OUTLINE OF THE ECOSYSTEM COMPONENT IN REGIONAL TDA AND INITIAL KEY FINDINGS

Current Status by Habitats

- Mangrove & Wetlands
- Coral Reefs & Seagrass Beds

Distribution map
Area (total SCS compared with the SEA & global, sub-region & countries)
Sub-regions & habitat building species richness
Trend of changes / Habitat degradation and losses
Threats & impacts

Climate change & the consequences to ecosystems

Outline of climate change and consequences to marine ecosystem
Status of Increased SST & coral bleaching SEA
????

Prioritization for biodiversity conservation

The SCS – a high biodiversity basin
Biodiversity hotspots and sensitive areas

- The target sites identified by the SCS Project (UNEP, 2007)
- Updated target site/areas based on ranking of countries of SCS SAP Project

Endemic, Endangered, threatened species
Risk assessment, including economic loss
Protection status

- Map of coastal and marine PAs
- Habitat area under protection
- Management effectiveness

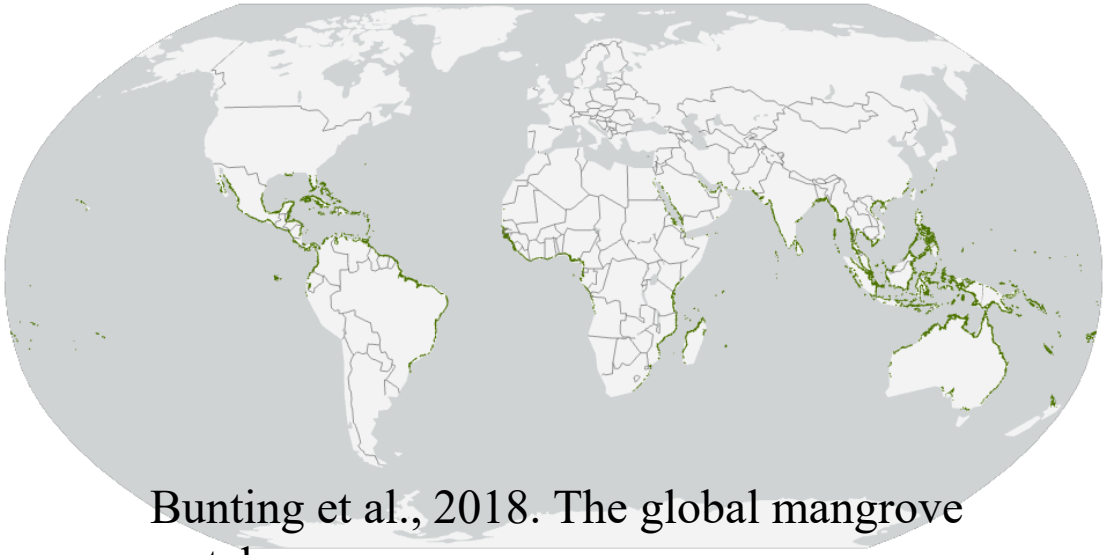
Priority Transboundary Biodiversity Issues

Gaps and priority challenges
Recommended priority actions, including regional cooperation

- Conservation of biodiversity hotspots
- Networking for conservation of migrating species
- Connectivity & MPA ecological network
- Support to resilience to climate change
- ???

Mangrove distribution and area (ha)

Sub-division	Area (ha)	Sources
Guangdong	9,891	National report on mangroves in the SCS (UNEP, 2008)
Guangxi	8,375	
Hainan	3,930	
Quang Ninh – Hai Phong	33,969	
Red river estuary	9.311	
Can Gio	24,592	
Mekong river estuary	81,665	
Cambodia	85,100	
East Thailand	27,981	Talaue-McManus, 2000
West Thailand	20,366	
Pahang	2,482	
Johor	24,679	
Riau-Batam	276,000	
West Kalimantan	40,000	
Sarawak	167,992	
Sabah	365,460	
Palawan	34,853	
Mindoro Occidental	6,201	
West Luzon	10,924	

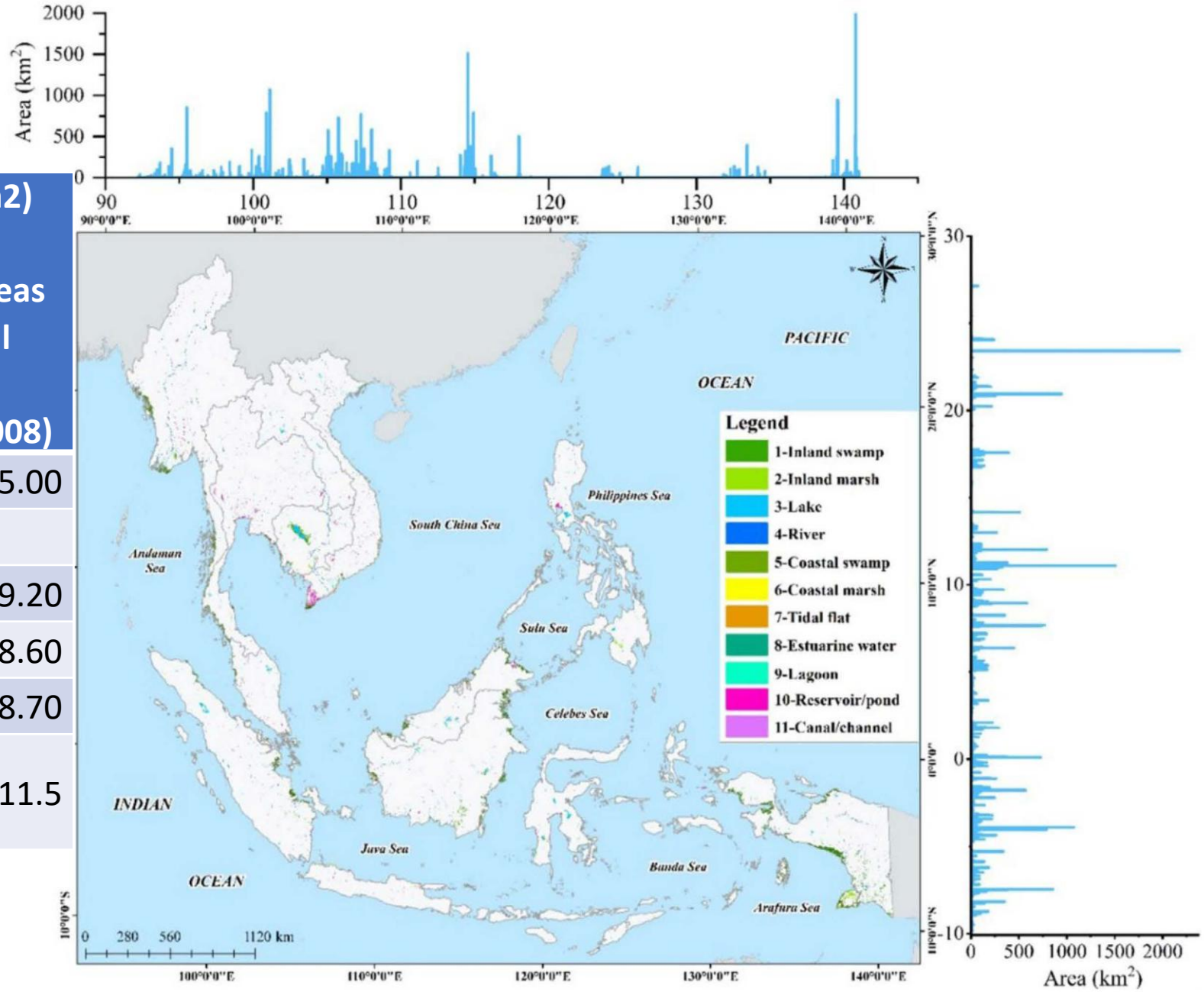


Bunting et al., 2018. The global mangrove watch

Country as the SAP (2008)	**Mangrove area bordering the SCS (in ha, 2008)**
Cambodia	72,350
China	23,446
Indonesia	934,000
Malaysia	532,100
Philippines	28,014
Thailand	62,618
Viet Nam	156,608
Total	1,799,136
World	15,763,000
% world total	11.41

Wetland distribution and area in the Southeast Asia (Yang Liu et al,. 2022)

Wetland type	Area (km2) for coastal wetlands in SEA (Yang Liu et al. 2022))	Area (km2) for SCS target areas of coastal wetland (UNEP,2008)
Coastal swamp	48,002.66	22,705.00
Coastal marsh	2,224.54	
Lagoon	353.75	349.20
Tidal flat	3,078.59	6,918.60
Estuarine water	4,875.24	12,038.70
Total	123,268.61	42,011.5



Area (km2) of coastal wetland types bordering the South China Sea (UNEP, 2008) by countries

Country	Estuary	Lagoon	Peat Sawmp	Non Peatsawmp	Intertidal flat	Total
SCS total	12,038.7	349.2	6,469.3	16,235.7	6,918.6	42,011.5
Cambodia	120.0	45.0	270.5	287.6	48.9	772.0
China	138.7	2.2	-	-	61.9	202.8
Indonesia	7,850.0	-	5,174.5	15,850.0	3,653.3	32,527.8
Philippines	245.2	-	-	-	1,593.0	1,838.2
Thailand	848.1	-	1,024.3	98.1	776.1	2,746.5
Vietnam	2,888.9	302.0	-	-	733.3	3,924.2

Sub-regions & true mangrove species:

True mangrove species in South East Asia: 42

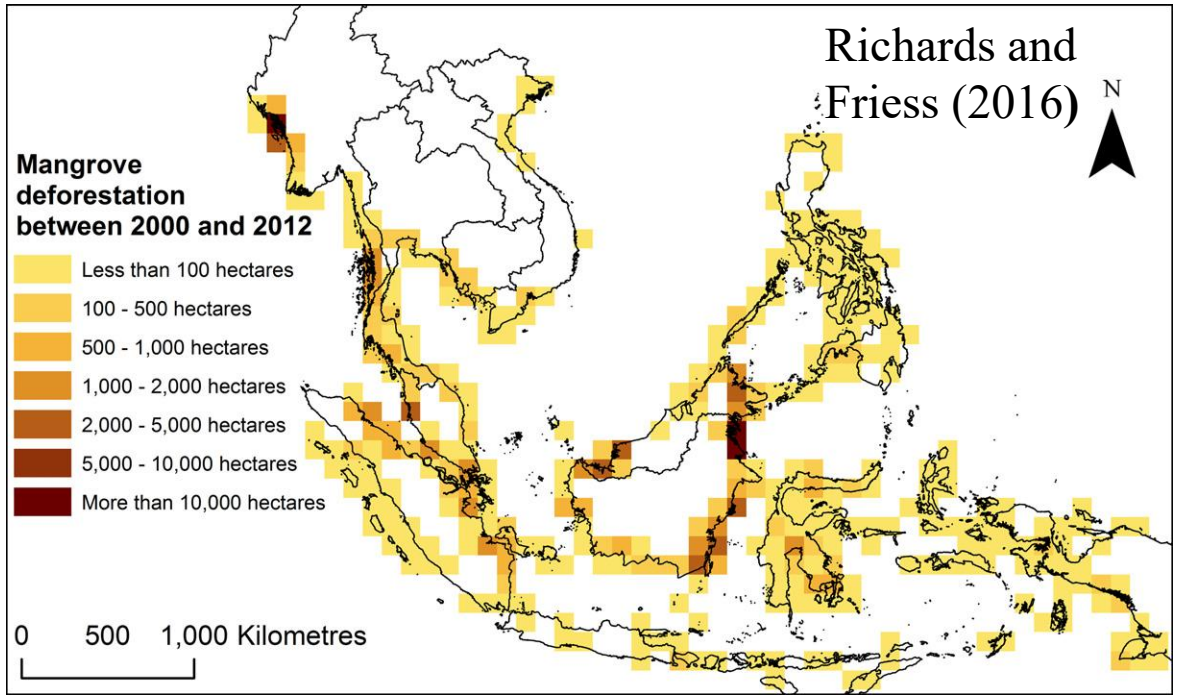
True mangrove species in the SCS by country (National Report, UNEP, 2008)

- Southern China: 28 species
- Vietnam: 37
- Thailand (Gulf of Thailand): 27
- Indonesia (13 provinces bordering/connecting the SCS): 36
- Philippines: 28

Variation of true mangrove species from the north to south along the coast of Vietnam:

- Northeast – 14, North Delta – 16, North Central 18, South Central – 23, South East – 32, Mekong delta – 33 (National Report, UNEP, 2008)

NOT YET AVAILABLE DATA & INFORMATION FROM MALAYSIA & SINGAPORE



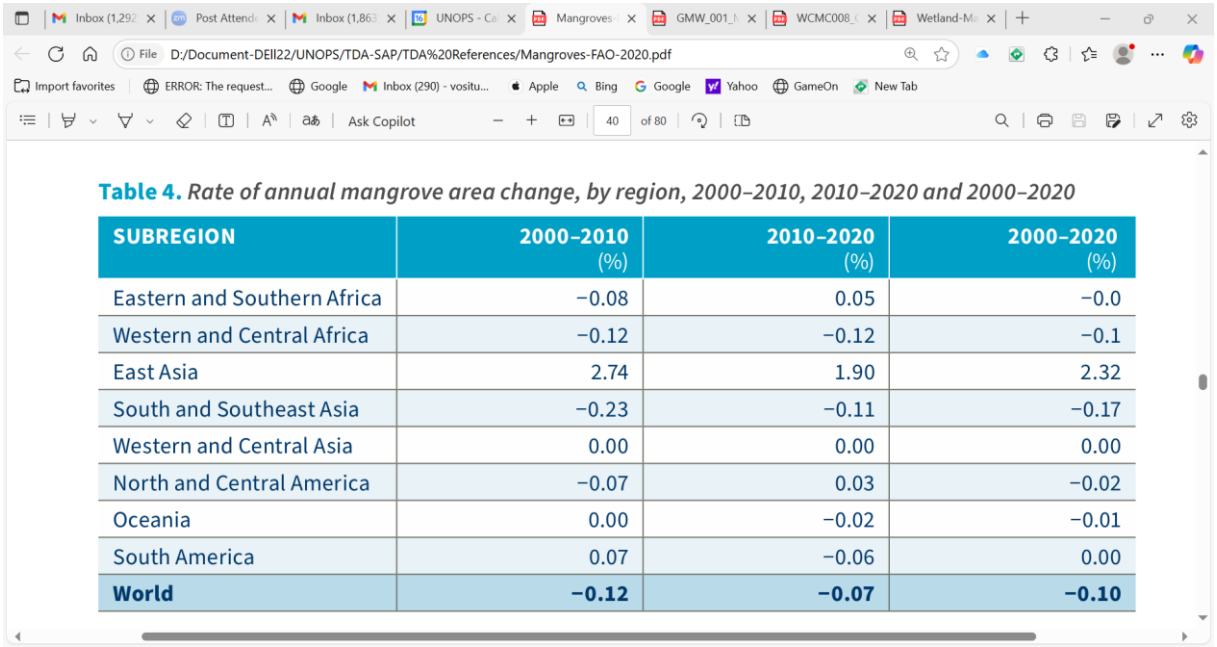


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Table 4. *Rate of annual mangrove area change, by region, 2000–2010, 2010–2020 and 2000–2020*

SUBREGION	2000–2010 (%)	2010–2020 (%)	2000–2020 (%)
Eastern and Southern Africa	−0.08	0.05	−0.0
Western and Central Africa	−0.12	−0.12	−0.1
East Asia	2.74	1.90	2.32
South and Southeast Asia	−0.23	−0.11	−0.17
Western and Central Asia	0.00	0.00	0.00
North and Central America	−0.07	0.03	−0.02
Oceania	0.00	−0.02	−0.01
South America	0.07	−0.06	0.00
World	**−0.12**	**−0.07**	**−0.10**

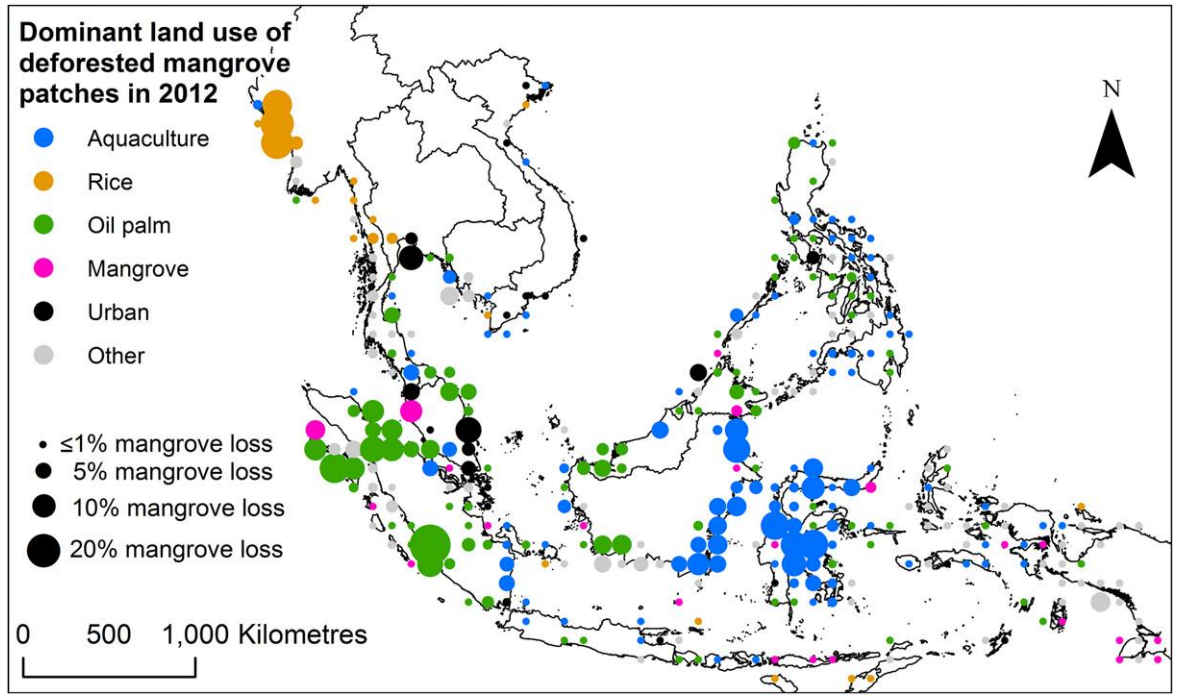
Mangrove degradation and losses

Highest rate of annual decline (-0.17%) in South & Southeast Asia but improved in East Asia (+2.32%)

Most areas in Southeast Asia under deforestation

Main threats for the SCS mangroves

- Aquaculture (all countries)
- Urban development (all countries)
- Oil palm in Malaysia & rice field in Vietnam



Global drivers of mangrove loss, 2000–2020 indicating **sever impact of aquaculture & less impacts from natural disasters** (FAO, 2020)

LOSS OF WETLAND AREAS THROUGH CONVERSION FOR:

Agriculture
Aquaculture
Port and harbour development
Human settlement
Tourist development
Urbanization
Industrialization

Any updated information on loss and degradation of wetlands in the SEA and SCS?

DEGRADATION OF WETLAND ECOSYSTEMS AS A RESULT OF:

Over-exploitation of living resources
Use of inappropriate fishing techniques and gear
Pollution
Deforestation in upland area
Invasive species
Global trends and natural episodic events such as sea level rise, typhoons and tsunami

Overall, it has been estimated that around 30% of coastal wetlands are lost in Southeast Asia each decade giving an approximate annual loss in value of 3% per annum

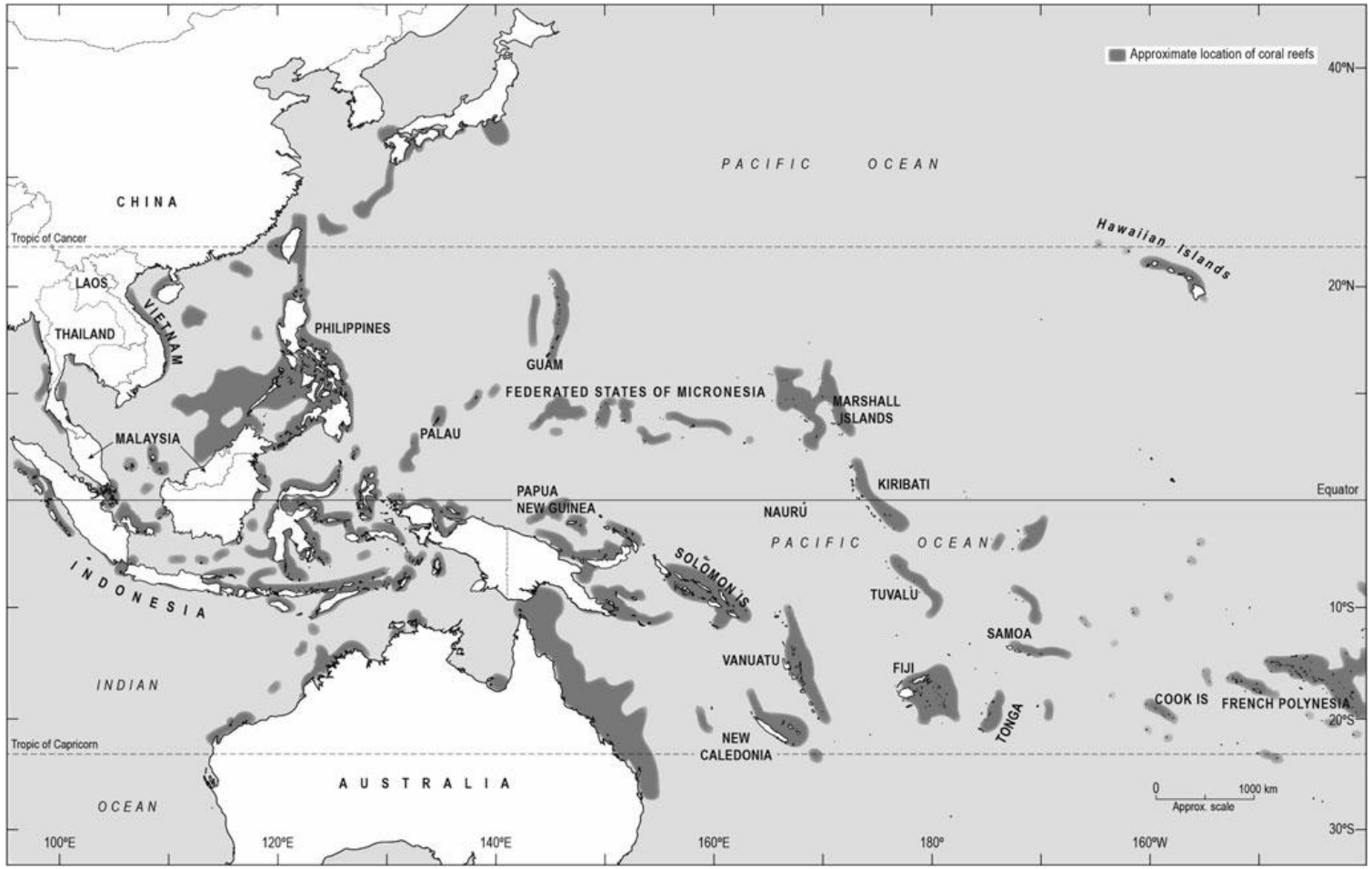
Root causes: Population growth, and urbanisation of the coastal fringe, combined with rapid economic growth in this region (SAP, 2008)

Coral reef distribution and area (ha)

28% of Earth's coral reefs (almost 70,000 sq km) allocated in the South East Asia (Burke et al., 2011)
Approximately 20% of SEA's reefs occurred in the SCS (UNEP, 2004)

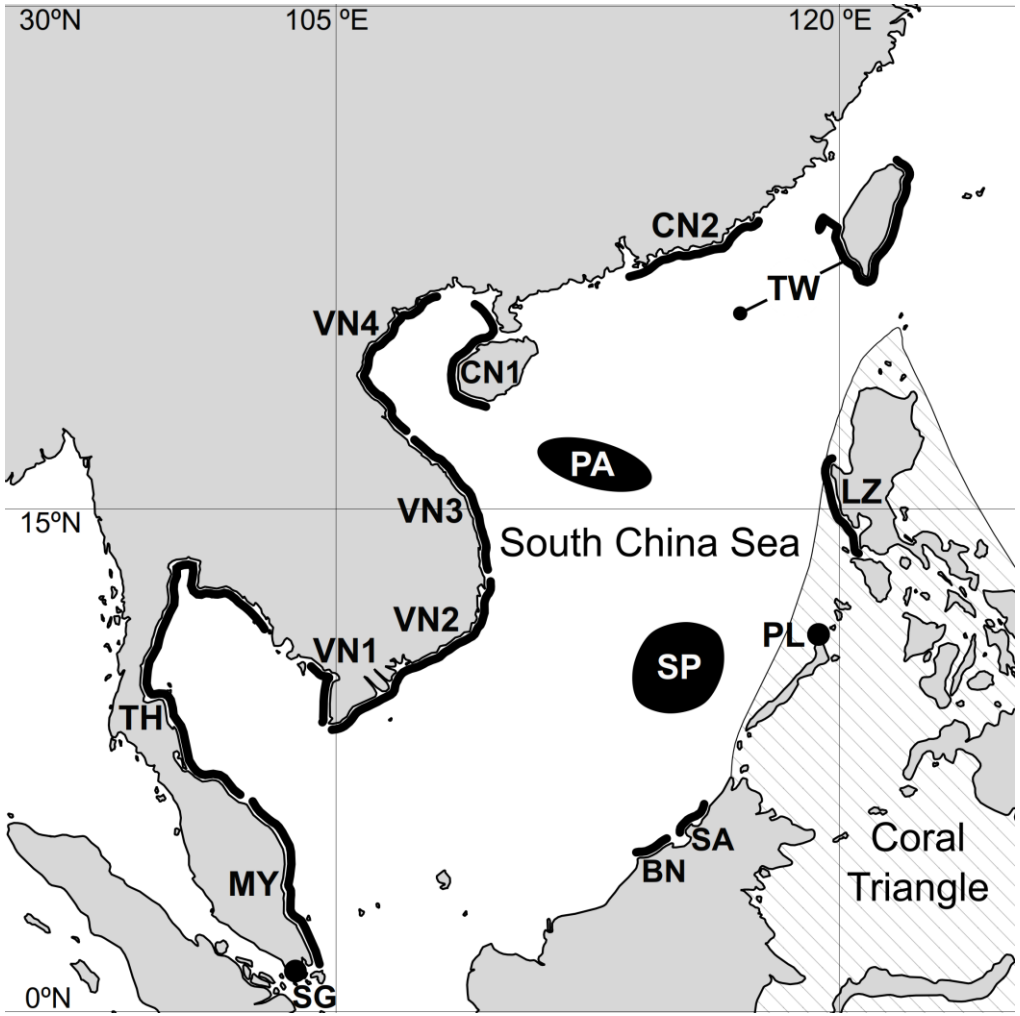
Reef area (ha) in the SCS geographic region (UNEP, 2008 & Sparling et al., ?)	
Brunei	20,000
Cambodia	2,807
Southern China	90,000
Indonesia	39,287
Malaysia	43,411
Philippines	464,000
Singapore	5,500
Thailand	90,000
Taiwan	70,000
Viet Nam	110,000

Total for coastal areas of the SCS	935,005



Code	Areas	Species richness
SG	Singapore	255
MY	West Malaysia (Middle Rocks and eastern Peninsular Malaysia)	398
TH	Thailand	264
VN1	Southwestern Vietnam	251
VN2	Southern Vietnam	**398**
VN3	Central Vietnam	252
VN4	Northern Vietnam	176
PA	Paracel Islands (Paracel Islands and Macclesfield Bank)	201
CN1	Southern China (Weizhou, northwest Hainan, Sanya and Xuwen)	102
CN2	Southeastern China (Wanshan Islands, Hong Kong and Dongshan)	95
BN	Brunei	**391**
SA	Western Sabah (Labuan, Pulau Tiga and Kota Kinabalu)	248
SP	Spratly Islands	333
PL	Northern Palawan (El Nido)	**398**
LZ	Western Luzon (Batangas, Bolinao and Anda)	**433**
TW	Taiwan (Taiwan and Pratas Islands)	316

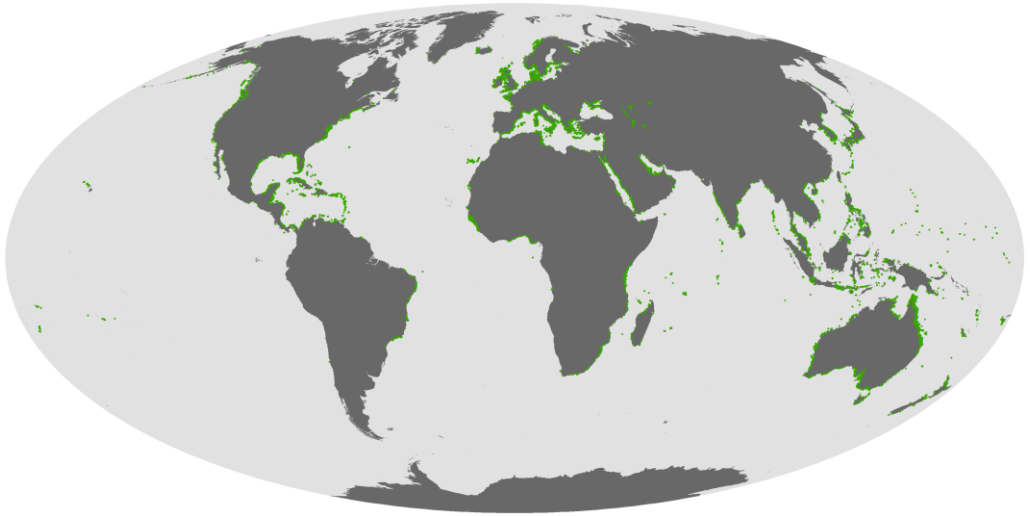
Coral reef sub-ecoregions & hard coral species richness (source: Danwei et al., 2015)



Seagrass distribution and area (ha)

Regional compared with global area:

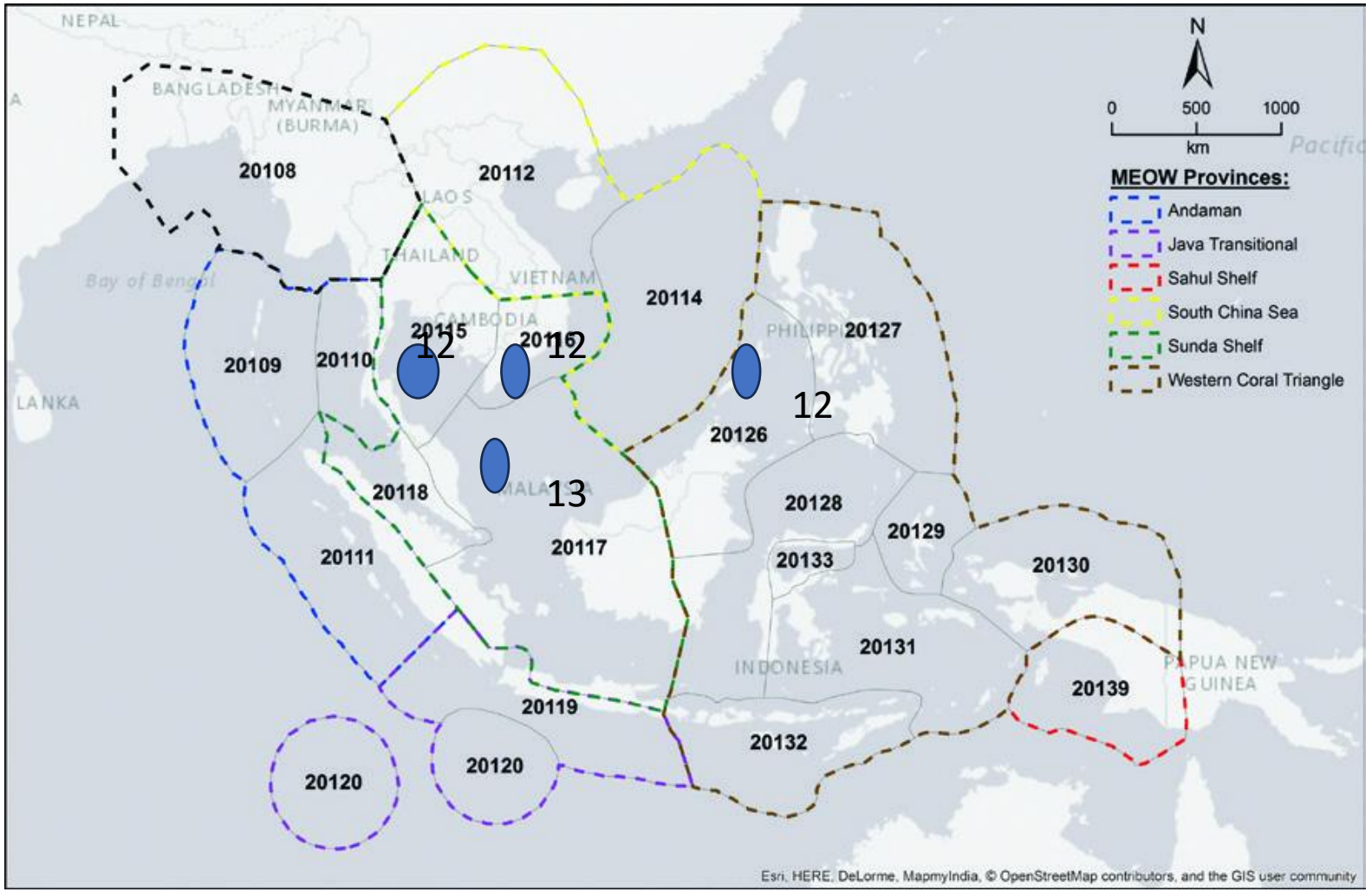
- UNEP-WCMC, Short FT (2021): 321,681.5 km^2 of seagrass beds in total of the world
- SCS Seagrass occupies only 2.5% of the world
- Differences in the area values in the SEA due to resolution image in using remote sensing technique or study scale



Area (km2) of seagrass beds	SEA (Sudo et al., 2021)	SEA (GDS - UNEP-WCMC)	SEA (Fortes et al.,2018)	SCS SAP for only SCS (UNEP, 2008)
Brunei Darussalam	1.5	NA	1.5	NA
Cambodia	229.8	NA	324.9	338.14
Southern mainland China	71.4	7,584	NA	19.68
Indonesia	2,934.6	17,597	8,812.9	33.05
Malaysia	49.0	541	16.3	2.22
Philippines	82.1	14,923	27,262.2	232.45
Singapore	2.0	127	0.3	NA
Thailand	189.9	1,813	148.5	25.53
Vietnam	157.5	216	157.4	135.03
Total	3,717.8	42,801	36,724	786.1

The species richness of seagrasses (Fortes - Botanica Marina 2018):

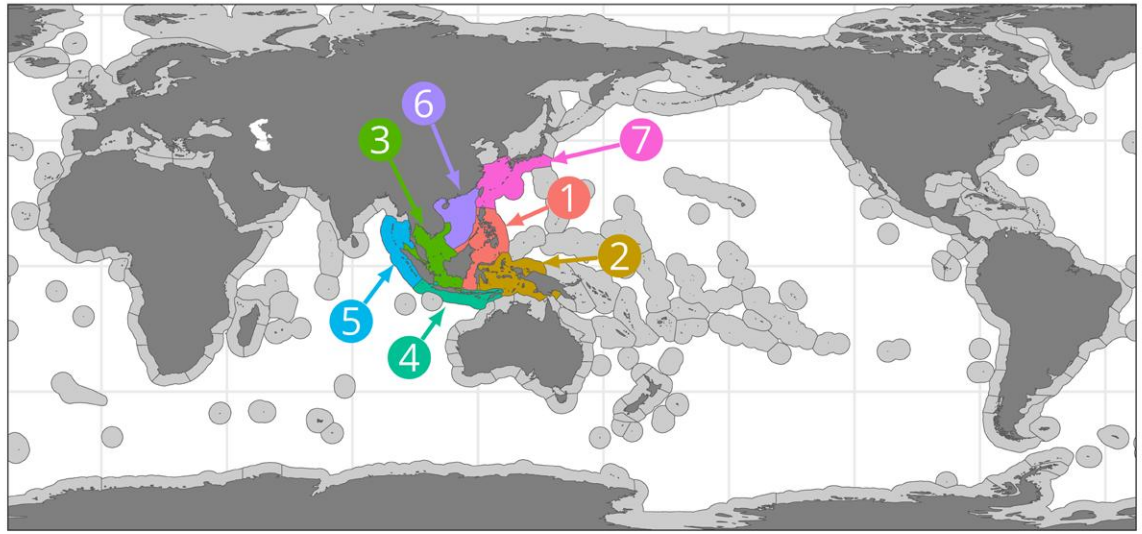
- At the province level - highest in the Sunda Shelf and Western Coral Triangle (15 species).
- At the ecoregional level - highest in Gulf of Thailand, Southern Vietnam, Sunda shelf/Java Sea and Palawan/North Borneo with recoded 12-13 spp.



Seagrass eco-regions a & seagrass species richness

In total: 18 species in the SCS compared with 60 in the world (SAP, 2008)

Marine provinces and ecoregions of Southeast Asia, based on Spalding et al. (2007). Provinces are made out of ecoregions with the following codes:
20108 Northern Bay of Bengal; 20109 Andaman and Nicobar Islands; 20110 Andaman Sea Coral Coast; 20111 Western Sumatra; **20112 Gulf of Tonkin; 20114 South China Sea Oceanic Islands; 20115 Gulf of Thailand; 20116 Southern Viet Nam; 20117 Sunda Shelf/Java Sea**; 20118 Malacca Strait; 20119 Southern Java; 20120 Cocos-Keeling/Christmas Island; **20126 Palawan/North Borneo**; 20128 Sulawesi Sea/Makassar Strait; 20129 Halmahera; 20130 Papua; 20131 Banda Sea; 20132 Lesser Sunda; 20133 Northeast Sulawesi; 20139 Arafura Sea.

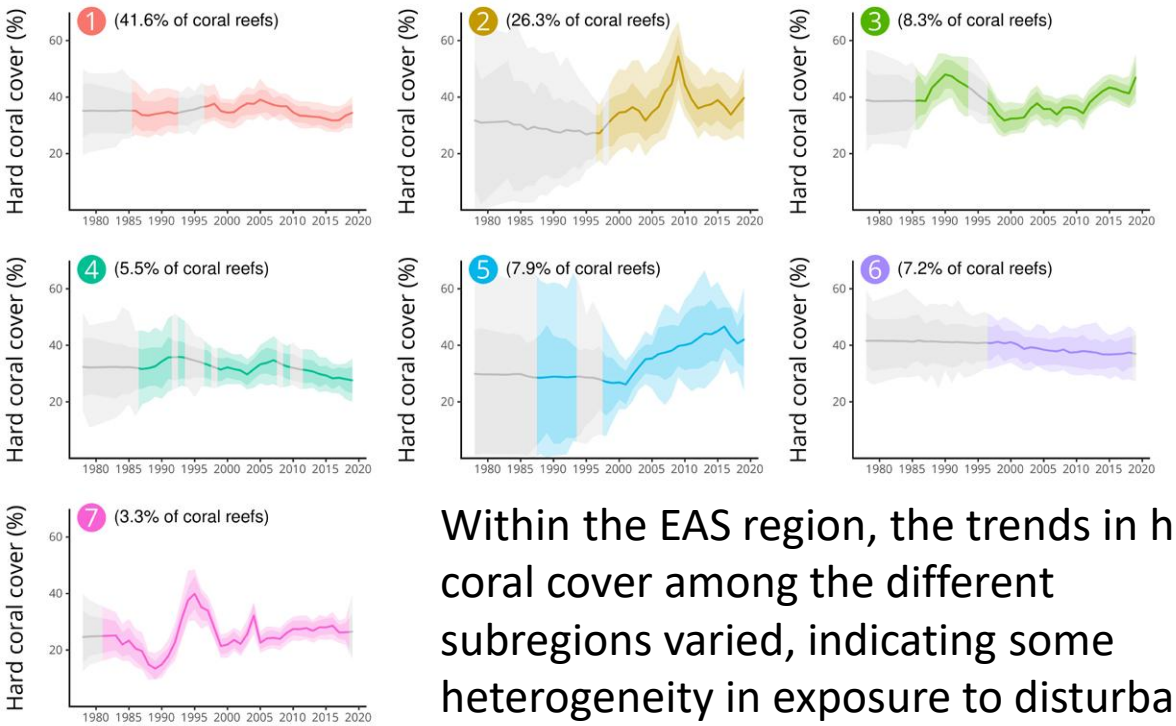


Status and trends of changes of coral reefs in the SCS

Remained stable in hard coral cover but reef degradations occurred, reflecting in:

- Changes of reef communities during recovery after damages by human impacts and coral bleaching
- Reduction in reef biodiversity & fishery resources by illegal fishing, overfishing, sedimentation & coral bleaching
- Loss and/or decline of endangered & threaten species
- Loss of reef area by reclamation/landfills

Root causes: Coastal development, blooms of marine tourism, extensive fisheries for market demands



Within the EAS region, the trends in hard coral cover among the different subregions varied, indicating some heterogeneity in exposure to disturbance and subsequent recovery.

(**Status of Coral Reefs of the World: 2020**)

For the SCS, average hard coral cover in subregions 1,3 show considerable fluctuations and subregion 6 remained stable

Substantial decreases in algal cover were evident in subregions 1 and 3. Algal cover in subregion 6 remained relatively constant throughout.

Threats to coral reefs ranking by the SCS Project (UNEP, 2008)

	Cambodia		Indonesia		Malaysia		Philippines		Thailand		Viet Nam		Region
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Weighted Score
Direct threats													
Over-fishing	1	0.4	1	5.2	5	29.0	1	61.9	7	84.07	1	14.69	195.2
Destructive fishing	2	0.7	2	10.5	2	11.6	2	123.8	5	60.05	2	29.38	236.1
Sedimentation	5	1.9	4	21.0	1	5.8	3	185.7	4	48.04	3	44.04	306.4
Pollution (Eutrophication)	4	1.5	5	26.2	4	23.2	5	309.6	6	72.06	4	58.72	491.2
Coral bleaching	8	3.0	3	15.7	7	40.5	9	557.2	1	12.01	5	73.4	701.8
Indirect threats													
Unsustainable fisheries and aquaculture	3	1.1	8	41.9	9	52.1	4	247.6	8	96.08	8	117.4	556.3
Coastal development	6	2.2	7	36.7	6	34.7	6	371.5	3	36.03	6	88.08	569.2
Unsustainable tourism	9	3.3	9	47.2	3	17.4	8	495.3	2	24.02	9	132.1	719.3
Deforestation on upland areas	7	2.6	6	31.4	8	46.3	7	433.4	9	108.09	7	102.8	724.6

Threats to coral reefs in SEA identified by Reef at Risk (Burkle et., 2011)

- Overfishing
- Destructive fishing (poison & blast fishing)
- Sedimentation & pollution
- Coastal development as a growing threat
- Coral bleaching

Overall results. The reefs in this region are the most threatened in the world. About 95 percent are at risk from local threats, with almost half in the high and very high threat categories. The few places that are in the low-threat category are located in the more sparsely populated eastern areas.

Reviewed by Morrison & Aalbersberg (2022):

- Human activities threatening coral reefs in all or most countries in the SE Asian and Pacific Island region, including: small scale & commercial fisheries; small scale and extensive tourisms; construction of ports, resorts, roads and groynes; coastal agriculture & aquaculture; coastal shipping; mining and military activities.

- Impacts to coral reefs: • Direct reef damage and losses & mortality of corals, invertebrates and fish • Sedimentation • Hydrodynamic changes • Biodiversity change • Mechanical damage • Pollution by sewage • Eutrophication • Chemical discharge • Anchoring & walking on corals • Hazardous substances (including plastics) into reef system • Live corals removal • Hazardous substance and toxic use • Blast damage in limited areas

Threats – Impacts – Ecological consequences

Threats to seagrass bed in the SCS indicated in the SAP adopted 2008 (UNEP, 2008) & the number of literatures (peer-reviewed/non-peer-reviewed scientific papers and reports) reporting drivers responsible for the decline of seagrass beds (Sudo et al., 2021)

Reviews by Sudo et al., 2021 indicated that:

- Decline mostly caused by coastal development, followed by aquaculture activities, destructive fishing, and water quality deterioration
- More seagrass beds declining in Vietnam & southern mainland China, may be ascribed to coastal development
- Most seagrass beds stable or even increasing along the coast of Thailand may reflect a natural recovery from the catastrophic disturbance

Comparison with 2008

	Ranking of threats in the SCS (UNEP, 2008)	Number of literatures reporting drivers responsible for the decline of seagrass beds (Sudo et al., 2021)			
		Southern mainland China	Thailand	Vietnam	South East Asia
Destructive fishing such as push net, trawler	1	1	6	3	10
Sedimentation from coastal development	4		2	3	6
Waste water effluent/water quality	3		2	3	8
Nutrients	6				
Coastal construction /development	5	4	6	3	19
Over-fishing	2				
Aquaculture		6	2	6	14
Tourism		1	1	2	4
Shipping				2	3
Mangrove plantation		1			1
Natural factors			10	2	16

Climate changes & their consequences to ecosystems

Rising Temperatures
Ocean Acidification
Sea Level Rise
Extreme Weather Events (typhoon, coastal & river flooding)

Consequences to marine habitats

- Coral bleaching
- Hypoxia – mass mortality of living features
- Physical damages
- Cumulative impacts with anthropogenic stressors
- Adaptation & resilience

POUR EVIDENCES, SOME ON BLEACHING

Emergent ecological responses
[*https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1280&context=bio_fac]*
Distributional shifts: zonation patterns
Distributional shifts: biogeographical ranges
Changes in species composition, diversity and community structure
Changes in primary and secondary production
Population dynamics and evolution

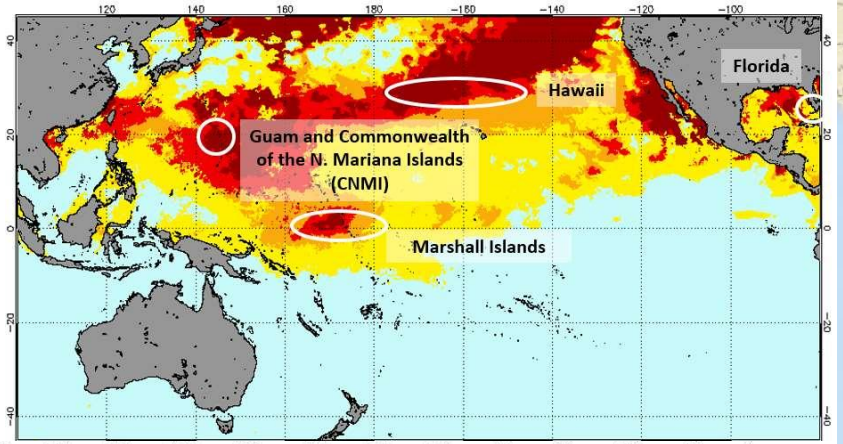
Marine & Coastal Ecosystems Caribbean	RESPONSE VARIABLE CATEGORIES	CLIMATE CHANGE Warming / heat waves	Extreme weather events	Atmospheric CO_2 concentration	Ocean acidification	Sea level rise	Salinity (hyper)	Cooling	Rainfall regimes (reduced)	Inundation
 CORAL REEFS	Density/Abundance	20%	25%		4%					
	Distribution									
	Growth	10%	8%		32%	20%				
	Habitat structure	21%	42%		18%	80%				
	Metabolism	6%			7%					
	Photosynthesis/Respiration	9%			18%					
	Reproduction	14%	8%		14%					
	Other	19%	17%		7%					
	Total number of studies	**78**	**12**		**28**	**5**				
 MANGROVE FORESTS	Density/Abundance	7%	17%			8%	16%	63%	21%	
	Distribution	10%				23%			7%	
	Growth	46%	22%	100%		54%	50%	5%	36%	67%
	Habitat structure	2%	22%					16%	36%	
	Metabolism	5%				15%	8%			
	Photosynthesis/Respiration	29%	28%				26%	16%		33%
	Reproduction		11%							
	Other									
	Total number of studies	**42**	**18**	**15**		**13**	**39**	**19**	**14**	**9**
 SEAGRASS BEDS *Thalassia testudinum*	Density/Abundance	20%	33%				20%			
	Distribution	20%	67%			100%				
	Growth	20%					20%			
	Habitat structure									
	Metabolism	20%					20%			
	Photosynthesis/Respiration	20%					40%			
	Reproduction									
	Other									
	Total number of studies	**5**	**3**			**1**	**10**			

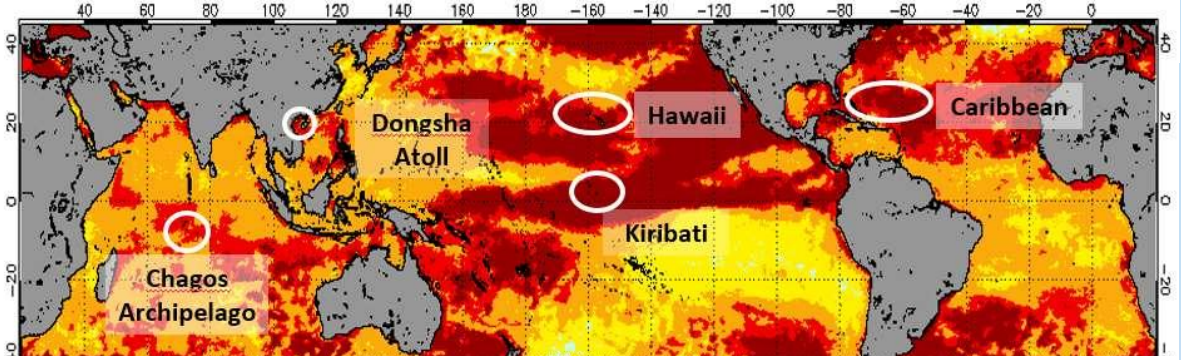
Response Legend — Fully / Mostly Negative; Fully / Mostly Positive; Fully / Mostly Neutral; Fully / Mostly Unclear; Mixed; Not tested

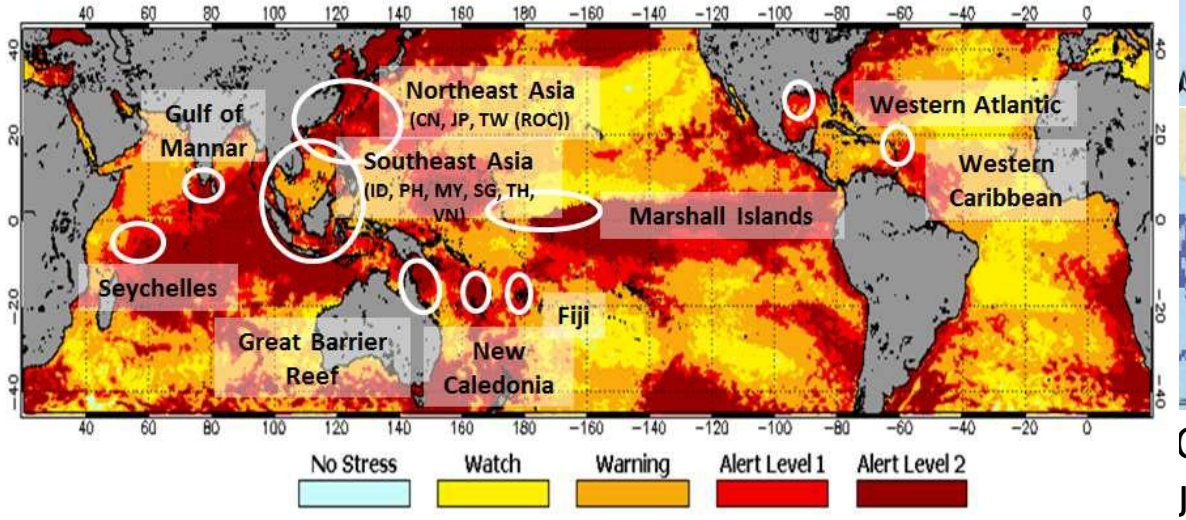
Ewan Tregaross, 2024 (Biology Conservation

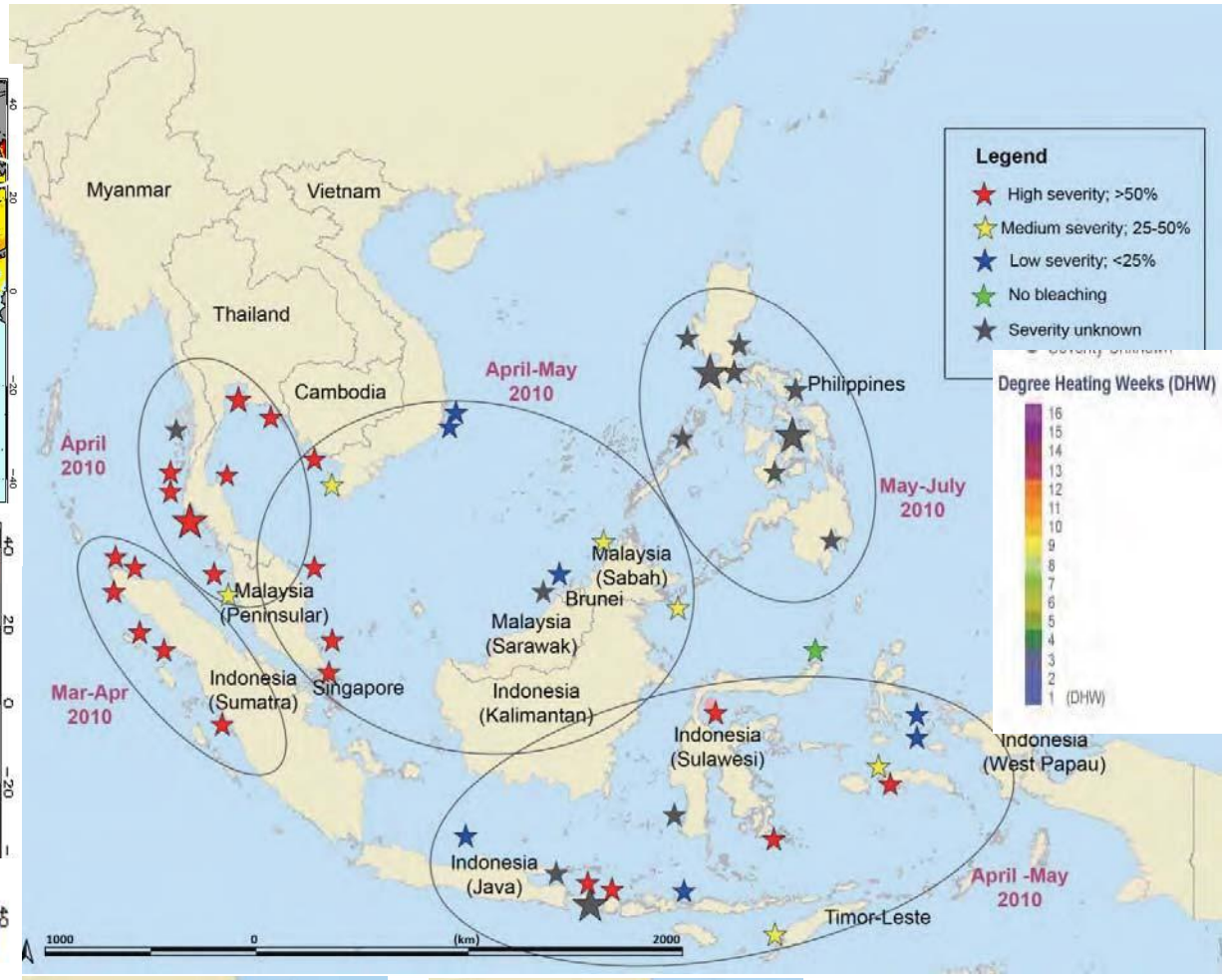
Increased SST and coral bleaching

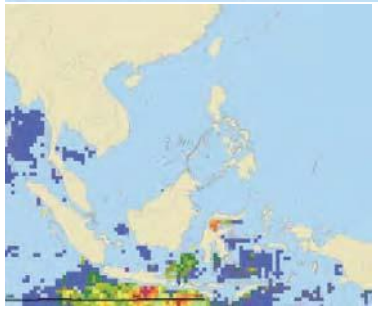
NOAA Coral Reef Watch Maximum Bleaching Alert Area map for 2014, 15, 16. Marked are the areas where bleaching observed

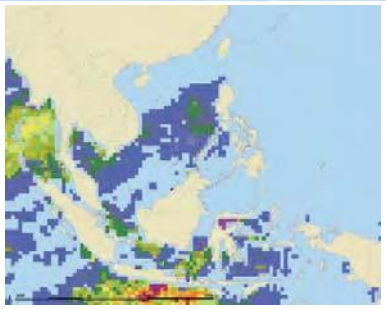


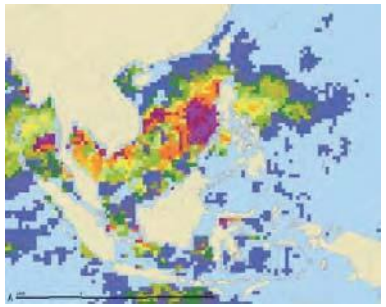












Coral Bleaching Degree Heating Week (DHW) for April, May & July, 2010

Bleaching events by eco-regions bordering the SCS

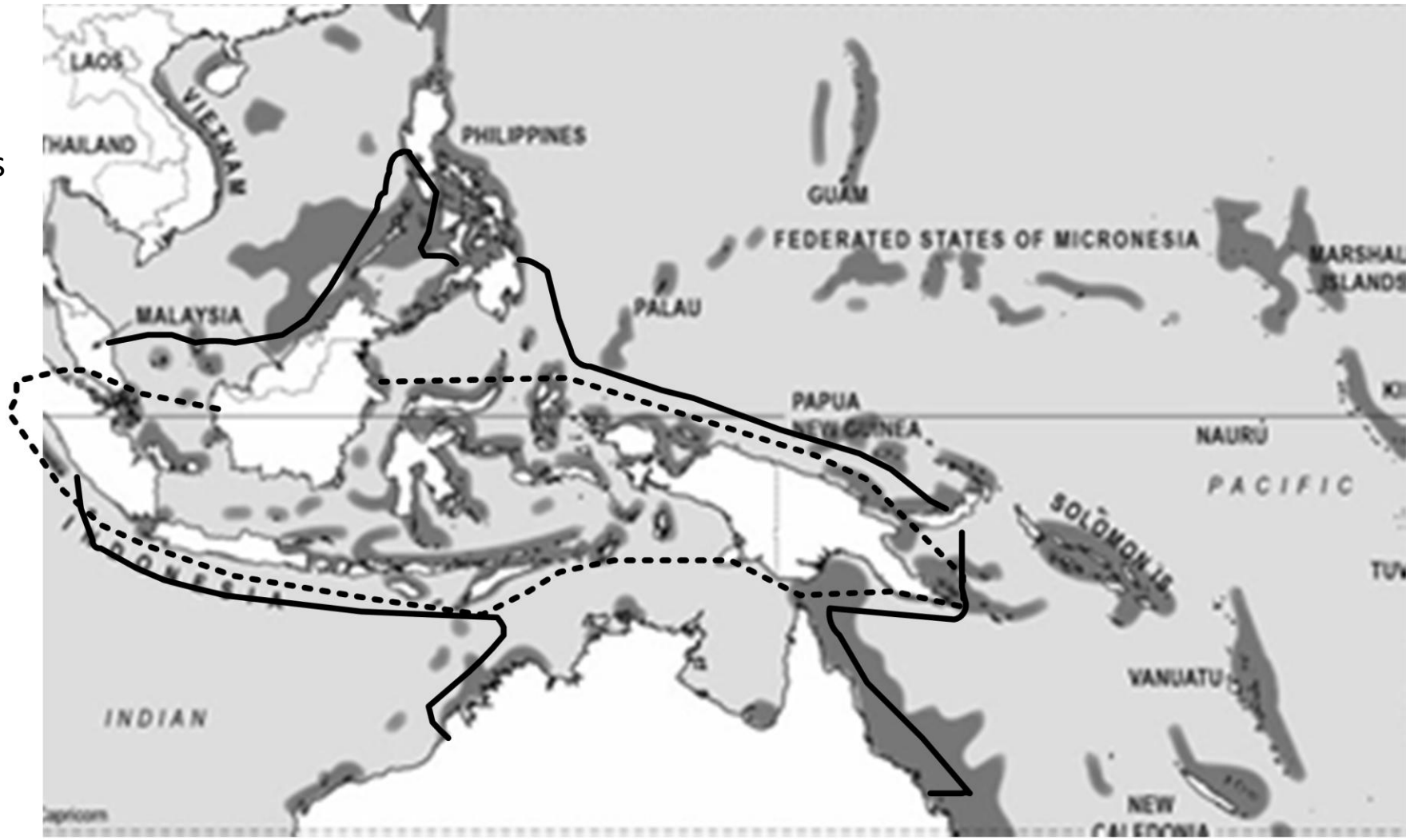
[Susceptibility levels: minimal (<5% bleached), moderate (5-30% bleached), severe (>30% bleached)

Eco-region	1st Global 1998	2nd Global 2010	3rd Global				Regional 2019	4th Global 2024
			2014	2015	2016	2017		
Taiwan								
Southern China								
Northern & central Vietnam								
South Vietnam								
Southwestern Vietnam								
Thailand								
West Malaysia								
Singapore								
Brunei								
Western Sabah								
Northern Palawan								
Western Luzon								

Prioritization for biodiversity conservation

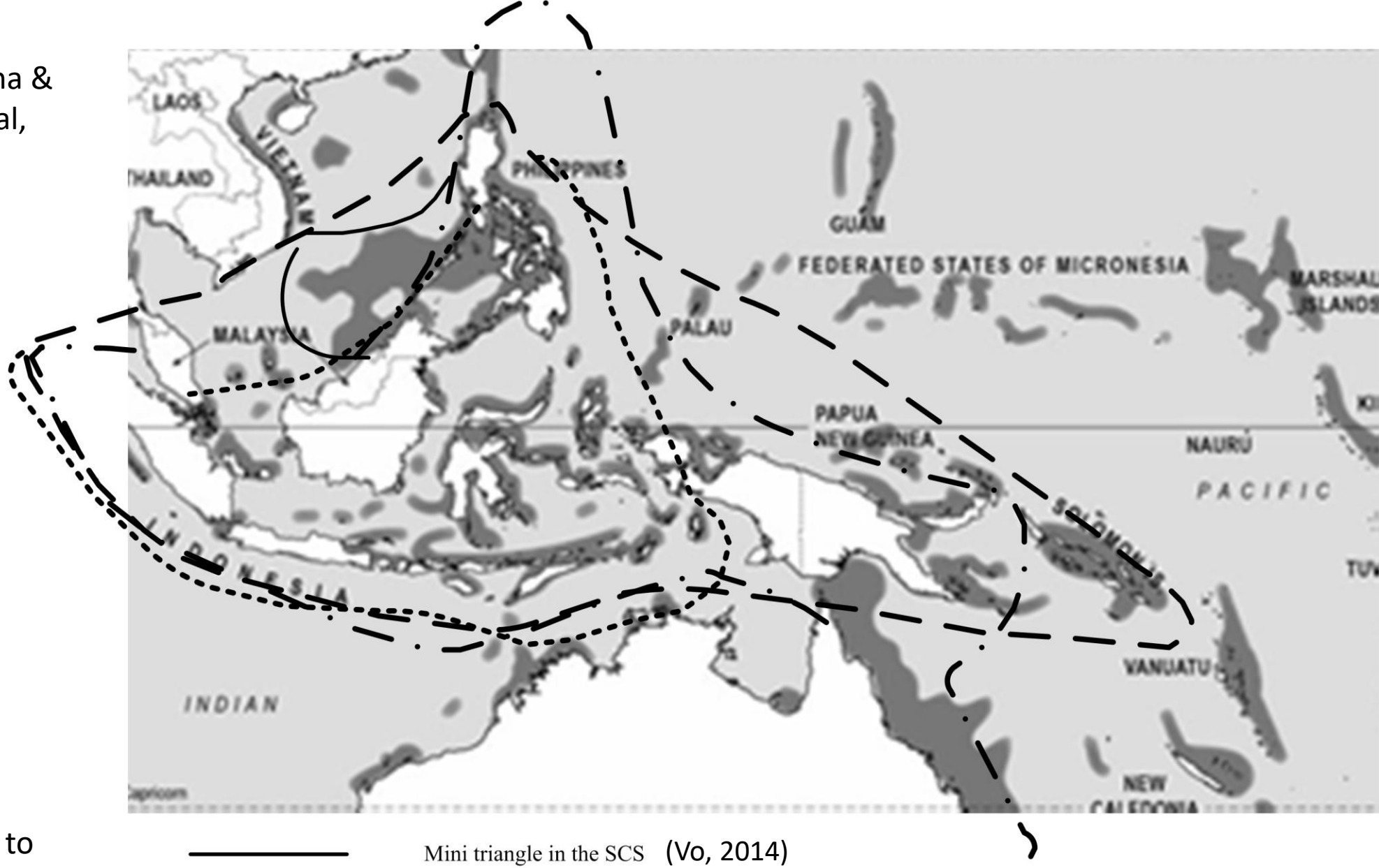
The SCS – a high biodiversity basin

Reviews on diversity of mangroves and wetlands in the SEA &SCS



The southern part of the SCS belonging to diversity centers of mangroves and seagrasses in the world

Reviews on diversity of fauna & flora in the SCS (Danwei et al, 2015 for CRs, others?)



A part of the SCS belonging to various diversity centers of reef corals in the world

Biodiversity hotspots and sensitive areas

The target sites identified by the SCS Project (UNEP, 2007)

- 26 mangrove sites;
- 43 coral reef sites;
- 26 seagrass sites;
- 40 wetlands sites (15 estuaries; 12 inter-tidal mudflats; 7 coastal lagoons; and 6 swamp forest sites)

Requests for inputs from countries for: (**no feedback until now**)

- Hotspots of biodiversity (target habitats, species diversity, migrating species, source & sink)
- Socio-economic & management importance
- Risk assessment (based on threats & impacts)
- Risks to economic sectors, including economic loss
- Consequence of and resilience to climate changes

Ranking based on scoring critical indicators at the site/local level

Biodiversity significance (scoring 0,1,2, 3 for none and the lowest to highest significance under each indicator)

Site name & its coordinates	Total area (<1000, >1000 – 20,000 & >20,000ha)	MG area (<500, >500 – 10,000 & >10,000ha)	Tidak flat area (<500, >500 – 10,000 & >10,000ha)	SG area (<500, >500 – 2000 & >2000ha)	MG true species richness (<10, >10-15, >=15)	Migrating species (1, 2-3 & >3 spp.)	Source & sinks (based on spawning, nursery grounds & circulation)	Ranking (total score)

Socio-economic importance & management issues (scoring 0,1,2, 3 for none and the lowest to highest importance/priority under each indicator)

Site name & its coordinates	Fisheries	Tourism	Potential use	Economic valuation	Management approach	Protection status	National priority	Ranking (total scores)

Risk assessment (scoring 3,2,1,0 for high, medium, low or none risk respectively)

Site name & its coordinates	Overfishing	Illegal fishing	Sedimentation Eutrophication	Uncontrol tourism	Landfills	Habitat loss	Community change	MG cover decline	Ranking (total scores)

Consequences of climate changes since 2010

Site name & its coordinates	Risk to sea level rise (high, medium, low)	Typhoon (year / impact level (high, medium, low)	Flooding (years / impact level (high, medium, low)	Recovery/ adaptation after events (excellent, good, bad)	Remarks on susceptibility & resilience

Economic valuation

Values of habitat goods and services

Outputs of the SCS Project – Values of annual production in the SCS (SAP, UNEP, 2008)

	Area ha	US$/ha	Total US$
Mangroves	1,799,136	2,872	5,167,568,376
Coral reefs	750,307	1,542	1,157,393,566
Seagrass	73,769	1,181	87,164,713

Cost benefit analysis - SAP costs compared with value of annual production saved

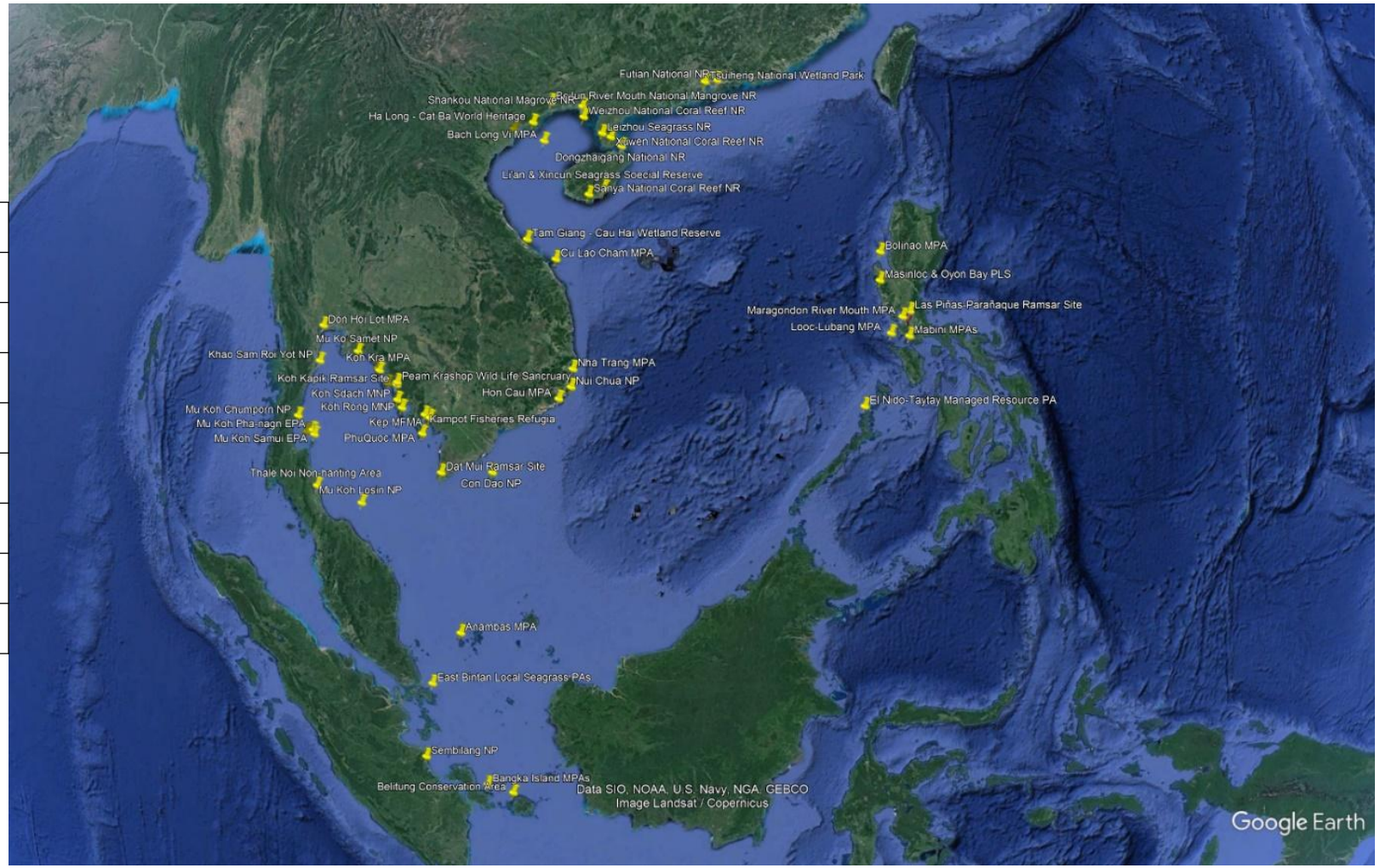
- Mangroves 2.99 million US dollars compared with 5.1 billion US dollars of annual production;
- Coral reefs 3.96 million US dollars compared with 1.1 billion US dollars of annual production;
- Seagrass 1.58 million US dollars compared with 87.2 million US dollars of annual production;
- Wetlands 5.99 million US dollars compared with 1.2 billion dollars of annual production

Updated data and information on economic valuation (**waiting inputs from countries and RTF-EV**)

Mapping coastal PAs at all categories
Description of PAs (total area, area of mangroves, tidal flats, seagrass, coral reefs, categories and management authorities)
PAs management effectiveness
Recent & future MPA network

Protection status (additional inputs from country reports required)
[Recent figure based on the achievement reports in implementing the SAP 2008-2021 and PCA/GSA documents]

Habitat related	**No. PAs**	**Habitat area**
Mangroves	22	145,129.2
Coral reefs	31	71,608.7
Seagrass beds	17	17,547.2
Estuaries	7	381,517.0
Swamps	3	119,708.0
Lagoon	3	9,107.6
Intertidal flats	4	43,852.8
Total	**82**	**788,470.5**

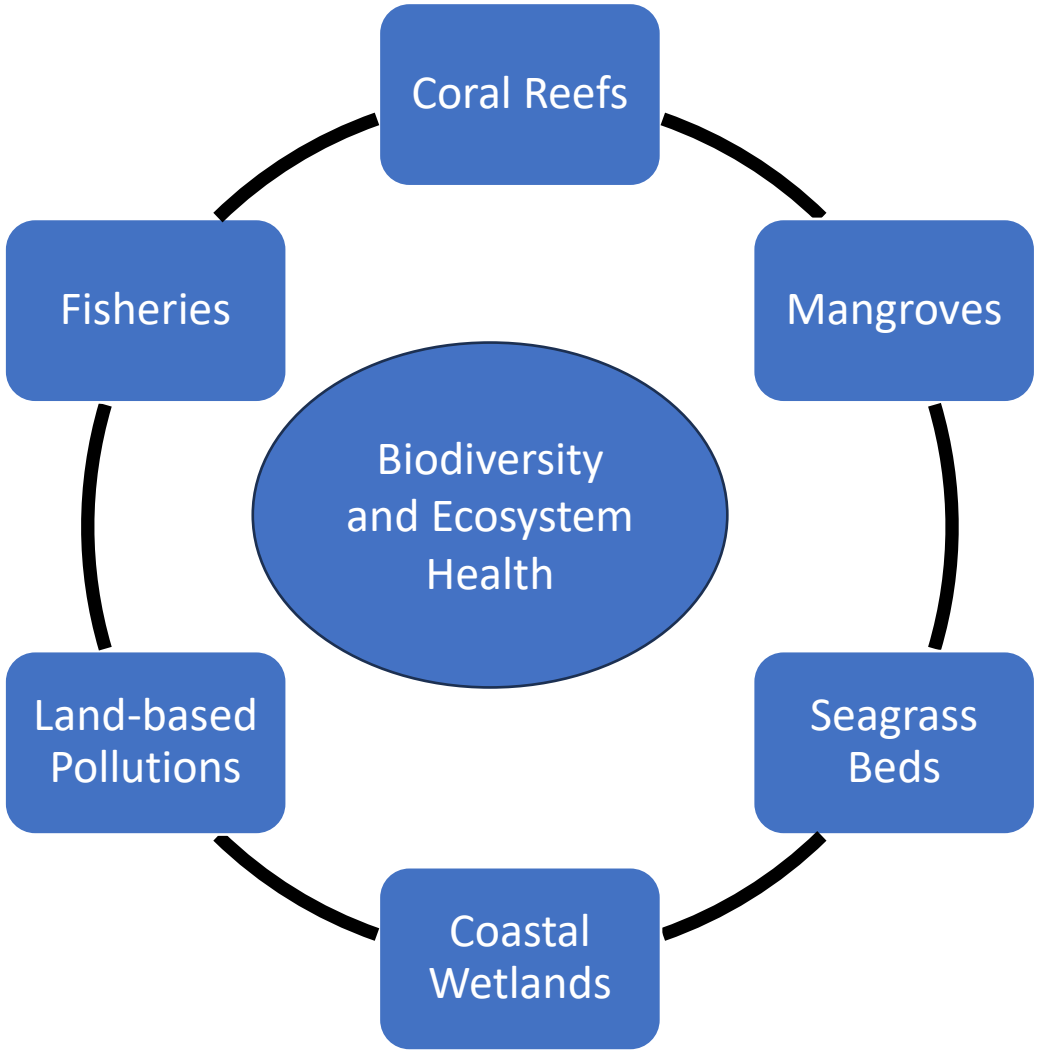


Policies and institutional arrangement
[Integrating with the governance component]

Priority Transboundary Biodiversity Issues
Habitat losses
Local extension of species
Reduction of species richness
Declines of living resources – fishery trading
Impacts of transboundary pollution
Habitat related transboundary tourism
Migrating species
Resilience to anthropogenic threats and climate change

Gaps and priority challenges
Recommended priority actions, including regional cooperation

- Conservation of biodiversity hotspots
- Networking for conservation of migrating species
- Connectivity & MPA ecological network
- Support to resilience to climate change
- ???



SITE/AREA DATA & INFORMATION NEEDED

REQUIRED ADDITIONAL DATA AND INFORMATION FOR THE REGIONAL TDA

Trend of changes / Habitat degradation and losses	***Losses of habitats***: name of locality, habitat area (ha, km2), when, impact ***Habitat degradation***: trend of change of cover, density, area and causes; evidence of community changes, decline of living resources
Outline of climate change and consequences to marine ecosystem	***Evidences on consequences of Ocean Acidification, Sea Level Rise, Extreme Weather Events*** (typhoon, coastal & river flooding) ***Area/sites susceptible to coral bleaching*** in 2010, 2014-1017, 2019, 2024 & respective severity (light, moderate, severe)
Risks to economic sectors, including economic loss	Evidences on impacts of habitat loss & degradation ***to livelihood, economic activities and/or economic loss*** as a consequence
Biodiversity hotspots and sensitive areas	***Name of each area/site and its characterization*** such as: mangrove, coral reef, seagrass area (ha, km2); species richness of habitat building groups, diversity of fauna & flora, endangered & migrating species; source & sinks (based on spawning, nursery grounds & circulation)
Importance in socio-economy & management	***Name of each are/site and its importance*** on fisheries, tourism, potential use, economic valuation, protected area (category, area of CR, MG, SG & target species protected), national priority

Integrate between COBSEA WGCME and RWGs on habitats (Data from non-participating countries of SCS SAP Project?)