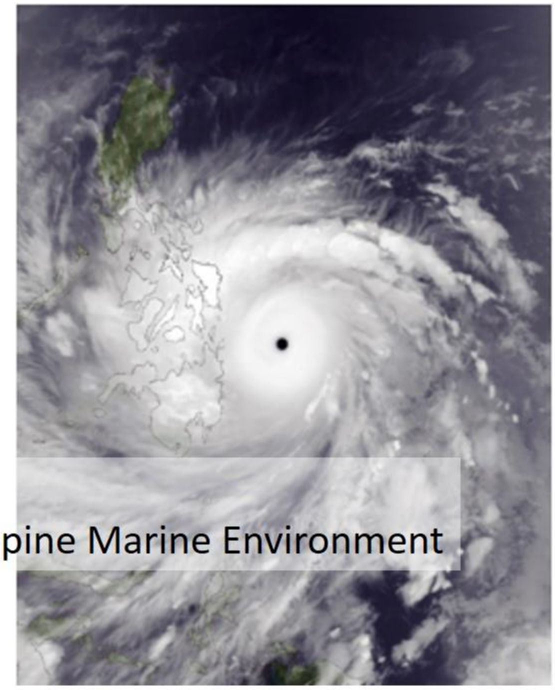


Climate Change:
Impacts on Philippine Marine Environment

LTDavid, et al.

Coastal ecosystems will have to deal with climate related hazards:

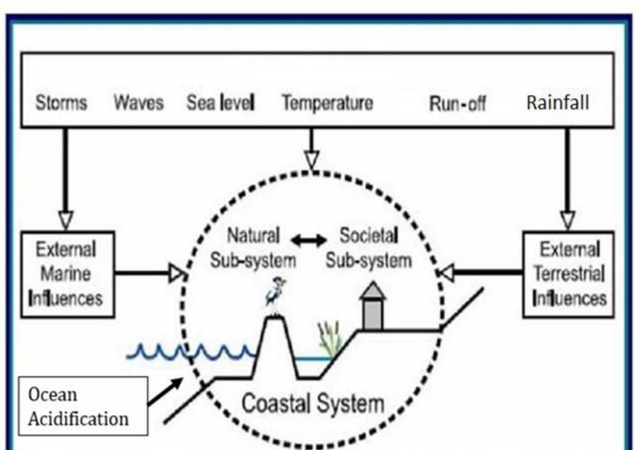
Increase in ocean temperature;

and Ocean acidification

Disturbed water budgets

Increasing strength of storm events and its associated storm surges;

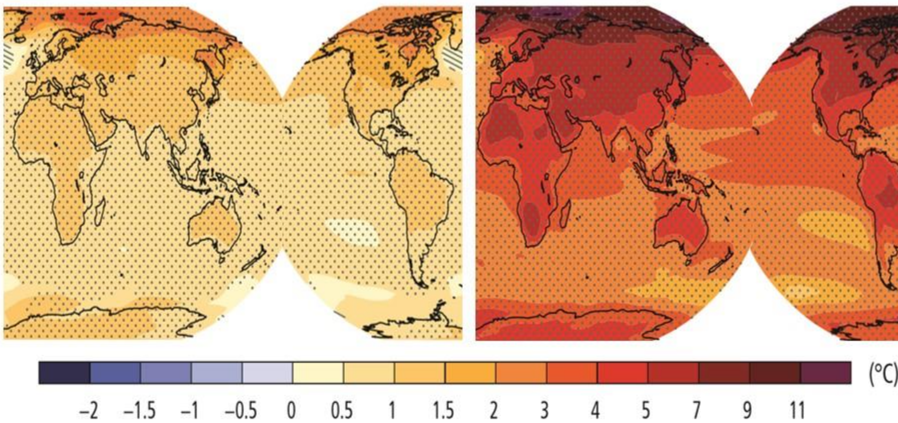
Sea level rise



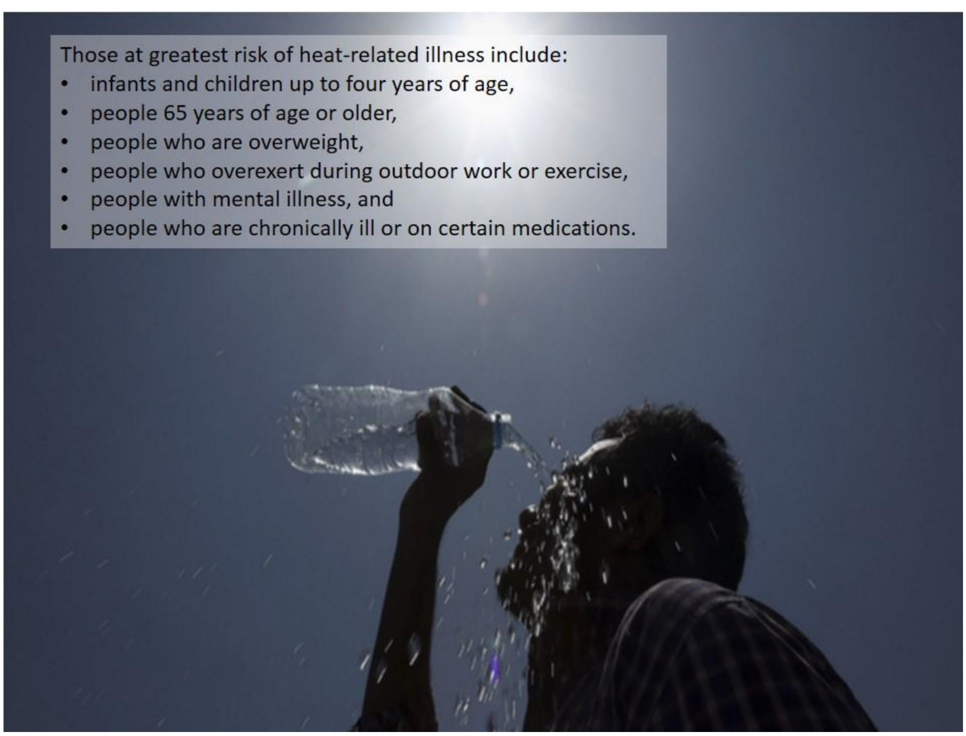
Adapted from Nicholls, et al., 2007

EXPOSURE – long-term Temperature

Change in average **surface temperature**
(1986–2005 to 2081–2100)



Source: IPCC – AR5

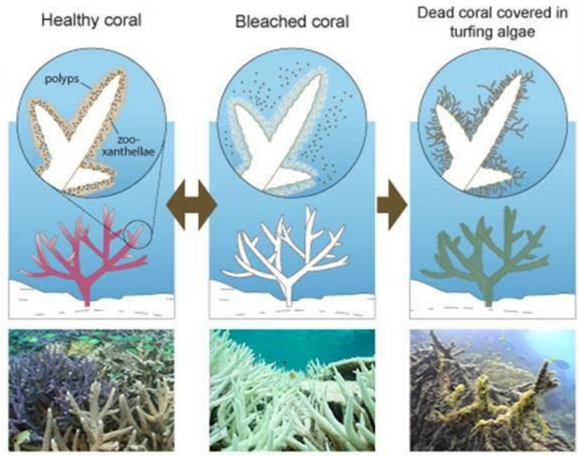


TEMP
ACIDIFICATION
RAIN
STORM
SLR

IPCC models project that by 2100 the Western Equatorial Pacific region shall experience significant increases in sea surface temperature (SST = 1 to 4°C)

Increase in sea temperature is one of the climate factors with the most significant impact.

In the tropics, increase in temperature result in coral bleaching. Prolonged bleaching can lead to coral death; loss of coral reef structure and macroalgae overgrowth.



https://blogs.ntu.edu.sg/

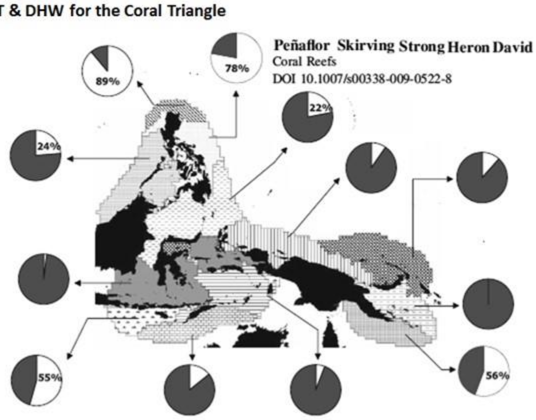
CORAL REEFS

Sea-surface temperature and thermal stress in the Coral Triangle over the past two decades

E. L. Peñaflor * , W. J. Skirving, A. E. Strong, S. F. Heron, L. T. David

Marine Science Institute, University of the Philippines, Diliman, Quezon City, 1101 Philippines
NOAA NESDIS Coral Reef Watch, E/RA31, SSMC1, 1335 East-West Highway, Silver Spring, MD 20910 USA

SST & DHW for the Coral Triangle



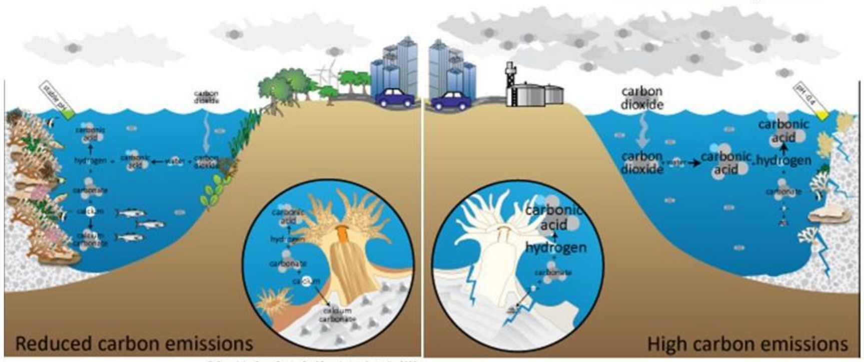
Overall, this study shows that more warming and more thermal stress events were observed from 1996 onwards as compared to the earlier half of the record.

In addition, climate change is bringing about change in ocean pH

This can lead to additional loss of coral reef structure.

TEMP
ACIDIFICATION
RAIN
STORM
SLR

Between 1751 and 1994 surface **ocean pH** is estimated to have decreased from approximately 8.25 to 8.14.
Ocean pH is globally projected to increase 0.3-0.4 units by 2100.



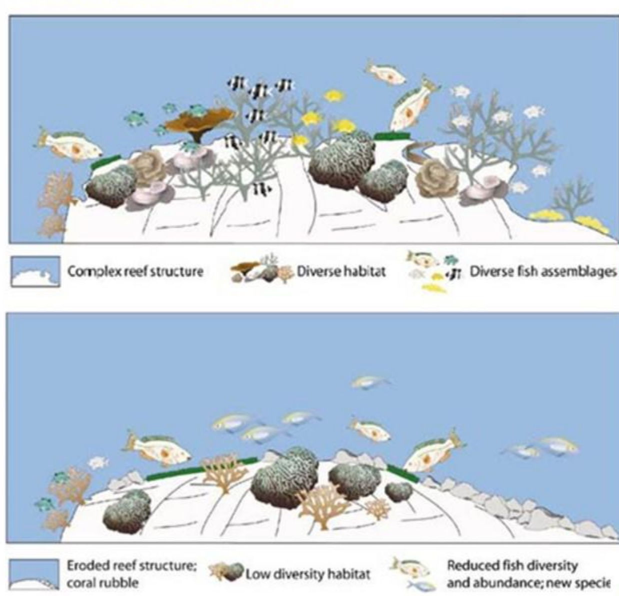
https://www.e-education.psu.edu/earth103/node/722

EXPOSURE – Ocean Acidification

TEMP
ACIDIFICATION
RAIN
STORM
SLR

A complex reef architecture harbors a diverse marine ecosystem.

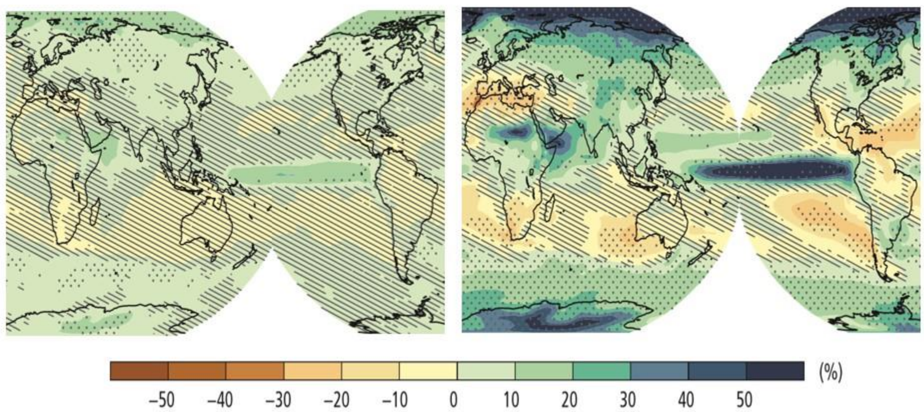
Loss of coral structure can lead to a decrease in both fish biomass and diversity.



Munday *et. al.*, 2007

EXPOSURE – Changing Extreme Weather Frequency, Intensity or Duration

Change in **average precipitation** (1986–2005 to 2081–2100)



Source: IPCC – AR5

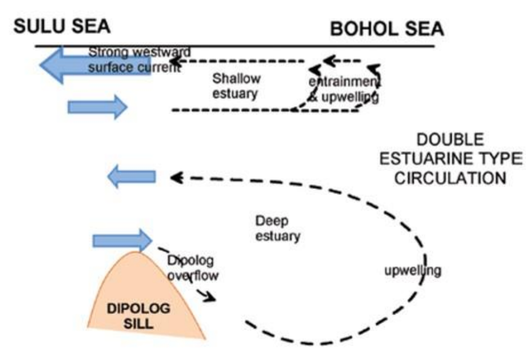
OCEANOGRAPHY

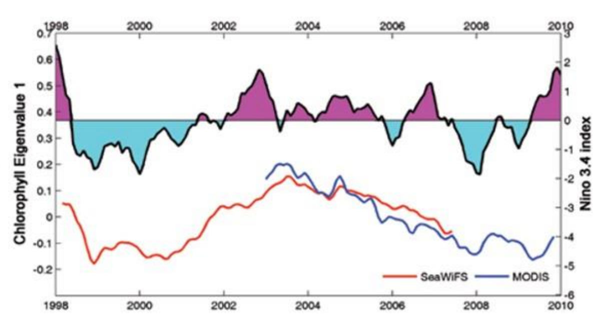
Entrainment and Upwelling Barrier Layer Control of in the Bohol Sea, Philippines

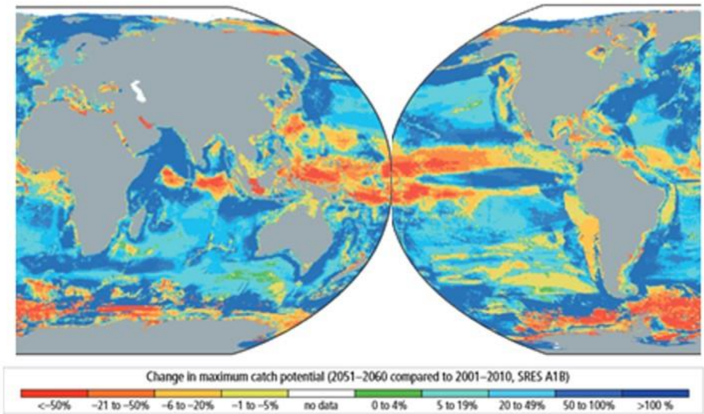
Olivia C. Cabrera, Cesar L. Villanoy, Laura T. David, and Arnold l. Gordon 24(1):130–141,
doi:10.5670/oceanog.2011.12.

Upwelling supports fisheries by providing nutrients from the deep oceans.

However, anomalous rainfall (such as during La Nina events) limits the depths of effective upwelling.







Source:
IPCC –AR5

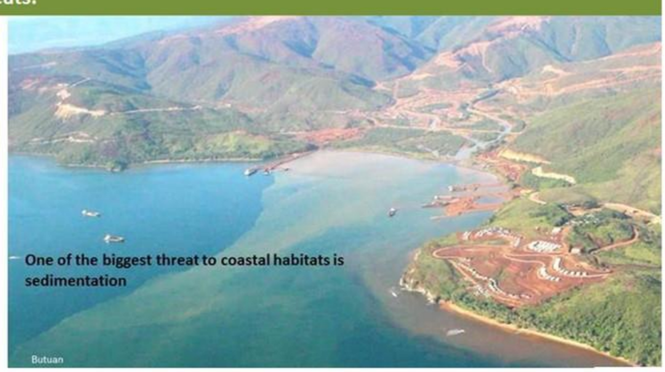
Projected global redistribution of maximum catch potential of ~1000 exploited marine fish and invertebrate species.

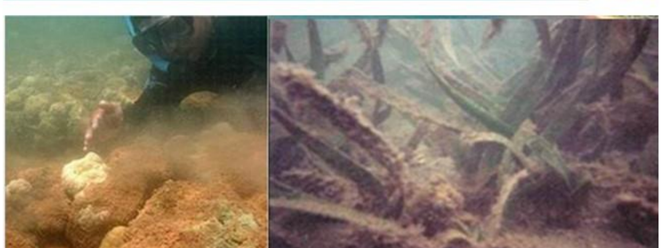
(Projections compare the 10-year averages 2001–2010 and 2051–2060 using ocean conditions based on a single climate model under a moderate to high warming scenario, without analysis of potential impacts of overfishing or ocean acidification.)

Even the best protected sites are challenged by a combination of climate and human-induced external threats.

TEMP | ACIDIFICATION | RAIN | STORM | SLR

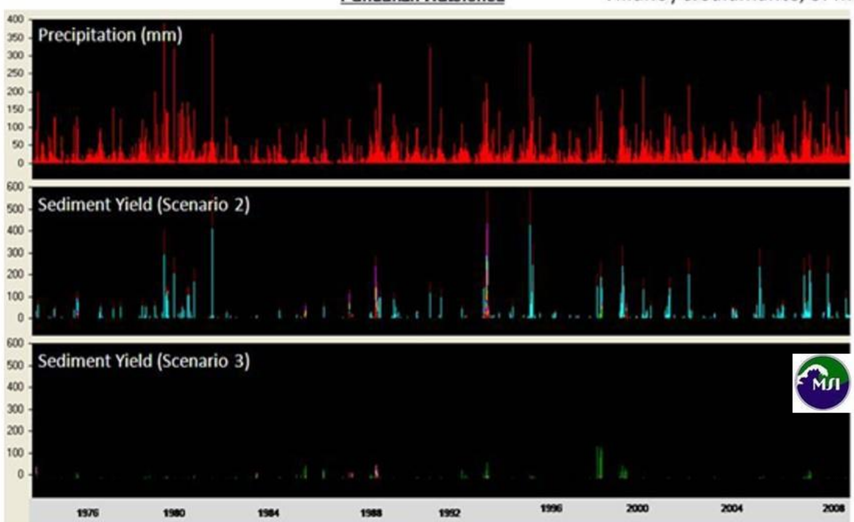
One of the worst perennial threats is coastal sedimentation, which can make the water turbid – making it hard for seagrass to grow. Worse still, it can bury and suffocate coral reefs.





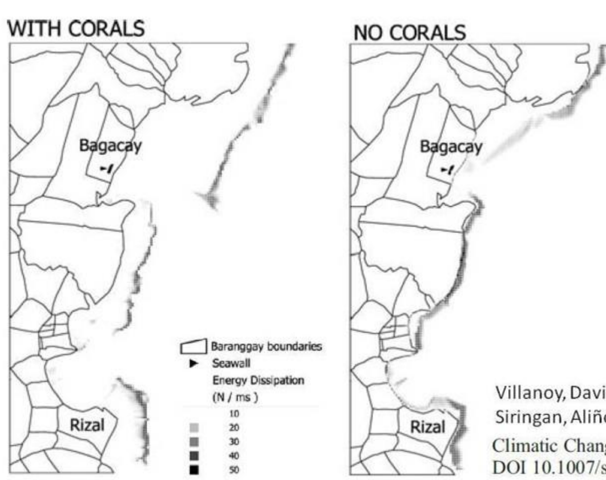
SEDIMENTATION PROBLEM

Ecosystem Rehabilitation as long-term Adaptation: Reforestation is a very effective adaptation option to stabilize soil



The destruction of coastal resources have dire effects of coastal integrity.

Coral reefs, seagrasses and mangroves, provide protection to coastal communities as they naturally buffer against high-energy waves, even under scenario of sea-level rise

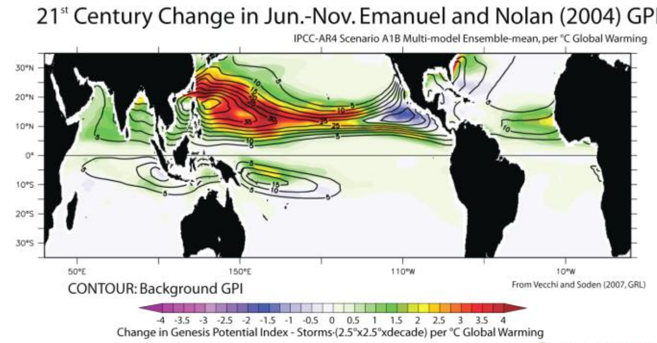


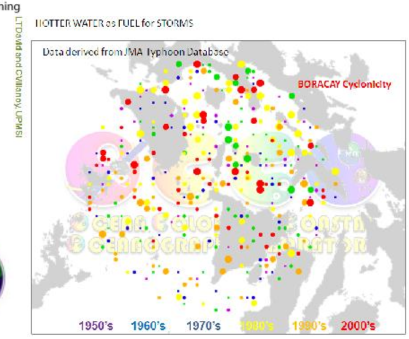
Villanoy, David, Cabrera, Atrigenio, Siringan, Aliño, Villaluz

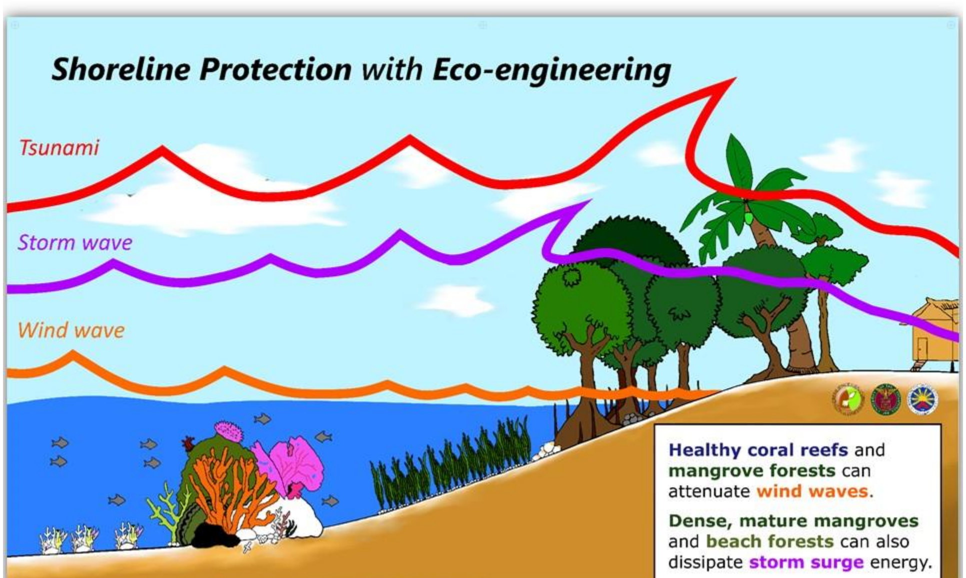
Climatic Change

DOI 10.1007/s10584-012-0399-3

EXPOSURE – inc in Temperature fuels STORMS







Ecosystem Rehabilitation as long-term Adaptation: Seagrass and seaweed also attenuate wave energy and act as sources of coastal sediment

In mangroves, the hazard of concern is sea level rise.

TEMP | ACIDIFICATION | RAIN | STORM | SLR

The main effect is on the establishment of the propagules which need to be above sea surface during the daytime in order to photosynthesize.

http://www.greenpeace.org/international/news/climate-change-in-the-pacific

The United Nations estimates that 13% of world's mangroves will be drowned by 2100.

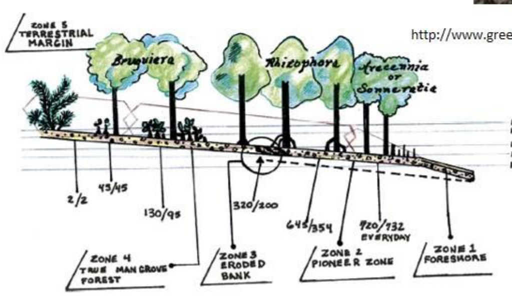
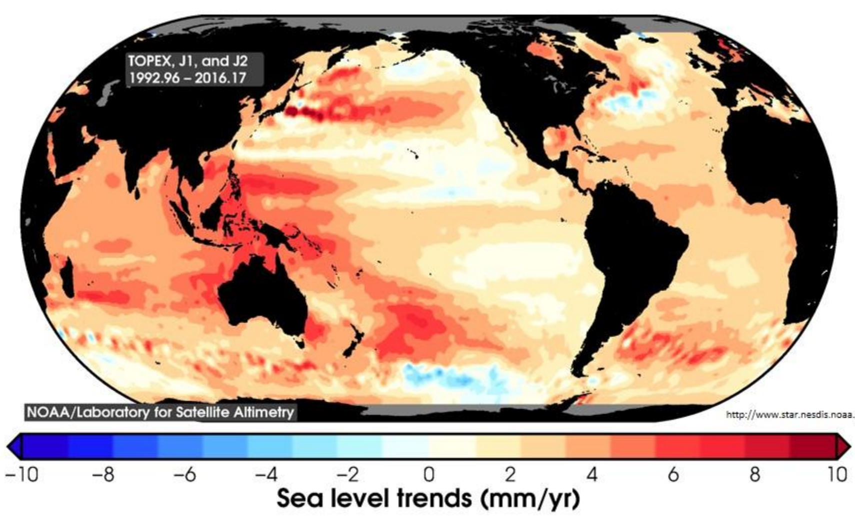


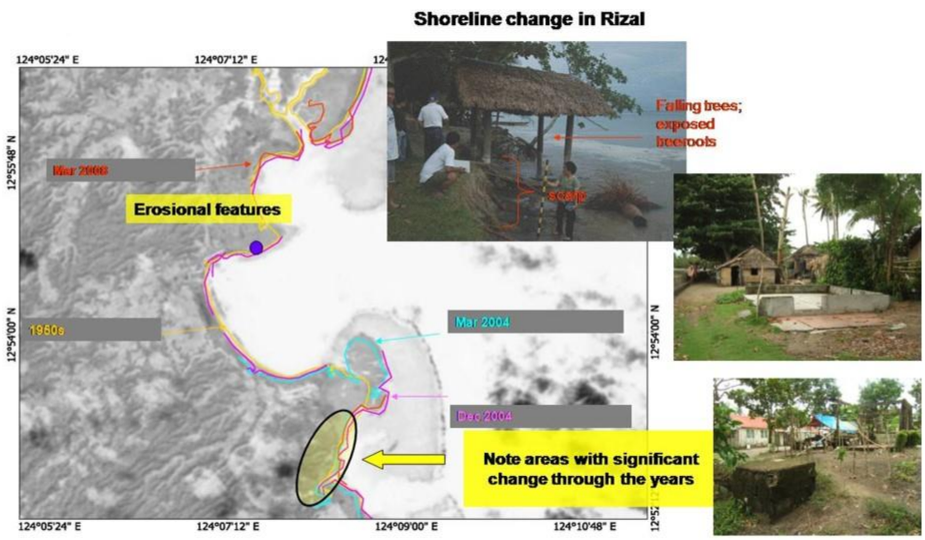
Fig. 2. Mangrove zonation related to tidal datums in Sumatra, Indonesia (modified from Whitten et al., 1987).

It is also expected that there will be change in species composition as sea level rise may favor faster growing spp in new areas.

Historical sea level trends shows the western Pacific experiencing the highest rise

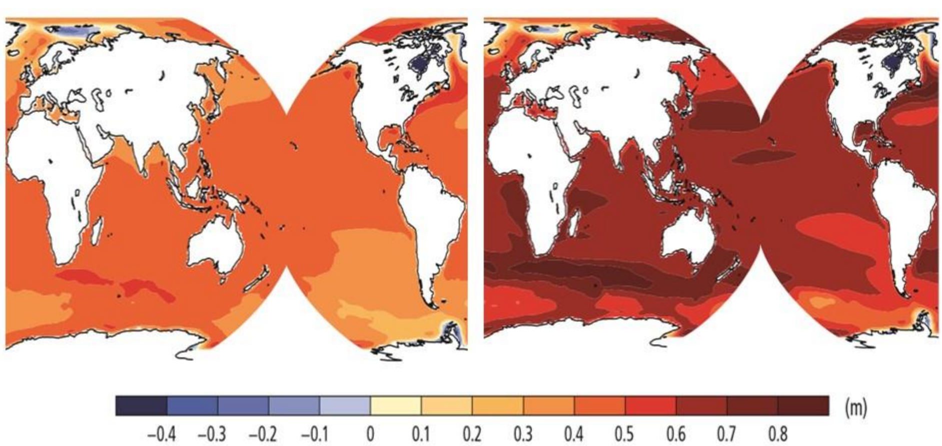


The impact of sea level rise can no longer be ignored in the islands of the western Pacific, including the Philippines.

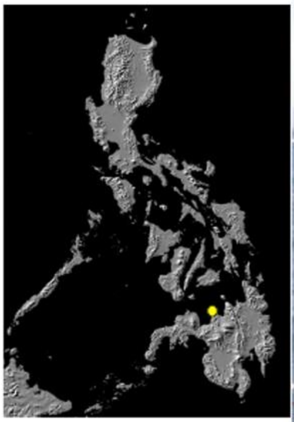


EXPOSURE – long-term Sea-level Rise

Change in **average sea level** (1986–2005 to 2081–2100)



Source: IPCC – AR5



Gasan. Cagayan de Oro 2004

UPMSI:FSiringan,

Climate Disaster and Development Journal

Vegetation resistance and regeneration potential of Rhizophora, Sonneratia, and Avicennia in the Typhoon Haiyan-affected mangroves in the Philippines: Implications on rehabilitation practices

Carlo Carlos1 · Rafaela Jane Delfino1 · Drandreb Earl Juanico1,2 · Laura David1,3 · Rodel Lasco1,4

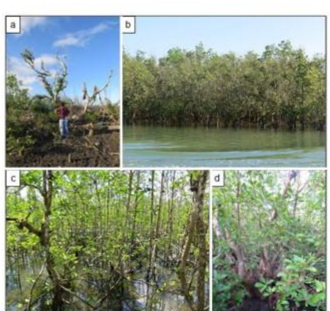
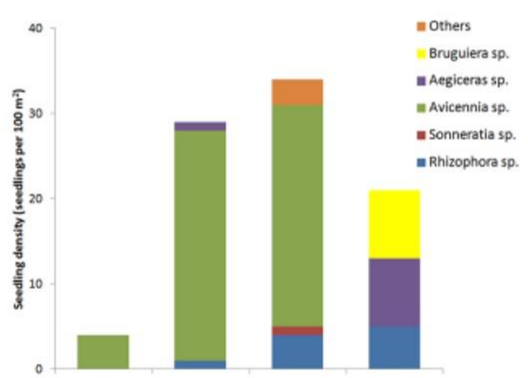
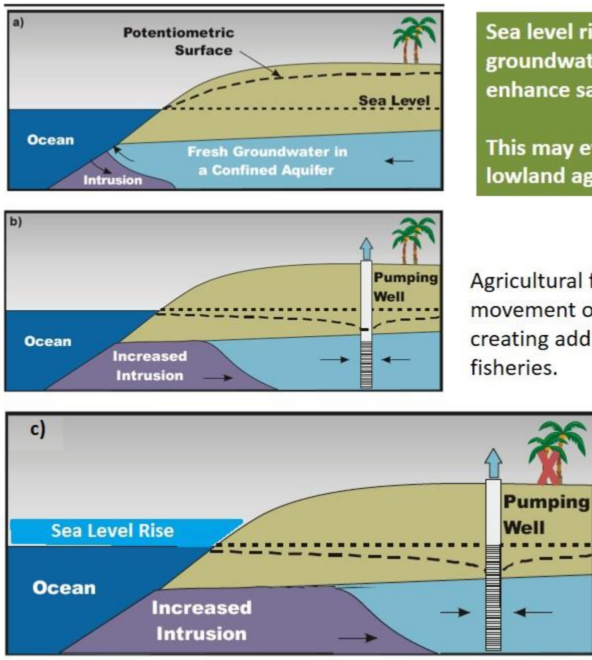


Figure 2. Condition of the mangroves in the study sites six months after Typhoon Haiyan (Yolanda): (a) the mangroves of Tacloban were badly damaged; (b) Ormoc mangroves having intact stand showing refoliation; and (c) Quinapondan and (d) General MacArthur having recovered mangrove stands.





modified from www.wrd.org

Sea level rise, together with groundwater pumping, may enhance salt water intrusion.

This may eventually lead to lowland agriculture failure.

Agricultural failure may also lead to movement of farmers to coastal areas, creating additional pressure on coastal fisheries.

TEMP | ACIDIFICATION | RAIN | STORM | SLR

Land subsidence

- The removal of water allows the aquifer sediments to compact.
- Once compacted, the overlying unsaturated zone sediments will also drop in elevation.

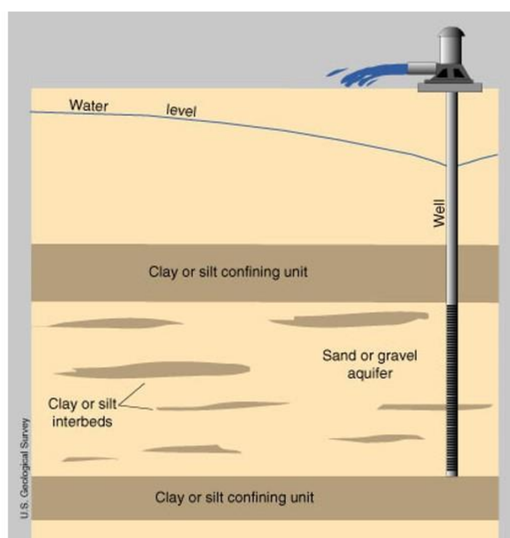


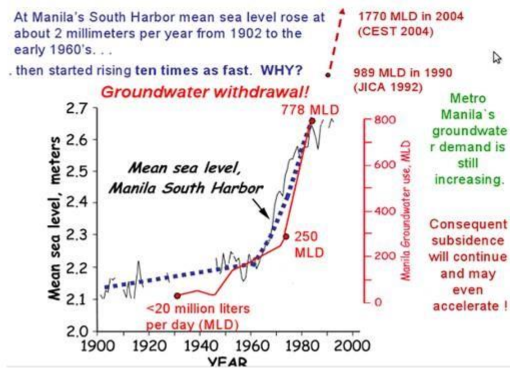
Figure 2. An aquifer system susceptible to compaction that results in land subsidence. Release of water from clay and silt confining units and interbeds causes a reduction in thickness of these compressible sediments.

Exacerbating conditions → GROUNDWATER EXTRACTION

In the Philippines and other areas in Asia sea-level rise is exacerbated by subsidence **due to unregulated groundwater extraction.**

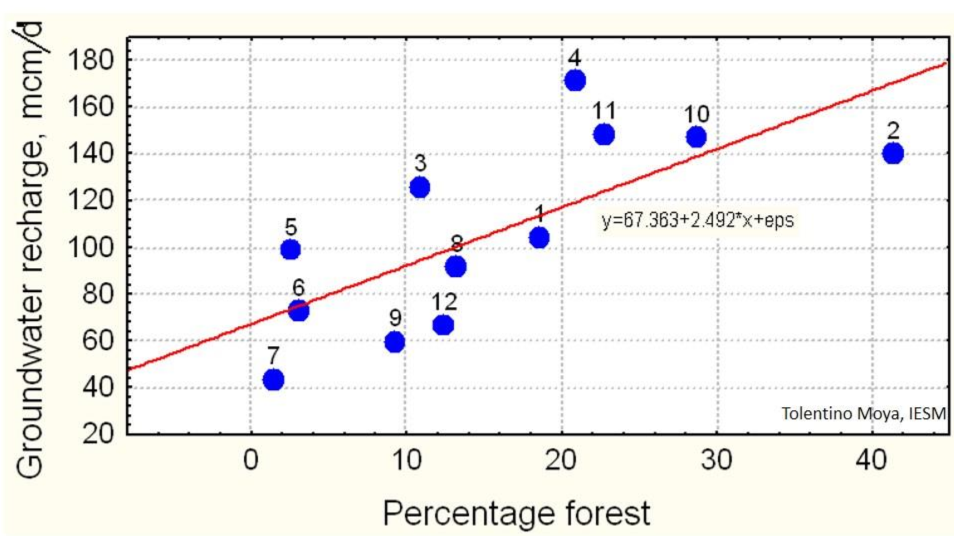
Effort must be made to protect sources of water and to start exploring rainwater catchments.

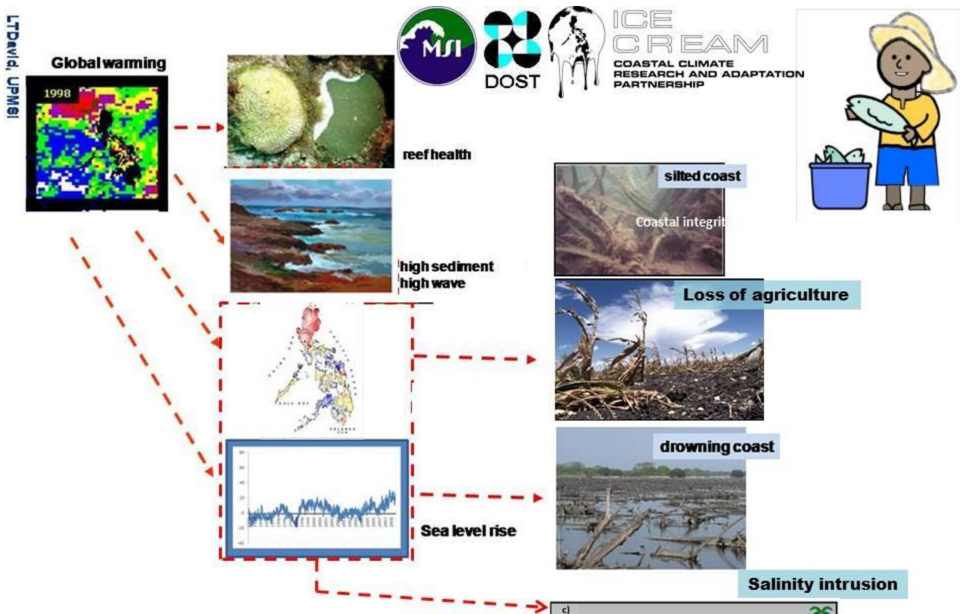
Slowly buried house,
Bgy. Binaungan, Obando, Bulacan
-F. Siringan, UPMSI



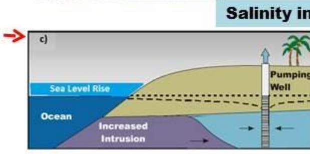
WATERSHED PRESERVATION

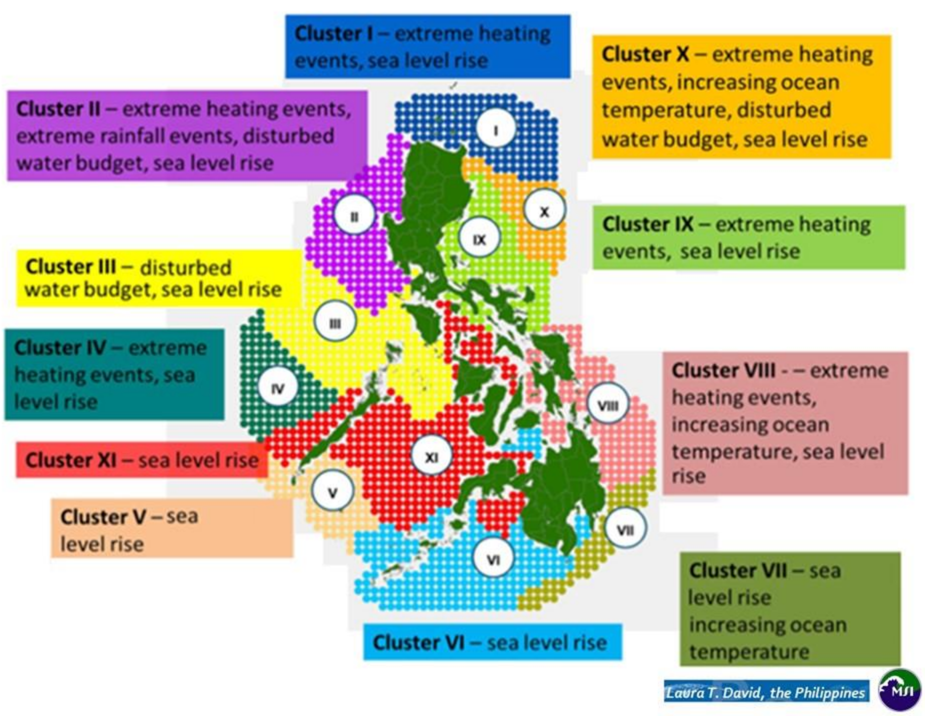
Groundwater Recharge & forest cover





Loss of habitat typically result in the decline of smaller-bodied fishes that are dependent on the habitat for shelter and bigger ones dependent on habitat as nursery

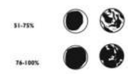
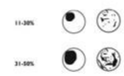
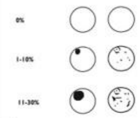




AMBIO

I-C-SEA Change: A participatory tool for rapid assessment of vulnerability of tropical coastal communities to climate change impact

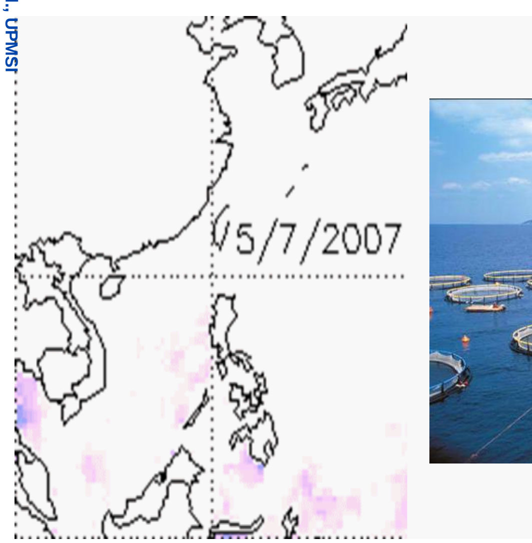
Wilfredo Y. Licuanan , Maricar S. Samson, Samuel S. Mamauag,
Laura T. David, Roselle Borja-del Rosario, Miledel Christine C. Quibilan,
Fernando P. Siringan, Ma. Yvainne Y. Sta. Maria, Norievill B. Espana,
Cesar L. Villanoy, Rollan C. Geronimo, Olivia C. Cabrera,
Renmar Jun S. Martinez, Porfirio M. Alino

3	What is the highest hard coral cover (%)?	over 50% 	between 25 to 50% 	less than 25% 
4	How much of the shallow areas are covered by seagrass?	seagrasses cover more than half of the reef flat	seagrasses cover more than 1/8 to 1/2 of of the reef flat	seagrasses cover less 1/8 of the reef flat
5	How much of the coastline is lined by mangroves?	More than 50% is lined by mangroves	Between 25 to 50% is lined by mangroves	Less than 25% is lined by mangroves
6	What kind of mangrove forest is left?	More than 3 mangrove species with *Avicenna* and *Sonneratia*	Mostly *Avicenna* and *Sonneratia*  *These species can easily adapt to rising sea level.*	Predominantly *Rhizophora*  *These species may drown as they cannot keep with the increase in sea level*

LTDavid et al., UPMSI

Human Activities

Mariculture and Climate Stress



•AVHRR

Aquatic Ecosystem and Health Management

The saga of community learning: Mariculture and the Bolinao experience

Laura T. David, Davelyn Pastor-Rengel,Liana Talaue-McManus, Evangeline Magdaong, Rose Salalila-Aruelo, Helen Grace Bangi, Maria Lourdes San Diego-McGlone, Cesar Villanoy, and Kristina Cordero-Bailey

Clear Caquiputan Advocacy

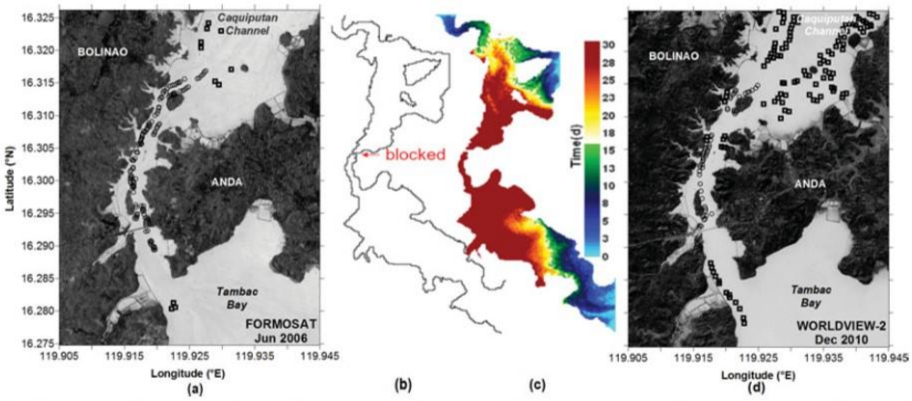
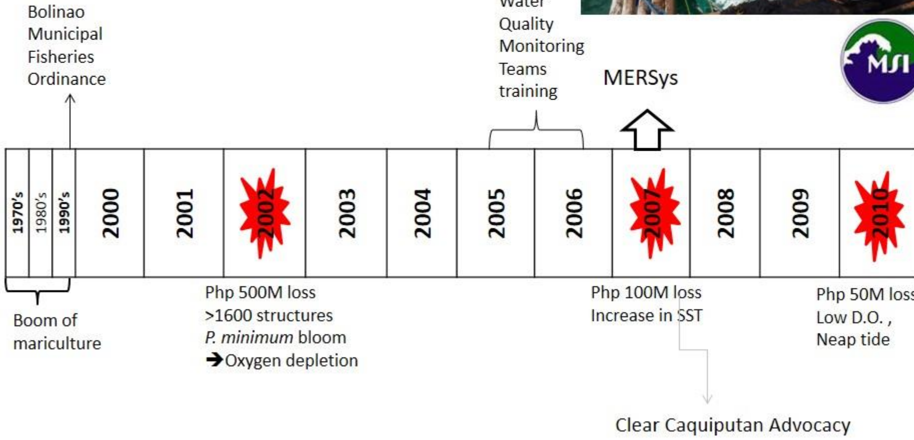


Figure 4. (a) Structures along Caquiputan Channel in 2006 (circles = fish cages, squares = fish pens). Predicted residence time of Caquiputan Channel (c) when blocked as shown in (b). (d) Structures along Caquiputan Channel in 2010.

LTDavid et al., UPMSI

Human Activities

Mariculture and Climate Stress

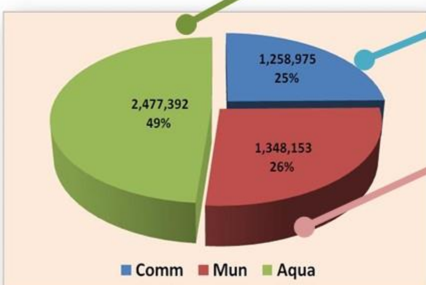


ADAPTATION

BIODIVERSITY is key to securing our FOOD RESOURCES especially under the CLIMATE CHANGE LENS

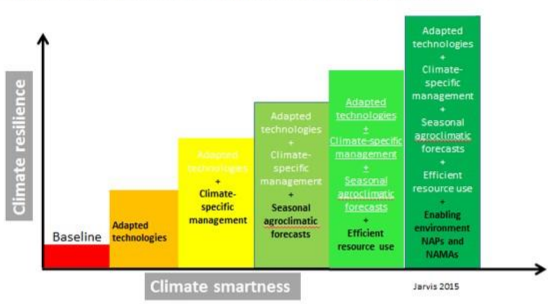
WISE MARICULTURE
- Site selection
- Stocking intensity and density
- Climate tolerant species

RESPONSIVE PELAGIC FISHERIES
- Care of Spawning and Nursery grounds
- Seasonal Fisheries
- Site selection



SUSTAINABLE MUNICIPAL FISHERIES
- Protection and Rehabilitation of Coastal Habitats
- Watershed management
- WISE MARICULTURE

Climate-smart *innovations* for climate-resilient agriculture



Dimensions of Food Security

- Dr. Paul Teng

- **Food Availability**
- **Physical Access**
- **Economic Access**
- **Utilization**
- **Stability**