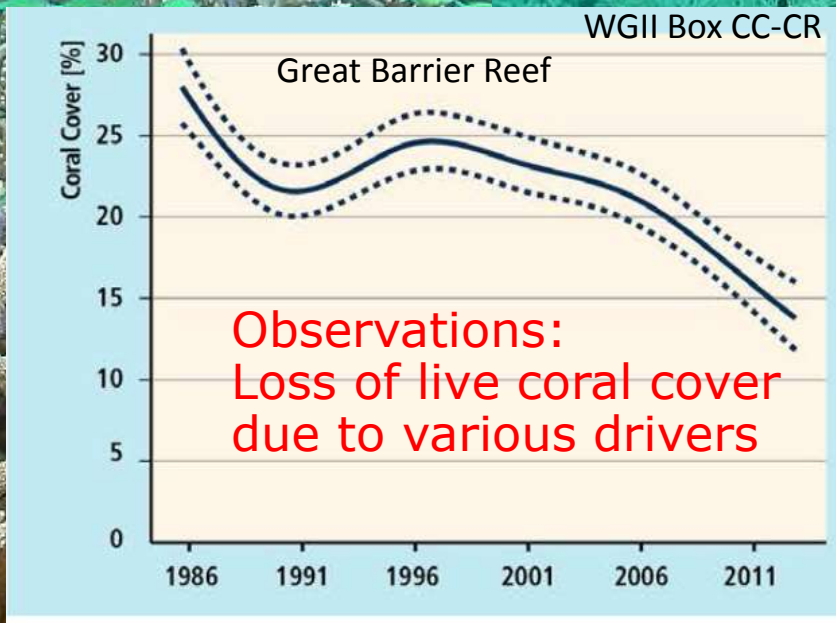


OBSERVATIONS

**0.8°C**

Vulnerable ecosystems identified in AR5

Warm water coral reefs under combined pressures at 0.8°C above pre-industrial:



Verons 2009

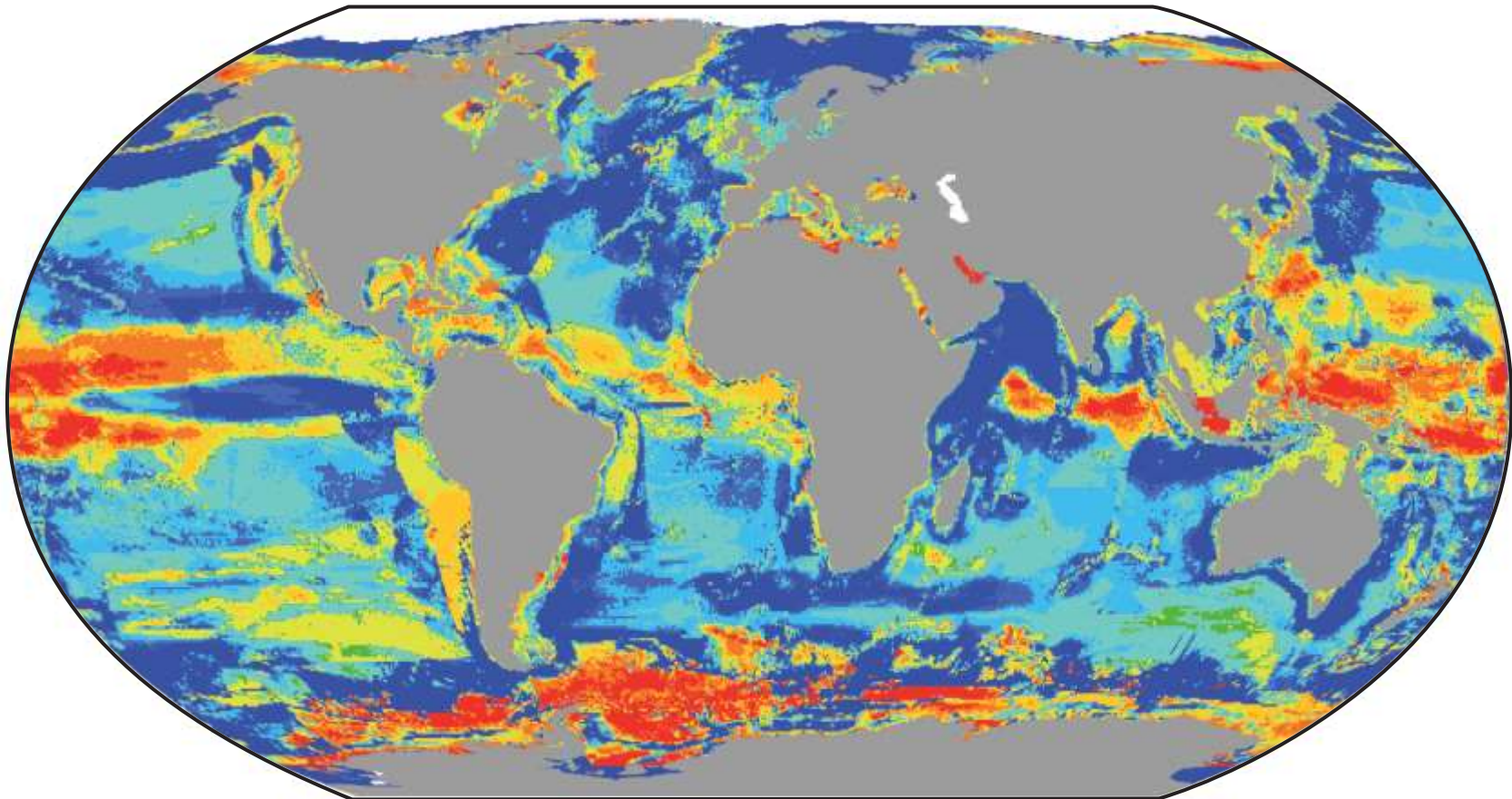
# Unabated Ocean Warming by 2050

Projections

2°C

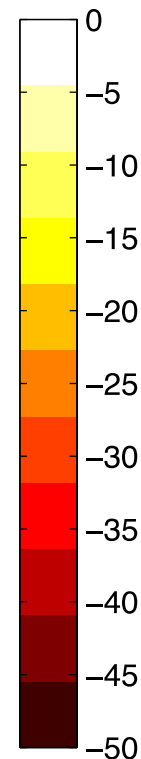
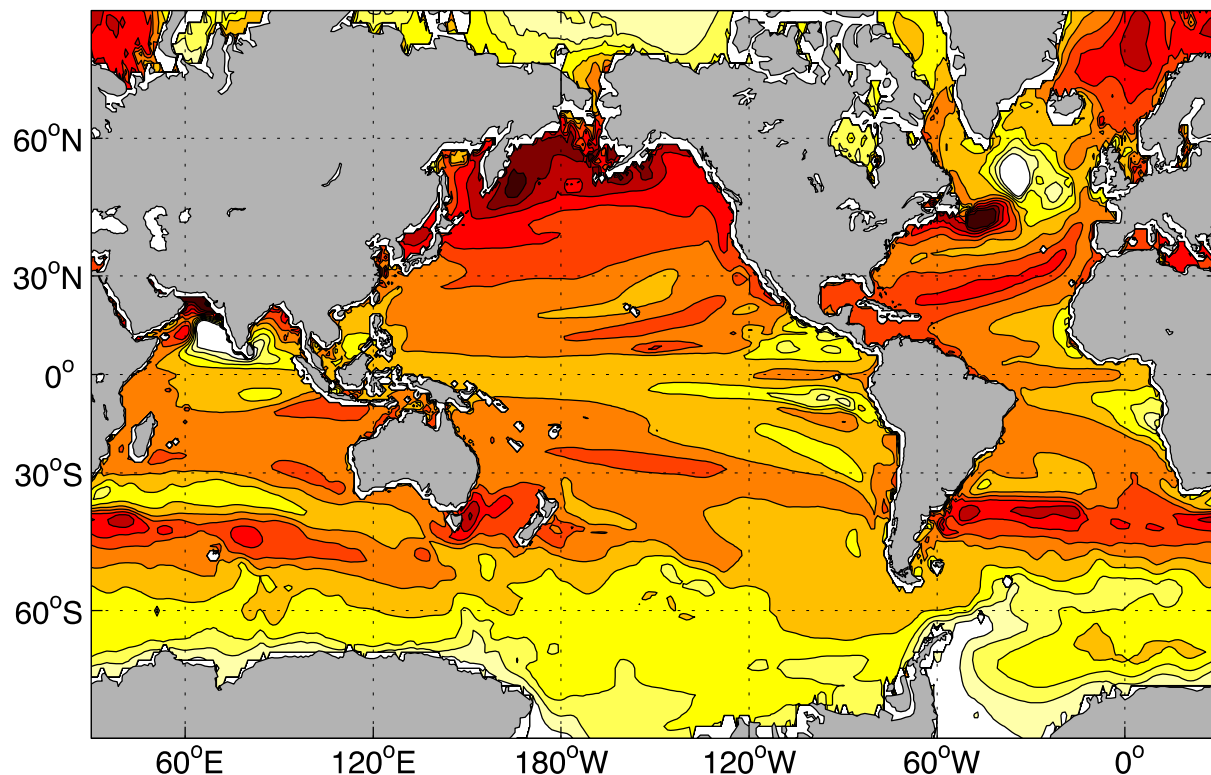
2051-60: fish and invertebrate biomass and diversity displaced and reduced at low latitudes

CHANGE IN MAXIMUM CATCH POTENTIAL (2051-2060 COMPARED TO 2001-2010, SRES A1B, 2°C warming of global surface T  
0.7°C warmer Sea Surface T)



>>2°C

REDUCED HABITAT range of marine fishes  
and invertebrates due to  
thermal constraints combined with oxygen loss  
in the oceans



Projections

% Decline in  
Metabolic Index  
 $\Phi$   
(= routine  
metabolic scope  
in marine  
animals)

by ~20% overall

Northern High  
Latitudes:  
by ~40%

2071-2100, 0-200m

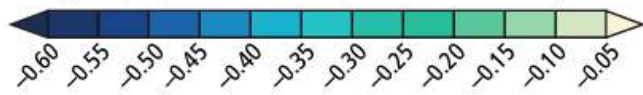
IPCC Earth System Model mean, RCP8.5 scenario

TO BE  
ASSESSED IN  
AR6

# Unabated Ocean acidification affecting mollusk and crustacean fisheries, and coastal protection by coral reefs

>>2 °C

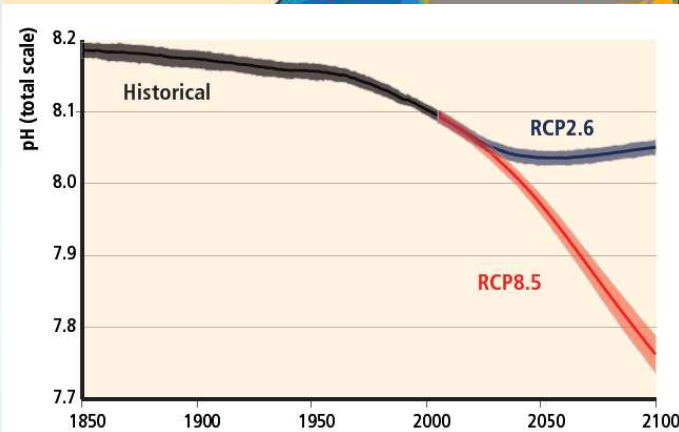
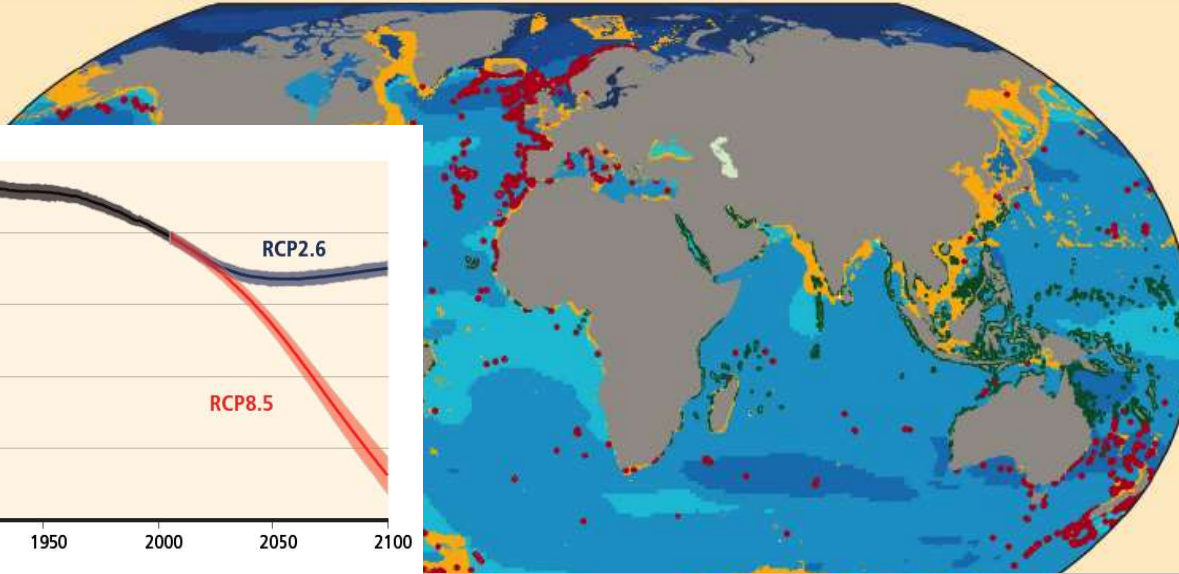
Change in pH (2081-2100 compared to 1986-2005, RCP8.5)



Mollusk and crustacean fisheries  
(present-day annual catch rate  $\geq 0.005$  tonnes  $\text{km}^{-2}$ )

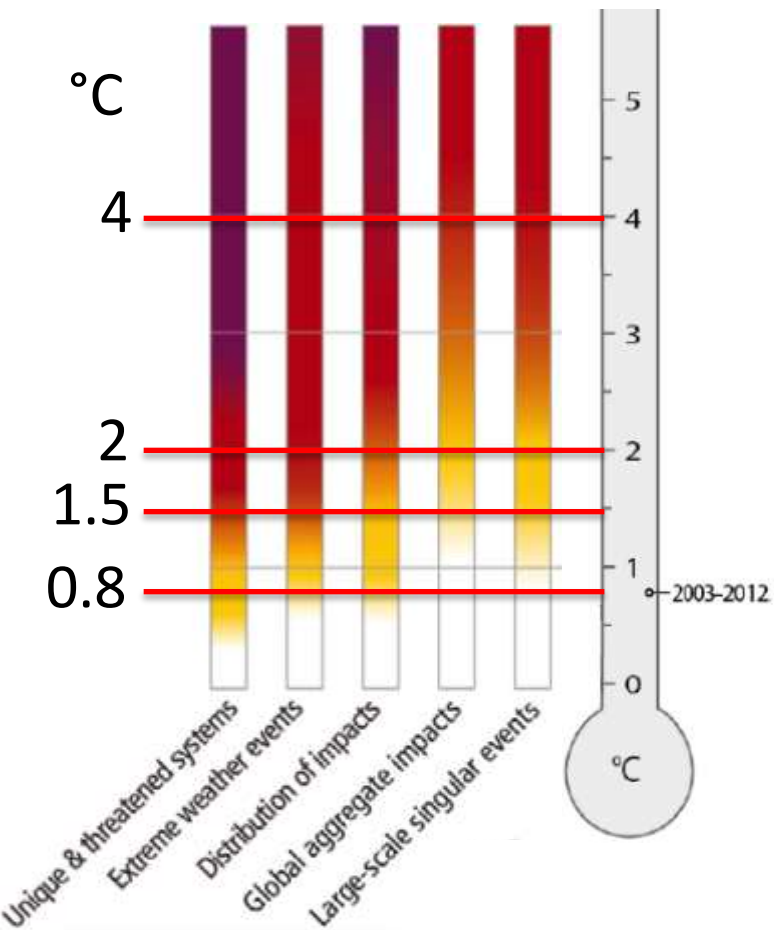
Cold-water corals

Warm-water corals



.....risks enhanced by warming extremes

LTGG Risk assessment IPCC WGII: **How to widely compare climate impacts?**



A role for natural marine systems to guide the setting of **long-term global goals** (LTGG, relative to preindustrial), considering levels of **risk**

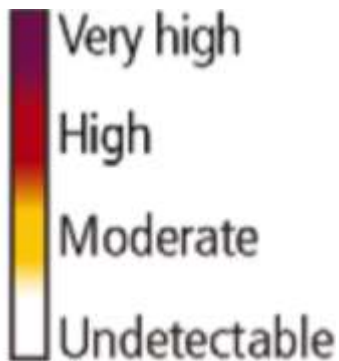
LTGG

4°C

2°C

1.5°C

0.8°C



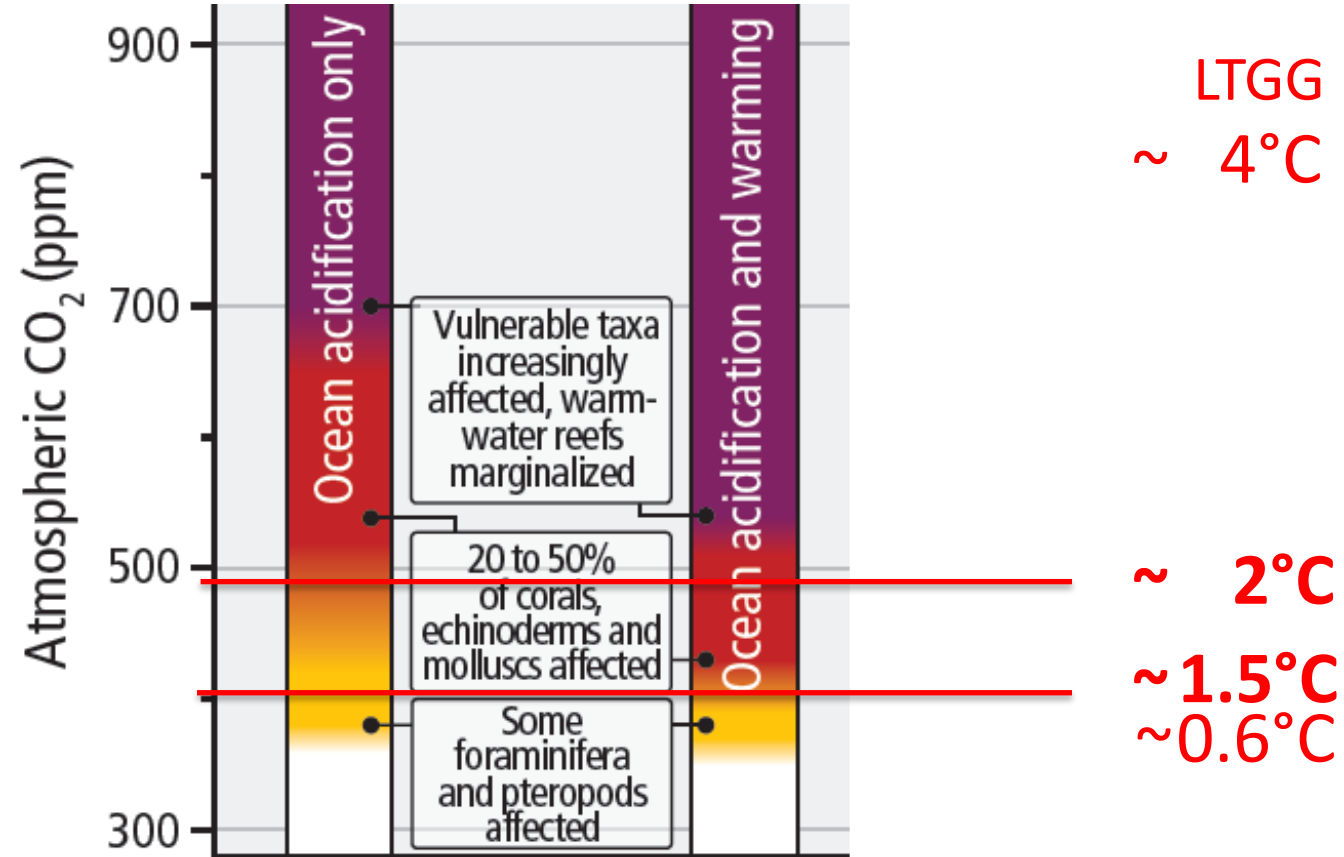
Level of additional risk due to climate change

...comparing LTGGs, identifying... **Key risks of impacts**  
 .... Risks to be avoided



**AN EXAMPLE: COMBINED IMPACTS OF CLIMATE DRIVERS:**  
ocean warming and acidification,  
 a comparative view across LTGGs based on risk

1.5°C  
 vs. 2°C  
 vs. >>2°C



Additional risk due to climate change

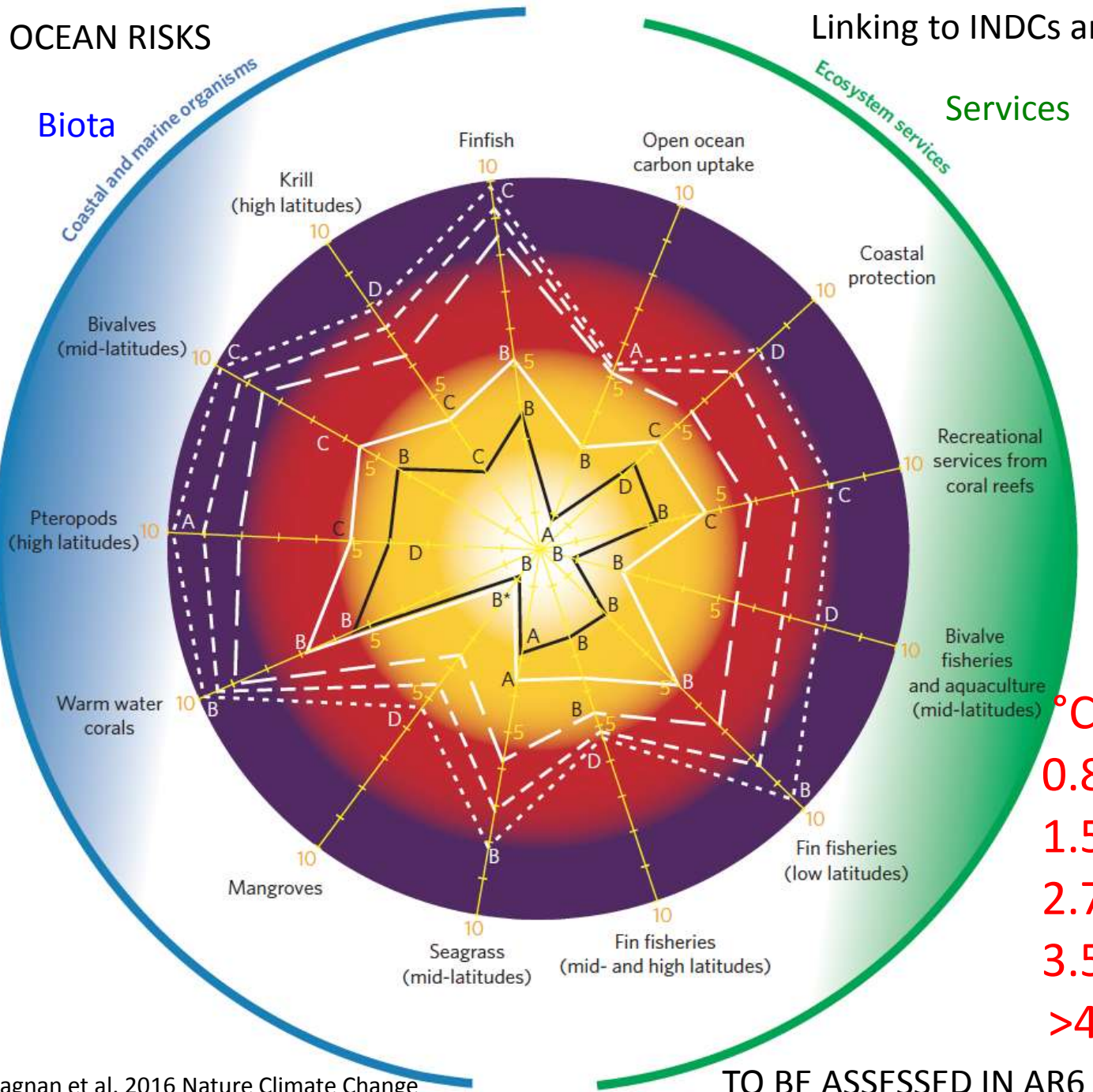


# OCEAN RISKS

# Linking to INDCs and Global Stocktake

## Biota

## Services



**Risk of impact**

Undetectable 0  
 Moderate 5  
 High  
 Very high 10

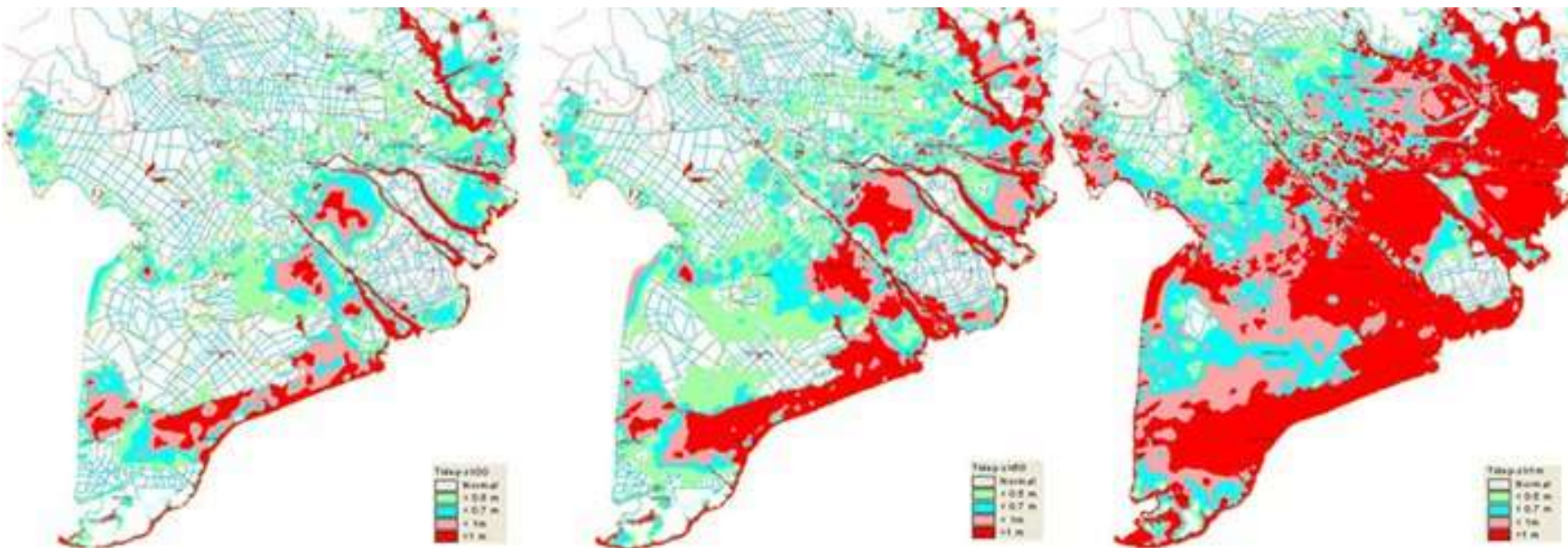
**Confidence levels for the present day and the RCPs**

E Very low  
 D Low  
 C Medium  
 B High  
 A Very high

**Emission scenarios**

Present day  
 IPCC RCP 2.6  
 Climate Action Tracker 2015 estimate (+2.7 °C)  
 Climate Interactive 2015 estimate (+3.5 °C)  
 IPCC RCP 8.5

0.8  
 1.5  
 2.7  
 3.5  
 >4



The maps show areas to be flooded with sea levels rising by 30 cm, 50 cm and 1 m respectively - Photo: Courtesy of the Vietnam Academy for Water Resources

# Impacts on coastal systems

Vietnam is expected to face very high impacts and associated annual damage and adaptation costs of several percentage points of GDP. The highest vulnerability comes from sea level rise and associated impacts.

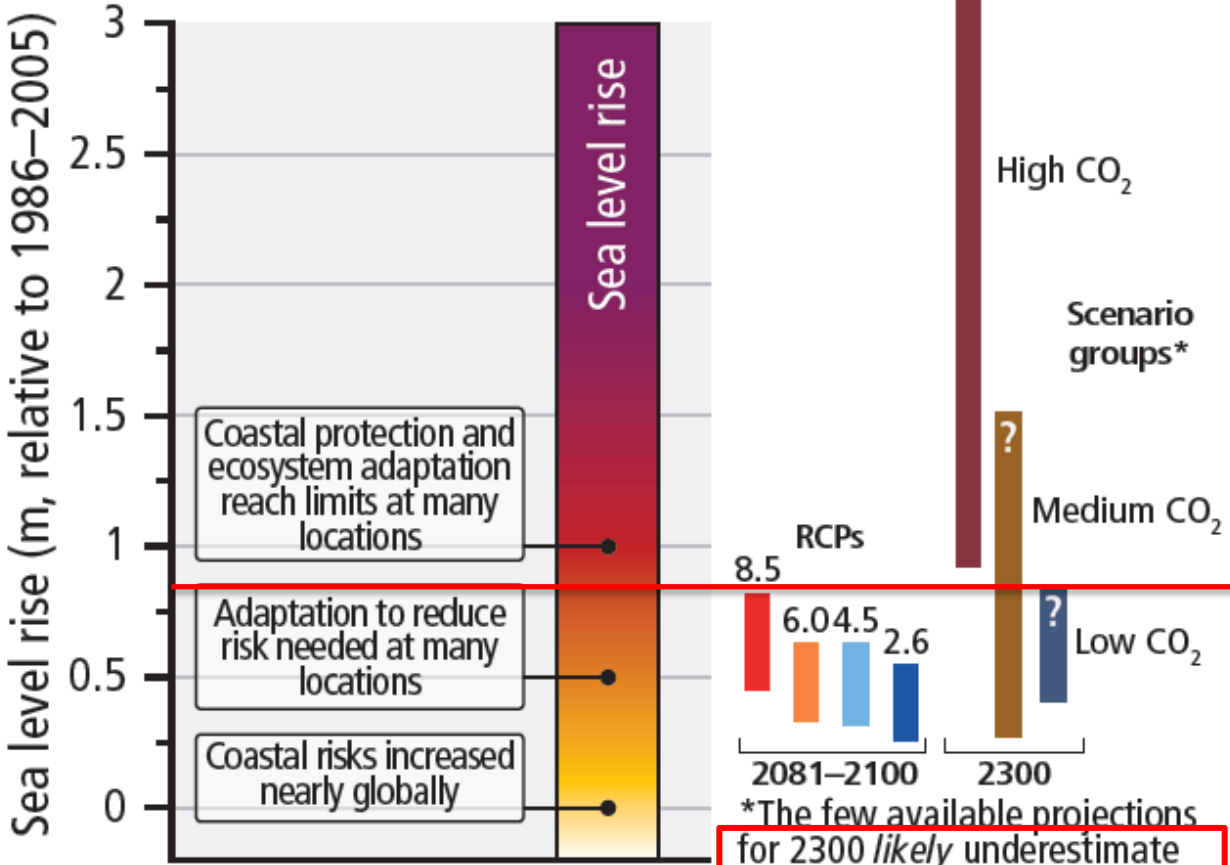
- **Impacts:** **Sea-level rise**, coral bleaching, ocean acidification, reduction in tourism arrival (*high confidence*), increased frequency of natural disasters like typhoons and floods.
- Specific regions at **high risk** in Vietnam are areas exposed to sea level rise and extreme events and with concentrated multidimensional poverty.



Ha Long Bay with high vulnerability of sea level rise. It is located on in northeast Vietnam, is known for its emerald waters and thousands of towering limestone islands topped by rainforests.

1.5°C

(c) Risk for coastal human and natural systems impacted by sea level rise



Increasing risk associated with high sea level beyond 2100 under RCPs > 2.6

~1.5°C (2300)

However.... Contribution of Antarctic ice sheet likely underestimated

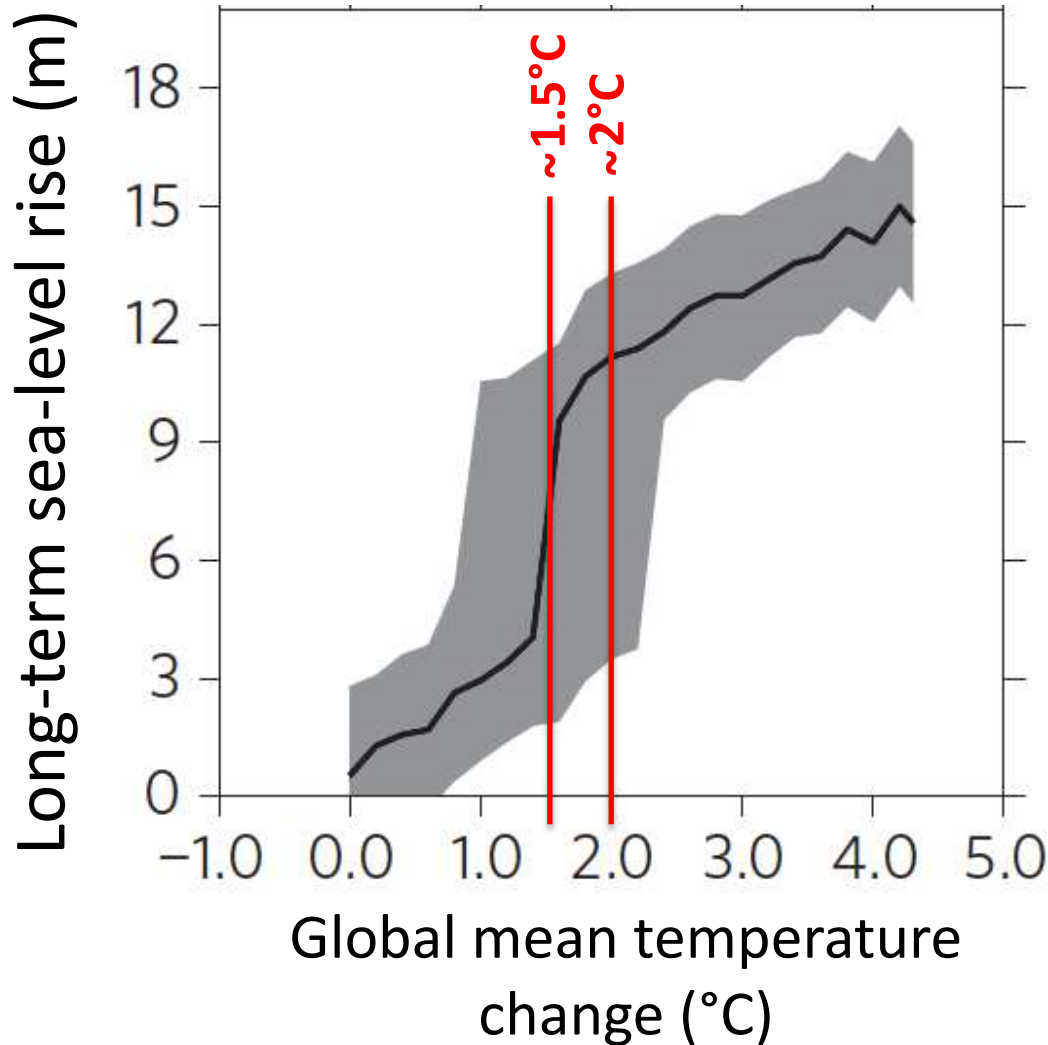
Level of additional risk due to climate change



SYR 2.5

ipcc

## High ambition mitigation needed



....affecting habitat, freshwater resources, human society through flood events

### Paleo-observations as a reference

**5-9 m** : ...during the last interglacial (Eemian, 125.000 ya, at 0.7-2°C above pre-industrial)  
(Dutton and Lembeck, Science 2012)

**>7m** : ...last time when the atmosphere had 400 ppm CO<sub>2</sub> (in Pliocene, 3-5 Mya)

TO BE  
ASSESSED  
IN AR6

## REDUCING RISKS: REGIONAL ADAPTATION IS ALREADY OCCURRING

- **Ocean acidification:** Defending oyster cultures at the US Westcoast against inflow of acidified water.
- **Marine Protected Areas:** Enhancing the resilience of coral reefs and their fish stocks against warming and acidification.
- **Restoration** of Mangrove Forests as in **Vietnam**



...but adaptation capacity is highest under moderate climate change,  $\leq 1.5^{\circ}\text{C}$

## A sense of urgency:

### Overcoming societal inertia and inaction in transformation....

- Ocean ecosystems are for the first time noted in the UNFCCC Paris agreement, even if only in the preamble.

However, more needs to be done:

- **strengthen further the visibility of the Ocean by its formal integration into the UNFCCC process.**
- **enhance and exploit the science basis of ocean related solution options:**
  - Marine protected areas
  - Blue growth (conservation/restoration)
  - Sustainable development (blue economy)



A common response even among those who know...!?



# Thank you!

IPCC WGII Ocean Reprint Collection:  
<http://ipcc-wg2.gov/publications/ocean/>

