

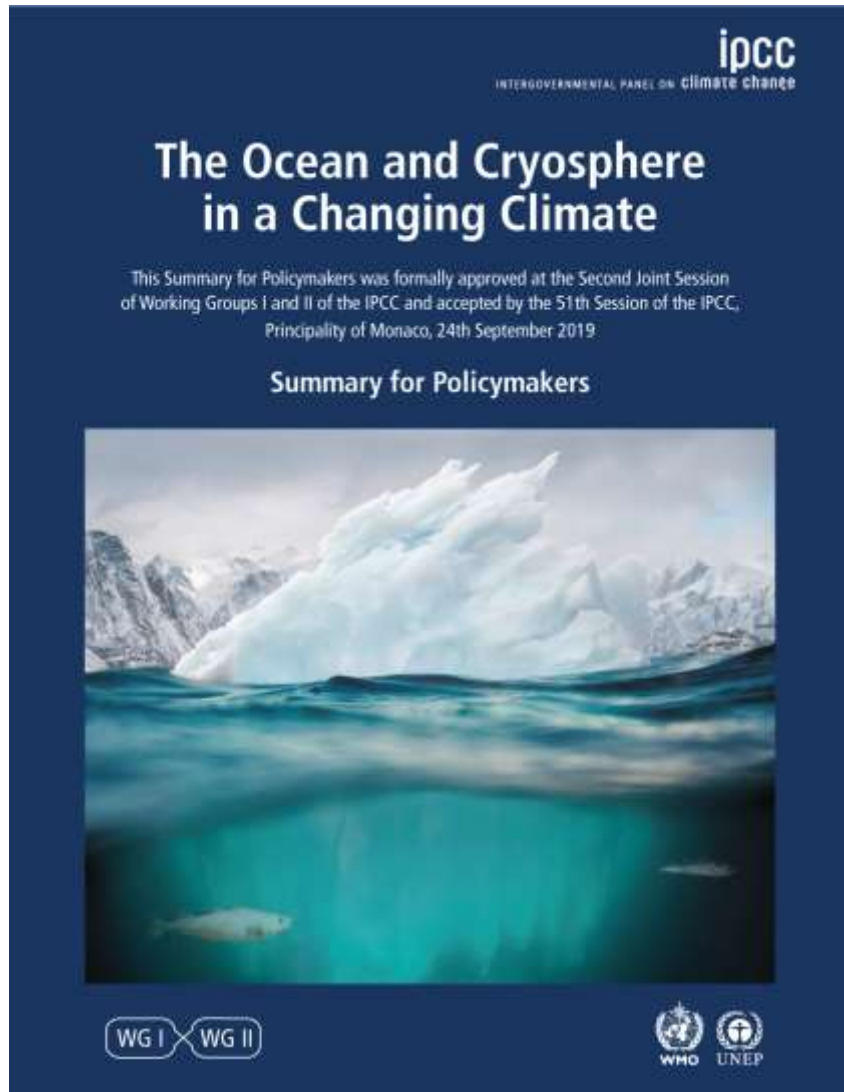
ipcc
INTERGOVERNMENTAL PANEL ON climate change

Responses of Coupled Human-Natural Eastern Boundary Upwelling Systems (EBUS) to Climate Change

COP25 • Madrid • 2-13 December, 2019

Javier Arístegui & William Cheung

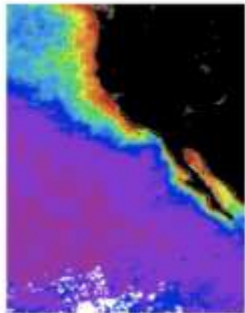
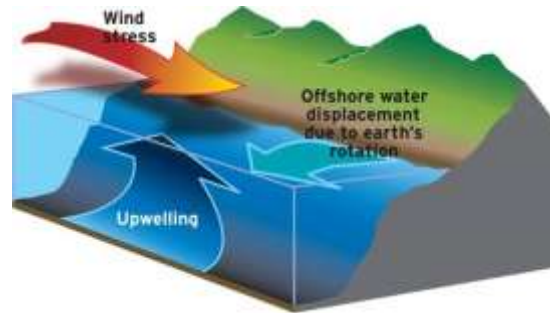




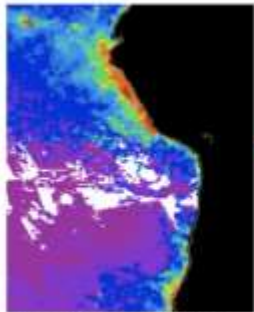
Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities



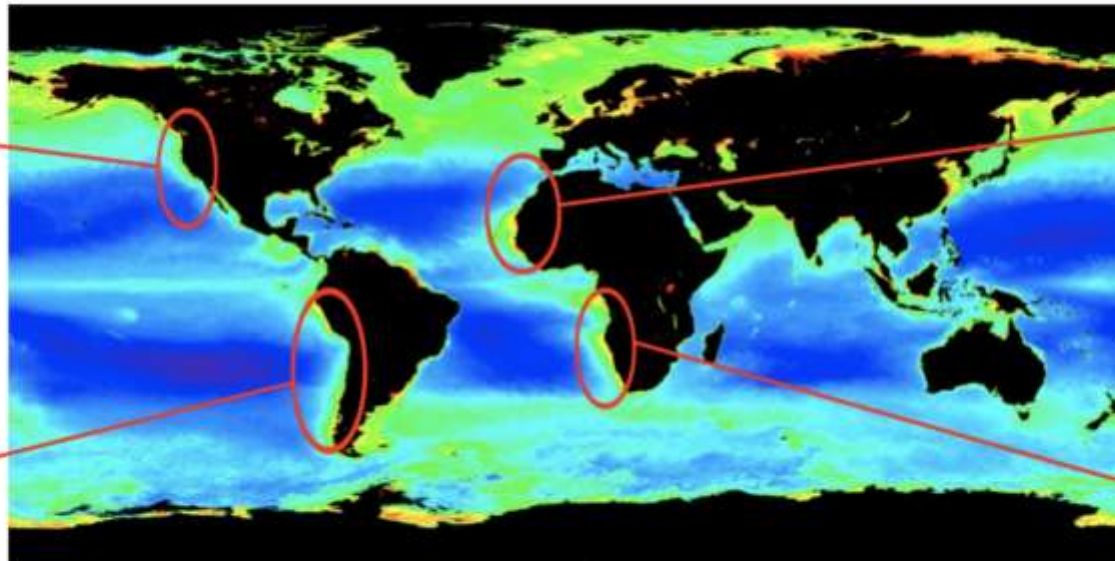
What is an EBUS?



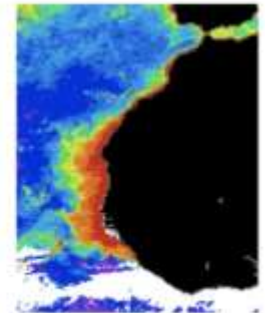
California Current



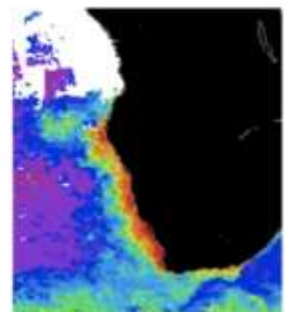
Humboldt Current



Surface chlorophyll concentration
(source SeaWiFS & CZCS, NASA/Goddard Space Flight Center)



Canary Current



Benguela Current



Why EBUS are important?

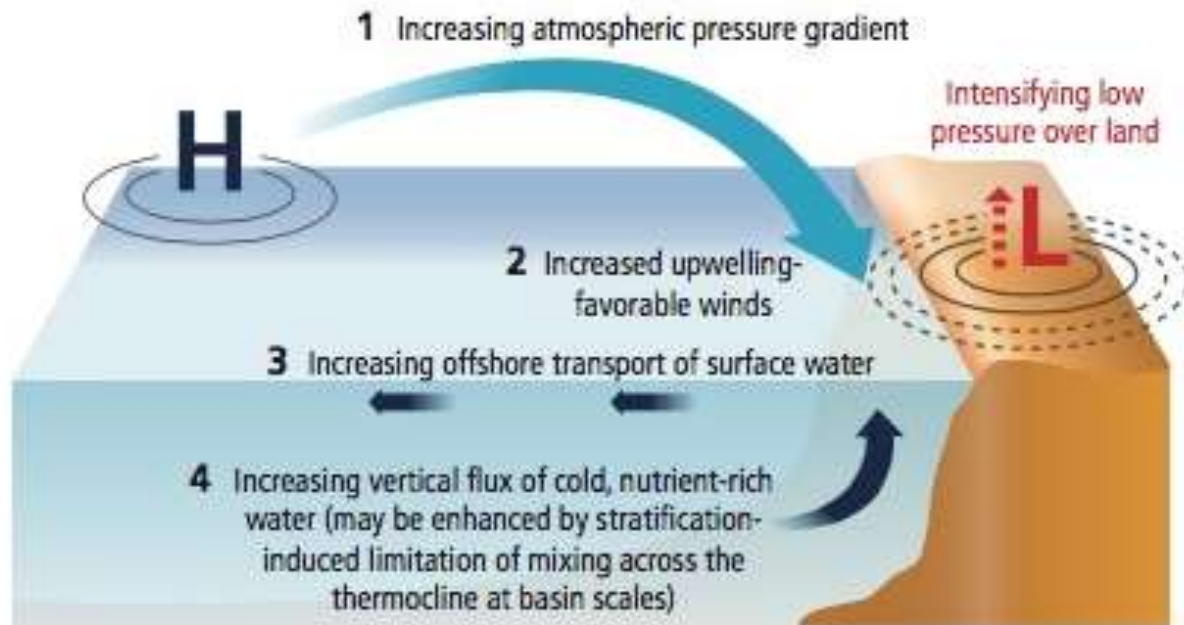
- Among the world's **most productive** ocean ecosystems, contributing around **17% of global catch**
- Catches are consumed locally, as well as being processed and exported as seafood, fish meals and oils to **support aquaculture and livestock production.**
- They also support **lucrative eco-tourism**, such as whale-watching
- The condensation of humid air in coastal areas, **benefits coastal vegetation and agriculture** and suppressing forest fires
- Some EBUS are close to important **thresholds** in terms of **oxygen loss and ocean acidification**



What are the observed changes?

Wind and upwelling intensification

Winds have intensified in most EBUS (except the CanC) during the last 60 years, due to global warming



IPCC-AR5



What are the observed changes and impacts?

		Ocean											LEGEND
		Arctic	EBUS ¹	North Atlantic	North Pacific	South Atlantic	South Pacific	Southern Ocean	Temperate Indian Ocean	Tropical Atlantic	Tropical Indian Ocean	Tropical Pacific	
Greenhouse Gases	Physical changes	Temperature	•	••	••	••	••	••	••	••	••	•	Physical changes increase decrease increase and decrease
		Oxygen	•	•	•	•	•	•	•	•	•	•	
		Ocean pH	•••	•••	•••	•••	•••	•••	•••	•••	•••	•••	
		Sea-ice extent	•••					•					
		Sea level	•	••	••	••	••	••	••	••	••	••	
Climate Change	Ecosystems	Upper water column	••	•	•••	••	••	••	•	••	•	••	Systems positive negative positive and negative
		Coral			•		•••			•••	•••	•••	
		Coastal wetlands			••	••	••		••	••	••	••	
		Kelp forest	••	••	••	••	•		•			•	
		Rocky shores			•••	••			•				
		Deep sea			•								
		Polar benthos	••					••					
		Sea-ice-associated	••					••					
	Human systems and ecosystem services	Fisheries	••	•	•••	•	•	•	•	••	•	•	
		Tourism	••	•		•	•	•	•	•		•	
		Habitat services	••	•	••	••	•	••		••	••	••	
		Transportation/shipping	••										
		Cultural services	••		•	•		•					
		Coastal carbon sequestration			••	••	•	•	•	•	••	•	

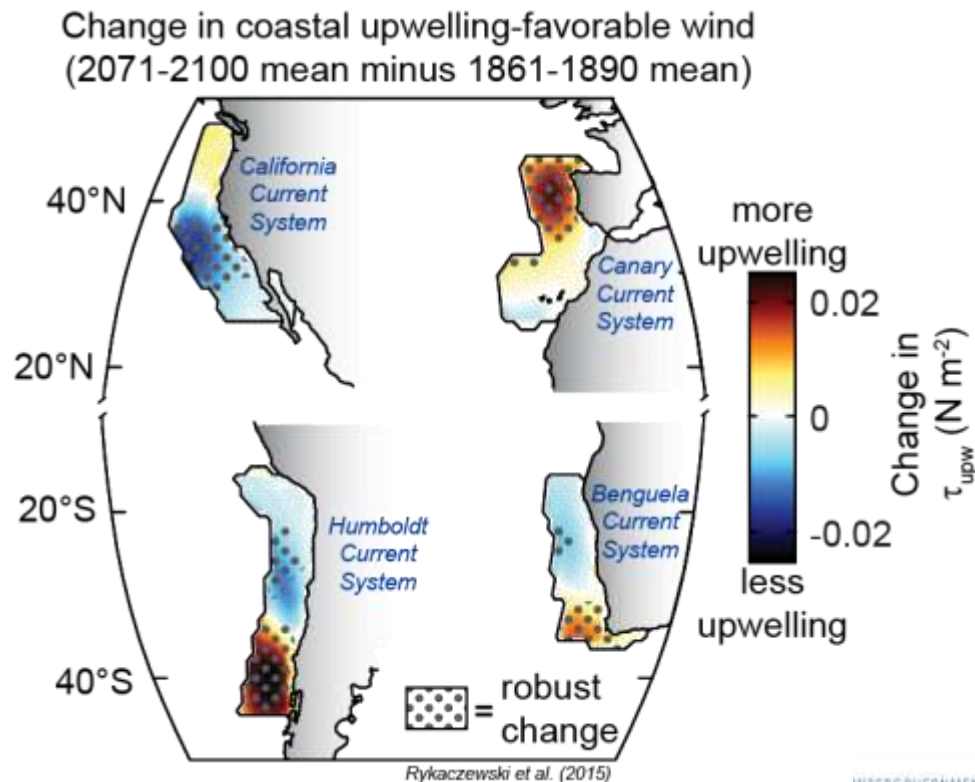
¹ Eastern Boundary Upwelling Systems (Benguela Current, Canary Current, California Current, and Humboldt Current); (Box 5.3)



What are the projected changes?

Wind and upwelling intensification

Climate models (ESMs) project reduction of wind and upwelling intensity in EBU's at low latitude and enhancement at high latitudes for **RCP8.5**, with an overall reduction in either upwelling intensity or extension

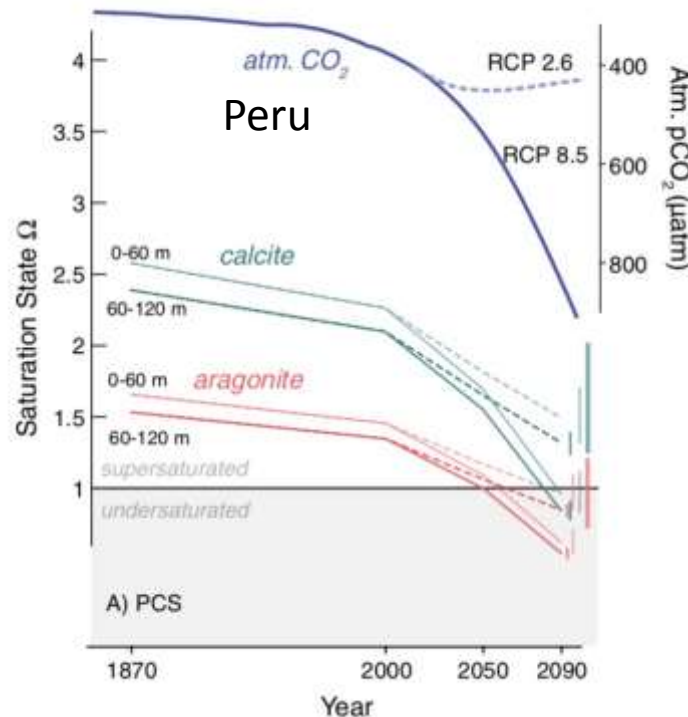




What are the projected changes?

Deoxygenation and acidification

Model projections for 2100 suggest strong effects of deoxygenation and reduced pH in the Humboldt Current and the California Current under RCP 8.5, affecting seafloor habitats and fisheries



Franco et al 2018

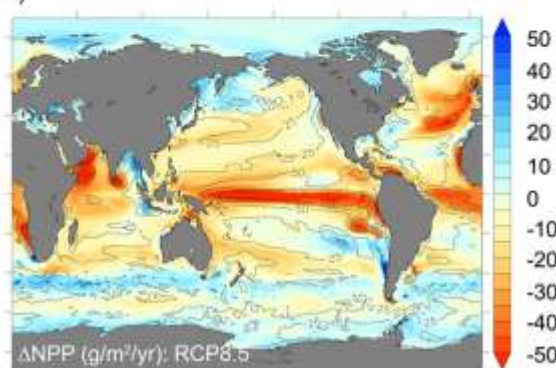
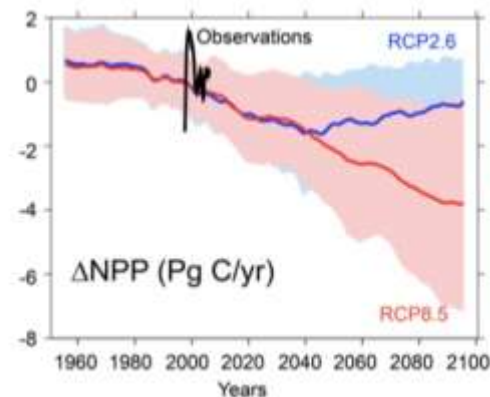
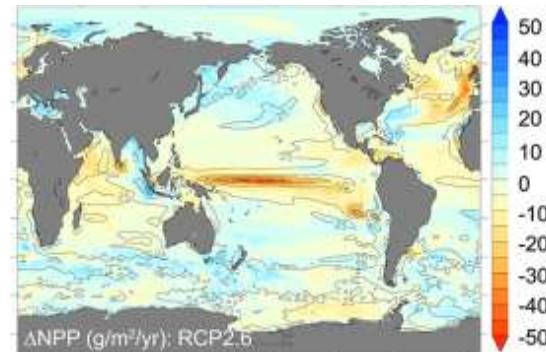
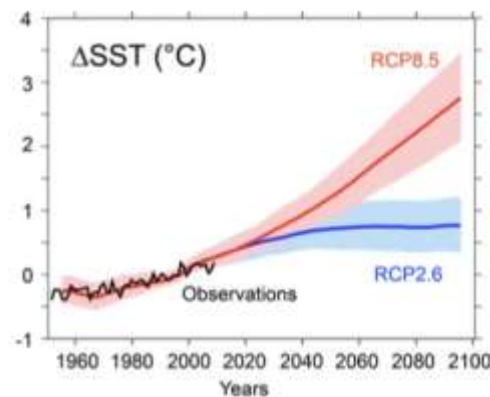


What are the projected changes?

Trends in primary production

EMS: variable trends with an average decrease in low latitude regions

Local winds and mesoscale oceanographic features (not resolved in ESMs) have a **greater impact** on regional productivity than large-scale wind patterns



Frölicher et al. 2016



What are the projected changes?

Projected impacts in fish biomass and fisheries

Fisheries are not only highly sensitive to upwelling conditions but also by fishing effects on the exploited populations.

Changing ocean conditions



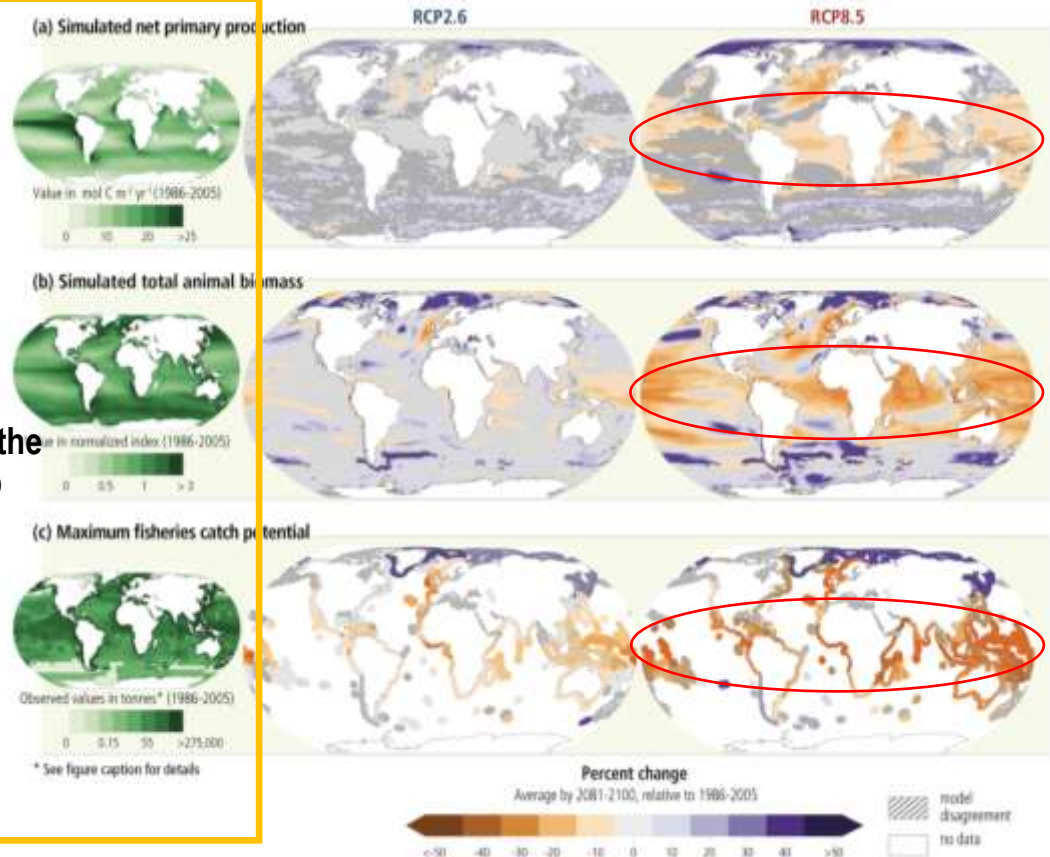
Provide carbon and energy for foodweb



Biomass of organisms in the upper part of the foodweb



Proxy of maximum sustainable yield



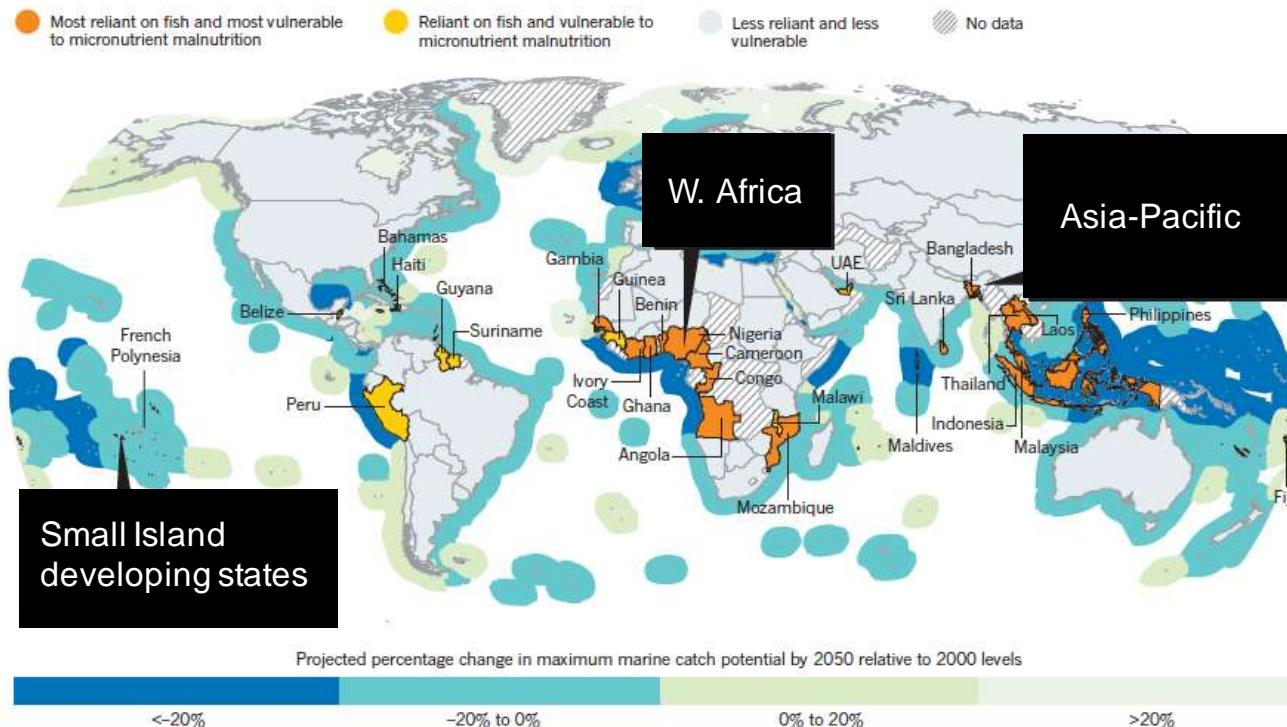


Change in ecosystem services

Implications for food security

Nutritional vulnerability to climate change

Coastal fisheries in the Canary Current are an important source of micronutrients to nearby West African countries that have particularly high susceptibility to climate change impacts and low adaptive capacity



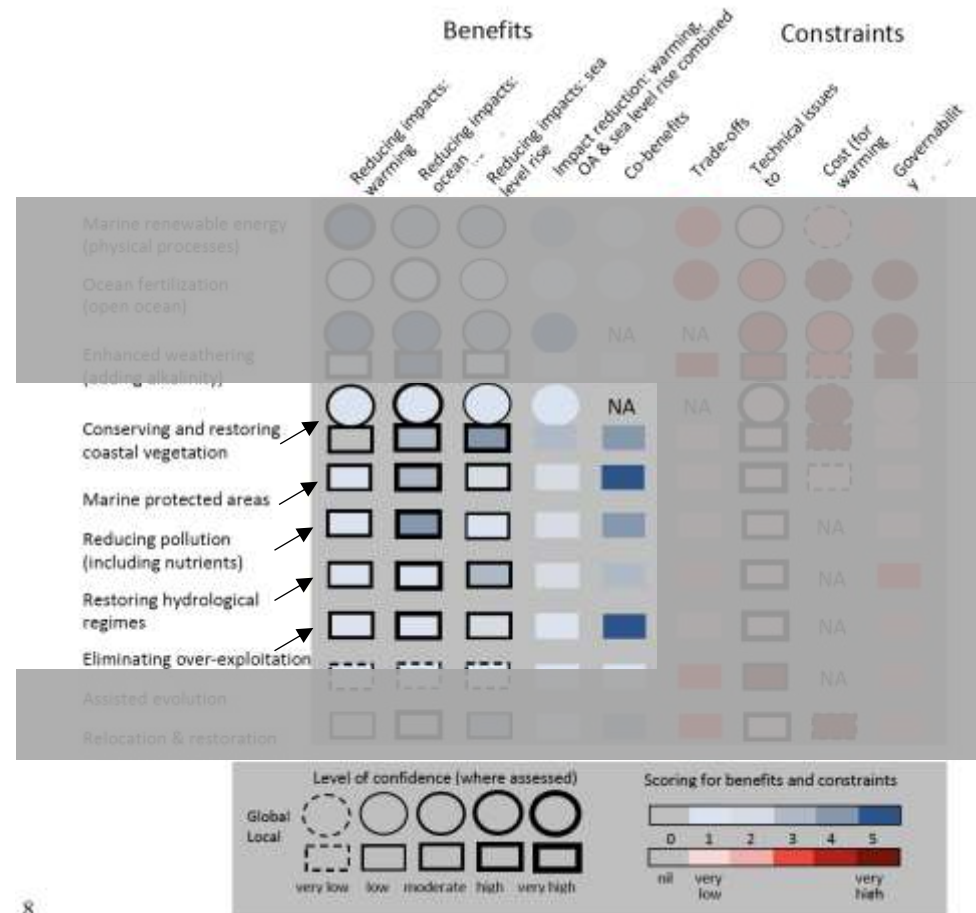
Golden et al., 2016



Risk reduction

Ocean-based responses

- Supported by protection, restoration, precautionary ecosystem-based management of renewable resource use, reduction of pollution and other stressors;
- Moderate to high benefits to local climate-risk reduction
- High/very high co-benefits and low trade-offs.



Knowledge for action



Changes in the coupled human-natural EBUS

- Given the high sensitivity of the coupled human-natural EBUS to oceanographic changes, the future sustainable delivery of **key ecosystem services** (fisheries, aquaculture, coastal tourism and climate regulation) is at **risk under climate change**
- For vulnerable human **communities with low adaptive capacity**, unmitigated climate change effects on EBUS (complicated by other non-climatic stresses) have a high **risk of altering their development pathways**

Knowledge for action

EBUS are sentinels of Climate Change—

They sustain us.

They are under pressure.

Their changes affect all our lives.

The time for action is now.

ipcc
INTERGOVERNMENTAL PANEL ON climate change



The image is a composite. The top half shows a tropical beach with a line of green trees and a sandy shore. In the background, a city skyline with many skyscrapers is visible across a body of water. The sky is blue with scattered white clouds. The bottom half of the image is an underwater scene. It features a large, brownish squid-like creature with a white eye-like spot on its head, resting on a green, textured coral reef. To the right, a blue and silver fish is swimming. The water is clear and blue, with some ripples on the surface.

Thank you