Introduction to marine/coastal wetlands

Training Workshop Module 1: Introduction to National Wetland Inventories

12th Sept 2024, Professor Dan Friess, Tulane University, dfriess@tulane.edu

Introductions

Cochran Family Professor of Earth and Environmental Sciences

Previously at the National University of Singapore

Coastal ecosystems – ecosystem services and blue carbon, the threats they face (often using remote sensing), and their conservation and restoration

Visit www.themangrovelab.com

- Founding member of the IUCN-Species Survival Commission Mangrove Specialist Group
- Member of the International Blue Carbon Initiative
- Co-chair of the BCI seagrass working group
- Former Deputy Director of the NUS Centre for Nature-based Climate Solutions

What we'll discuss in this session

General introduction

- Global distributions and drivers of habitat change
- Blue carbon loss in marine/coastal wetlands
- Key environmental processes in marine/coastal wetlands

Mapping

- National greenhouse gas inventories and NDCs
- Some mapping considerations for marine/coastal wetlands

What are marine/coastal wetlands?

See Max Finalyson presentation. According to the Ramsar Classification System for Wetland Types, as approved by the Conference of the Contracting Parties in Recommendation 4.7 and amended by Resolutions VI.5 and VII.11:

Wetlands are not just muddy, vegetated, swampy…

Marine/Coastal Wetlands

A -- **Permanent shallow marine waters** in most cases less than six metres deep at low tide; includes sea bays and straits.
B -- **Marine subtidal aquatic beds**; includes kelp beds, sea-grass beds, tropical marine meadows.
C -- **Coral reefs**.
D -- **Rocky marine shores**; includes rocky offshore islands, sea cliffs.
E -- **Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.
F -- **Estuarine waters**; permanent water of estuaries and estuarine systems of deltas.
G -- **Intertidal mud, sand or salt flats**.
H -- **Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.
I -- **Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.
J -- **Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea.
K -- **Coastal freshwater lagoons**; includes freshwater delta lagoons.
Zk(a) – **Karst and other subterranean hydrological systems**, marine/coastal

Tabulations of Wetland Type characteristics, Marine / Coastal Wetlands:

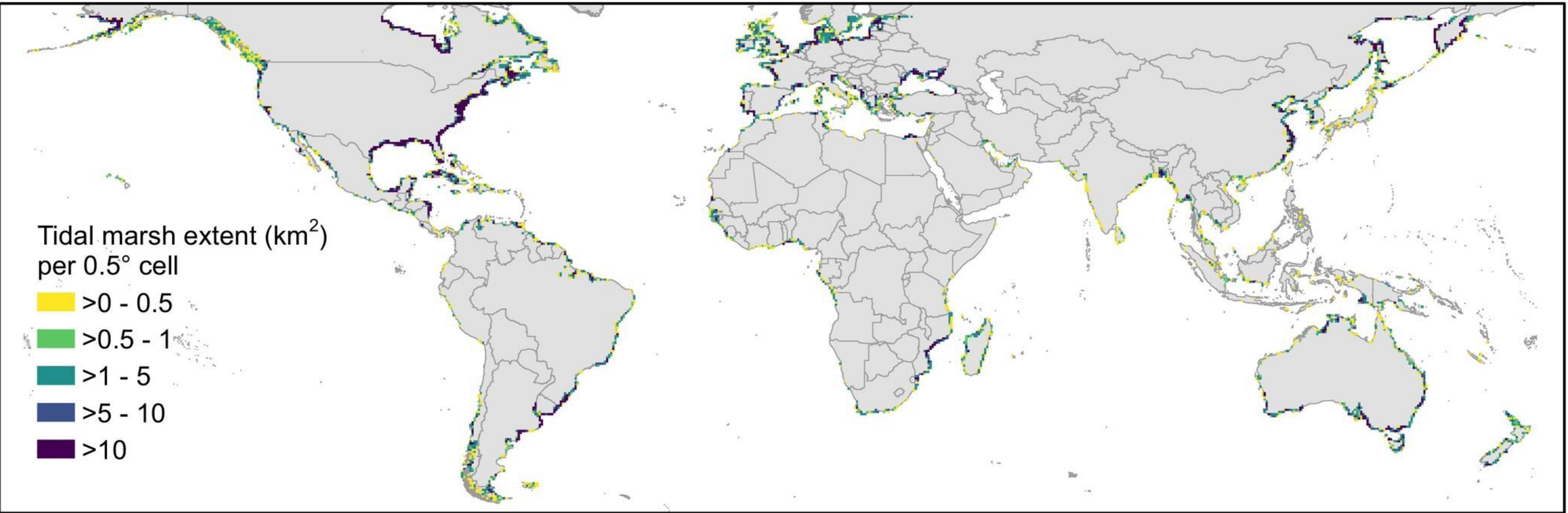
Saline water	Permanent	< 6 m deep	A
		Underwater vegetation	B
		Coral reefs	C
	Shores	Rocky	D
		Sand, shingle or pebble	E
Saline or brackish water	Intertidal	Flats (mud, sand or salt)	G
		Marshes	H
		Forested	I
	Lagoons		J
	Estuarine waters		F
Saline, brackish or fresh water	Subterranean		Zk(a)
Fresh water	Lagoons		K

Note that this classification is a mix of ecosystems and physical landforms – challenges for remote sensing

Global distribution – tidal marshes

According to Worthington et al. 2024: 52,880 km^2

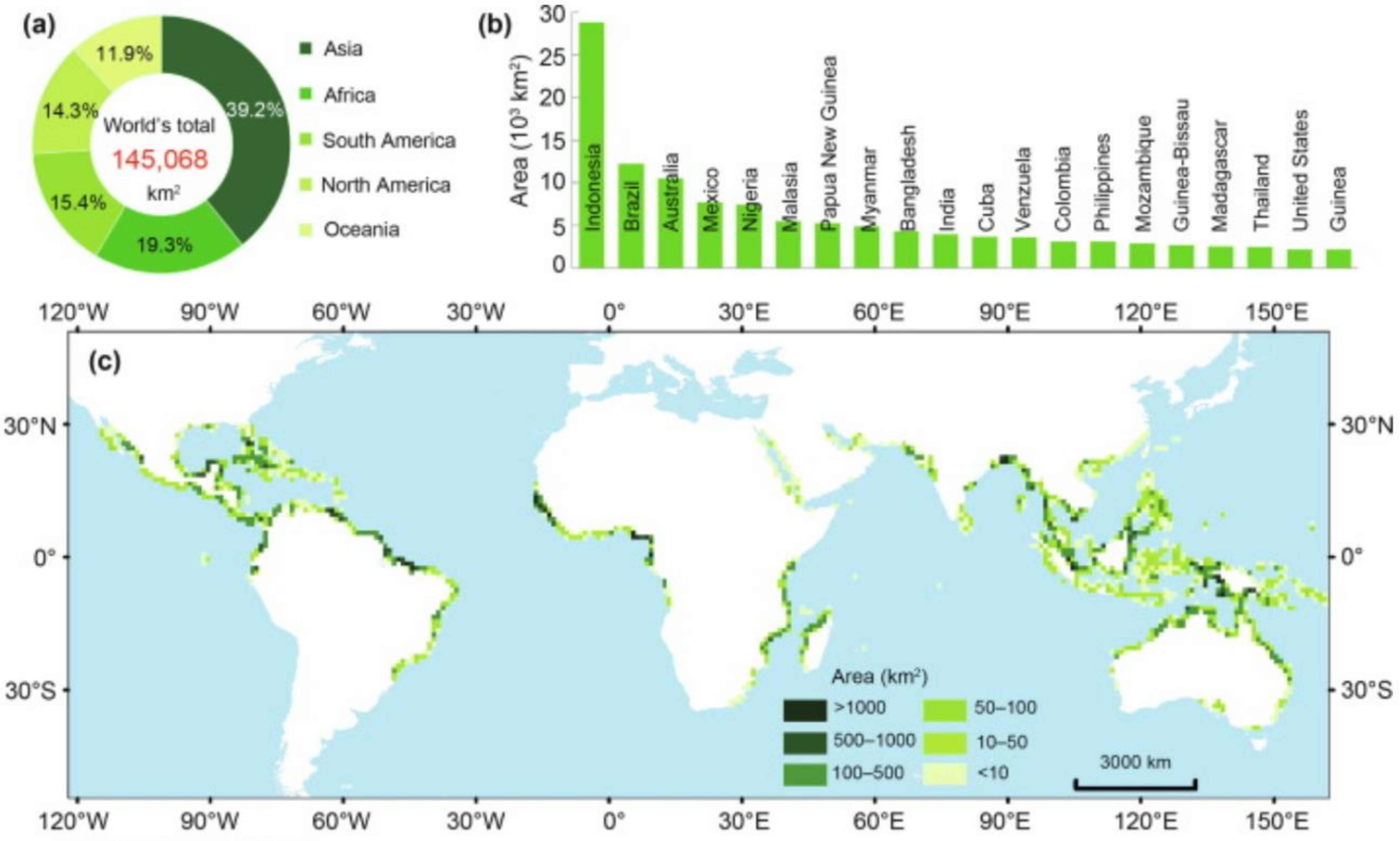
Some uncertainty with tropical marsh or high arctic marsh due to low training data availability



Global distribution - mangroves

Lots of global datasets available for mangrove area!

Tropical, sub-tropical and warm temperate. Estimated area in 2020 = 145,068 km^2 (Jia et al. 2023)



Global distribution - seagrasses

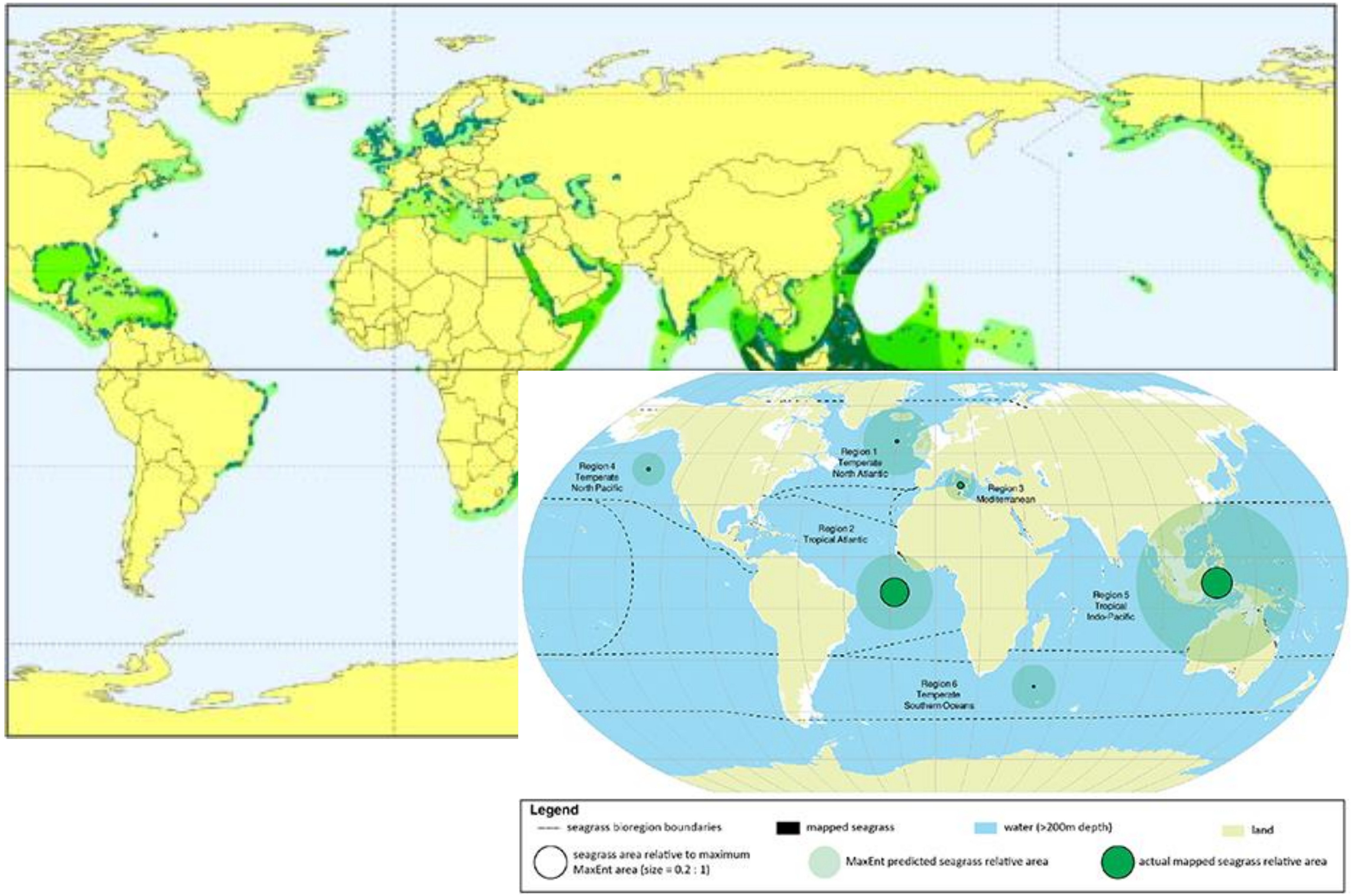
Expected near global distribution

HUGE UNCERTAINTY – no global map

McKenzie et al. 2020 – 160,387 km^2 (high confidence) or 266,562 km^2 (low confidence)

UNEP 2016 – 800,000 km^2 (might miss some out at high latitudes?)

1,646,788 km^2 modelled by Jayathilake & Costello 2018

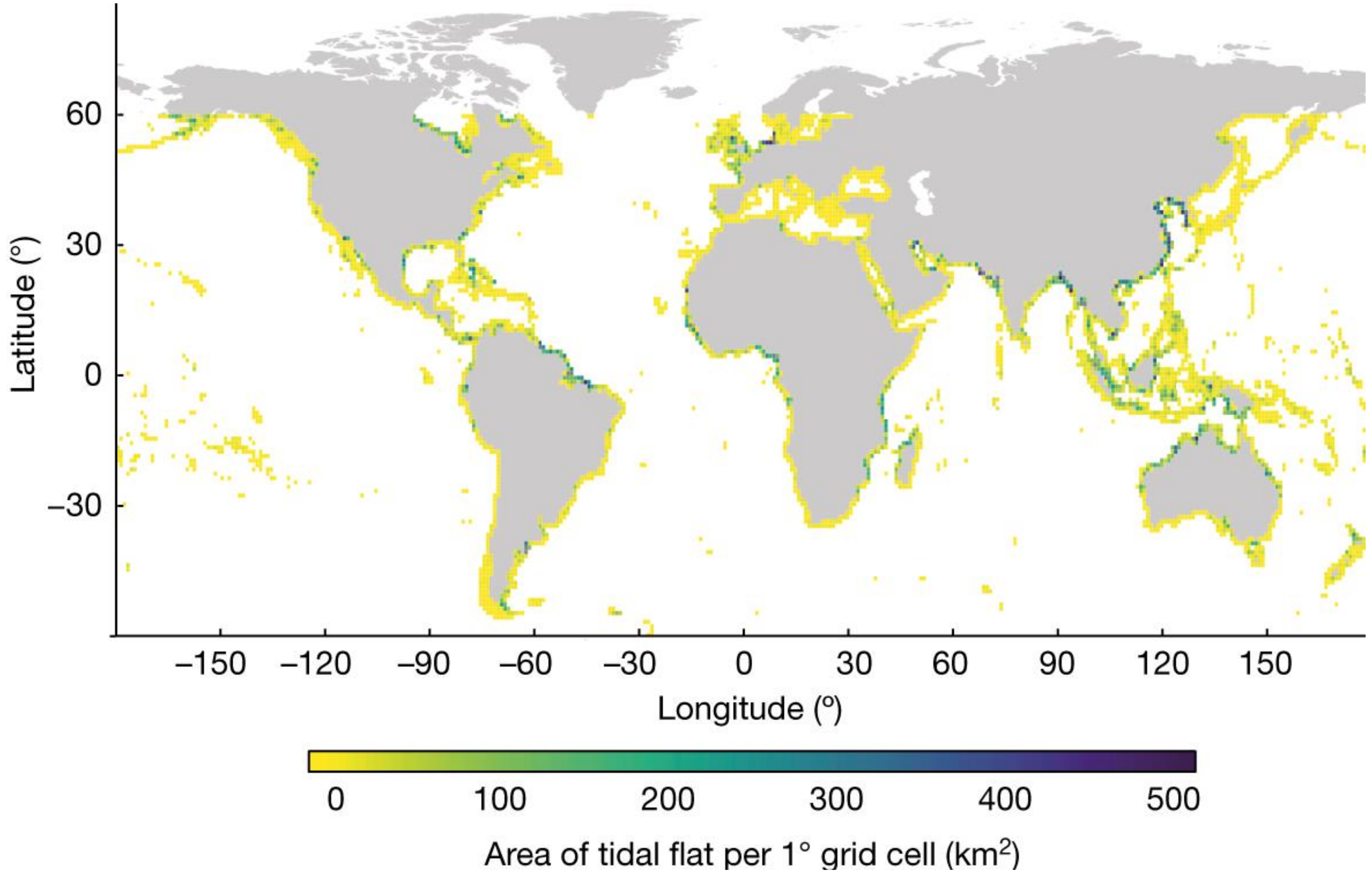


Global distribution - tidal flats

According to Murray et al. 2019 – 127,921 km^2

Near global distribution

~50% in Indonesia, China, Australia, the United States, Canada, India, Brazil and Myanmar



Global distribution - coral reefs

According to the Allen Coral Atlas:
- Shallow reefs = 348,361 km^2
- Coral habitat = 80,213 km^2

Easier to define shallow reef habitat, but not all may be coral reefs

Distribution of deepwater coral reefs is unknown

We are still missing global extent data on many of the other submerged and

Shallow reef extent (though not all is coral habitat) from the Allen Coral Atlas

What's causing marine/coastal wetland loss?

	Tidal marsh	Mangrove	Seagrass	Tidal flat	Coral Reef
Human drivers					
Commodity production					
Urban development & infrastructure					
Salt pans		X			
Harvesting	X	X			X
Invasive species	X		X	X	X
Water quality, eutrophication			X	X	X
Changes in sediment supply	X	X			X
Climate change					
Sea-level rise	X	X	X	X	
Cyclones	X	X			
Heat waves			X		X
Precipitation changes	X	X	X	X	X

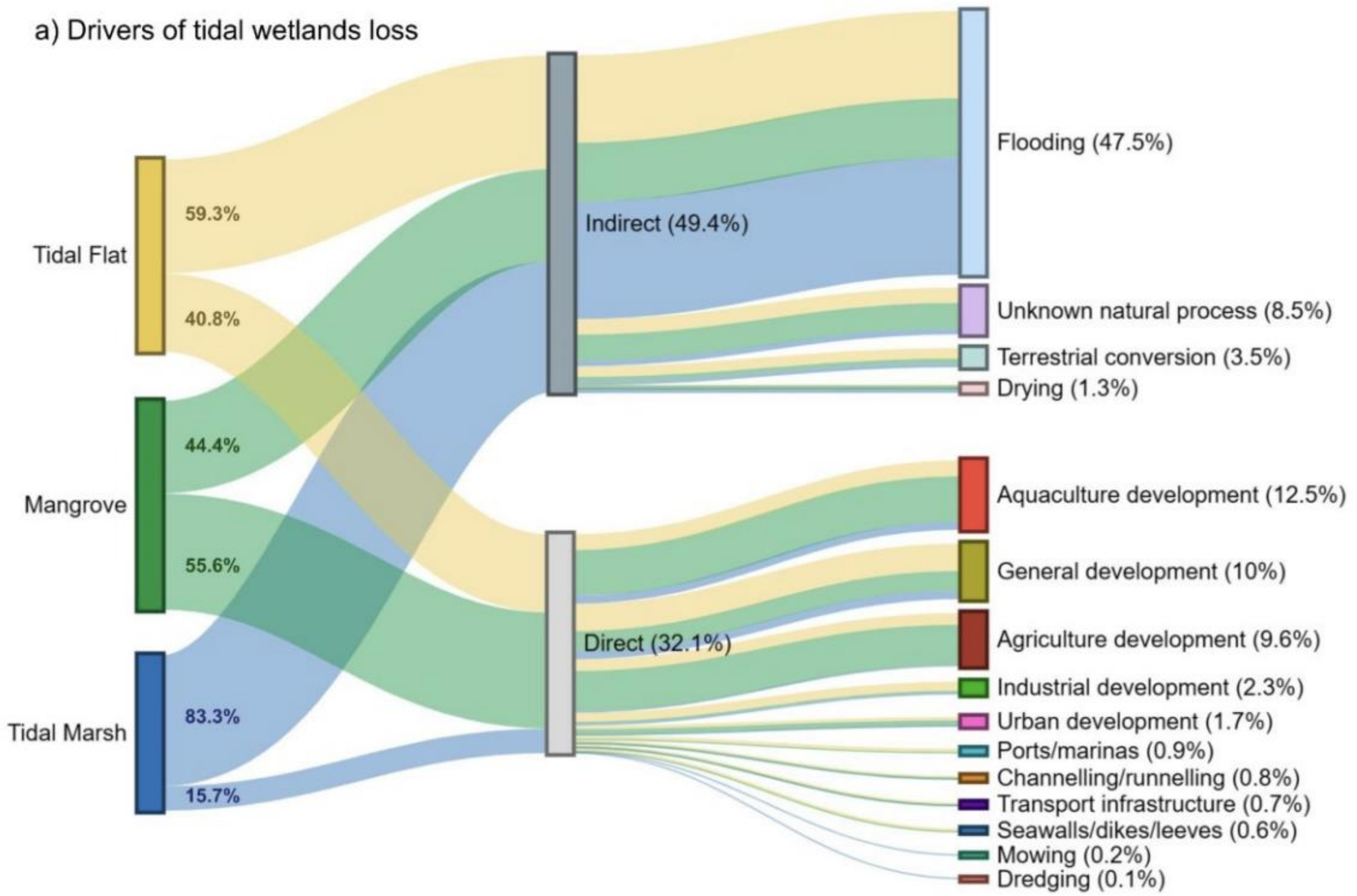
What's causing marine/coastal wetland loss?

Between 1999 and 2019

Indirect drivers account for the majority of loss

Climate change may influence some of the indirect drivers

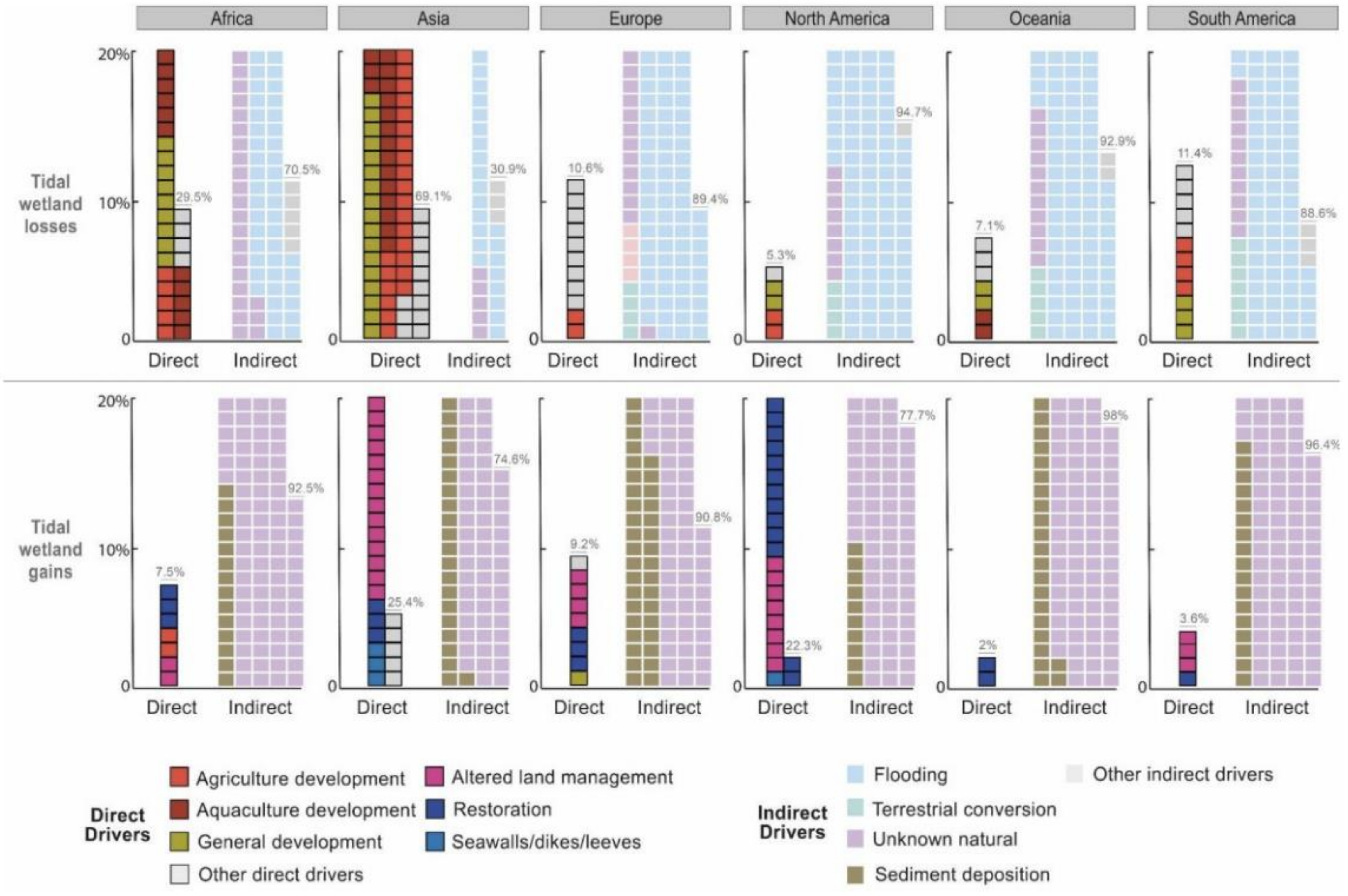
Ecosystem specific (e.g., marsh is more indirect than direct, but mangroves are the opposite)



Perrodin *in review.*

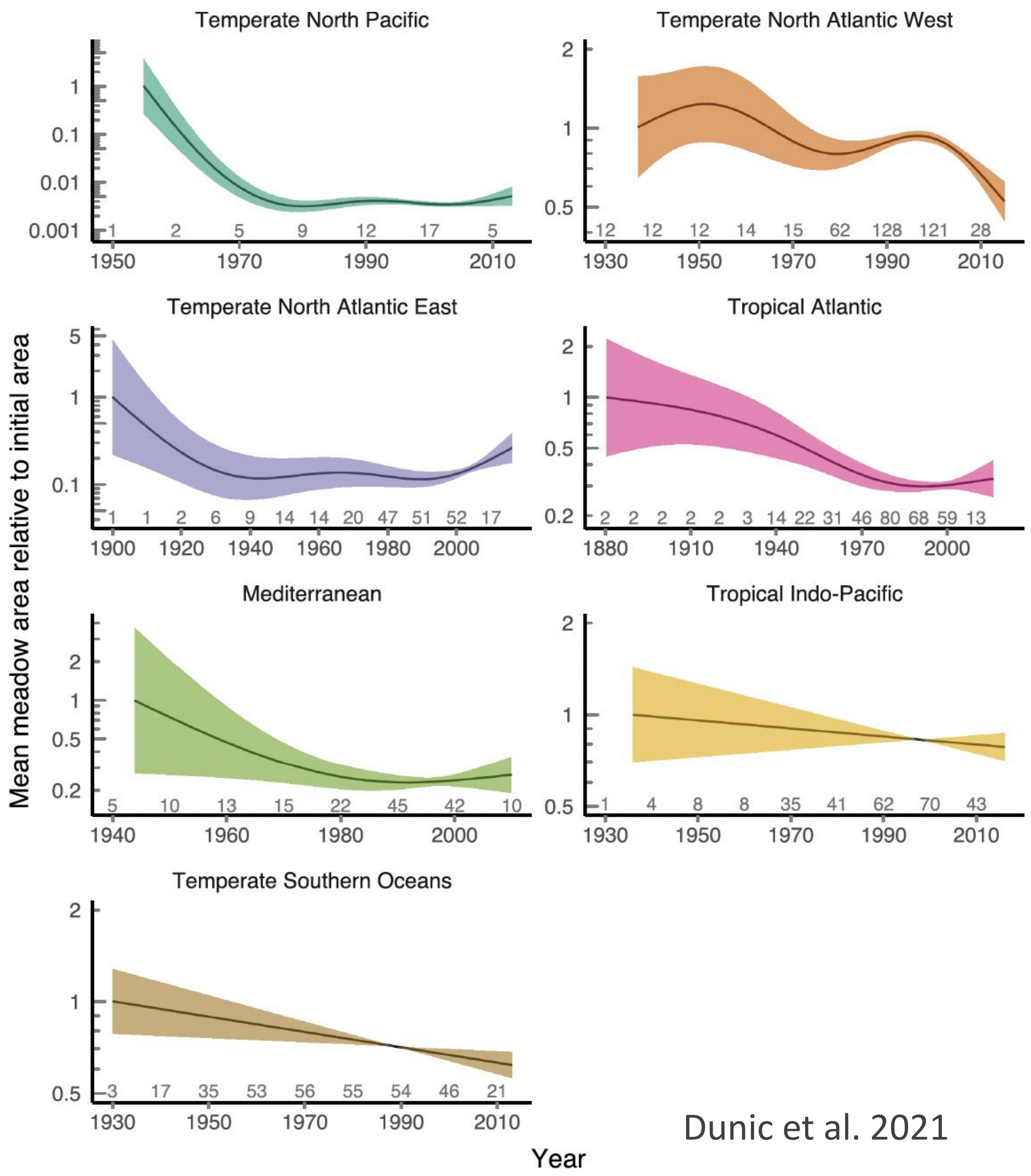
What's causing marine/coastal wetland loss?

Also region-specific (Asia has more direct than indirect drivers)



Perrodin *in review.*

Seagrass loss

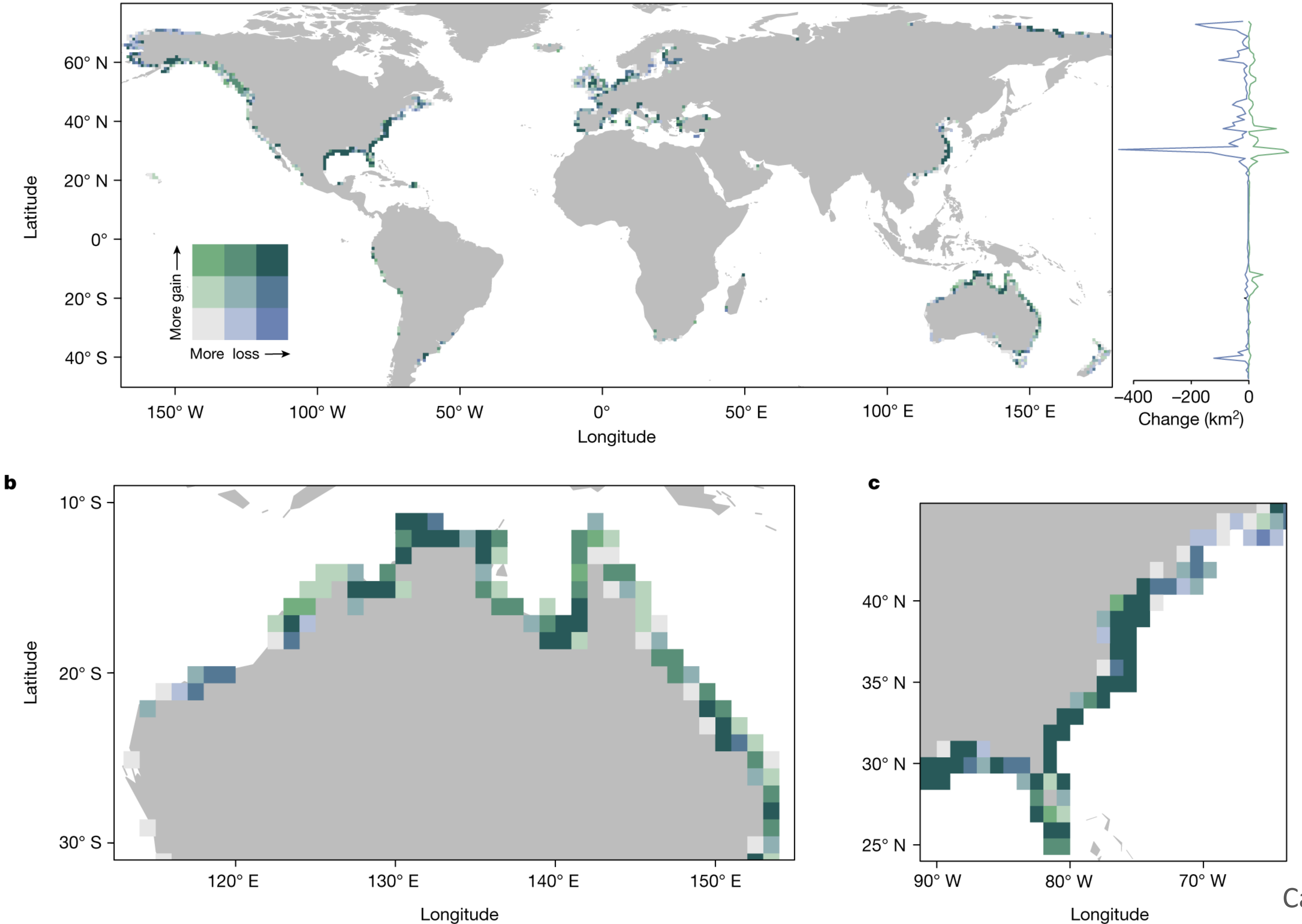


Dunic et al. 2021

Based on a meta-analysis of 574 site-level observations from 175 studies

>5600 km^2 lost, but still likely represents only 1/10 of the world’s seagrass area

Tidal marsh loss



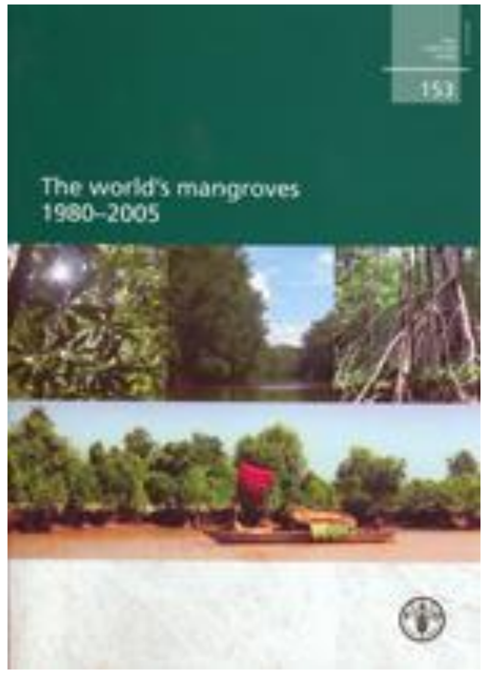
Huge historical loss

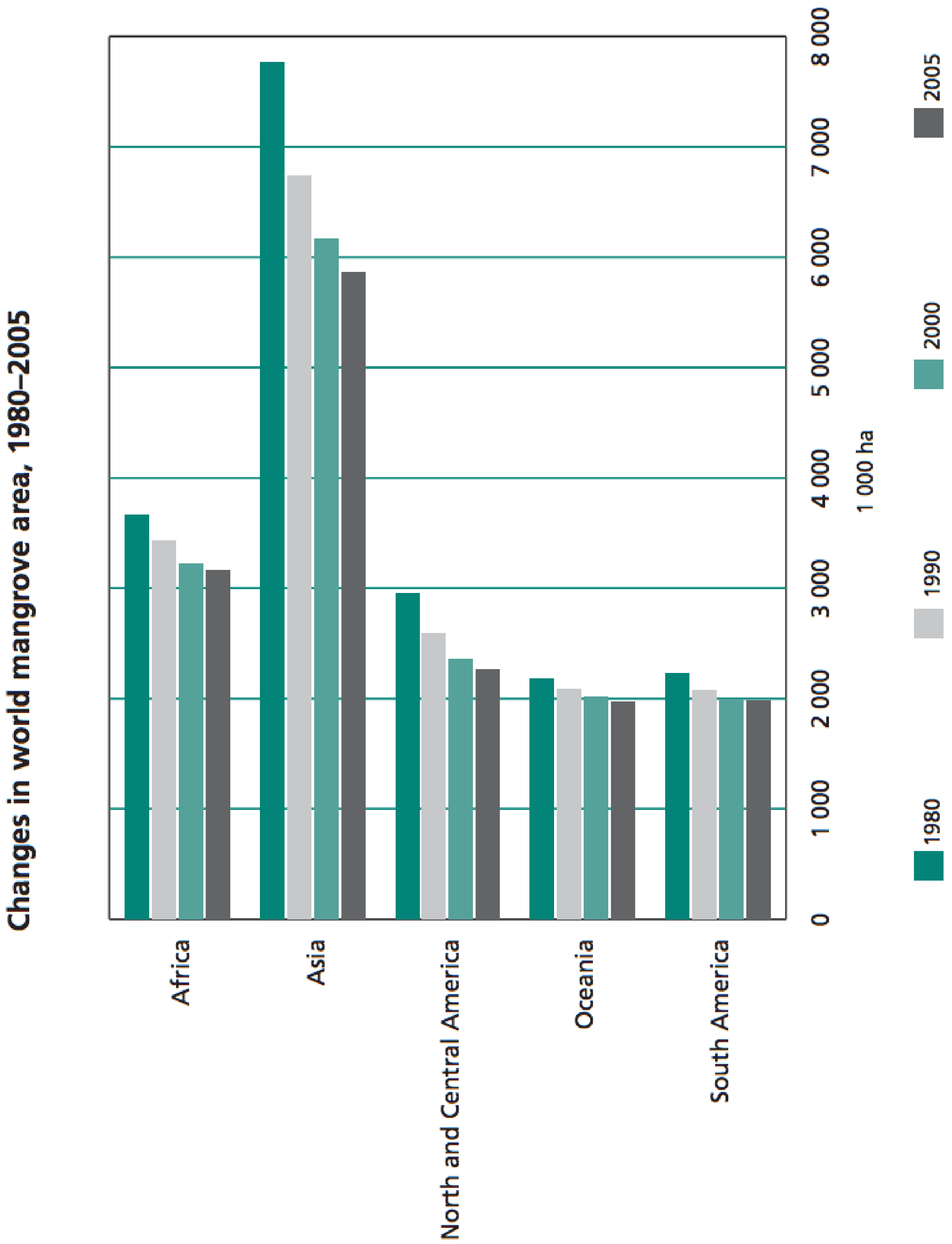
But similar decline to mangroves, now 0.28% per year between 2000 and 2019

Released 16.3 Tg CO_2e year^{-1}

Campbell et al .2022

Mangrove loss





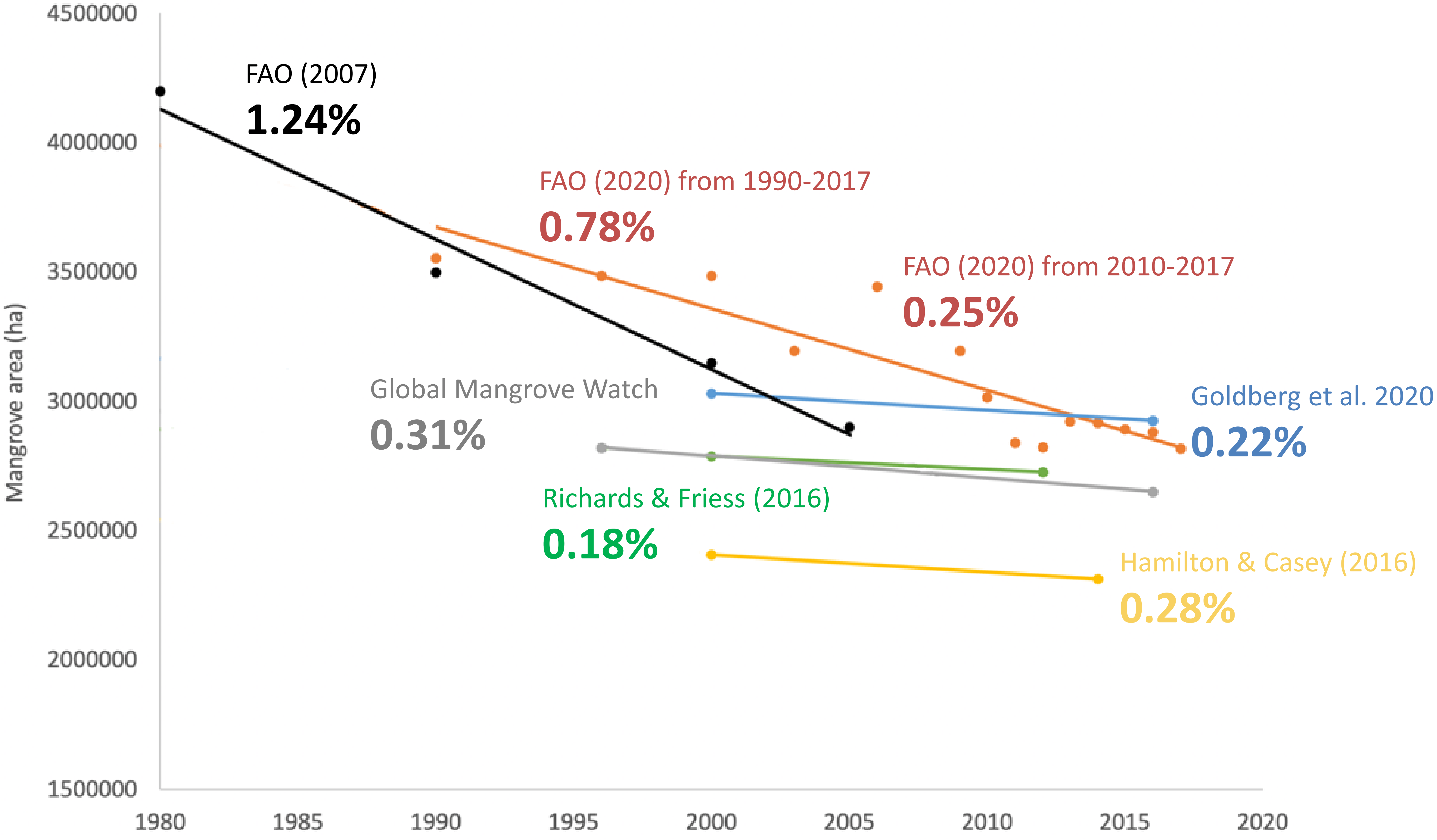
Global loss was previously estimated at 1-3% per yr

Asia:
-Largest mangrove area
-Highest loss

Study in 2016 (Hamilton & Casey) howed that global mangrove loss from 2000 to 2012 was 0.26-0.66% per year

Two more independent studies suggest mangrove loss is at a similar or lower rate

Mangrove loss is reduced from the 20th century

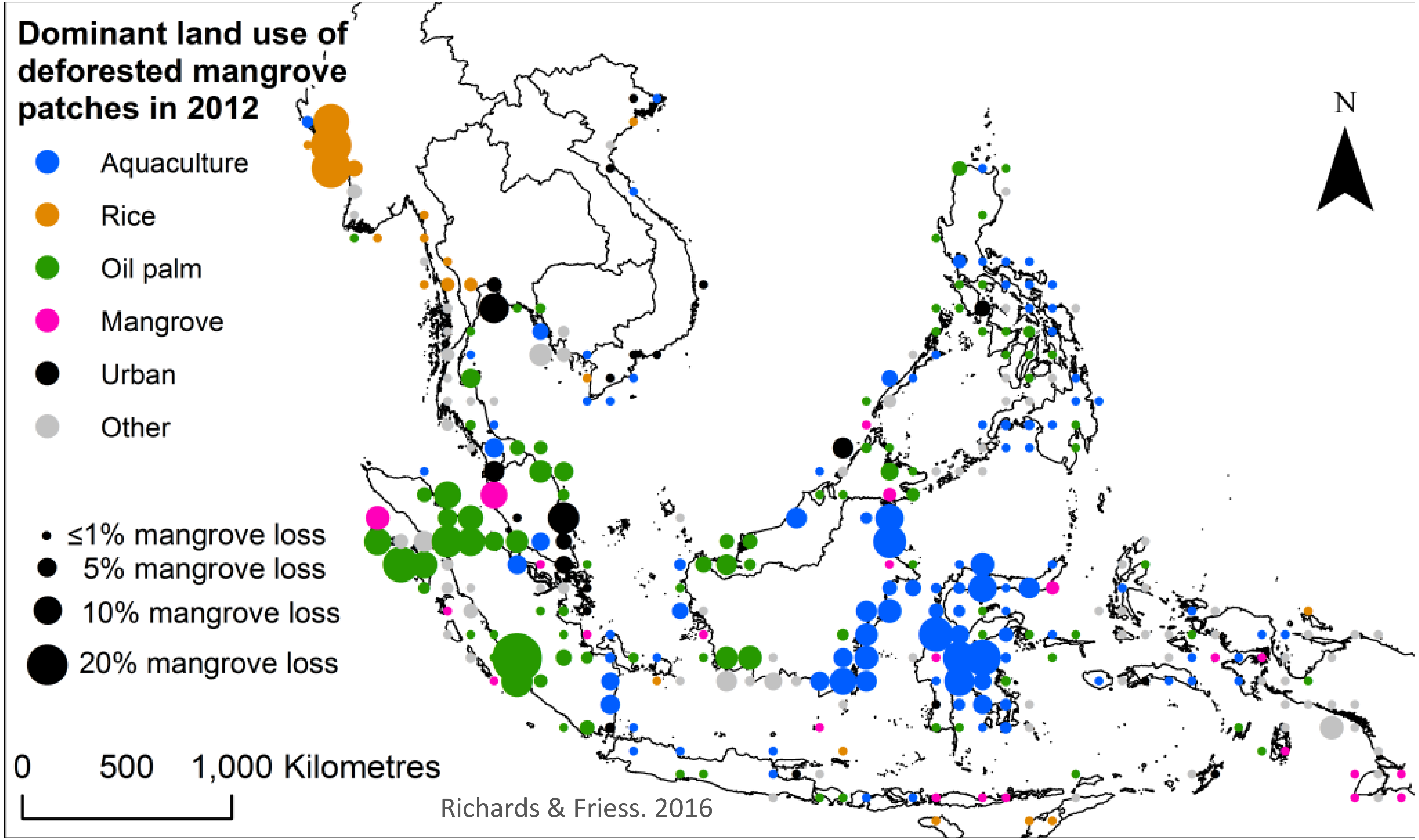


Mangrove in Indonesia used to decrease by 1.2% per year

Now only 0.18-0.31% of loss per year according to regional and global datasets

Mangroves could be considered a conservation success story!

What is causing mangrove loss?



First regional-scale study of proximate drivers of mangrove loss

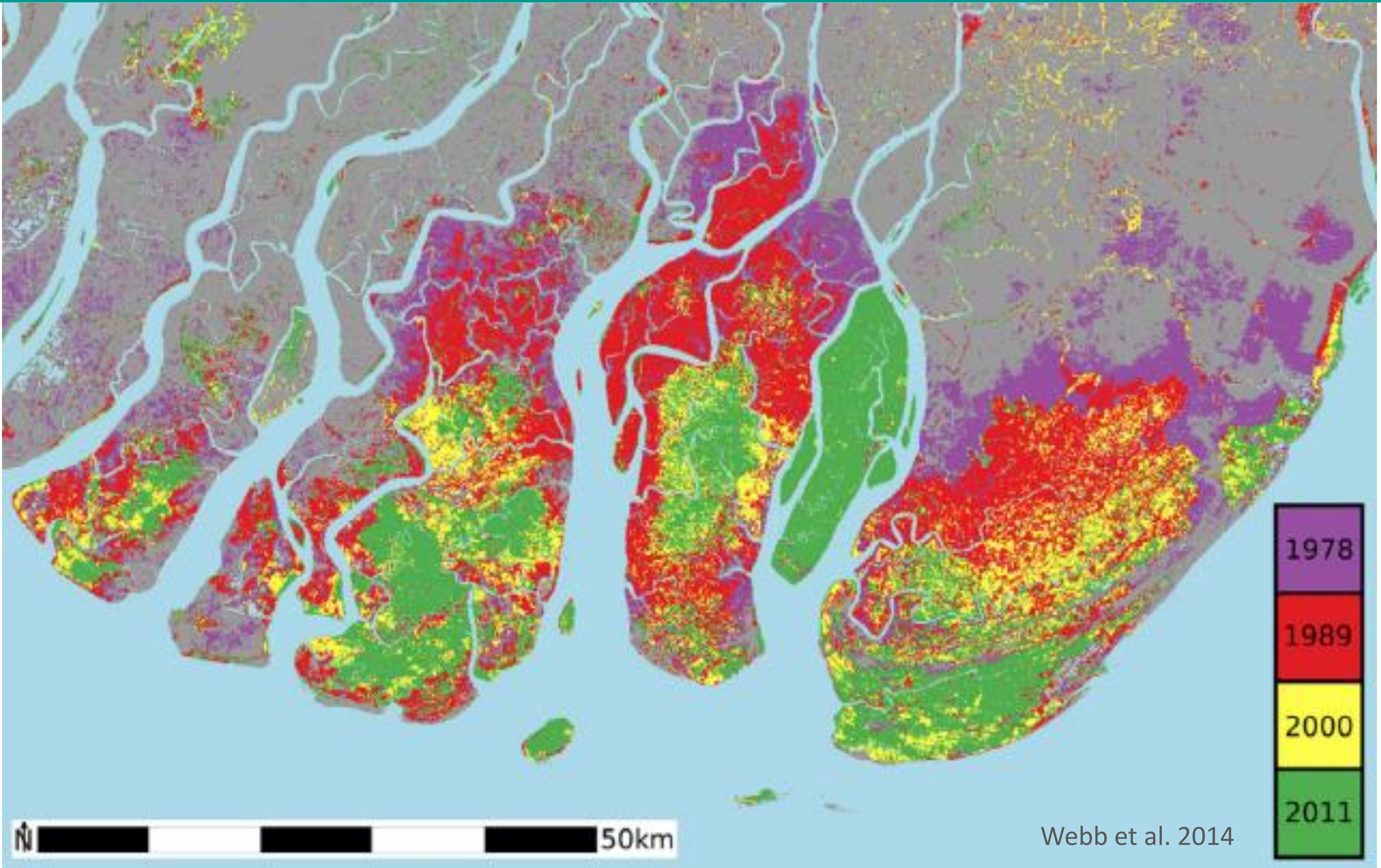
Aquaculture was the biggest cause of mangrove loss (30%)

Other commodities also driving mangrove loss

Aquaculture

Oil palm plantations

Rice paddy



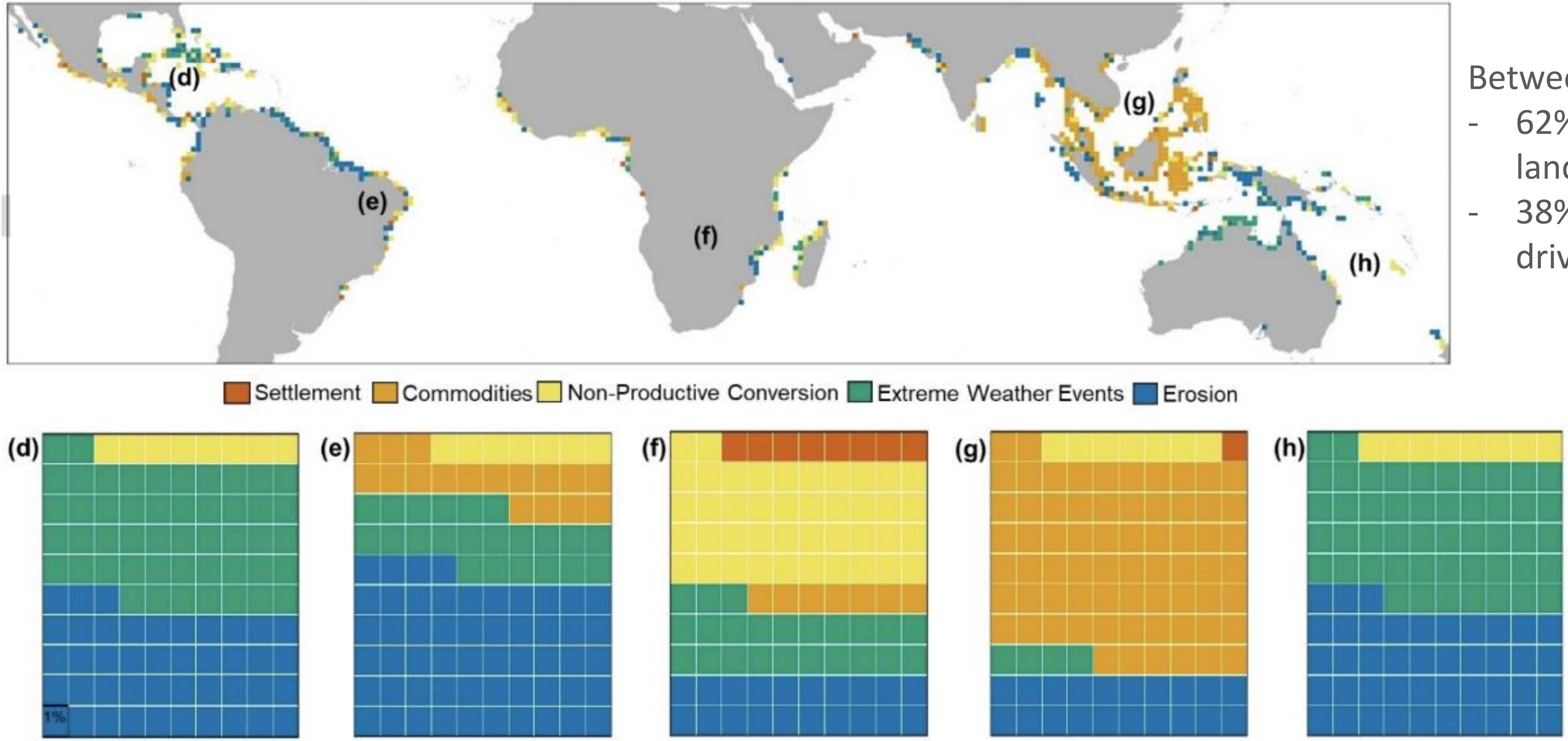
Webb et al. 2014

Ayeyarwady delta, Myanmar

Landward encroachment of rice into mangroves

Speed of deforestation linked to food security policies

But loss drivers are regionally variable



Between 2000 and 2016:

- 62% of loss was from land-use change
- 38% from “natural” drivers

Goldberg et al. 2020

Climate change and marine/coastal wetlands

Climate change *may* have *some* benefits for *some* ecosystems in *some* places

But mostly the impacts are expected to be negative

Main stressor depends on the type of marine/coastal wetland

But all involve pushing ecosystems beyond some physical/physiological threshold

Friess et al. 2022.

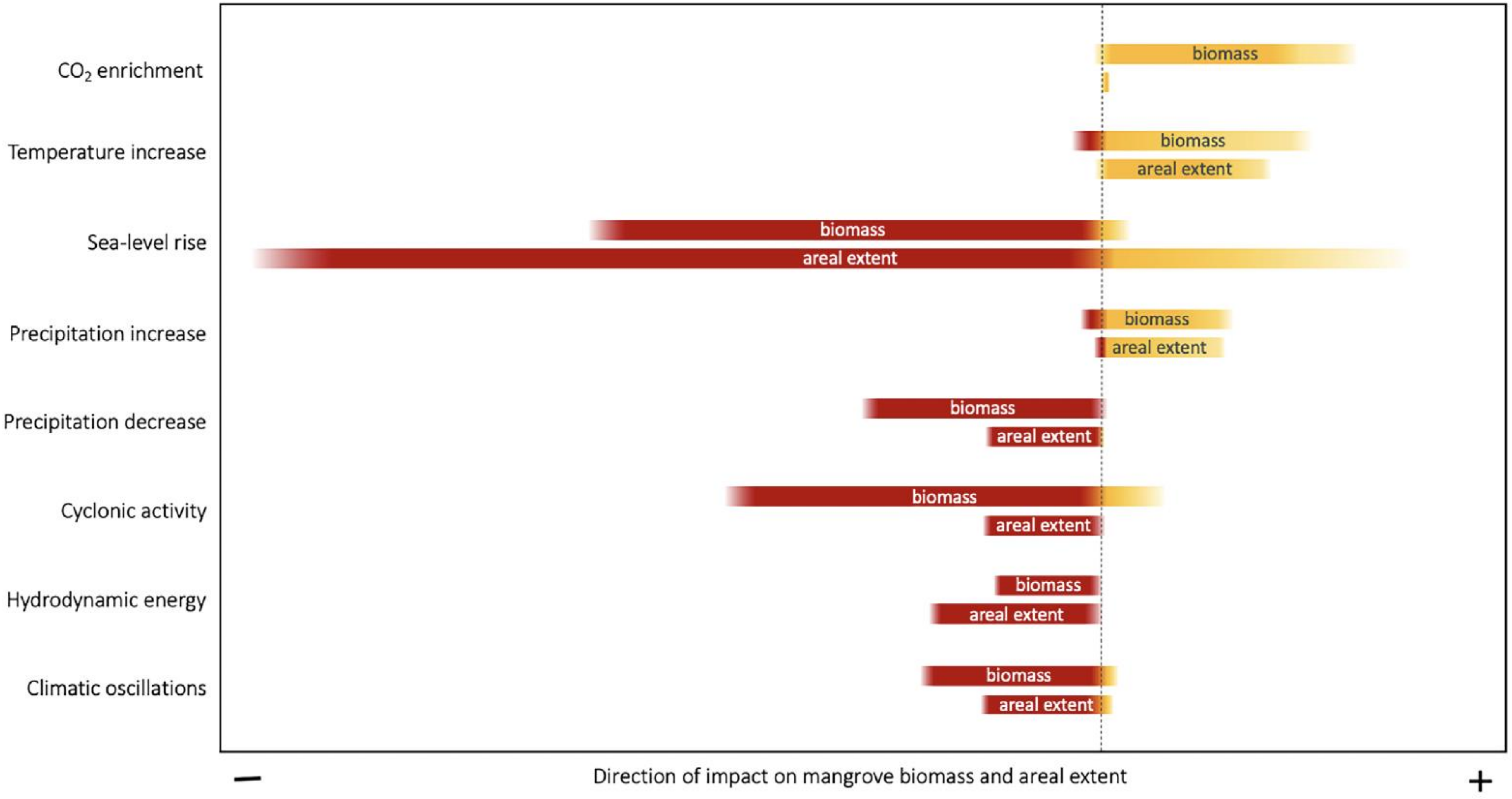


FIGURE 1 Contributions of different climate change impacts to increases and decreases in mangrove biomass and areal extent under 2.0°C warming. The magnitude of positive and negative impacts ascribed to each stressor is indicative only, and based on expert judgment

Wetland loss leads to ecosystem service loss

Realizing the full potential of marine and coastal wetlands: why their restoration matters

Exceptionally biodiverse, and among the most socially and economically valuable ecosystems on Earth, marine and coastal wetlands are in jeopardy. Already, between one-third and one-half of these ecosystems have been degraded or depleted – and they continue to diminish at a much faster rate than terrestrial systems.

Ecosystem restoration of coastal and marine wetlands promotes food and water security for sustainable development. And it delivers on climate change mitigation and adaptation, as well as on biodiversity conservation targets.

Why are marine and coastal wetlands so important?

Healthy, functioning natural wetlands are critical to human health and well-being – as well as to sustainable development. But despite the tremendous value they bring, an estimated 35% of the world's marine and coastal wetland areas were lost between 1970 and 2015 – at three times the rate of forest loss.

Blue carbon ecosystems are powerhouses for capturing and storing carbon.

- Carbon dioxide captured by marine and coastal wetlands is commonly called blue carbon.
- Flooded regularly by tidal waters, mangrove forests, intertidal marshes, and seagrass beds capture and store carbon in their sediment up to 55 times faster than tropical rainforests.
- If undisturbed, the carbon stored in these sediments is stable and can remain for hundreds or thousands of years. But once disturbed or drained, substantial amounts of carbon can be rapidly released.
- Including the restoration of blue carbon ecosystems in Nationally Determined Contributions provides a nature-based approach for delivering on the Paris Agreement on Climate Change.

Maintaining healthy coastal wetlands is often the most cost-effective method for preventing shoreline erosion.

- Mangroves and coral reefs absorb more than 90% of the energy of wind-generated waves.
- Mangroves, saltmarshes, and coral reefs all reduce the speed and height of storm surges. And because their roots bind the shoreline, they resist erosion by wind and waves while increasing resilience against climate change.

WHAT ARE MARINE AND COASTAL WETLANDS?

Most of the world's coastline – including ecosystems such as mangroves, lagoons, seagrass beds, saltwater marshes, estuaries, unvegetated tidal flats, kelp forests, and coral reefs – fall within the definition of marine and coastal wetlands of the Convention of Wetlands. Roughly 7% of all the Earth's wetlands are marine and coastal.

Marine and coastal wetlands are important fish spawning, nursery, and feeding grounds.

- Marine and coastal wetlands specifically help guarantee our food supply – as most commercial fish depend on coastal wetlands for part of their life cycle.
- At least two-thirds of all the fish consumed worldwide are dependent on coastal wetlands.

https://www.ramsar.org/sites/default/files/documents/library/factsheet_wetland_restoration_coastal_e.pdf

Oceanography and Marine Biology: An Annual Review, 2020, **58**, 107–142
© S. J. Hawkins, A. L. Allcock, A. E. Bates, A. J. Evans, L. B. Firth, C. D. McQuaid, B. D. Russell, I. P. Smith, S. E. Swearer, P. A. Todd, Editors
Taylor & Francis

ECOSYSTEM SERVICES AND DISSERVICES OF MANGROVE FORESTS AND SALT MARSHES

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Abstract Coastal wetlands such as mangrove forests and salt marshes provide a range of important benefits to people, broadly defined as ecosystem services. These include provisioning services such as fuelwood and food, regulating services such as carbon sequestration and wave attenuation, and various tangible and intangible cultural services. However, strong negative perceptions of coastal wetlands also exist, often driven by the perceived or actual ecosystem disservices that they also produce. These can include odour, a sense of danger, and their real or perceived role in vector and disease transmission (e.g. malaria). This review provides an introduction to the ecosystem services and disservices concepts and highlights the broad range of services and chdisservices provided by mangrove forests and salt marshes. Importantly, we discuss the key implications of ecosystem services and disservices for the management of these coastal ecosystems. Ultimately, a clear binary does not exist between ecosystem services and disservices; an ecosystem service to one stakeholder can be viewed as a disservice to another, or a service can change seasonally into a disservice, and vice versa. It is not enough to only consider the beneficial ecosystem services that coastal wetlands provide: instead, we need to provide a balanced view of coastal wetlands that incorporates the complexities that exist in how humans relate to and interact with them.

Keywords: blue carbon, coastal protection, coastal wetland, cultural ecosystem services, environmental policy, environmental service, wave attenuation

Introduction

Coastal wetlands are found along low-energy shorelines worldwide, with distinct but overlapping geographical distributions. Mangrove forests are restricted to the tropics, subtropics, and some warm temperate locations, covering 137,600 km² in 2010 (Bunting et al. 2018). Salt marshes are predominantly found in temperate and subarctic regions, though extensive salt marshes are also found in the tropics and subtropics, where they may form an ecotone with mangrove forests. The

Friess et al. 2020. *Oceanography and Marine Biology: an Annual Review* 58, 107-142.

CHAPTER 27

The Value of Coastal Wetland Ecosystem Services

Edward B. Barbier
Department of Economics, Colorado State University, Fort Collins, Colorado, United States

1. INTRODUCTION

Ecosystems can be viewed as assets that produce a flow of benefits, which are commonly referred to as *ecosystem services* (Barbier, 2011; MEA, 2005). Such benefits are diverse and wide-ranging and generally arise through the natural functioning of ecosystems. For example, as Daily et al. (2000, p. 395) state, "the world's ecosystems are capital assets. If properly managed, they yield a flow of vital services, including the production of goods (such as seafood and timber), life support processes (such as pollination and water purification), and life-fulfilling conditions (such as beauty and serenity)."

However, we are doing a poor job in managing and maintaining the world's ecosystems, especially coastal wetlands, which are some of the most heavily used and threatened natural systems globally (Doney et al., 2012; Halpern et al., 2008; Lotze et al., 2006; Worm et al., 2006). Their deterioration because of human activities is intense and increasing. For example, around one quarter of the world's mangroves have been lost because of human action, mainly through conversion to aquaculture, agriculture, and urban land uses (Barbier and Cox, 2003; Duke et al., 2007; Friess and Webb, 2014; Spalding et al., 2010). As much as 50% of salt marshes have been lost or degraded worldwide over recent decades (Barbier et al., 2011; Doney et al., 2012). This global decline in coastal wetlands is affecting their ability to provide critical ecosystem services, such as raw materials, food, and other products collected by local communities, the provision of nursery and breeding habitats for offshore fisheries, filtering and detoxification services, control of biological invasions, declining water quality, recreational opportunities, shoreline stabilization and control of coastal erosion, and protection from flooding and storm events (Alongi, 2008; Barbier, 2014; Cochard et al., 2008; Spalding et al., 2014; Worm et al., 2006). In addition, the changes in precipitation, temperature, and hydrology accompanying climate change are likely to threaten remaining coastal

Coastal Wetlands
https://doi.org/10.1016/B978-0-444-63893-9.00027-7

Barbier 2019. Coastal Wetlands (2nd Ed).

The importance of blue carbon

Blue carbon is the carbon stored in coastal and marine ecosystems

MANGROVES

SEAGRASSES

TIDAL MARSHES

GEOCHEMICAL

1. Sequester carbon dioxide from the atmosphere at very high rates
2. Store carbon at very high densities (in their soils) for long timescales

MANAGEMENT

3. Experiencing negative human impacts
4. Can save carbon through their conservation, restoration or management
5. Management has no social or environmental harm
6. Management aligns with broader climate mitigation and adaptation policies

Lovelock & Duarte 2019. Biology Letters 15, 20180781.

Broader definitions of blue carbon

OXFORD

BioScience, 2024, **74**, 253–268
https://doi.org/10.1093/biosci/biae007
Advance access publication date: 18 March 2024
Forum

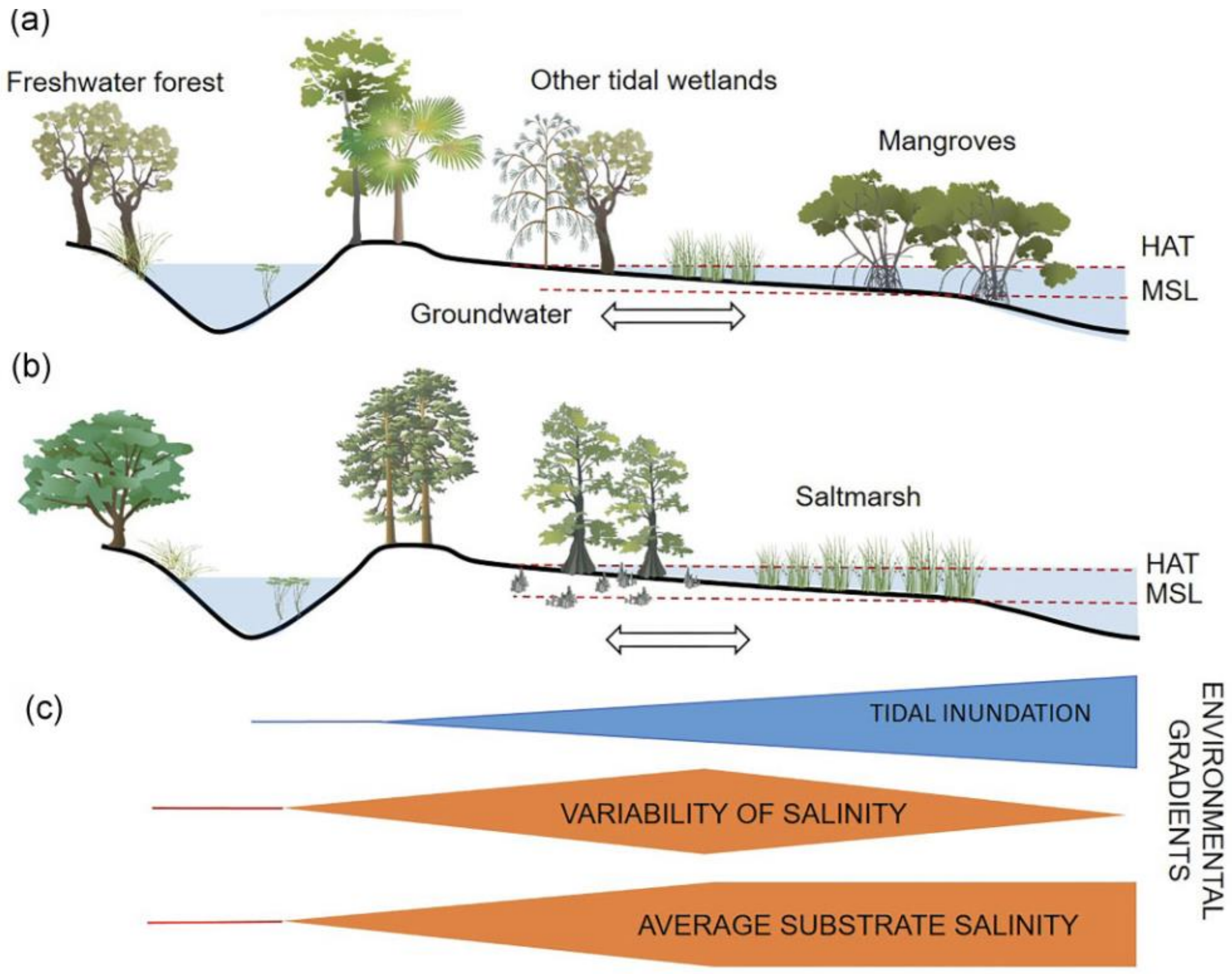
All tidal wetlands are blue carbon ecosystems

Maria Fernanda Adame, Jeff Kelleway, Ken W. Krauss, Catherine E. Lovelock, Janine B. Adams, Stacey M. Trevathan-Tackett, Greg Noe, Luke Jeffrey, Mike Ronan, Maria Zann, Paul E. Carnell, Naima Iram, Damien T. Maher, Daniel Murdiyarso, Sigit Sasmito, Da B. Tran, Paul Dargusch, J. Boone Kauffman and Laura Brophy

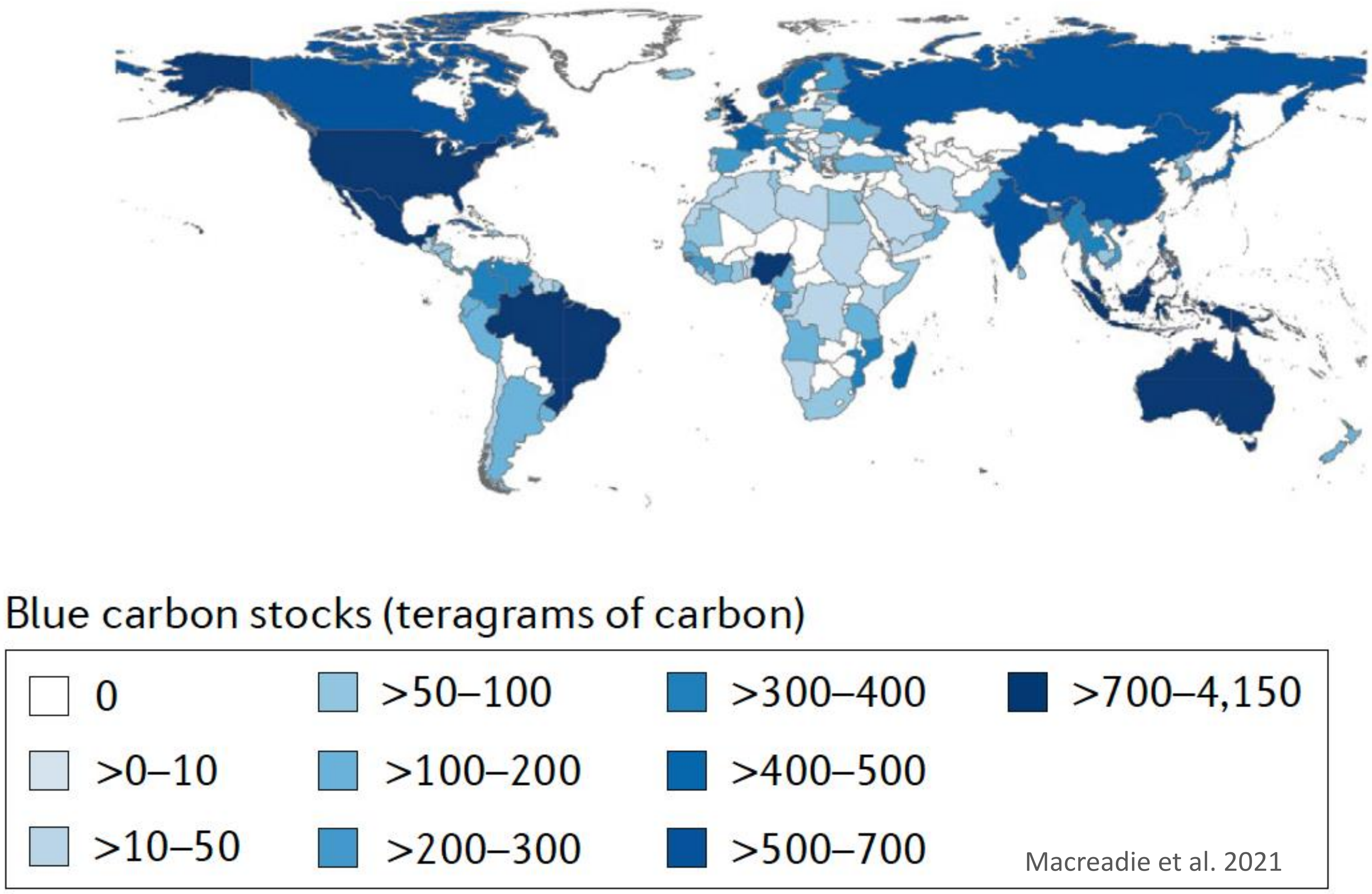
"Ecosystems that are influenced by marine waters that fix carbon dioxide and that store and accumulate it as organic carbon.

They are bounded by the highest levels of tidal inundation at the terrestrial edge and by the limits of the photic zone in the marine edge"

This better fits the Ramsar definition of wetlands



Blue carbon distributions



Globally, there are >30,000 Tg of blue carbon

4350-10,300 Tg C stored in mangroves

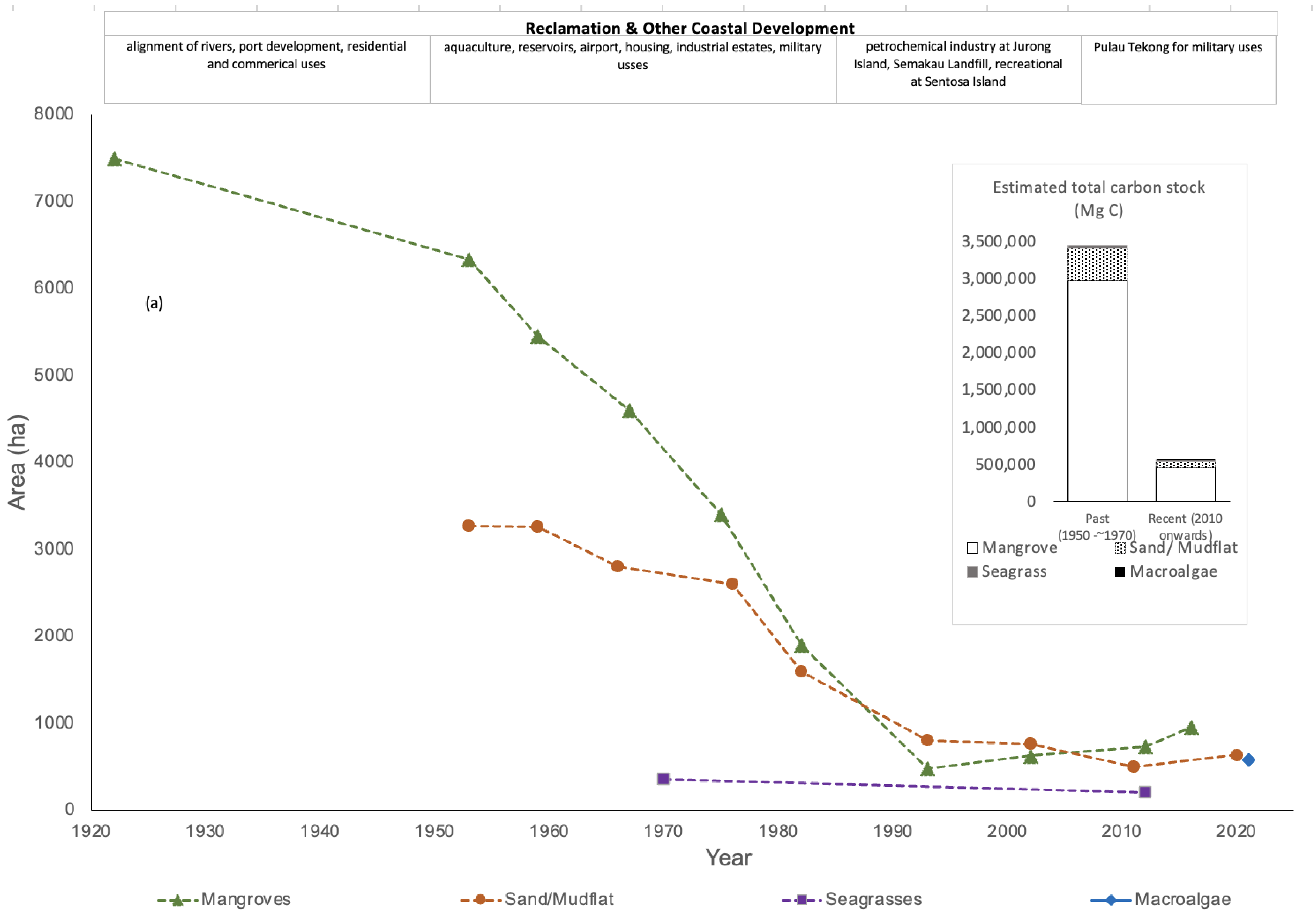
If we could do all possible conservation and restoration it would offset ~3% of global fossil fuel emissions every year

Blue carbon loss - national scale

National inventory of coastal/wetland carbon stocks estimate an ~85% decrease in blue carbon between 1950s-70s and today

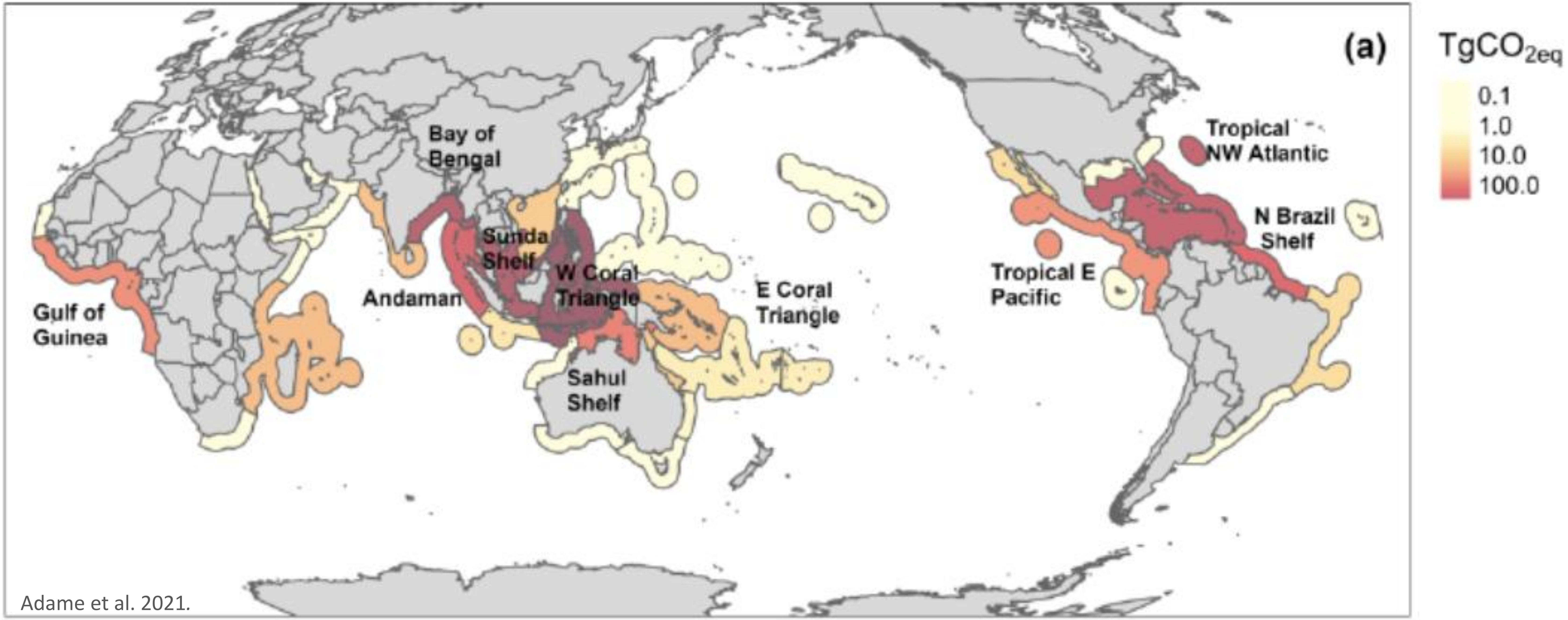
Estimated from aerial photography/ satellite remote sensing + coarse carbon models

We are improving this in order to include in Singapore’s National Greenhouse Gas Inventory



Blue carbon loss - global scale

Mangrove deforestation emissions + lost sequestration could be 3392 $TgCO_2$-e by 2100



Adame et al. 2021.

National Wetland Inventories help carbon accounting

A National Greenhouse Gas Inventory tracks a nation's greenhouse gas emissions and removal

National Wetland Inventories track area change through time, and potentially what is causing it

= ACTIVITY DATA + emissions factor = NATIONAL GREENHOUSE GAS SINK/SOURCE DYNAMICS

For example, US NWI was used in the most recent National Greenhouse Gas Inventory to recalculate more accurately the emissions from Flooded Lands

Led to a calculated increase in emissions

Let's take a short break!

Key biophysical processes in marine/coastal wetlands

It's their physical environment that makes wetlands so good at storing blue carbon

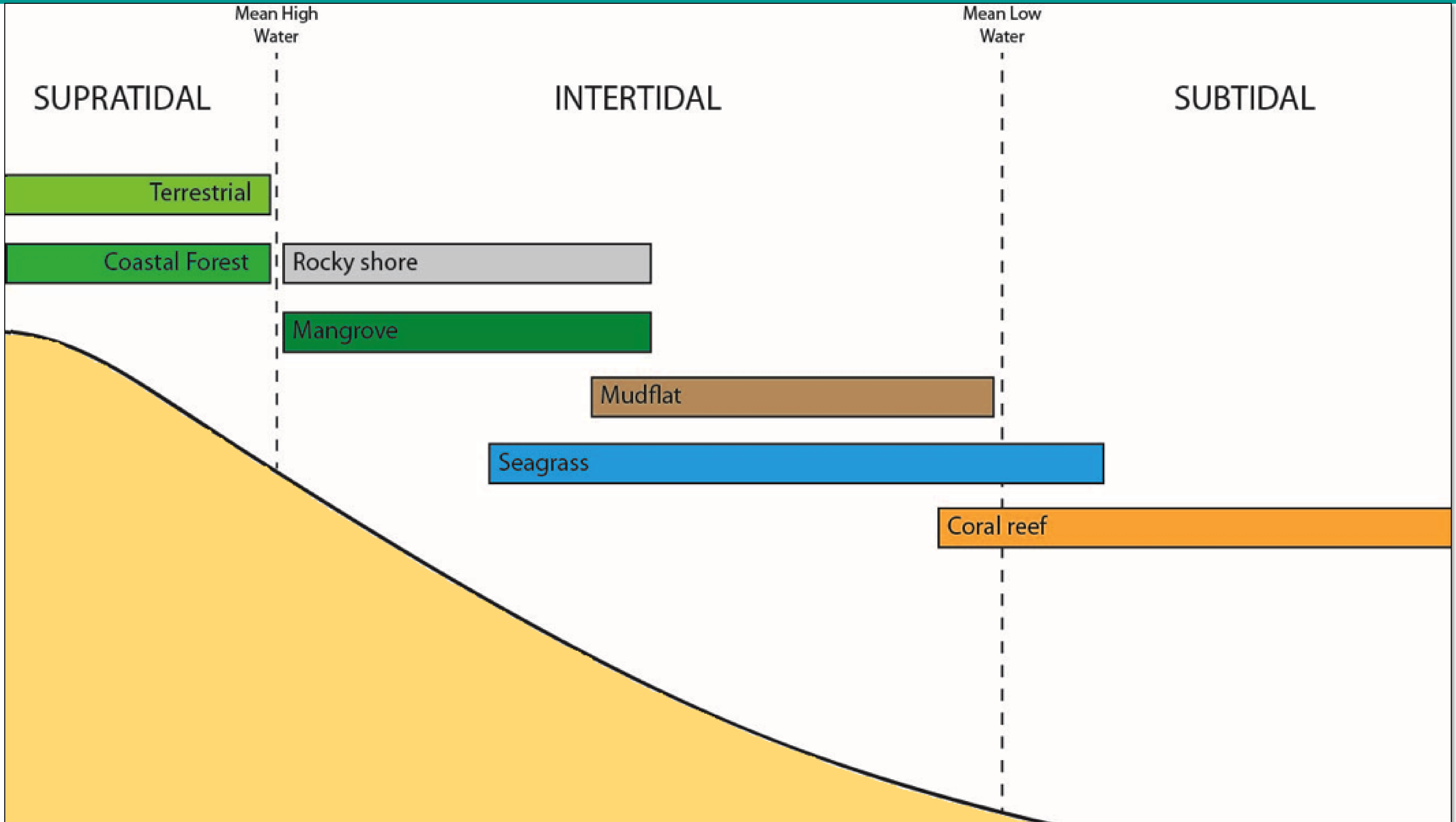
Marine/coastal wetlands persist across a range of biophysical gradients in the coastal zone

We need to map marine/coastal wetlands across these gradients

Tabulations of Wetland Type characteristics, Marine / Coastal Wetlands:

Saline water	Permanent	< 6 m deep	A
		Underwater vegetation	B
		Coral reefs	C
	Shores	Rocky	D
		Sand, shingle or pebble	E
Saline or brackish water	Intertidal	Flats (mud, sand or salt)	G
		Marshes	H
		Forested	I
	Lagoons		J
	Estuarine waters		F
Saline, brackish or fresh water	Subterranean		Zk(a)
Fresh water	Lagoons		K

Inundation is a key control on wetland landscape distribution



Site-scale controls on wetland establishment

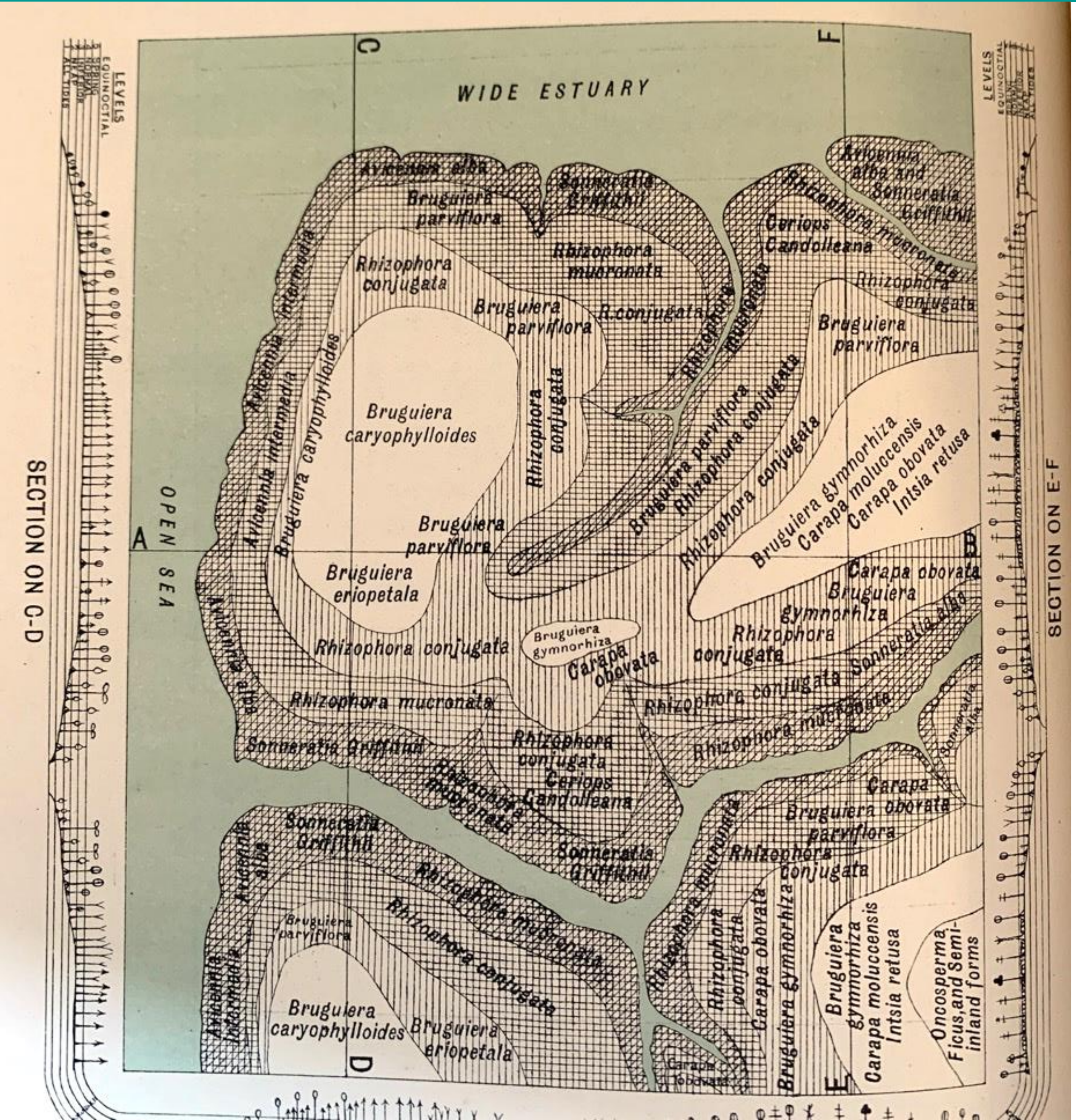
1. Propagule supply

2. Sheltered hydrodynamic conditions
   a. to allow rooting
   b. To allow sediment deposition

3. Substrate

4. Tidal flooding

Elevation is key to wetland establishment



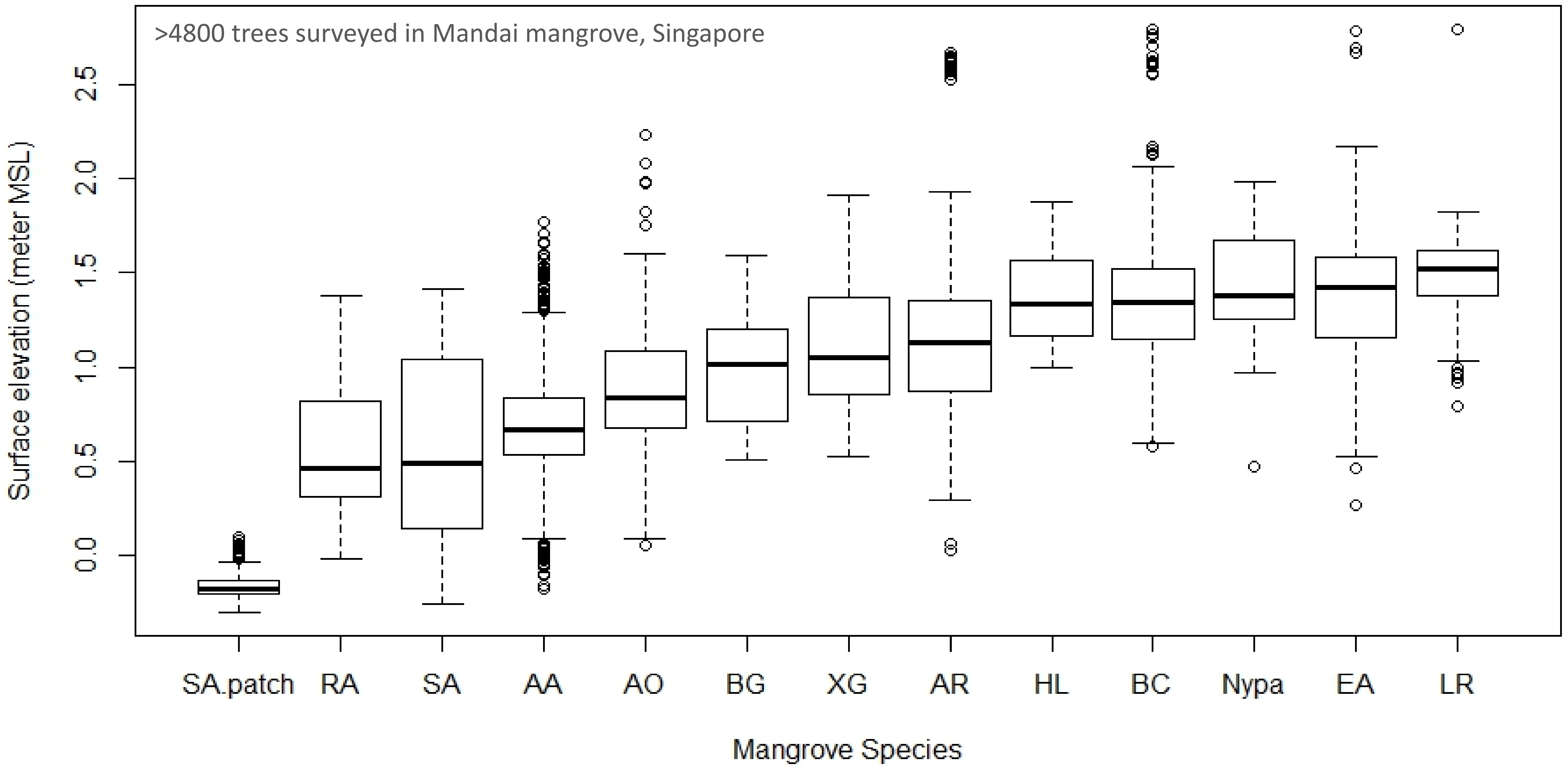
Site elevation controls the amount of flooding a wetland plant experiences

Different species have different tolerances to flooding

We've known this for 100 years!

Watson 1928. *Malayan Forest Records* No. 6

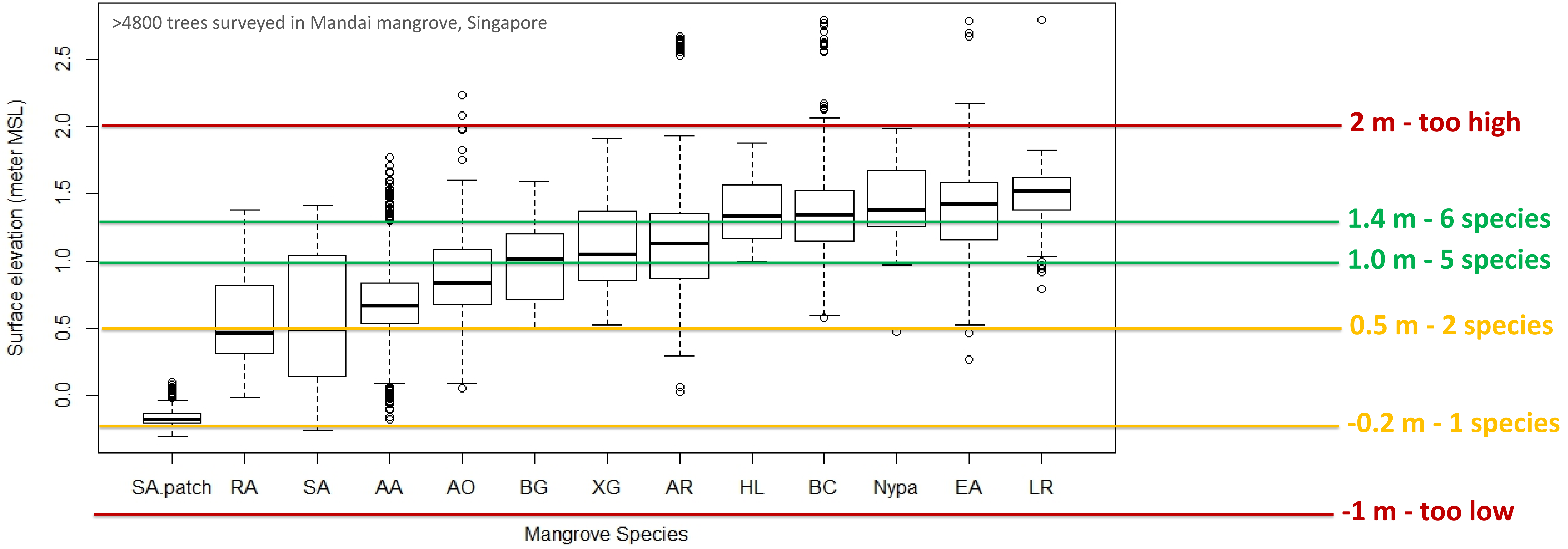
Elevation is key to wetland establishment



Different species grow at different elevations

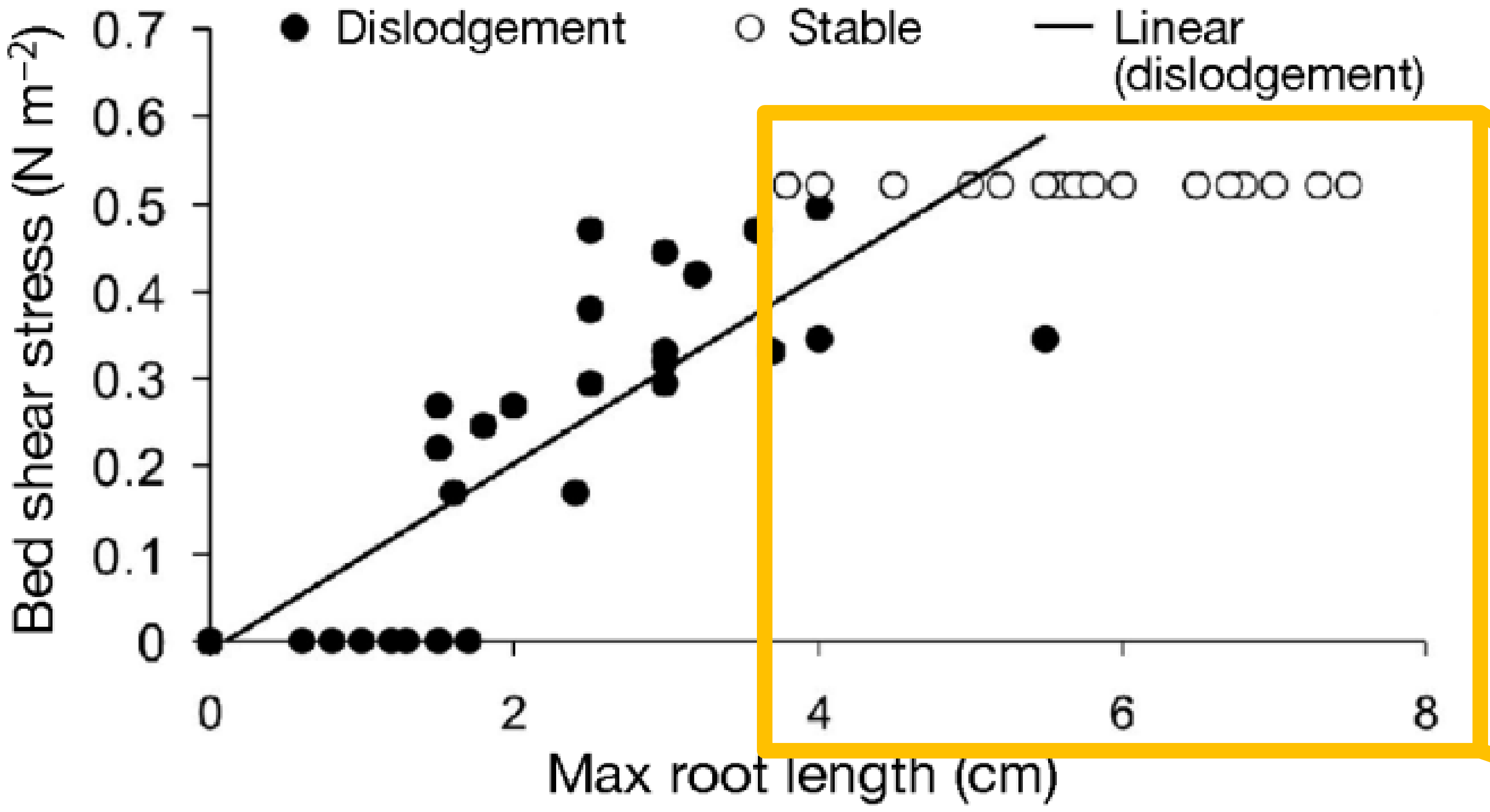
Leong et al. 2018. *Estuarine, Coastal and Shelf Science* 202, 185-192.

Elevation is key to wetland establishment

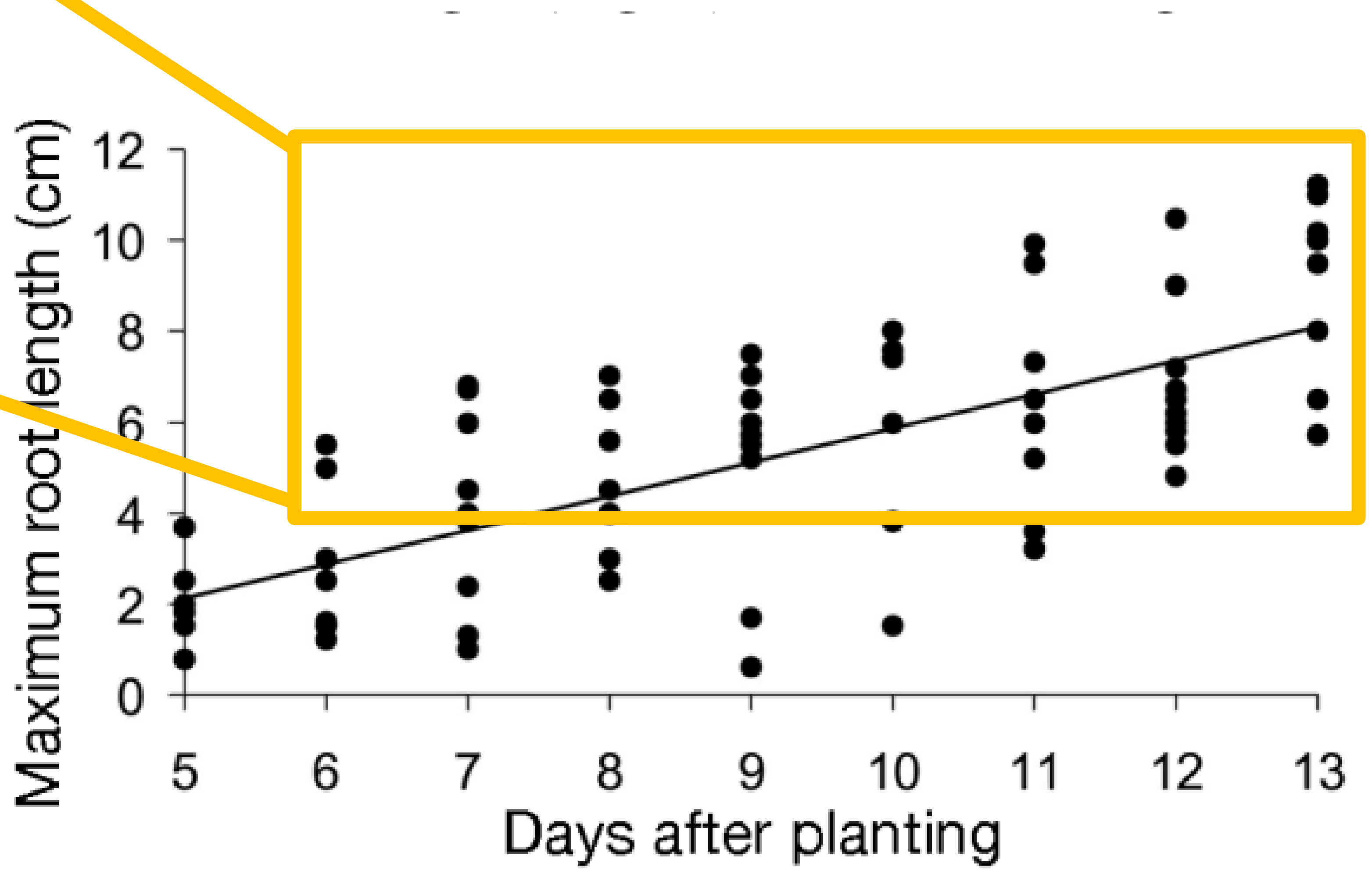


Leong et al. 2018. *Estuarine, Coastal and Shelf Science* 202, 185-192.

Hydrodynamics are important



Plants need a certain root length or else they will get dislodged by regular waves



Storms will dislodge even adult plants

Coastal wetland mapping

Mangroves are very easy to map – very unique (and uniform) spectral response compared to surrounding terrestrial forests

Tidal marshes somewhat easy to map (though grade into other marsh types)

Coral reefs generally easy to map (clear water), though vary in % cover

Seagrasses are the hardest to map, particularly submerged

Some key reviews for coastal wetland remote sensing

Give a wealth of information on:

- Data sensors and sources
- Classification and analysis approaches

Earth-Science Reviews
Volume 238, March 2023, 104337

Remote sensing for cost-effective blue carbon accounting

Martino E. Malerba [a], Micheli Duarte de Paula Costa [a], Daniel A. Friess [b c], Lukas Schuster [d], Mary A. Young [e], David Lagomasino [f], Oscar Serrano [g h], Sharyn M. Hickey [i j k], Paul H. York [l], Michael Rasheed [l], Jonathan S. Lefcheck [m], Ben Radford [i j n], Trisha B. Atwood [o], Daniel Ierodiaconou [e], Peter Macreadie [a]

Ecological Indicators
Volume 117, October 2020, 106560

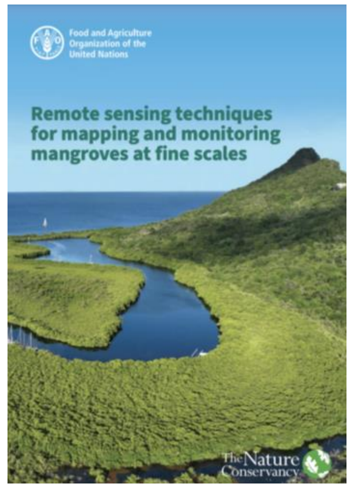
Review

Opportunities for seagrass research derived from remote sensing: A review of current methods

Bijeesh Kozhikkodan Veettil [a b], Raymond D. Ward [c d], Mariana Do Amaral Camara Lima [c], Milica Stankovic [e], Pham Ngoc Hoai [f], Ngo Xuan Quang [g h]

A Review of Spectral Indices for Mangrove Remote Sensing

by Thuong V. Tran [1,2,*], Ruth Reef [1] and Xuan Zhu [1]



remote sensing

Review

Remote Sensing Approaches for Monitoring Mangrove Species, Structure, and Biomass: Opportunities and Challenges

Tien Dat Pham [1,*], Naoto Yokoya [1], Dieu Tien Bui [2], Kunihiko Yoshino [3] and Daniel A. Friess [4]

ENVIRONMENTAL RESEARCH LETTERS

TOPICAL REVIEW • OPEN ACCESS

A review of carbon monitoring in wet carbon systems using remote sensing

Anthony D Campbell[1,2], Temilola Fatoyinbo[1], Sean P Charles[3], Laura L Bourgeau-Chavez[4], Joaquim Goes[5], Helga Gomes[5], Meghan Halabisky[6], James Holmquist[7], Steven Lohrenz[8],

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Advances in Earth observation and machine learning for quantifying blue carbon

Tien Dat Pham [a], Nam Thang Ha [b], Neil Saintilan [a], Andrew Skidmore [a c], Duong Cao Phan [d], Nga Nhu Le [e], Hung Luu Viet [f], Wataru Takeuchi [g], Daniel A. Friess [h]

What data can be used to map marine/coastal wetlands?

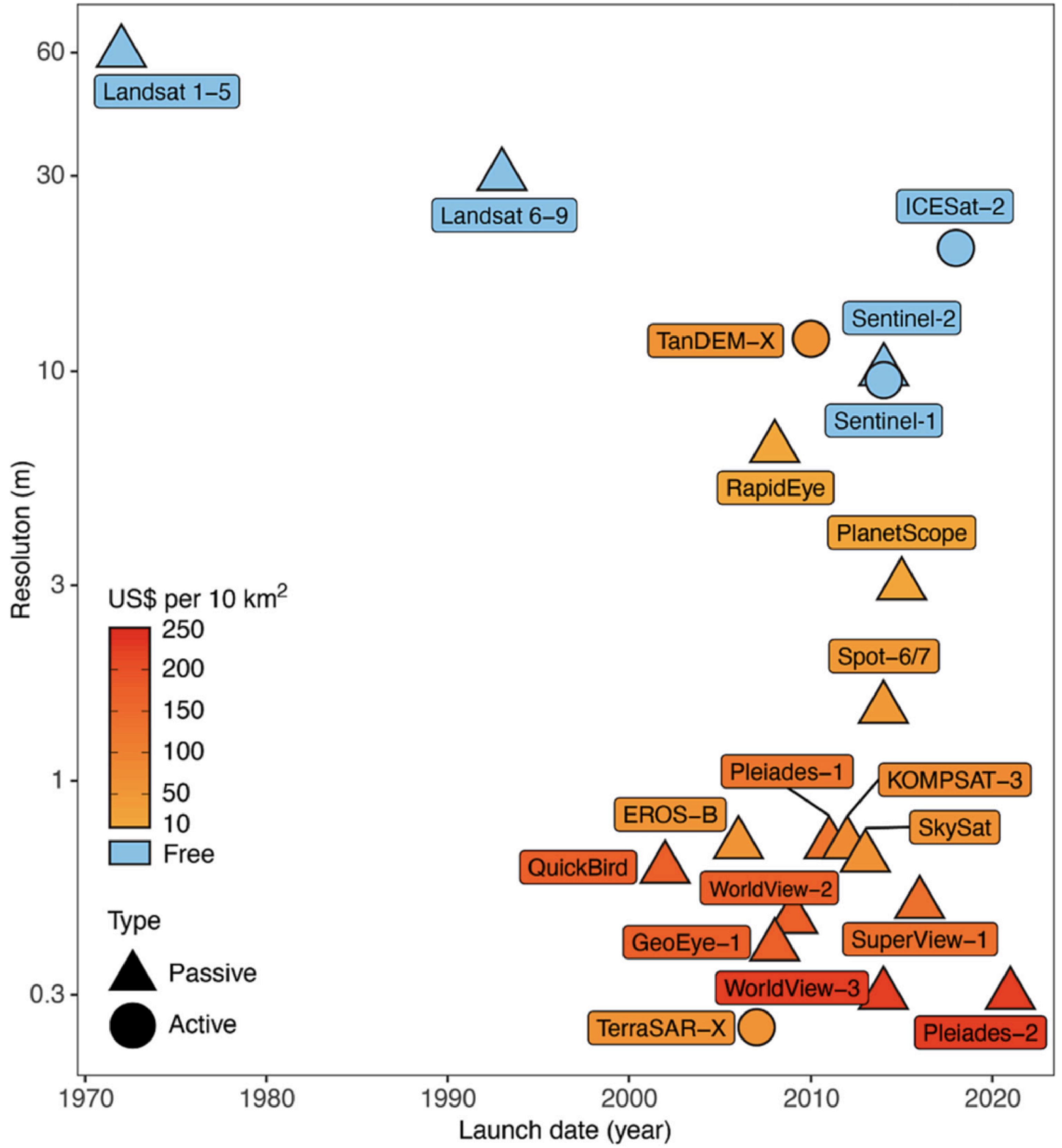
A lot of data sources are used to map wetlands

Often a trade off between spatial scale and temporal scale (launch date)

Trade off between spatial scale and cost

See also Dr. Dronova's talk on Day 1 and yesterday

So how do you choose?



Picking the right data for your task and settings

Technique	Habitat	Small scale (5-10 ha)	Middle scale (100 ha)	Large scale (> 1000 ha)
Landsat sat. (res: 30m)	Mangrove	P/A (inaccurate)	P/A	P/A
	Saltmarsh	P/A (inaccurate)	P/A	P/A
	Seagrass	Not feasible	Not feasible	Not feasible
Sentinel sat. (10m)	Mangrove	P/A, Density, Sp.	P/A, Density, Sp.	P/A, Density, Sp.
	Saltmarsh	P/A, Density, Sp.	P/A, Density, Sp.	P/A, Density, Sp.
	Seagrass	P/A (clear water)	P/A (clear water)	P/A (clear water)
Commercial sat. (< 2m)	Mangrove	P/A, Density, Sp., Height	P/A, Density, Sp., Height	P/A, Density, Sp., Height
	Saltmarsh	P/A, Density, Sp.	P/A, Density, Sp.	P/A, Density, Sp.
	Seagrass	P/A, Sp. (clear water)	P/A, Sp. (clear water)	P/A, Sp. (clear water)
Unmanned aerial vehicles	Mangrove	P/A, Density, Sp., Height	P/A, Density, Sp., Height	Not feasible
	Saltmarsh	P/A, Density, Sp., Height	P/A, Density , **Sp., Height**	Not feasible
	Seagrass	P/A, Sp. (clear water)	P/A, Sp. (clear water)	Not feasible
Seismo-Acoustic	Mangrove	Not feasible	Not feasible	Not feasible
	Saltmarsh	Not feasible	Not feasible	Not feasible
	Seagrass	P/A, Density	P/A, Density	Not feasible
Purpose		Tidal cycles, disturbances, restoration projects	Species distribution, community composition	National carbon inventories

Choosing the best remote sensing approach is dependent on:

- Your task/objectives
- Cost
- Accuracy you wish to achieve
- Ecosystem being monitored
- The scale of your mapping (Small Island States might use different data from large countries)

Recommendations	Specifications	Habitat	Activity
Recommended	User friendly	Mangrove	P/A = Presence/Absence
Intermediate	Cost effective	Saltmarsh	Density = Foliage density
Not recommended	Accuracy and bias	Seagrass	Sp. = Species composition
Not feasible			Height = Vertical extension

Malerba et al. 2023

Picking the right data for your task and settings

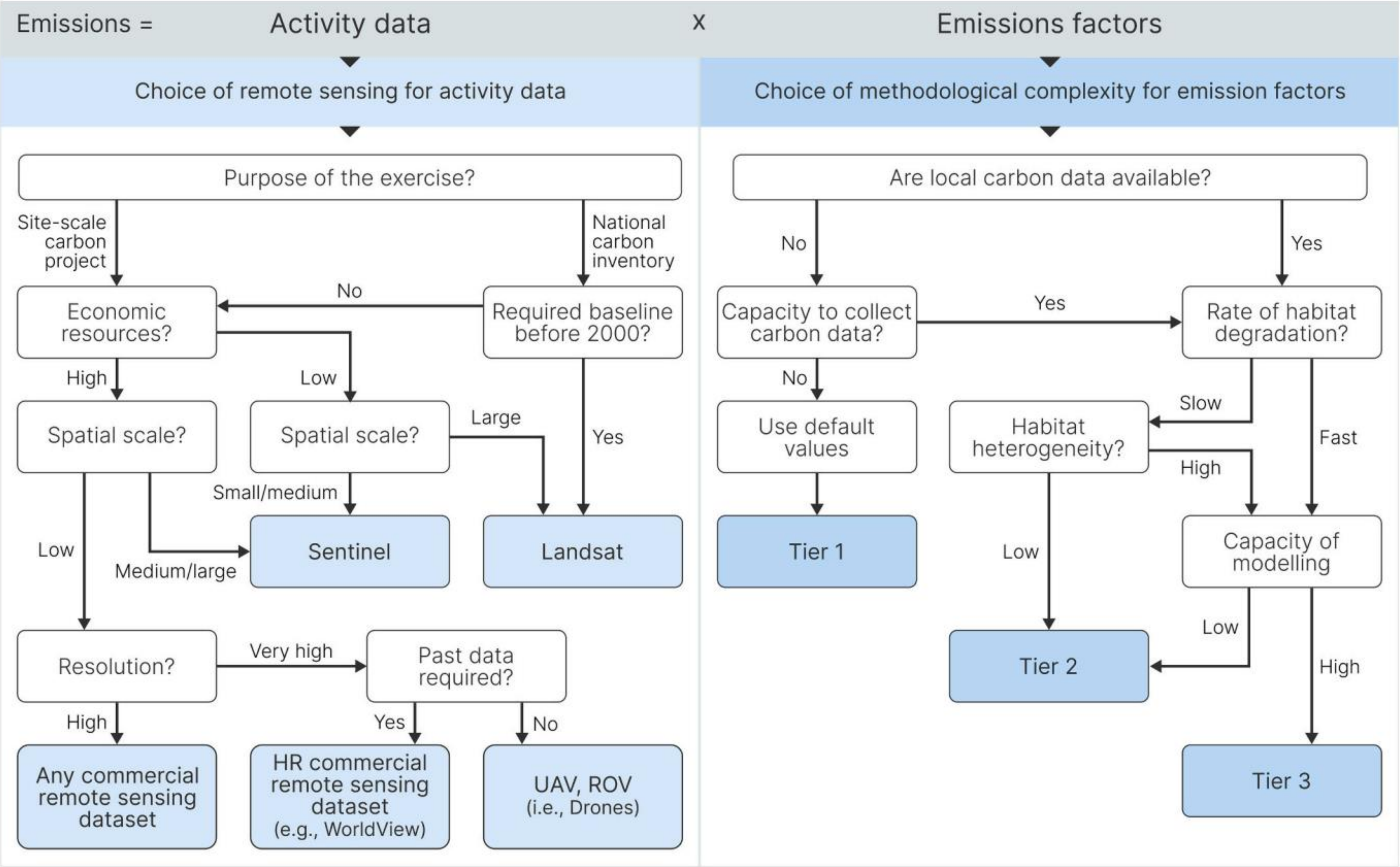


Fig. 4. Decision tree for estimating carbon stocks for BCE following the carbon gain-loss approach. The start of the process (top of diagram) represents Eq. (2). The left-hand side guides the remote sensing technique for estimating activity data, and the right-hand side aids the choice of estimating emission factors.

Malerba et al. 2023

An example workflow for remote sensing for National Greenhouse Gas Inventories

Activity data (land use change) from remote sensing

x emissions factor (carbon implications)

Mapping drivers of wetland loss

Important to quantify drivers, or ‘activity data’ if you want to use for National Greenhouse Gas Inventories etc

Remember:
Land cover is not the same as land use

We can only really map proximate drivers of land use change

Drivers of degradation are extremely difficult to quantify

Many drivers are difficult to attribute to climate change

Mapping elevation in marine/coastal wetlands

Remember those physical gradients? Adding them to our maps can help us better define and differentiate marine/coastal wetlands

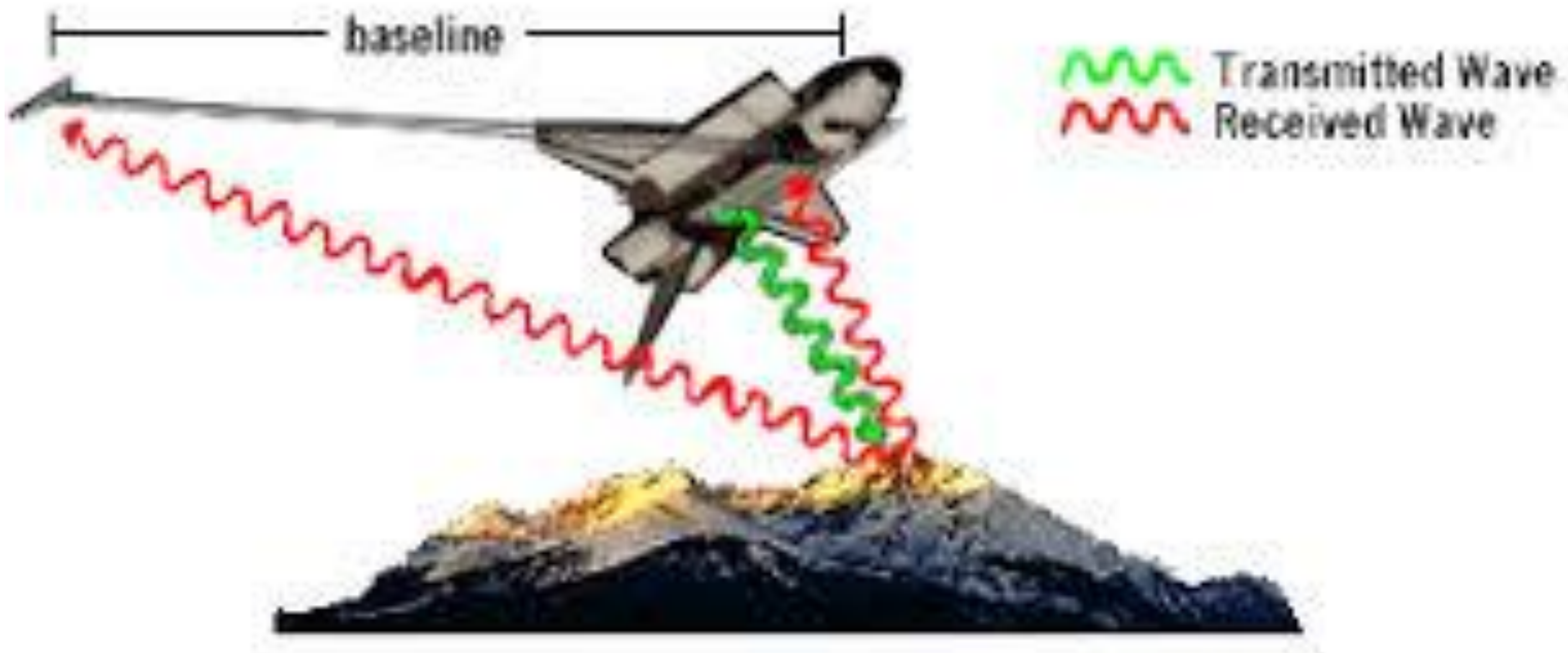
e.g., elevation data with global coverage are freely available from the Shuttle Radar Topography Mission (SRTM). It underpins Google Earth.

Combining datasets similar to the Wetland Intrinsic Potential Tool we saw yesterday

Issues with SRTM:

Data are for 2000 only

Very coarse vertical resolution



Radar signals being transmitted and recieved in the SRTM mission (image not to scale).

JAXA

A good example of national wetland mapping

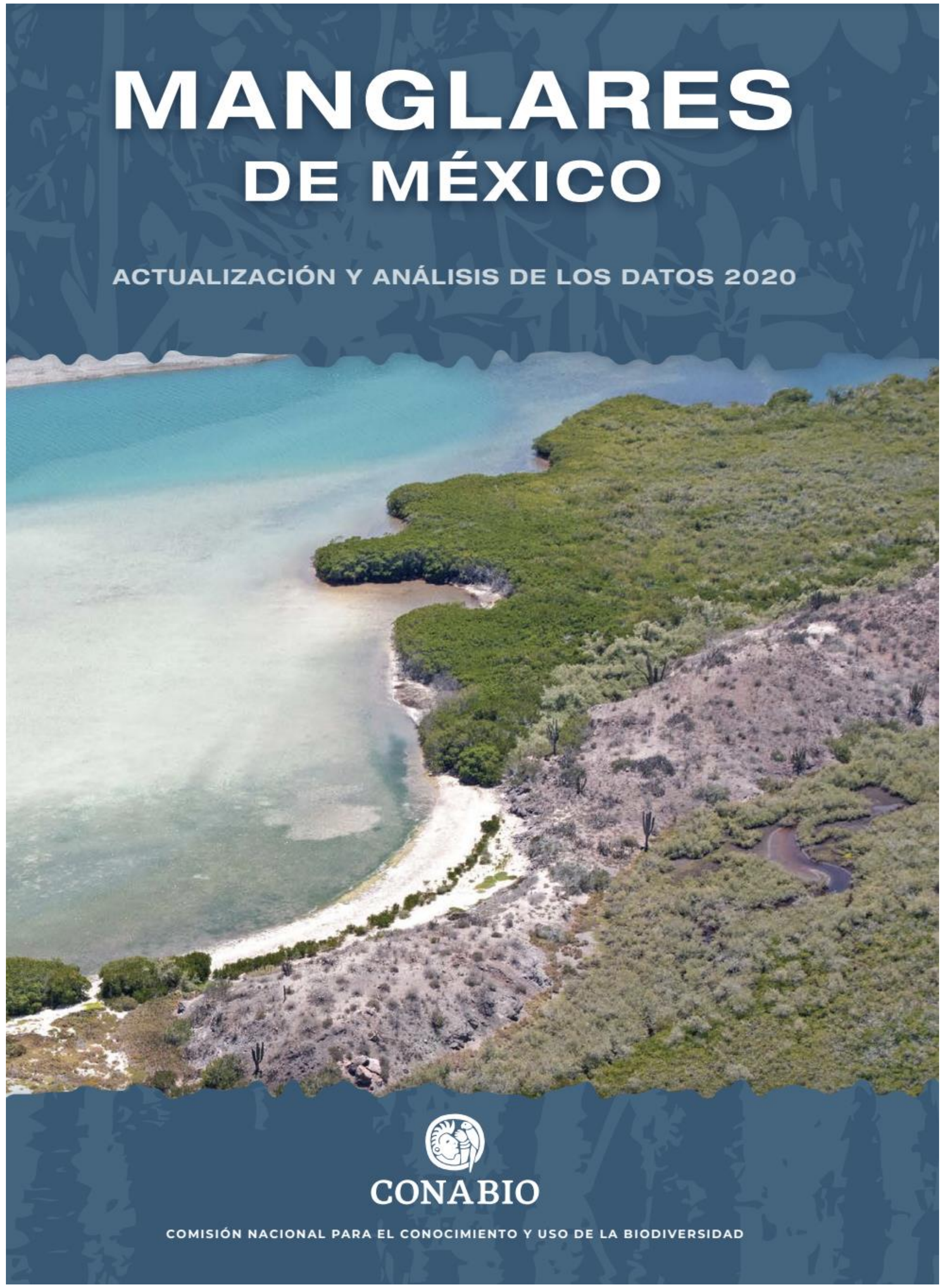
Mangrove mapping in Mexico

Updated every 5 years

Evolving process with accuracy assessment, improvement, changing wetland definitions etc

	Baja California	Michoacán	Jalisco	Colima	Tamaulipas	Guerrero	Sonora	Oaxaca
1970/1980	36	1 788	8 098	6 589	2 831	16 348	10 940	28 501
2005	36	1 543	2 150	3 294	3 281	8 434	11 098	18 522
2010	36	1 420	2 200	3 241	3 099	8 141	11 342	18 611
2015	39	1 438	2 271	3 302	3 327	6 693	12 111	18 690
2020	42	1 450	2 338	3 487	3 664	7 730	12 334	19 673

FIGURA 2.7 Superficie de manglar a nivel estatal y nacional, por cada fecha evaluada.



Summary

Marine/coastal wetlands are diverse and globally relevant

They have historically been lost at huge rates, and are still being lost today

Their loss has important implications for blue carbon and other ecosystem services

Wetland distribution determined by physical processes and tolerances

Mapping and modelling approaches are well established for many wetlands

Mapping potential and approaches differ by ecosystem

Incorporating physical variables (e.g., beyond vegetation mapping) can improve accuracy

Thank you

Questions?

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