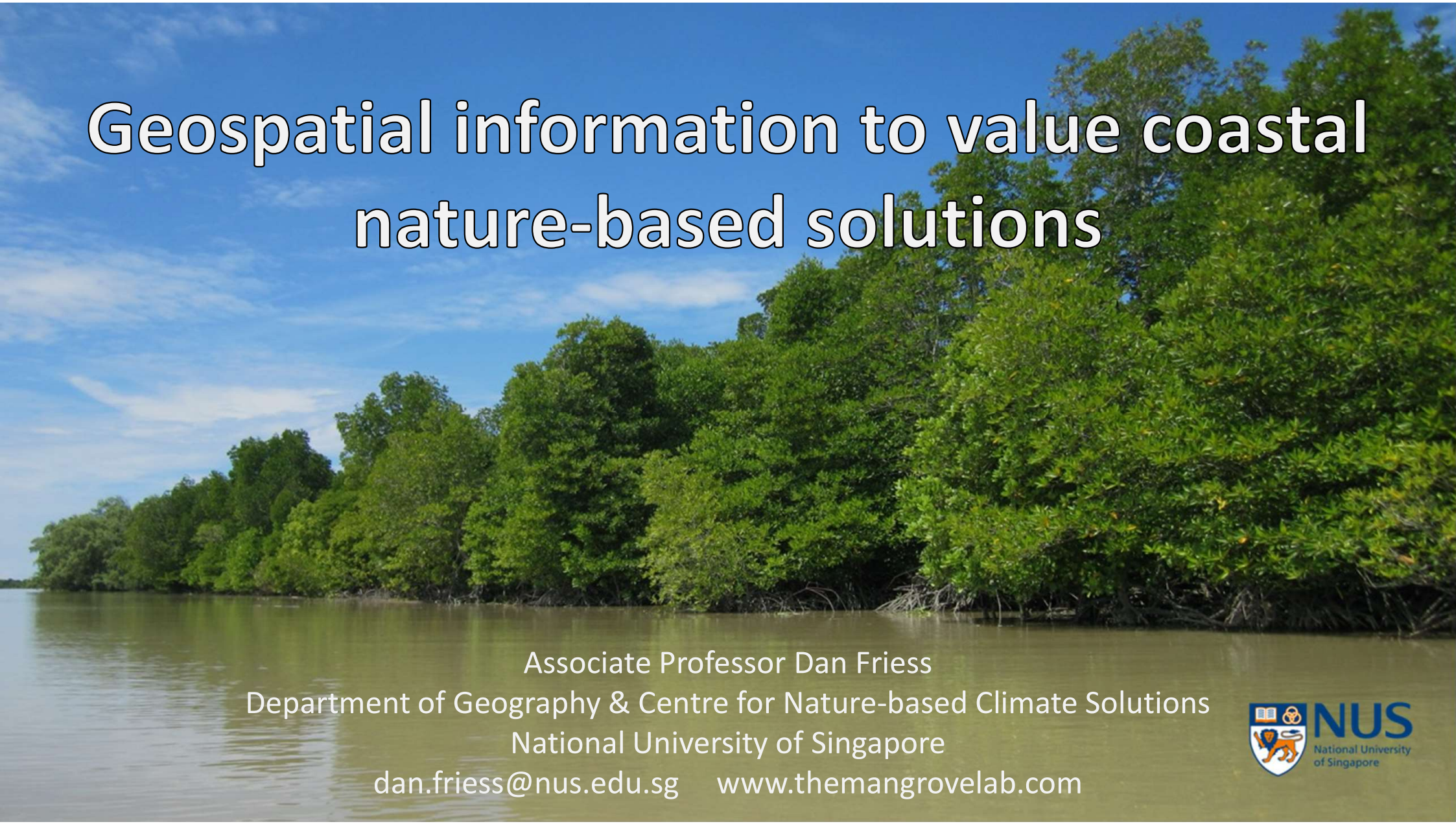
Geospatial information to value coastal nature-based solutions



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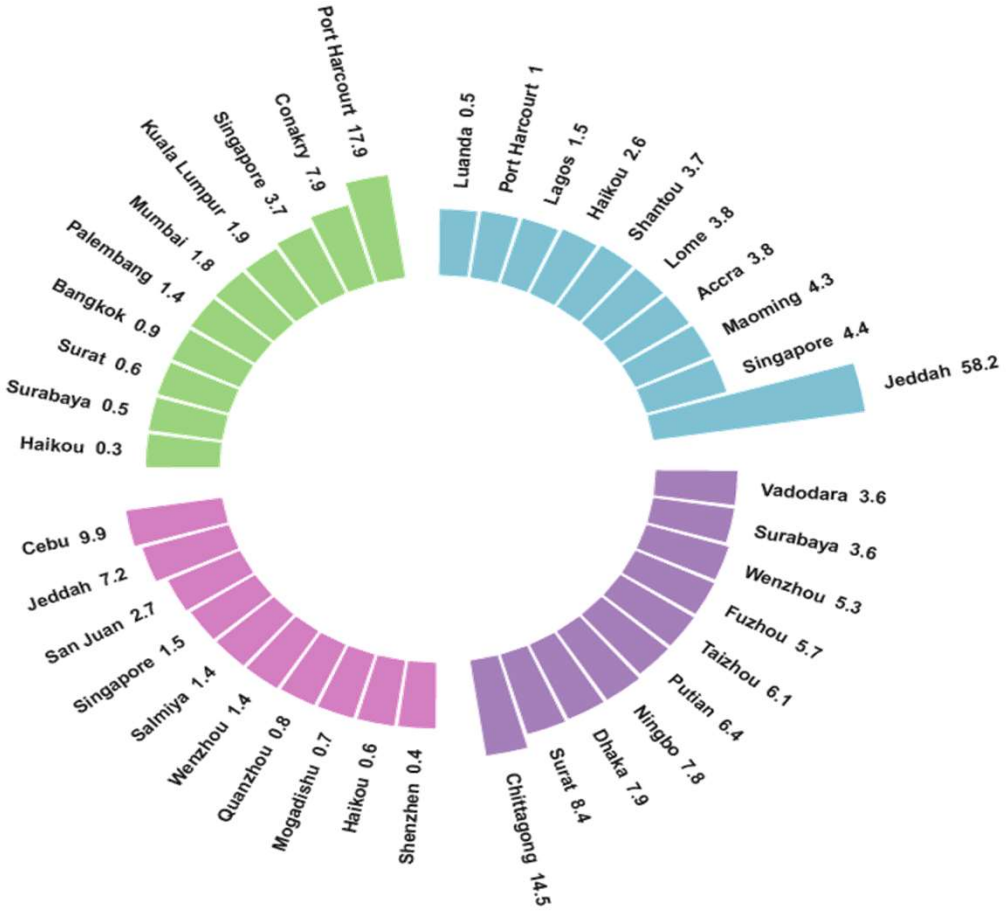
NUS National University of Singapore

Nature-based solutions

Management actions that use nature to address pressing societal challenges such as climate change



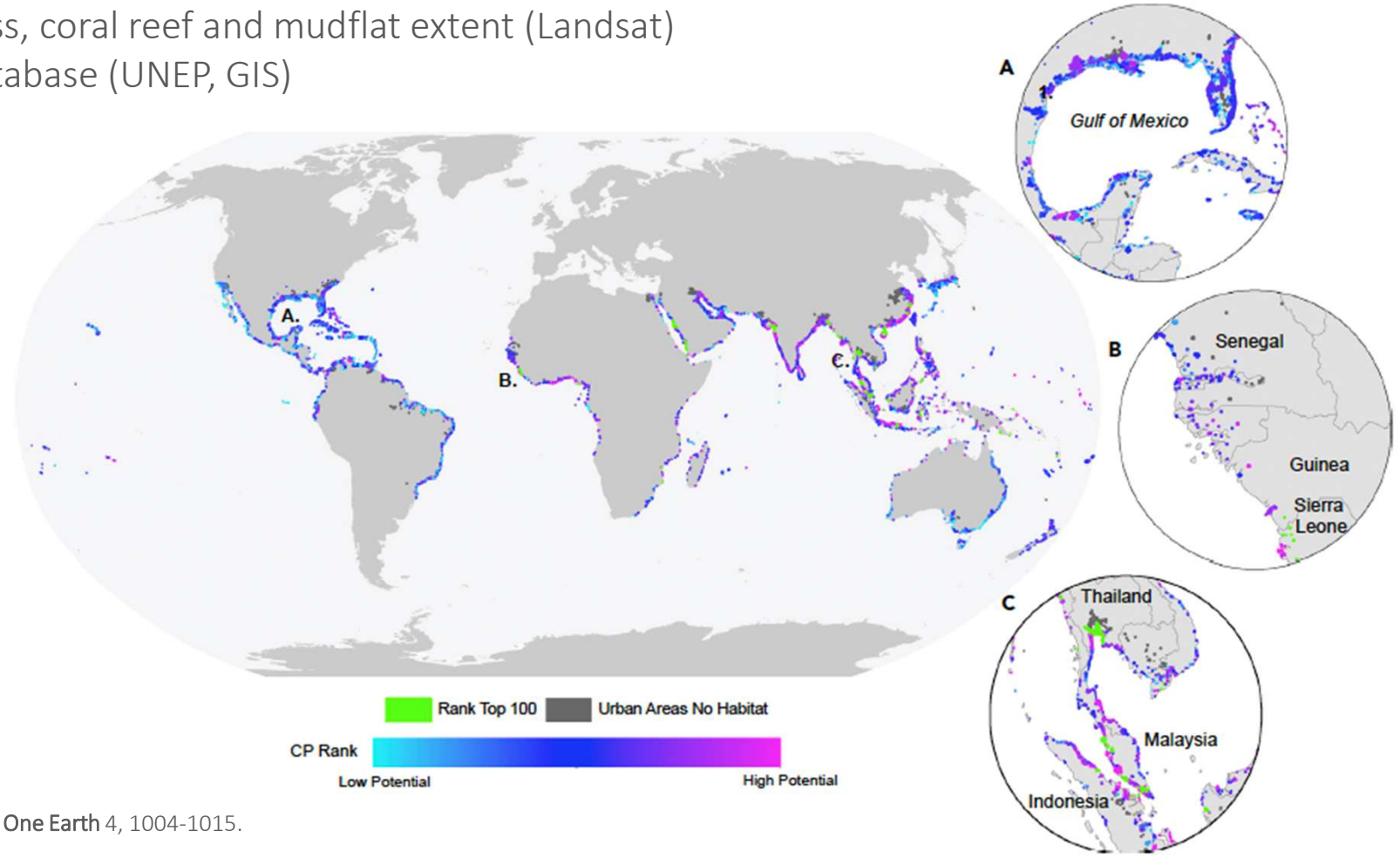
TOP CITIES WITH TROPICAL COASTAL NBS POTENTIAL

1 Jeddah, Saudi Arabia
2 Bangkok, Thailand
3 Kuala Lumpur, Malaysia
4 Port Harcourt, Nigeria
5 Singapore, Singapore
6 Surabaya, Indonesia
7 Manila, Philippines
8 Surat, India
9 Dubai, United Arab Emirates
10 Accra, Ghana

Mazor et al. 2021. **One Earth** 4, 1004-1015.

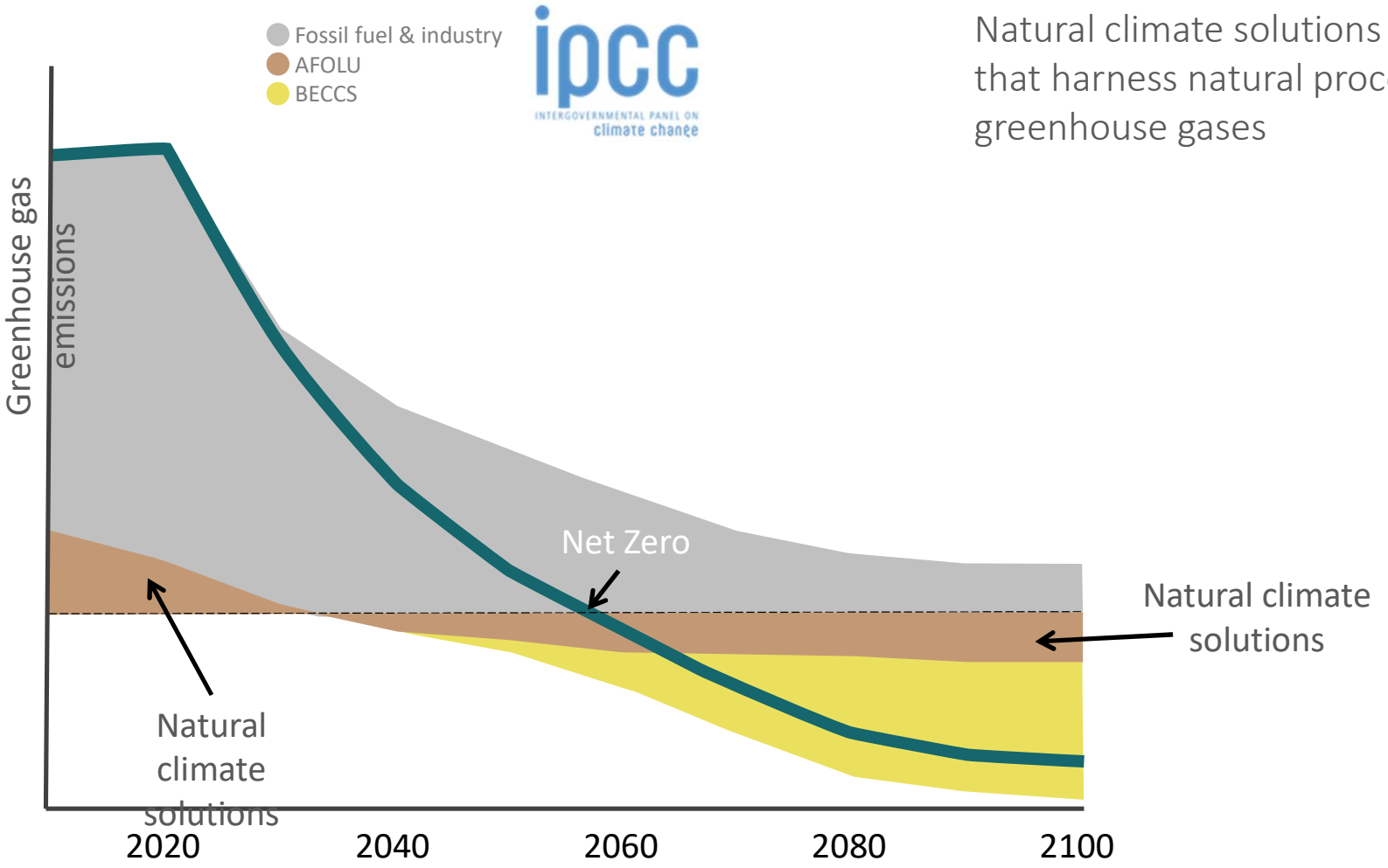
Nature-based solutions

- Coastal urban extent (digital elevation model, NASA global night time light imagery
- Global mangrove, seagrass, coral reef and mudflat extent (Landsat)
- Global protected area database (UNEP, GIS)



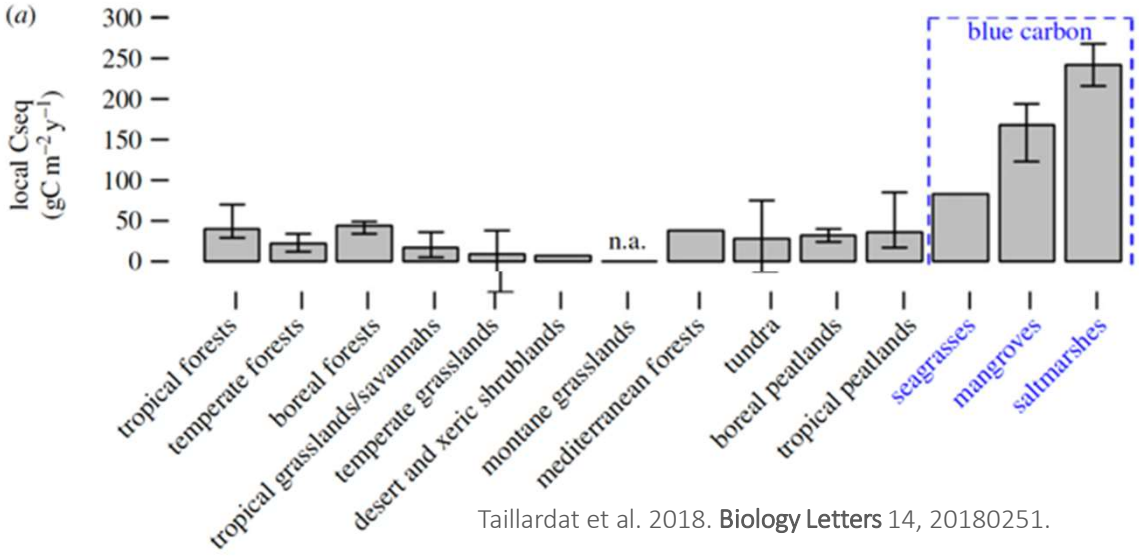
Mazor et al. 2021. **One Earth** 4, 1004-1015.

Natural climate solutions as a subset of NbS



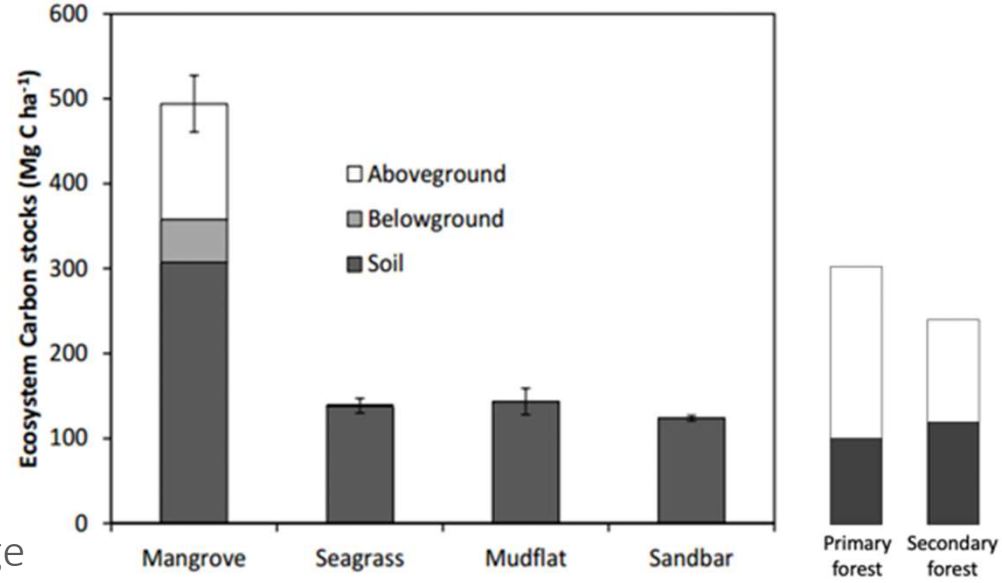
Natural climate solutions are climate mitigation options that harness natural processes to remove or reduce greenhouse gases

Blue carbon as a natural climate solution



Taillardat et al. 2018. Biology Letters 14, 20180251.

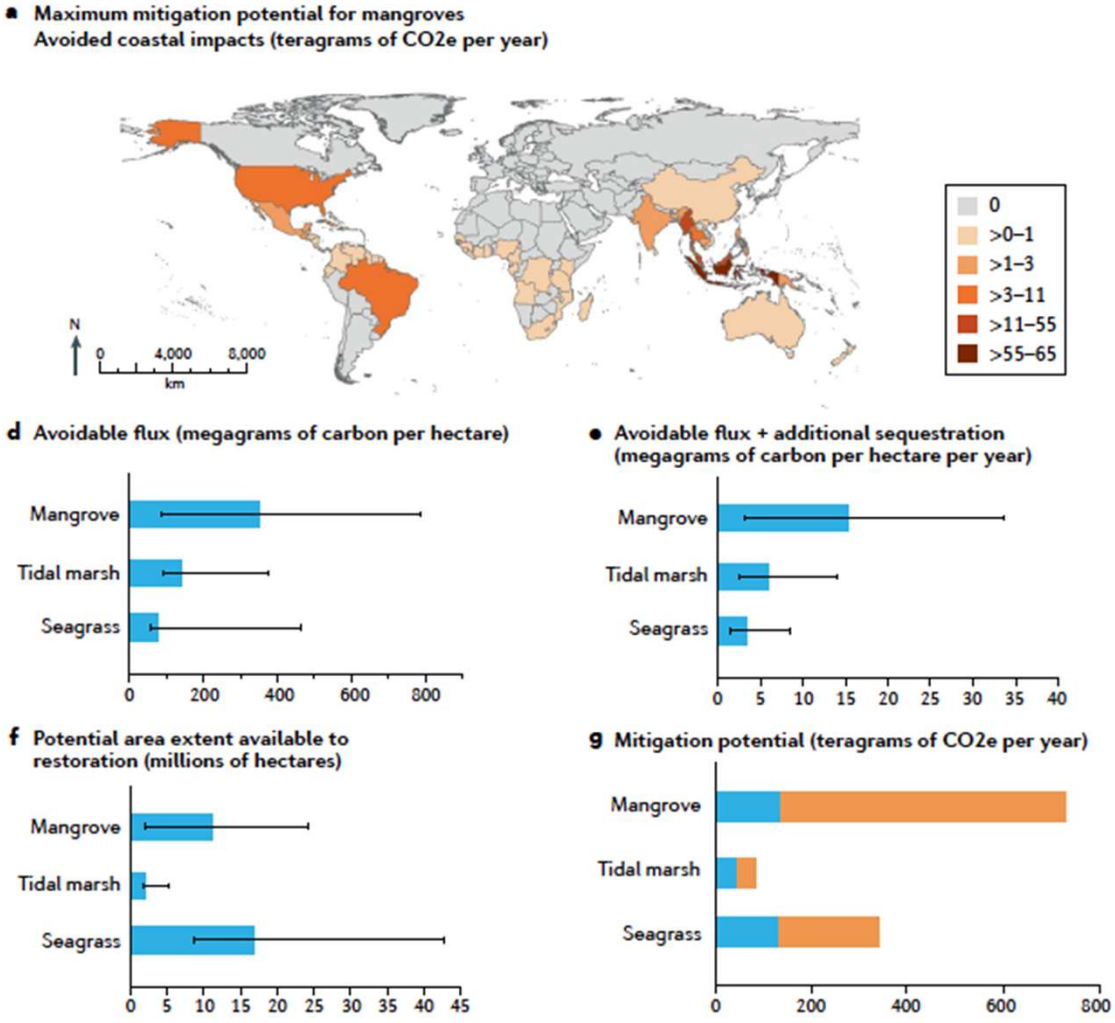
High rates of carbon sequestration



High densities of carbon storage (particularly in the soil)

Phang et al. 2015. Earth Surface Processes and Landforms 40, 1387-1400.

Global distribution of blue carbon



Southeast Asia has fantastic blue carbon potential:

- Highest blue carbon densities
- Largest blue carbon habitat extent
- Highest mitigation potential (because of high rates of habitat loss ☹)

Macreadie et al. 2021. Nature Reviews Earth & Environment 2, 826-839.

Huge global interest in blue carbon

Vox — **Supertrees: Meet Indonesia's carbon guardian**

The Guardian — Blue carbon: how three Australian marine sites lock away 2bn tonnes of CO_2

BBC NEWS — Northern Ireland's marine carbon stores help fight climate change

CHANNEL NEWSASIA — **How Singapore's mangroves can contribute in the battle against climate change**

The Economist — Seagrasses and mangroves can suck carbon from the air

THE STRAITS TIMES — Restoring mangroves to protect coasts, reduce warming

The Sydney Morning Herald — INDEPENDENT. ALWAYS.

'Liver of the oceans': Morrison banks on blue carbon for climate action

Opportunities for national accounting

Important for climate change mitigation at national levels

151 countries have at least 1 blue carbon ecosystem

United Nations Framework Convention on Climate Change

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

- 17 countries where **mangrove** carbon sequestration offsets >5% of national greenhouse gas emissions
- 17 countries where **mangrove** carbon sequestration offsets 1-5% of national greenhouse gas emissions

Taillardat et al. 2018. **Biology Letters** 14, 20180251.

National scale blue carbon efforts in 2020-2021

Explicit blue carbon targets in updated nationally determined contributions

BZ Belize
- Protect 12000 ha mangrove by 2030
- Restore 4000 ha mangrove by 2030

CR Costa Rica
- Protect 100% mangroves by 2025

GN Guinea
- Stabilise mangrove loss by 2030
- Restore 10000 ha per yr

LR Liberia
- Reduce blue carbon emissions 1800 $GgCO_2e$ 2030
- Restore 35% of degraded wetlands 2030

AE UNITED ARAB EMIRATES
- Plant 30 million mangroves 2030
- Protect 20% of mangroves + seagrasses 2030

LK SRI LANKA
- Restore 1000 ha mangrove 2030

SC SEYCHELLES
- Protect 50% mangroves + seagrasses 2025
- Protect 100% mangroves + seagrasses 2030
- Establish long term monitoring 2025
- National blue carbon inventory 2025

SL Sierra leone
- Restore and manage
- 5000 ha mangrove

WS Samoa
- Expand mangrove area by 5% 2030

Other national ambitions

ID INDONESIA
- Aim for blue carbon in next NDC

PG Papua new Guinea
- Incorporate blue carbon into NDC accounting by 2025

PH Philippines
- National Protection and Preservation of Mangrove Forest Act in Senate

US usa
- Blue Carbon for our Planet Act in the Senate

How will countries measure their blue carbon?

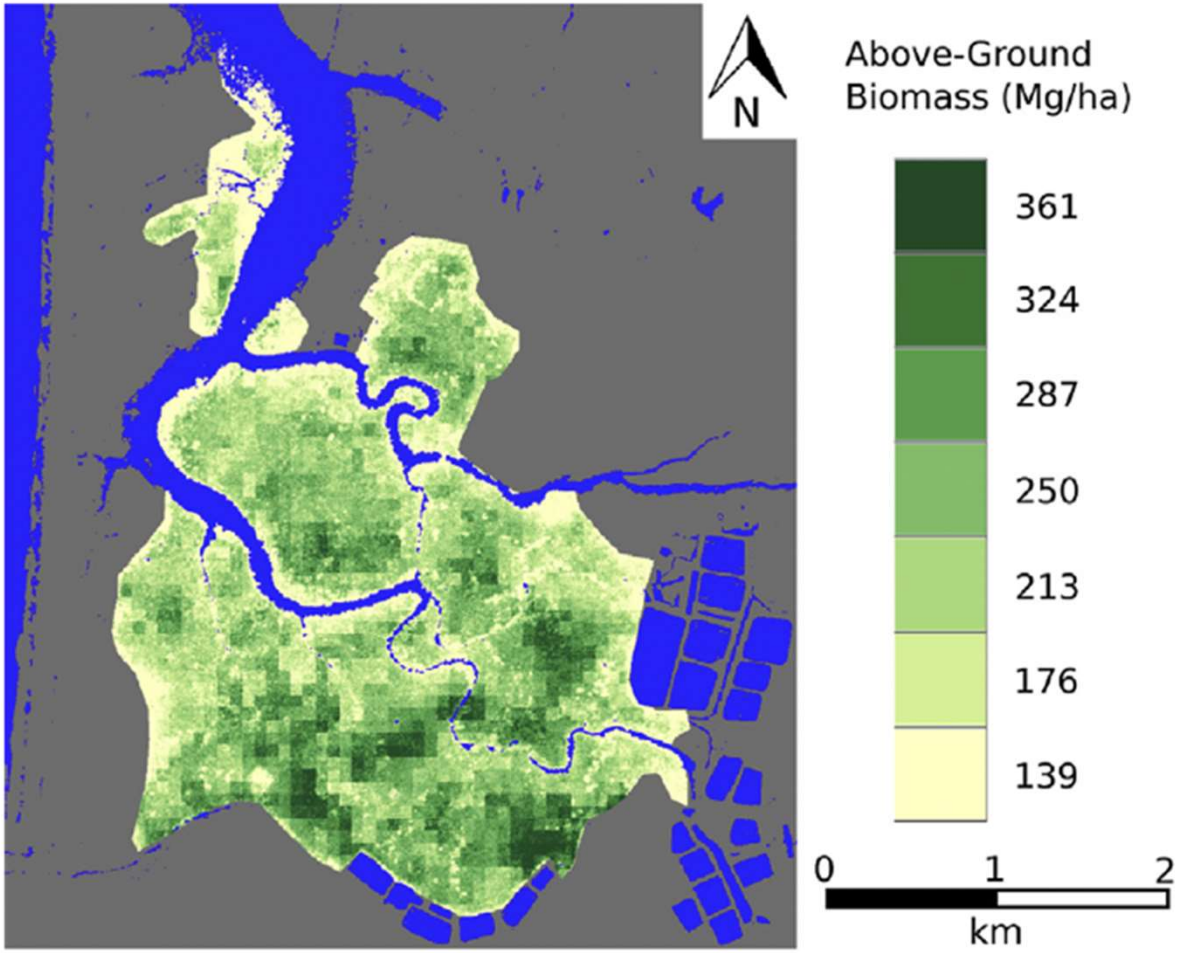
IPCC 2006 greenhouse gas inventory tiering system

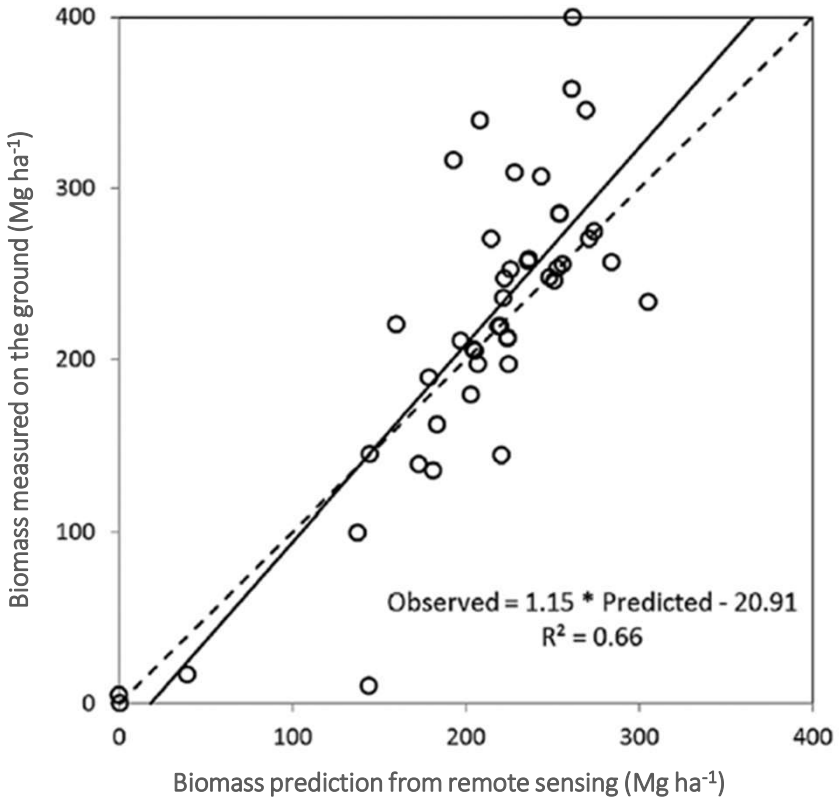
TIER 1 – international average values

TIER 2 – national/regional average values

TIER 3 – local measurements (often field-based for blue carbon, with many limitations)

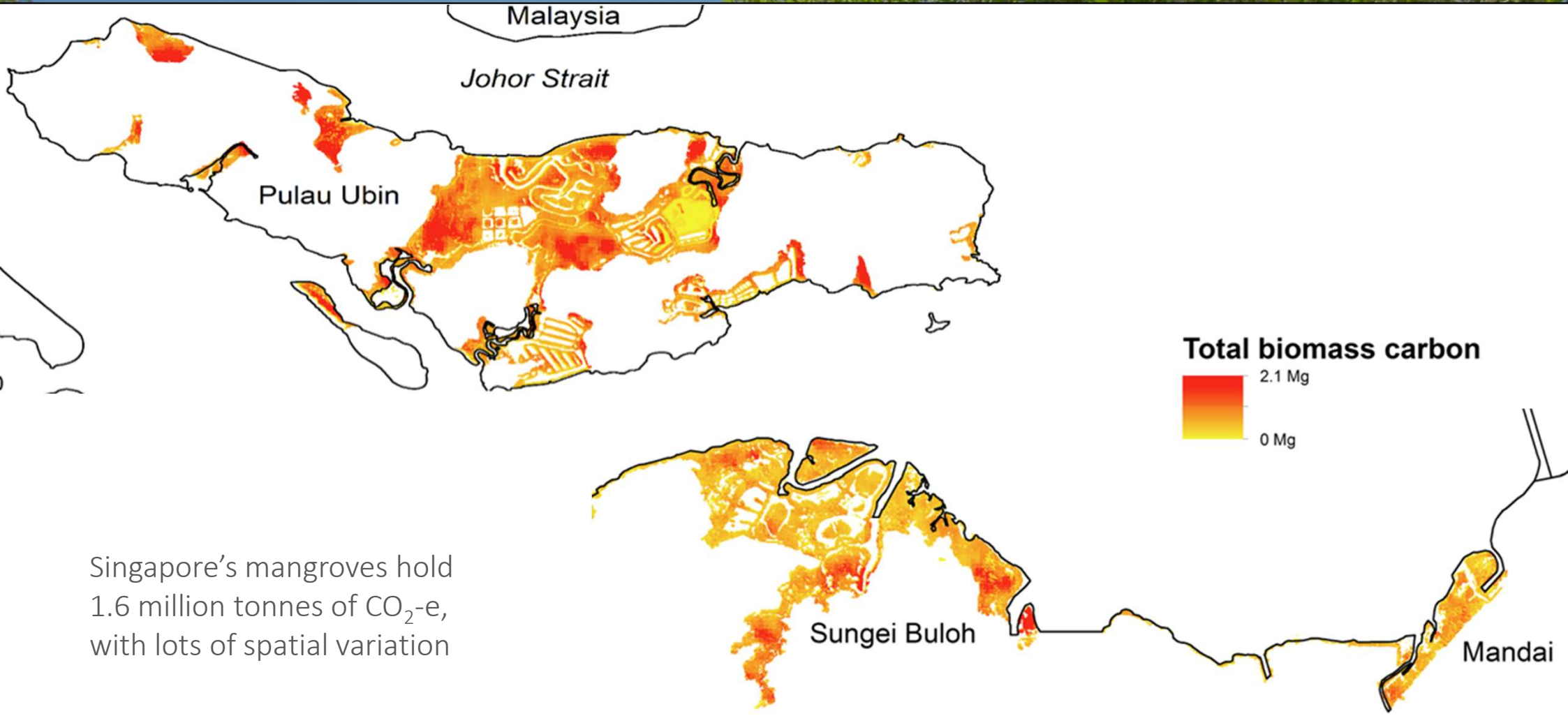
Remote sensing approaches to measure blue carbon





Jachowski et al. 2013. **Applied Geography** 45, 311-321.

National accounting

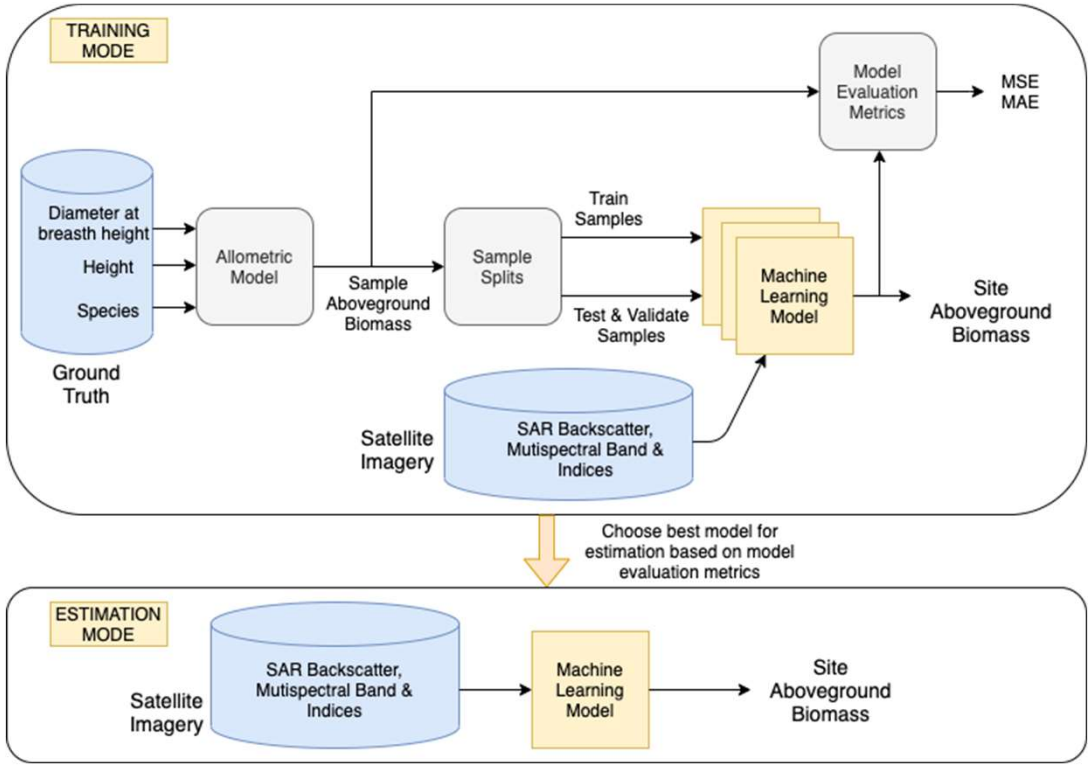


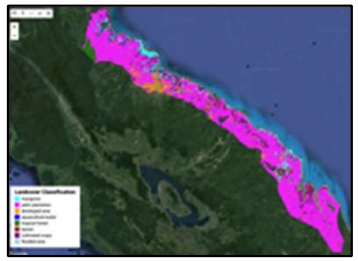
Singapore's mangroves hold 1.6 million tonnes of CO_2-e, with lots of spatial variation

Friess et al. 2016. Urban Ecosystems 19, 795-810

Commercialization of optical remote sensing

Commercial and national carbon accounting will need rapid and repeatable remote sensing





Perform Deforestation Analysis

Ground Control Collection Plan

Integration of Very High Resolution Satellite Imagery

AGB and BGB Estimates

Improves accuracy of the entire project

Reduces verification timelines

Significantly lowers costs

KUMI ANALYTICS

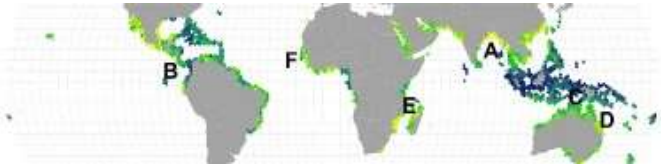
Moving towards valuation

To value carbon we need to know where it is + how much there is + market price

Question: how much mangrove blue carbon could potentially be traded, and where?

WHERE IS THE CARBON?

ABOVEGROUND BIOMASS, SRTM data (Simard et al. 2019)



SOIL CARBON MODEL (Sanderman et al. 2018)

WHAT MANGROVES QUALIFY FOR OFFSETTING?

MANGROVE DEFORESTATION from Landsat (Goldberg et al. 2020)

WHAT ARE THE ECONOMICS OF BLUE CARBON PROJECTS?

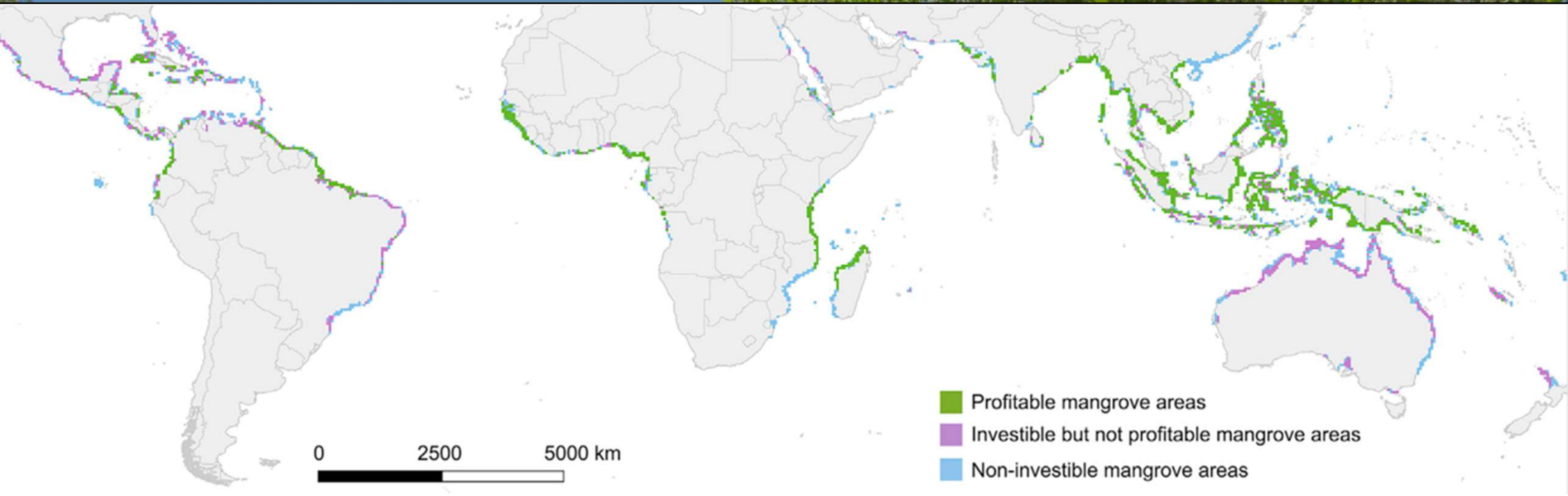
- Establishment and maintenance (weighted by GDP)
- Carbon price of US$1-100 per tonne of C
- Net Present Value

=

Investible mangroves = under threat and suitable for carbon credits, break even against cost

Profitable mangroves = financially viable under carbon credit prices (high C density/low cost)

Opportunities for carbon credits



Zeng et al. 2021. **Current Biology** 31, 1737-1743.

Investible mangroves = under threat and suitable for carbon credits

Profitable mangroves = financially viable under current carbon credit prices

~20% of the world's mangroves could be protected by carbon financing

10% would be profitable

Worth at least 1.2 billion USD per year

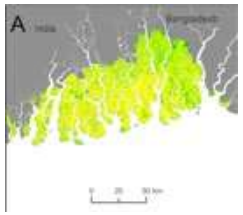
What would facilitate monitoring and valuing carbon?

Best practice, approved workflows

- Approved datasets on national/global habitat extent
- Approved methodologies for remote sensing of biomass

New measurements required

- Measuring and valuing the soil
- Measuring carbon stocks is easy, measuring fluxes is not



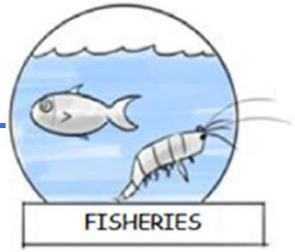
Data sharing and continuity

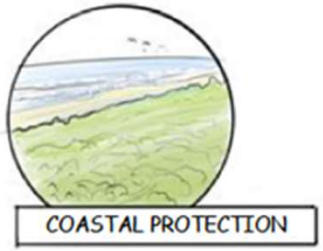
- Sharing of data beyond optical imagery (e.g., LiDAR, hydrodynamic models) and platforms
- Continuation of new programmes suitable for blue carbon monitoring (e.g., NASA GEDI)

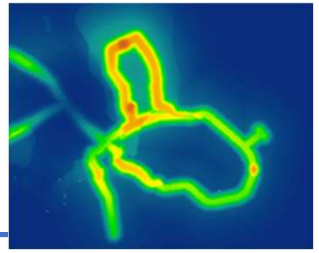
geospace sea

But the coastal zone is more than just blue carbon

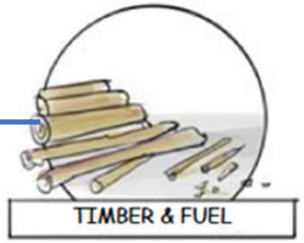
Fisheries demand

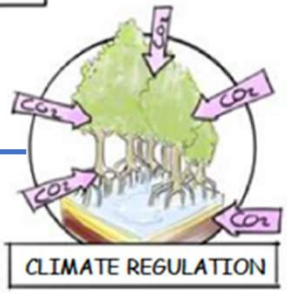


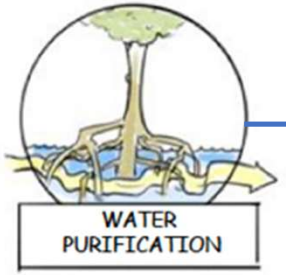


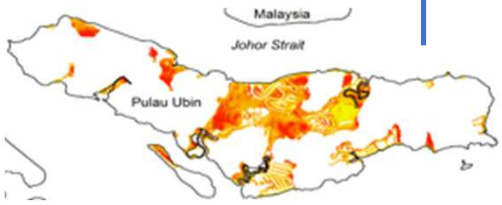


Visitation

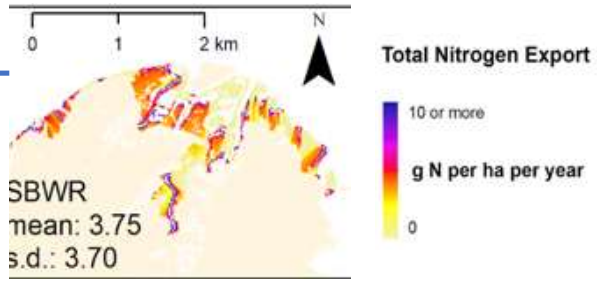








Biomass



Nutrient regulation

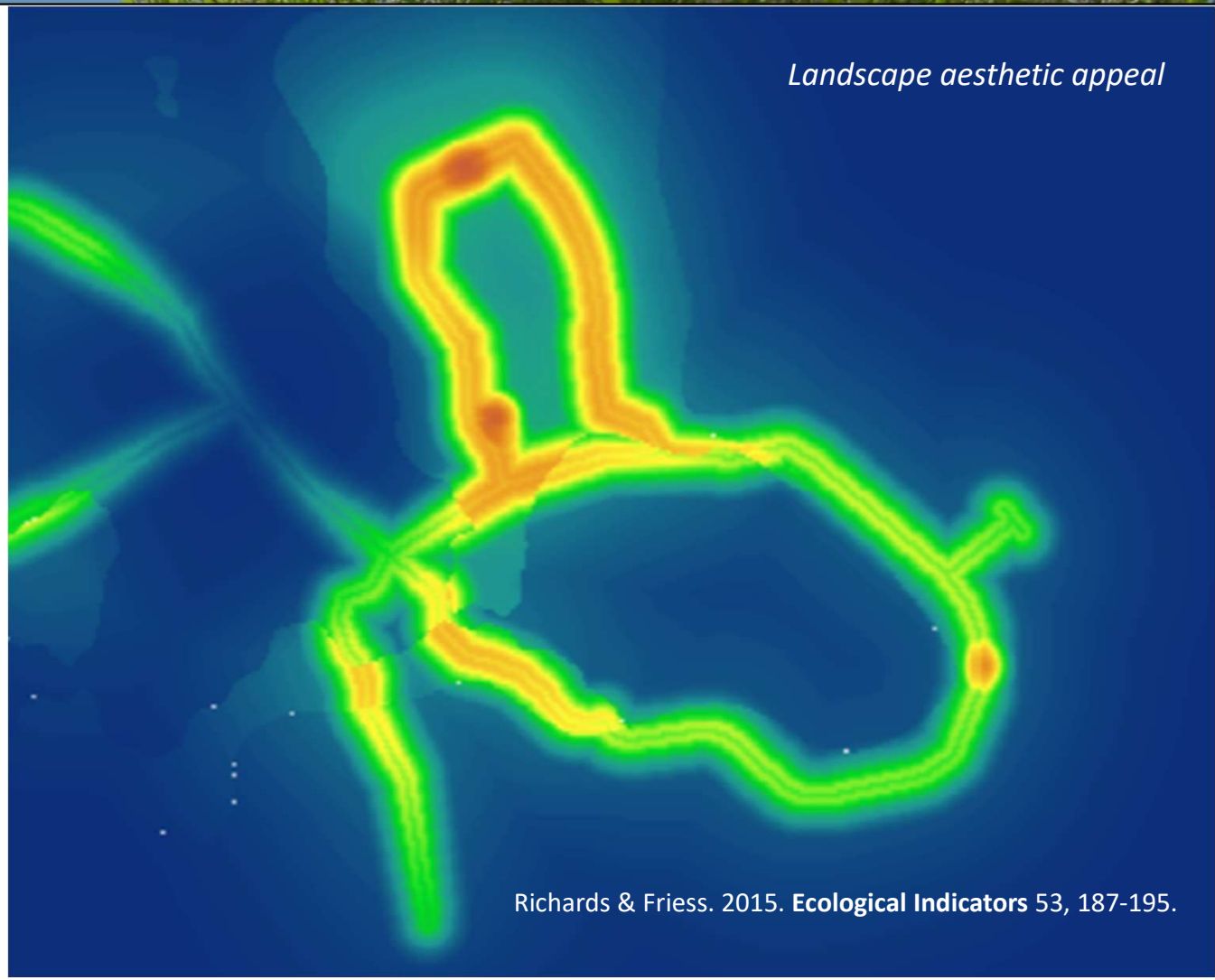
But the coastal zone is more than just blue carbon

Using social media, photo classification and MAXENT to model hotspots for cultural ecosystem services:

- Landscape aesthetics
- Biodiversity appreciation
- Social recreation (selfies!)

Can be used for any ecosystem

flickr



Summary

- Nature-based solutions are now an important part of our coastal development and climate change mitigation
- Geospatial data are a key input into understanding their distribution, quantity and value
- There are many constraints, including approved methodologies and data repositories
- Other geospatial sources beyond satellite imagery (e.g., social media) are needed in order to understand the full value of our coastal habitats beyond carbon

Thank you

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