

The 13th AUN/SEED-Net Regional Conference on Chemical Engineering 2020 (RCChE-2020)

Jointly held with

The 5th International Symposium on Conservation and Management of Tropical Lakes

“Insights and Challenges toward Achieving SDGs”



AUN/SEED-Net



Japan Science and
Technology Agency

Keynote speech 5 – Day 2, Feb 5, 2021

Managing Risk and Enhancing Resilience of Coral Reef in Southeast Asia

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Summary

Coral, throughout the world, are vulnerable towards impact of climate change – acidification, sea level rise, and water temperature – coastal development impacts including sedimentation, nutrient discharge, and other local stressors like disease, invasive species, (over) tourism, and unsustainable fishing. The main discussion points in this keynote speech is about analyzing past, present trend and future scenarios of coral bleaching, and socio-economic impact of coral degradation. Focus of discussion has been done especially in southeast Asia (SeA). Major threats to coral in SeA is highlighted which includes, over fishing, marine-based pollution, and integrated local threat and thermal stress. The paradox of over tourism, economic opportunities and coral degradation, and the successful and ongoing coral restoration strategy in Maya bay, Thailand is also discussed. Scenario-analysis and quantitative risk assessment is very much crucial, and bridging the gap between policy-makers and researchers should be enhanced with evidence-based science communication for the formulation of effective coral restoration policies. Discussion is wrapped up with analysis of the existing relevant policies in SeA, and the strategy for the formation of collaborative platform and enhancing resilience-based management strategy for coral restoration is proposed.

About the speaker

Dr Rajendra Khanal has the PhD in Urban Engineering from the University of Tokyo, Japan. Dr Khanal is currently a postdoc fellow at Tokyo Institute of Technology, Japan. He is the certified Environmental Leader, a qualified Food Technologist and an experienced Environmental Engineer, with over 11 years of professional research experiences in techno-managerial, policy research, capacity building, university-level teaching, programme development, project management, and environmental risk assessment. Dr Khanal is interested in sustainable management of urban environment by integrating three major pillars of sustainable development, i.e., Food Water and Energy, by integrating solid theoretical foundation, indigenous knowledge, scientific technology and evidence-based policy research with a focus on social, economic and environmental dimensions of sustainability. Know more, <https://sites.google.com/view/rajendra-khanal>

Managing Risk and Enhancing Resilience of Coral Reef in Southeast Asia

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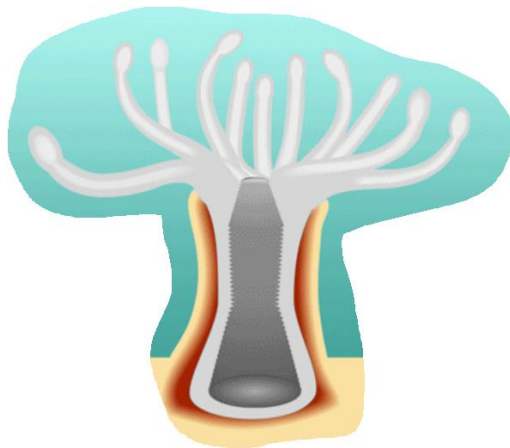
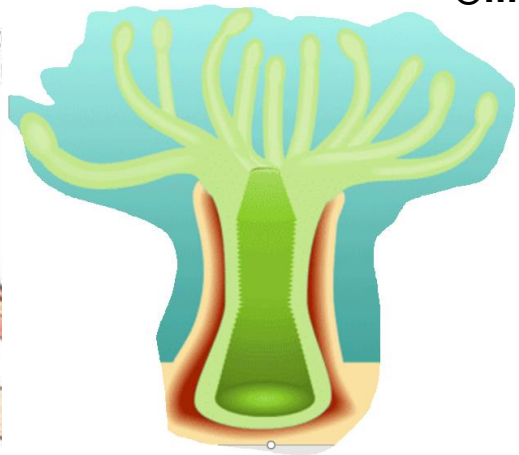
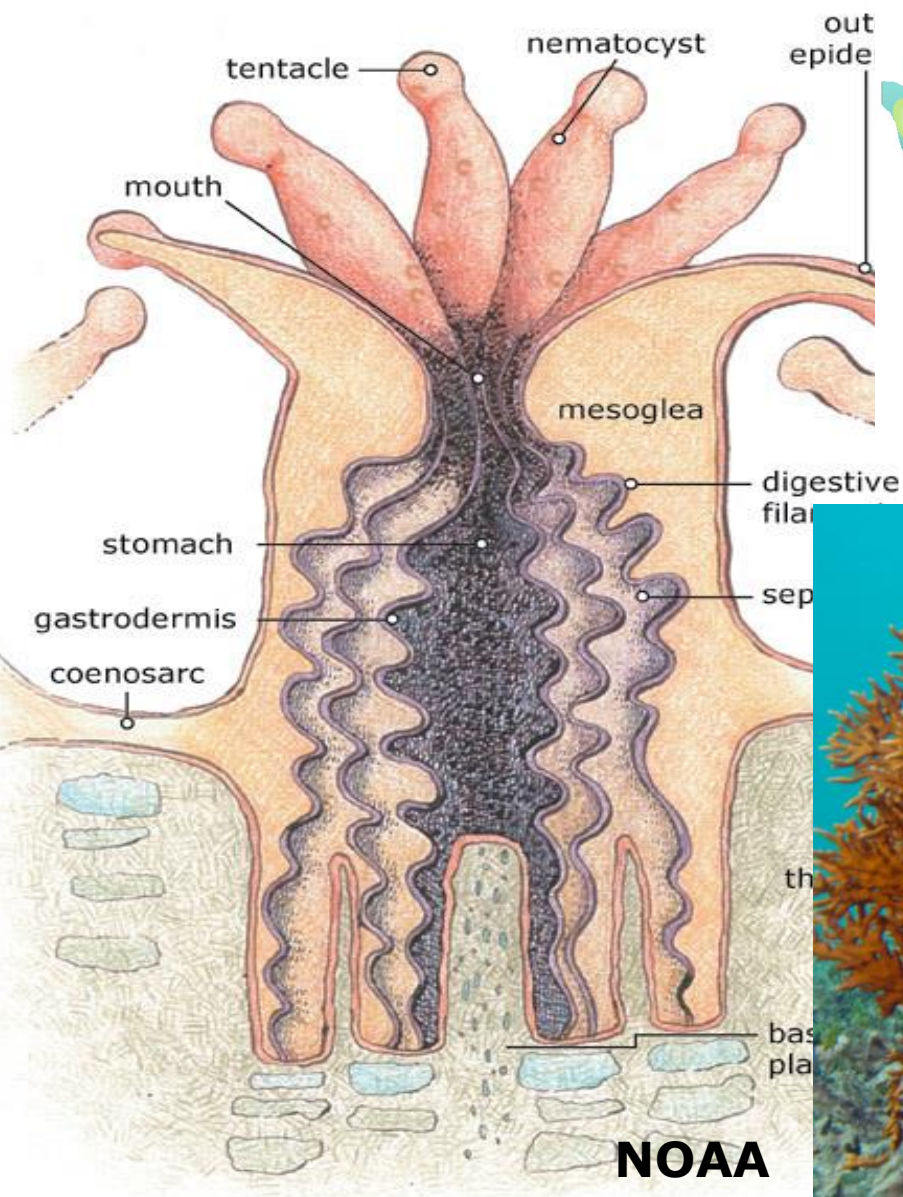


Managing Risk and Enhancing Resilience of Coral Reef in Southeast Asia



What are Corals?

©mrvanarsdale



Gizmodo

Coral polyps (1 – 3 mm)

Economic impact of coral degradation

a rapid-emission-reduction pathway, whereby temperatures are estimated to reach 2.2°C above pre-industrial levels by 2100 RCP2.6



a business-as-usual pathway that sees temperatures rising 4.0°C by 2100 RCP6



Figure 1 VALUATION OF SELECTED CLIMATE IMPACTS ON OCEAN (Billions of 2010 US\$)

	Low climate impacts		High climate impacts		Difference	
	2050	2100	2050	2100	2050	2100
Fisheries	67.5	262.1	88.4	343.3	20.9	81.2
Sea-level rise	10.3	34.0	111.6	367.2	101.3	333.2
Storms	0.6	14.5	7.0	171.9	6.4	157.4
Tourism	27.3	301.6	58.3	639.4	31.1	337.7
Ocean carbon sink	0.0	0.0	162.8	457.8	162.8	457.8
Total	105.7	612.2	428.1	1,979.6	322.5	1,367.4
<i>Percent of GDP</i>	<i>0.06%</i>	<i>0.11%</i>	<i>0.25%</i>	<i>0.37%</i>	<i>0.18%</i>	<i>0.25%</i>

Valuing the Ocean Environment Economic perspectives

Frank Ackerman
Elizabeth A. Stanton



Coral threats

Climate change

- Acidification – CO₂
- Sea level/temperature



Global

Pollution

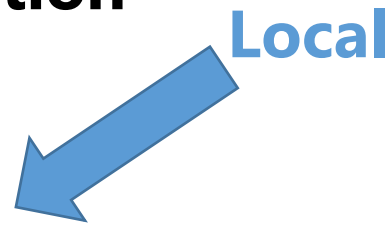
- Chemicals – UV filter
- Nutrient runoff/sedimentation



Global to local

Others

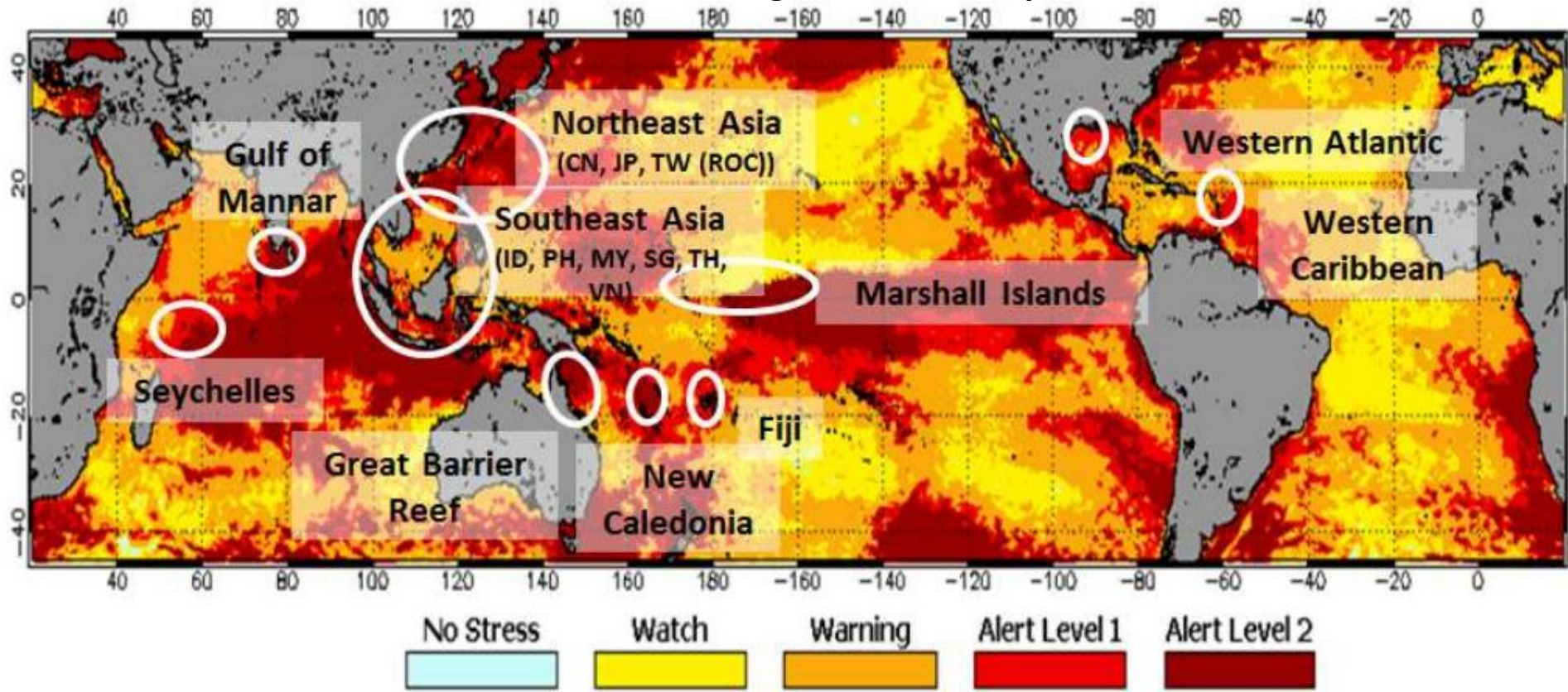
- Disease, invasive species
- Local stress - **tourism, coastal development, anchor, dynamite, (over)fishing, storms**



Local

Global coral bleaching 2014 -2017

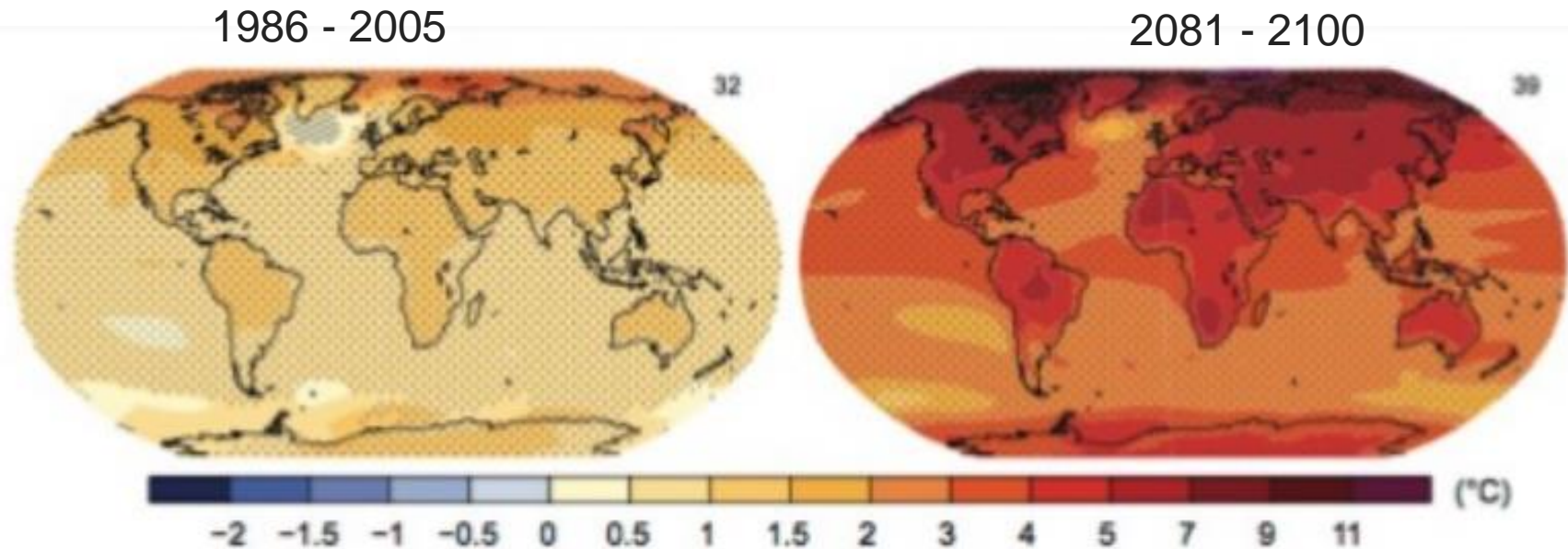
NOAA Coral Reef Watch Maximum Bleaching Alert Area map for 2016



Cambodia	Total site surveyed	Severely bleached	Moderately bleached	Minimally bleached	Year
	9	0	0	6	2015
17	4	8	4	2016	

Source:
MOE, Japan 2018

Global thermal stress

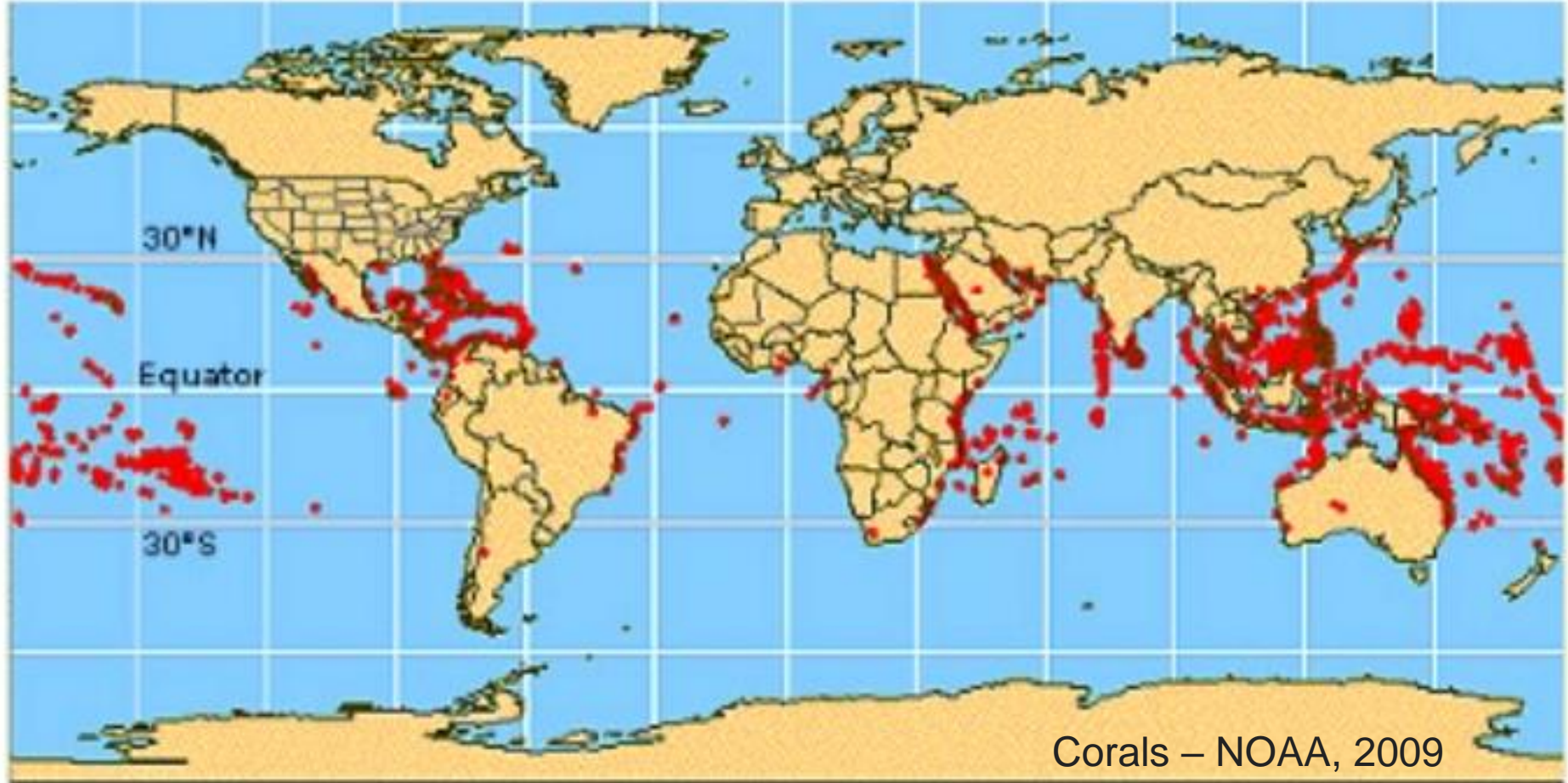


Change in Surface temperature - IPCC 2013 – Summary for policymakers
Mahabir, 2016

By 2050

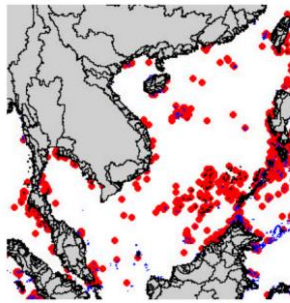
- **high thermal stress - 95% of coral reefs will experience and potential bleaching**
- **~ 15% of coral reefs will be able to in areas where aragonite levels are adequate for coral growth.**

Global corals



Mahabir, R. (2016). Coral Reefs: Challenges, Opportunities and Evolutionary Strategies for Surviving Climate Change in the Caribbean. *Journal of Mason Graduate Research*, 3(2), 71-96.

Coral Reef in Southeast Asia



Facts

- 100,000 sq km (34%)
- 600/800 corals
- USD ~10 billion / annum
- *Tourism 55% ~ 35 Mil people*
- *8000 business ~ 3 Mil local*

Risks

- 88% vulnerable
- ~ 95% threatened
- Climate change
- Marine exploitation
- **Acidification, PPCP**

Reefs at Risk

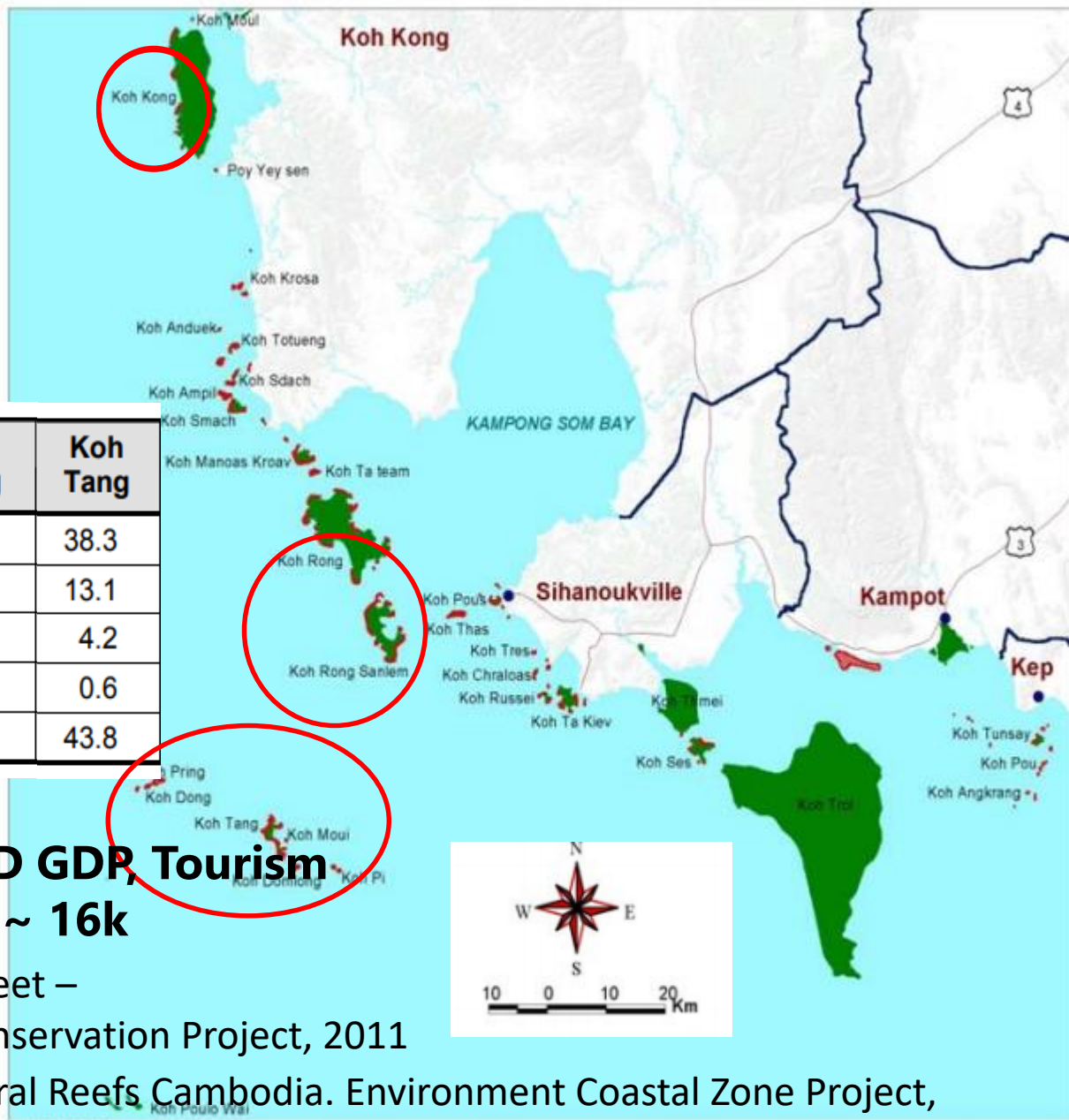
Burke, Laretta, Liz Selig, and Mark Spalding (2002)

in Southeast Asia

Globally 75% of coral reefs threatened (2020) –
 Business as usual - 90% by 2030 and close to > 95% by 2050
 ~ 30% increment in threatened coral in the past 10 years



Coral Reef in Southeast Asia - Cambodia

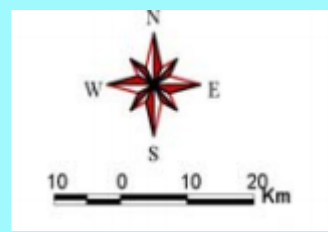


Benthos	Koh Kong	Koh Rong	Koh Tang
Live Coral (%)	47.4	23.1	38.3
Dead Coral (%)	29.6	44.9	13.1
Other Benthos (%)	4.2	5.1	4.2
Algae (%)	1.6	0.6	0.6
Abiotic (%)	17.2	26.4	43.8

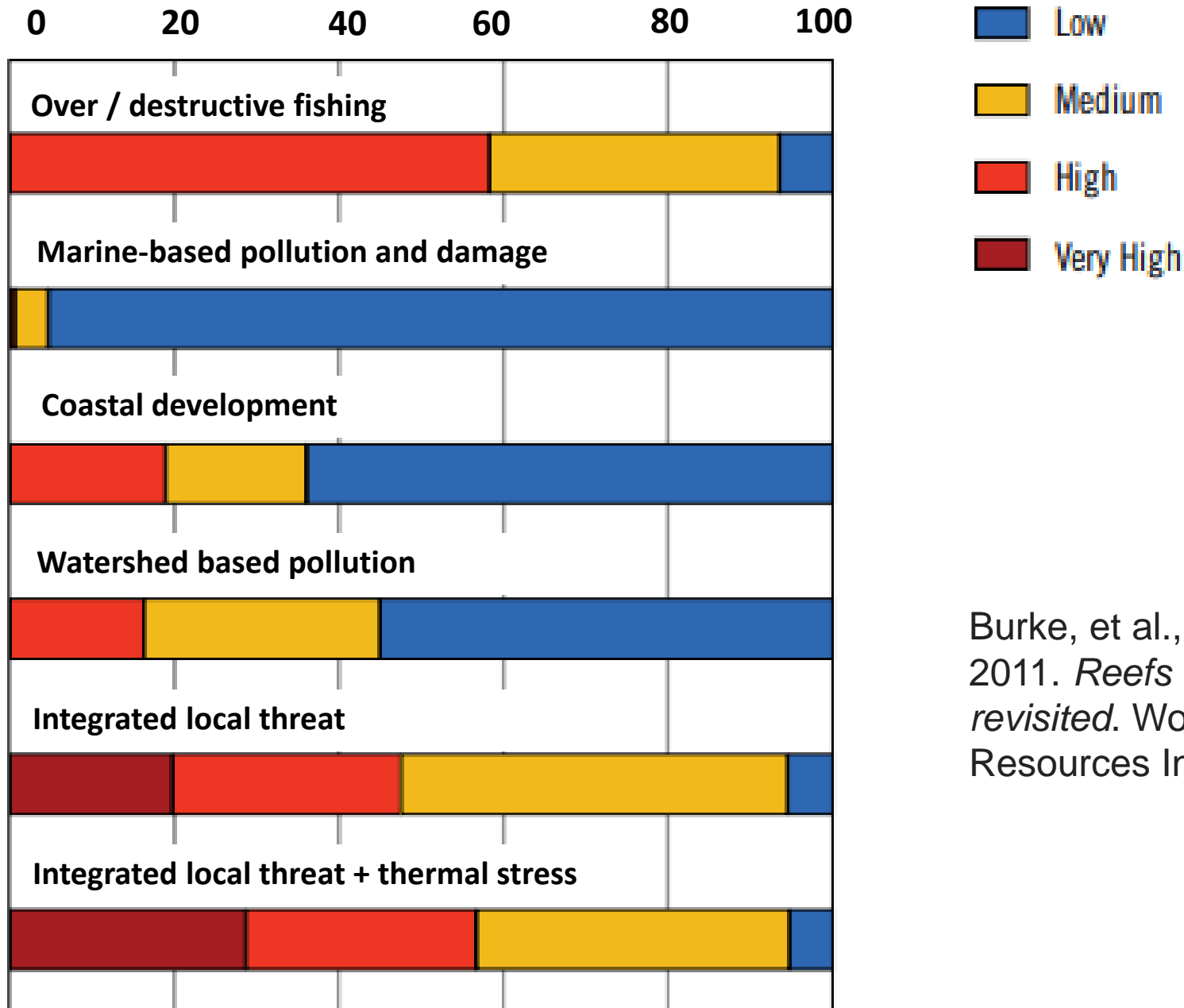
**280 sq km, ~ 68 Mil USD GDP, Tourism
 ~ 11 + Fishery 57, Jobs ~ 16k**

ICRI, 2017- South Asia Fact sheet –
 Cambodia; Cambodia Reef conservation Project, 2011

Nelson, V. (1999). State of Coral Reefs Cambodia. Environment Coastal Zone Project,
 MoE/Danida, Phnom Penh, Cambodia

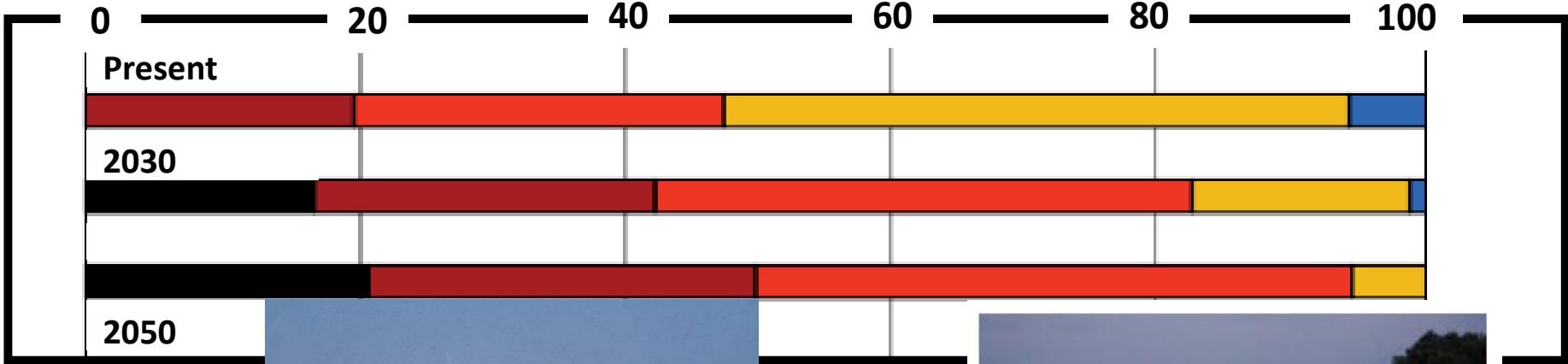
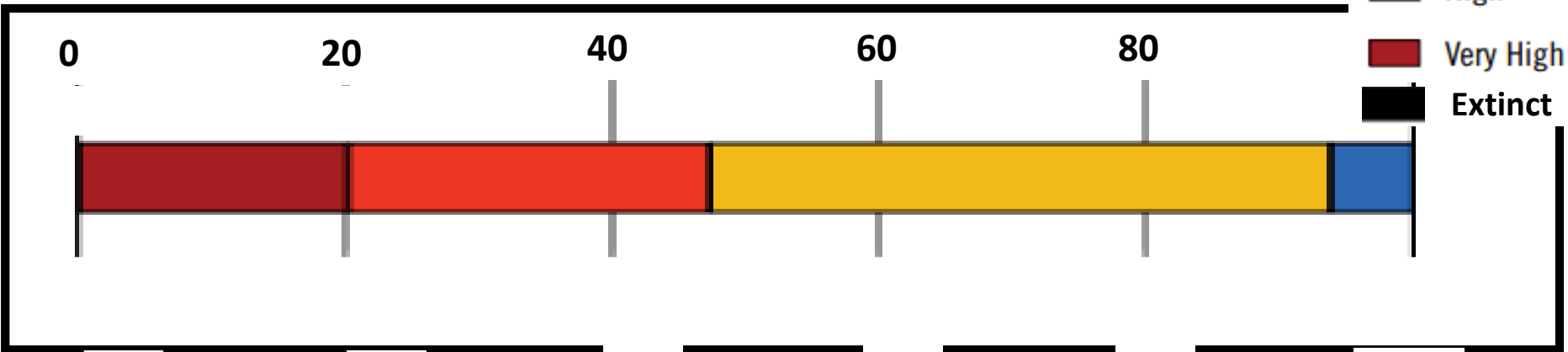


Coral threats in SeAsia



Burke, et al.,
2011. *Reefs at risk
revisited*. World
Resources Institute.

Coral threats in SeAsia - Fishing



2003, Cesar Environmental Economics Consulting (CEEC) / Lida Pet-Soede



Bomb fishing - UNEP 2004

Coral Threats in SeAsia

Country	Major Threats
Cambodia	Over fishing, blast fishing, poison fishing.
Indonesia	Over fishing, blast fishing, sand mining.
Malaysia	Over fishing, blast fishing, poison fishing, trawling.
Philippines	Over fishing, blast fishing, poison fishing, siltation.
Thailand	Over fishing, coastal tourism, siltation
Vietnam	Over fishing, poison fishing. UNEP 2004

Coastal development

Runoff and Land-based Pollution

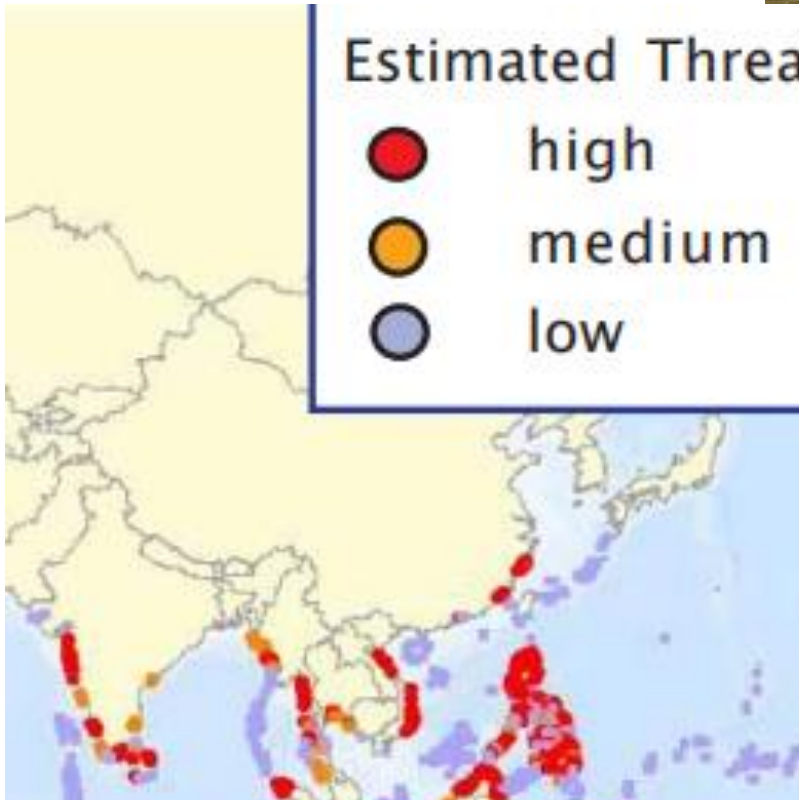
Locals- urbanization, sedimentation, nutrients



Nha Trang, Vietnam

Estimated Threat Level

- high
- medium
- low



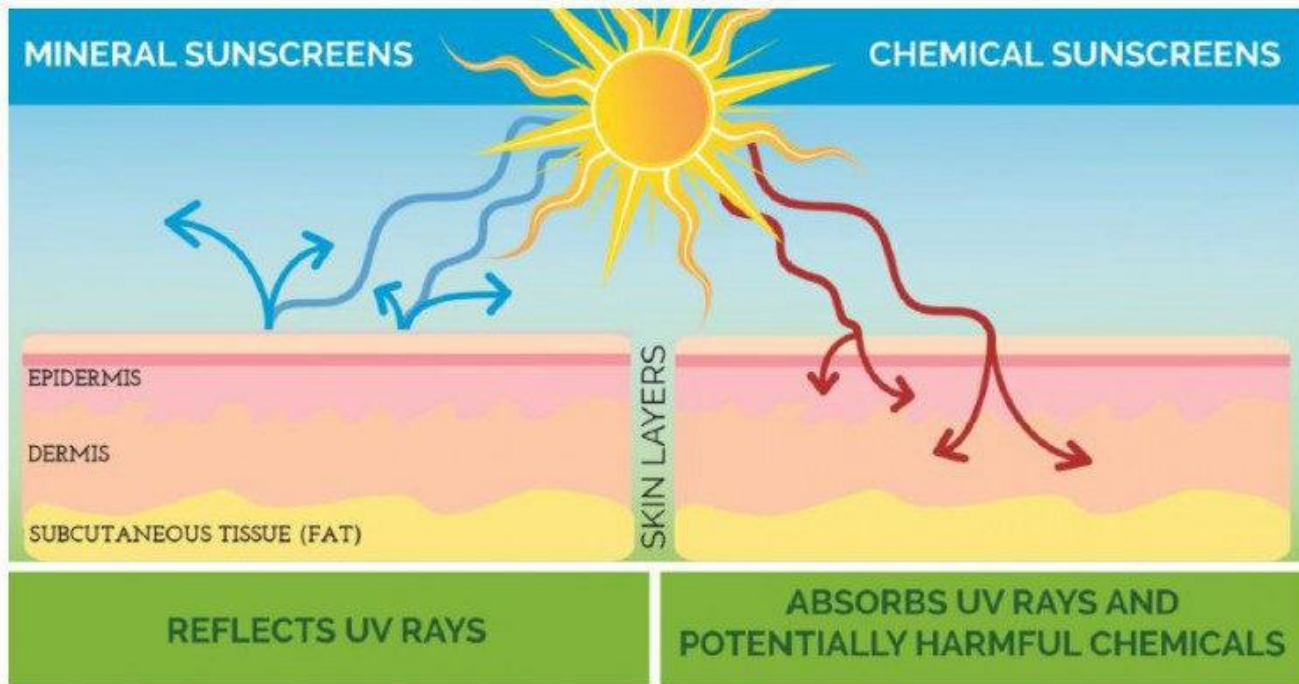
2003, Cesar Environmental Economics Consulting (CEEC)

Tourism



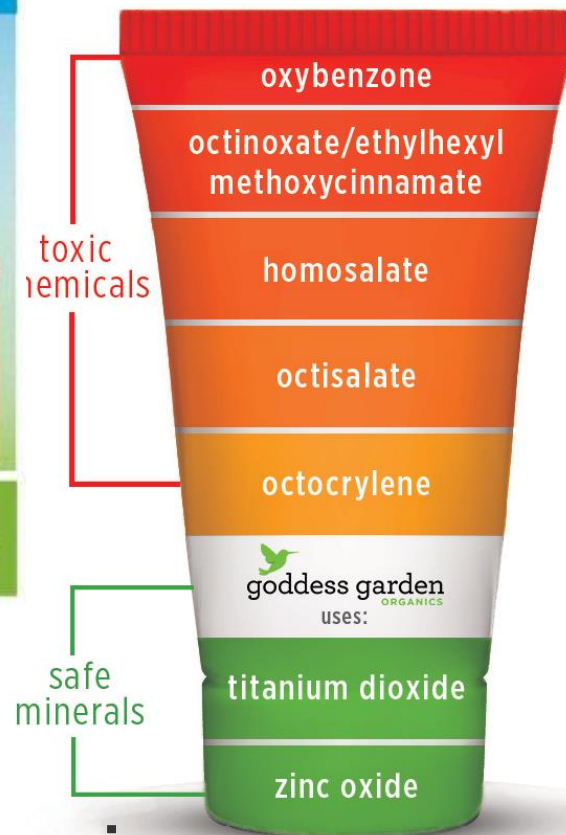
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UV-filters



SUNSCREEN TOXICITY RATINGS*

*from EWG.org/SkinDeep



Oxybenzone and octinoxate - banned / planning

Republic of Palau, Bonaire island, Hawaii and Mexico

Tourism

Maya bay, Thailand

2008

2017

● = 10 people

170 people

3500 people



@ BBC



@ BBC

@ BBC

Maya bay Restoration strategy

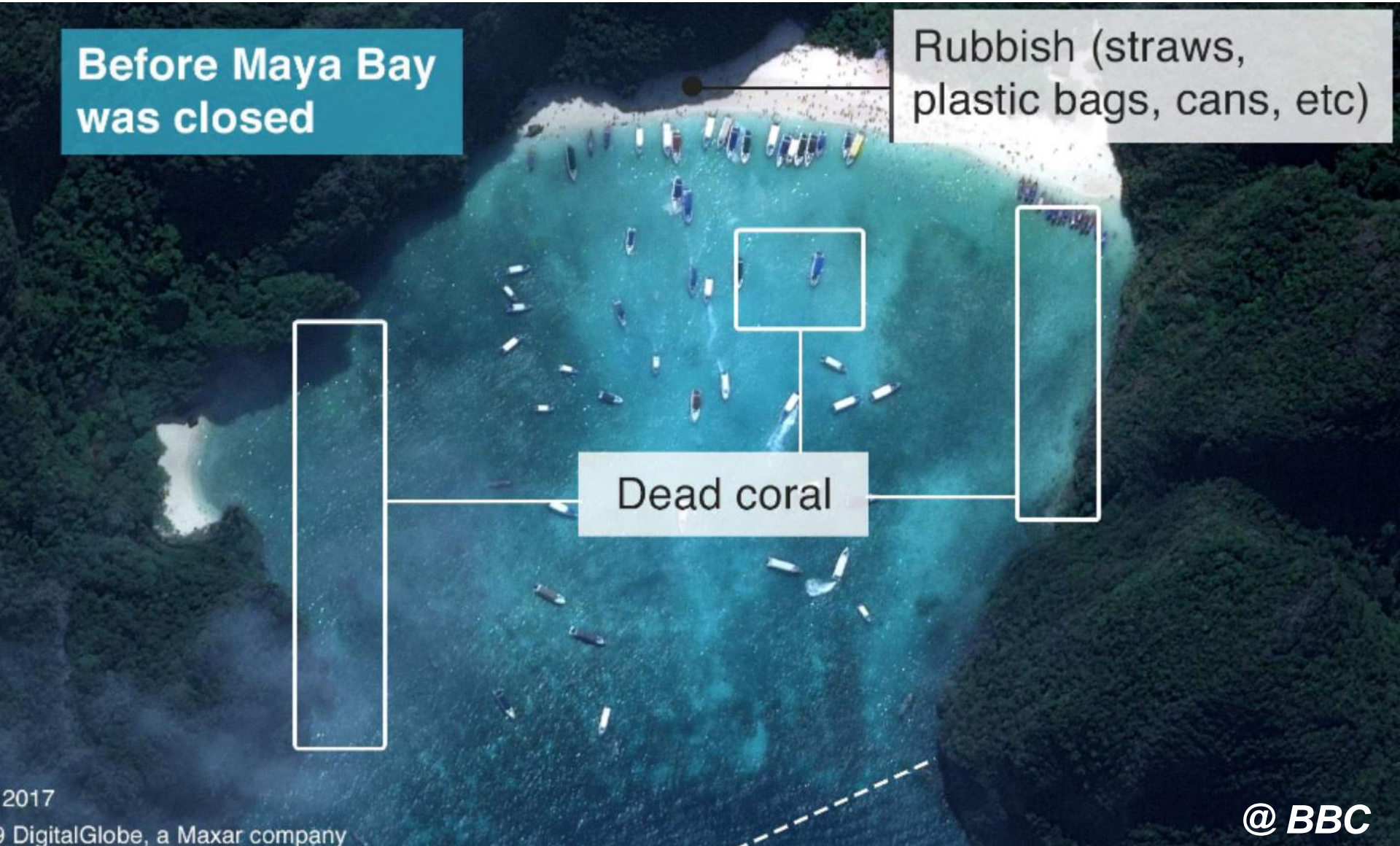
Before Maya Bay was closed

Rubbish (straws, plastic bags, cans, etc)

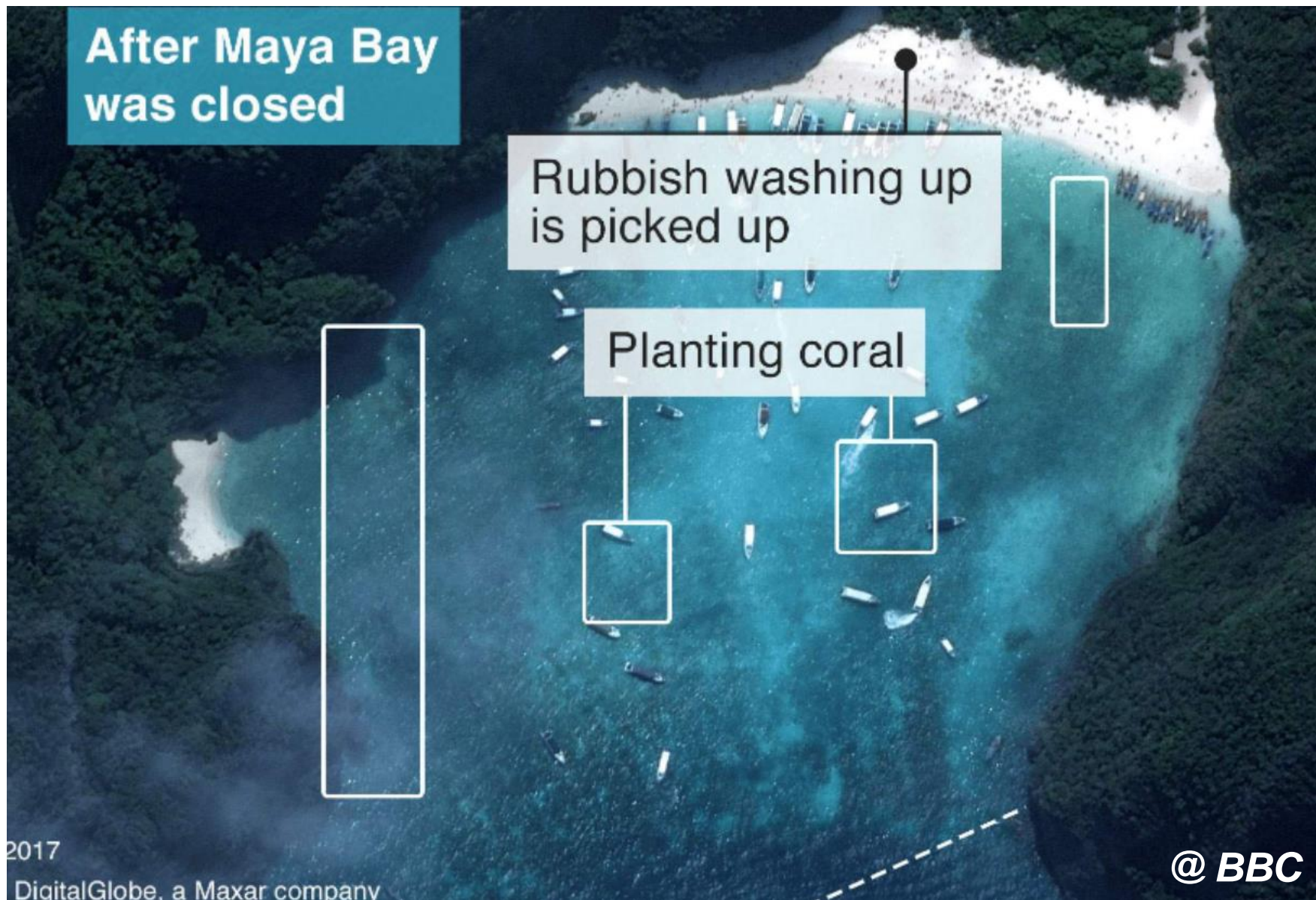
Dead coral

2017
© DigitalGlobe, a Maxar company

@BBC



Maya bay Restoration strategy



Maya bay Restoration strategy

After Maya Bay was closed

Coral nursery

Coral recovering naturally

Demarcation Line

Maya bay Restoration strategy

ทีมวิจัยการฟื้นฟูอ่าวมาหยา
กรมอุทยาน & ม. เกษตรศาสตร์

Blacktip reef sharks can now be spotted at Maya Bay



@BBC

The coral has begun recovering

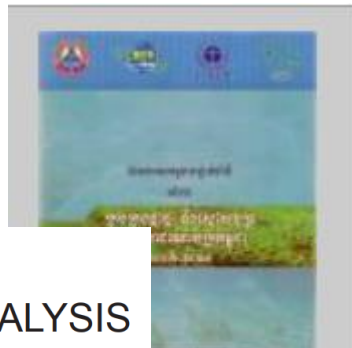
- Thailand
- Coral Reef Restoration Plan
- Reduce threats from
- Strategy 1: Tourism
- Strategy 2: Water pollution
- Strategy 3: Sedimentation
- Strategy 4: Fisheries

Coral relevant policies - SeAsia

CAMBODIA COASTAL SITUATIONAL ANALYSIS



Cambodia Coral Reefs Report



Cambodia National Action Plan for Coral Reefs and Seagrass



Thailand Coral Reefs GIS Database



Thailand Coral Reefs National Action Plan



Vietnam Coral Reef National Report



Vietnam Seagrass National Action Plan



Thailand Marine Sediment Quality Guidelines

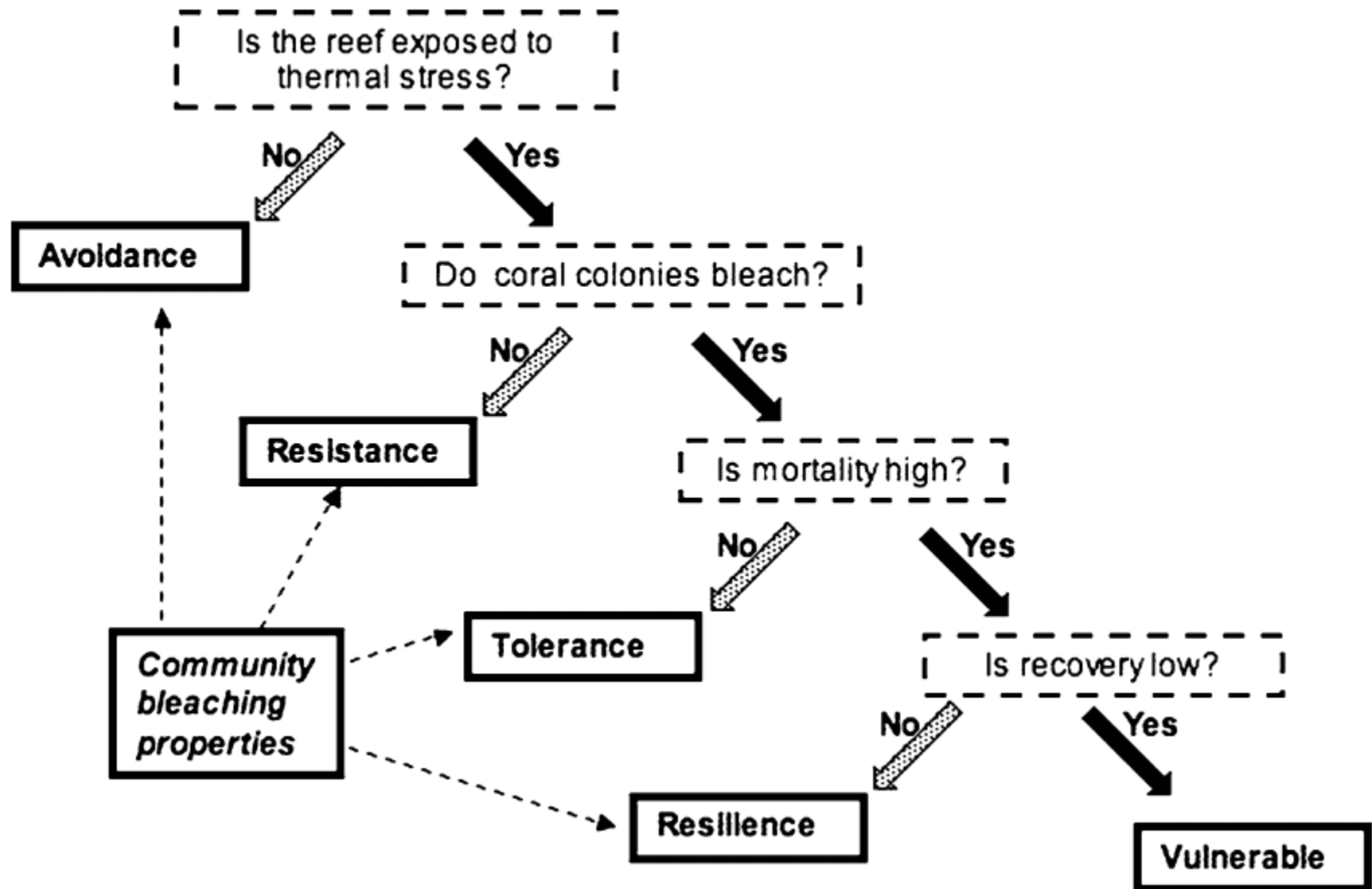


Thailand Seagrass GIS Database

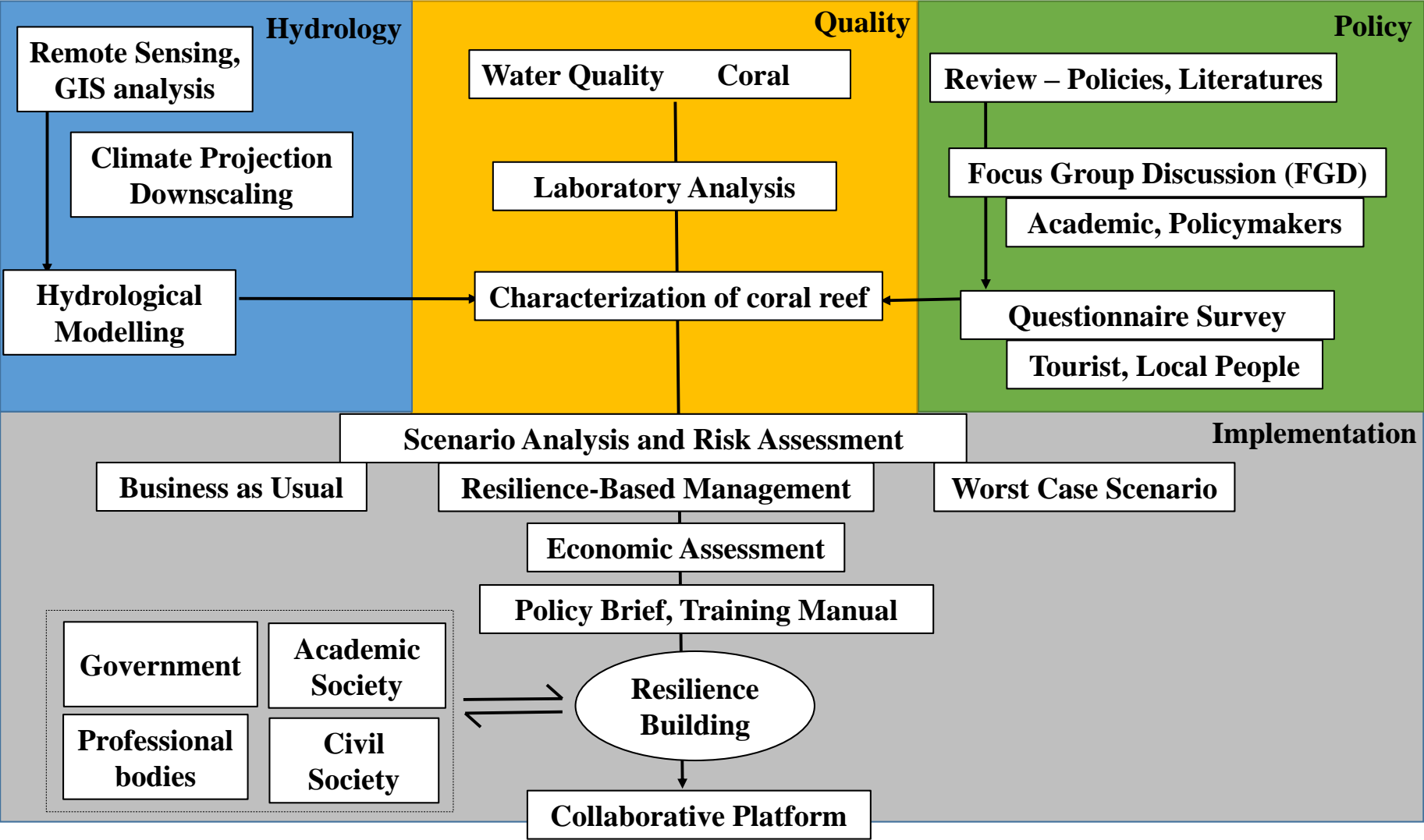


Thailand Seagrass National Report - English

Resilience decision tree



Resilience enhancing strategy



Collaborative Research Platform to Manage Risk and Enhance Resilience of Coral Reef

Resilience enhancing strategy

Sustainability

- Tourism
- Fishing
- Development



5 ft

<http://wallpaperswide.com/>

Genetics

Physiological

Community and environmental intervention

Genetic Engineering



Hon Mun Island, Vietnam

© VNE

Genetic manipulation, thermally-resistant [zooxanthellae](#)

What does resilience look like for coral reef ecosystems?



Recruitment © TNC

INDICATORS:

- I. Strong recruitment
- II. Broad size/age range
- III. High biodiversity
- IV. Low human impacts
- V. Healthy herbivore populations
- VI. Healthy corals- little disease
- VII. History of surviving stress



Broad size/age range. © TNC

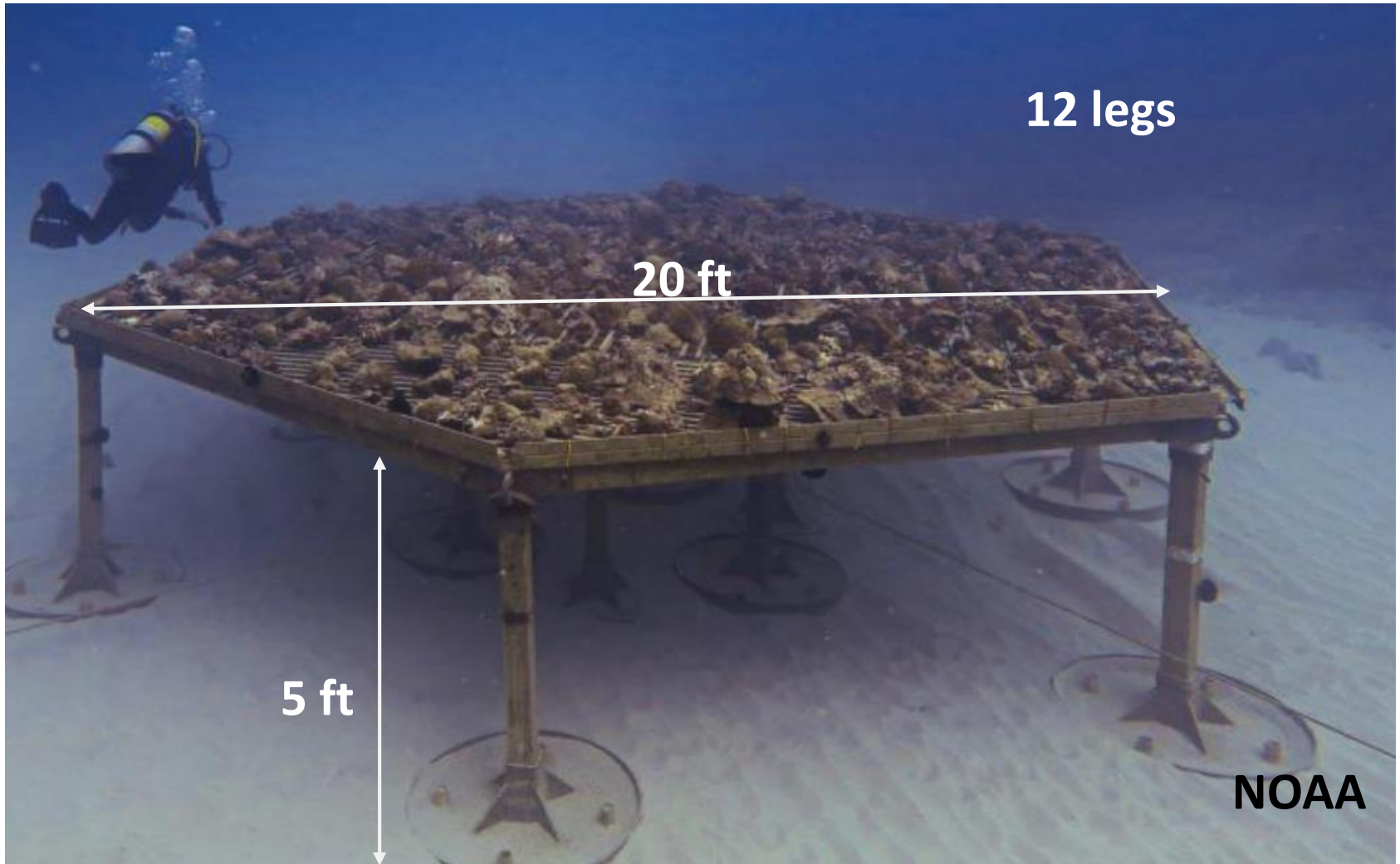


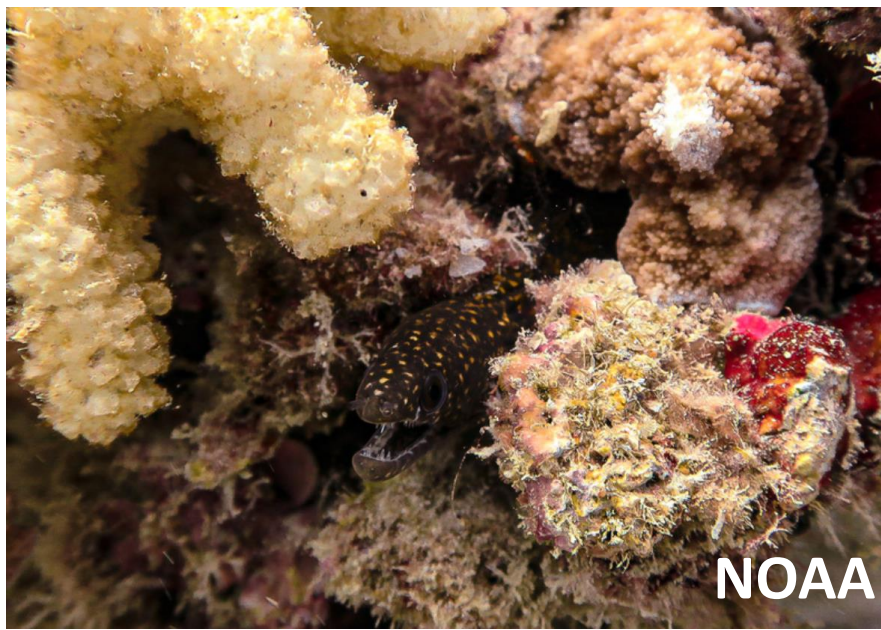
Herbivore populations © TNC



Surviving stress © TNC

Coral Nursery





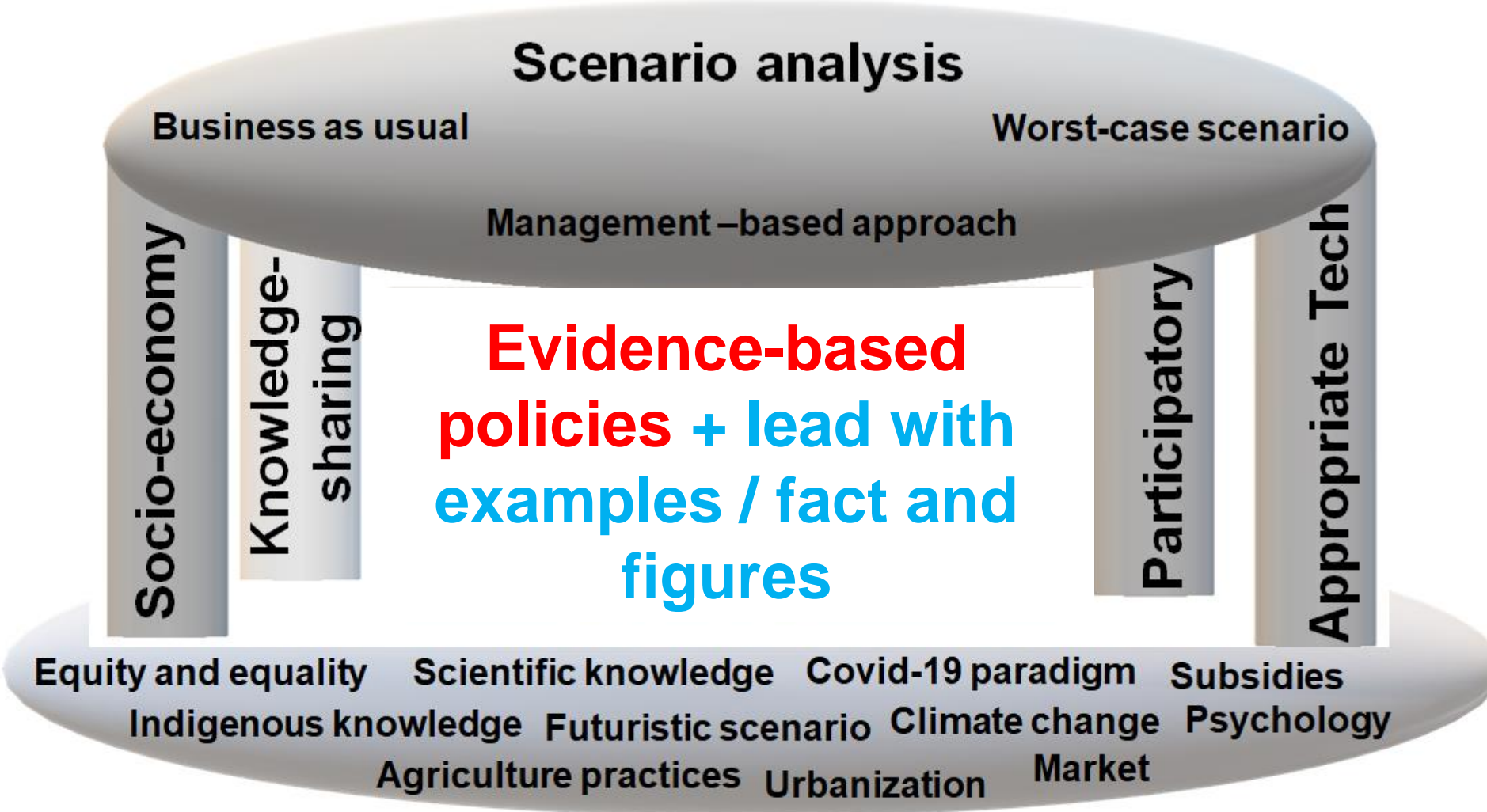
Coral Nursery



© Erich Bartels
Mote Marine Laboratory

Nedimyer's floating tree nursery (R)

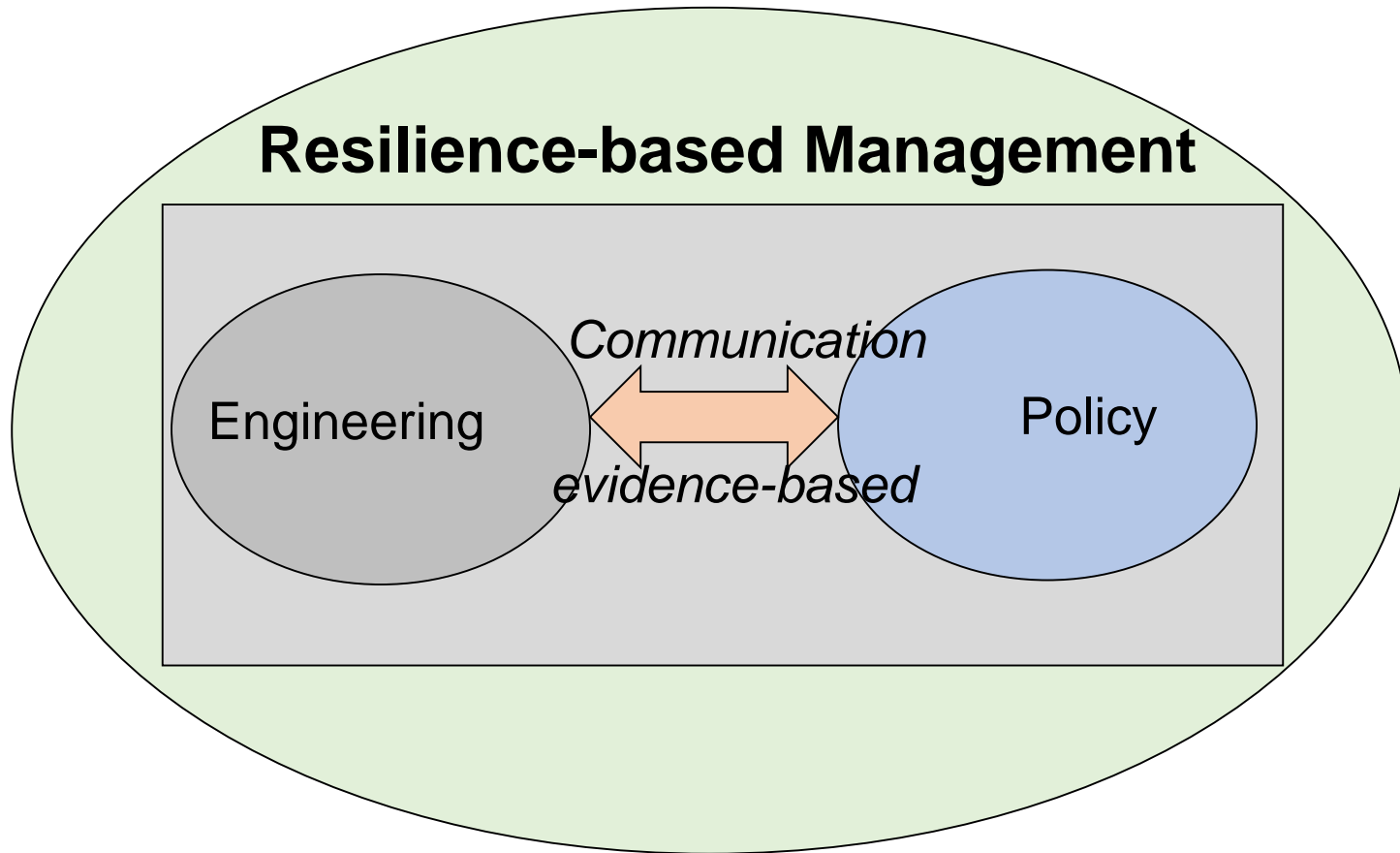
Resilience-based management



Income opportunities, sustainable tourism, sustainable fishing

Socio-economy and ecological approach

Conclusions



Contextualization of knowledge, research, evidence, policy, and economic empowerment

Conclusions

Climate change

- Acidification – CO₂
- Sea level/temperature



Global

Pollution

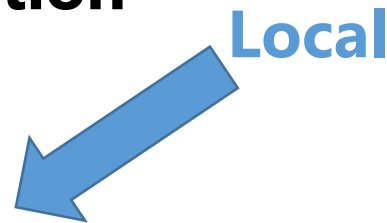
- Chemicals – UV filter
- Nutrient runoff/sedimentation



Global to local

Others

- Disease, invasive species
- Local stress - **tourism, coastal development, anchor, dynamite, (over)fishing, storms**



Local

Presentations at RCChE

- Current Presence and Possible Repercussions of UV Filters in Coral Reef in Okinawa Prefecture
 - Day 1- Session 2: Environment, 15:45 – 16:00 CST
 - <https://us02web.zoom.us/j/86083612136>
- Paradox of over-tourism, income opportunities and coral degradation: A case of Maya bay, Thailand
 - Day 2- Session 2- Environment 10:40-10:55 CST
 - <https://us02web.zoom.us/j/86083612136>
- Comparison of Coral Bleaching Hotspot Mapping in Southeast Asia (Thailand, Cambodia and Vietnam) based on Sea Surface Temperature Modelling by National Oceanic and Atmospheric Administration Coral Reef Watch before and during Covid-19 Pandemic
 - Day 2- Session 2- Environment 10:40-10:55 CST
 - <https://us02web.zoom.us/j/86083612136>

Acknowledgements

APN - Asia-Pacific Network for Global Change Research for funding this project - "Collaborative Research Platform to Manage Risk and Enhance Resilience of Coral Reef in Southeast Asia, CRRP2019-08MY-Khanal"

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