XVIII
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International Water Resources Association (IWRA)
Beijing, China | September 11-15, 2023

Challenges and Response Strategies for Water Resources in Islands and Coastal Regions Under Changing Climate

中山大學
SUN YAT-SEN UNIVERSITY

Land-water-emissions nexus along coastal blue carbon ecosystems

Zhangcai Qin, Prof.

In close collaboration with

Tingting Li	Chinese Academy of Sciences
Fan Wang	Sun Yat-sen University
Xiaosong Zhao	Chinese Academy of Sciences
Liye Zhu	Sun Yat-sen University
Xudong Zhu	Xiamen University

XVIII World Water Congress
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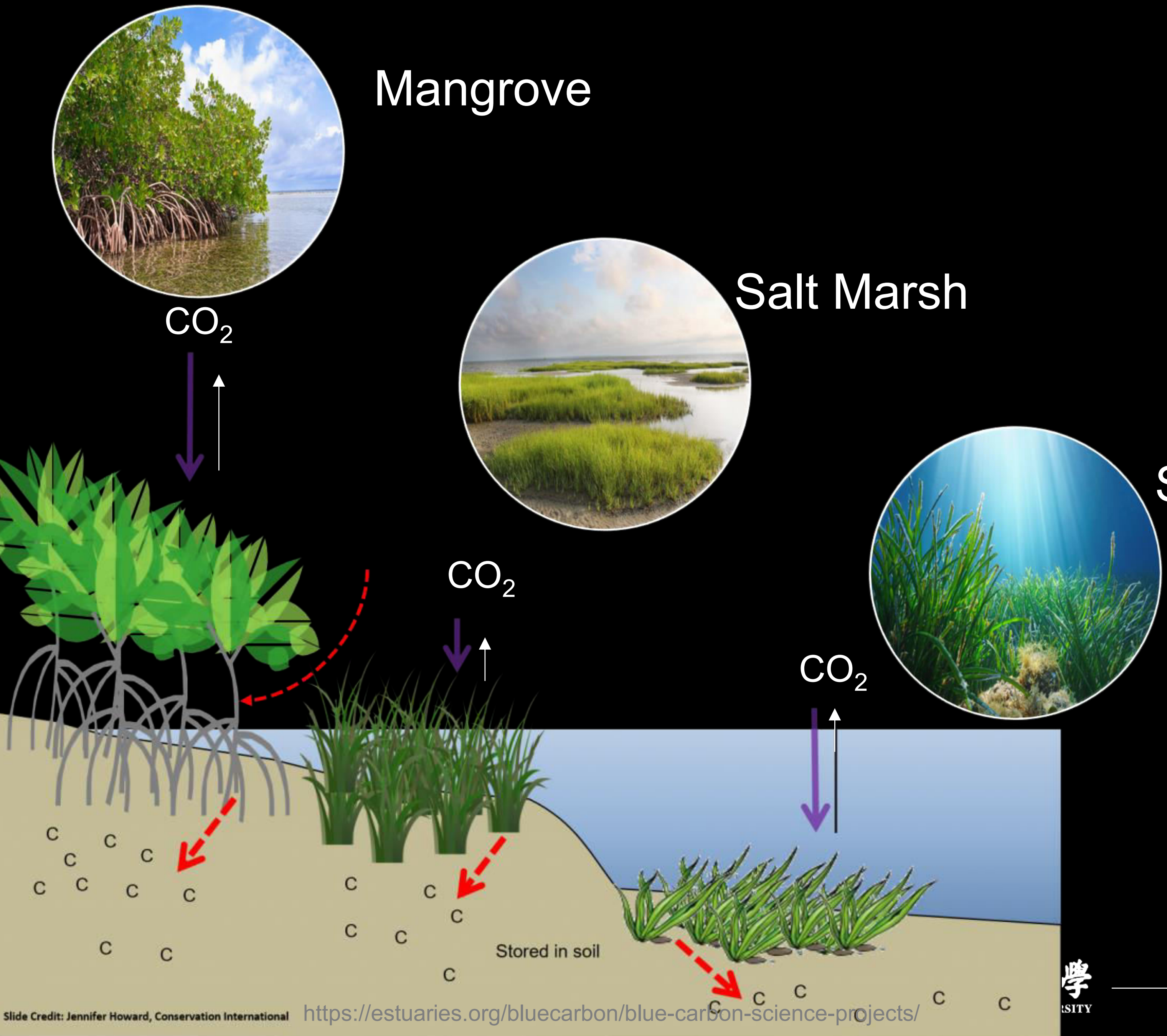
Coastal blue carbon ecosystems

Macreadie P, et al., Blue carbon as a natural climate solution. **Nature reviews earth & environment**. 2021, 2, pages826–839

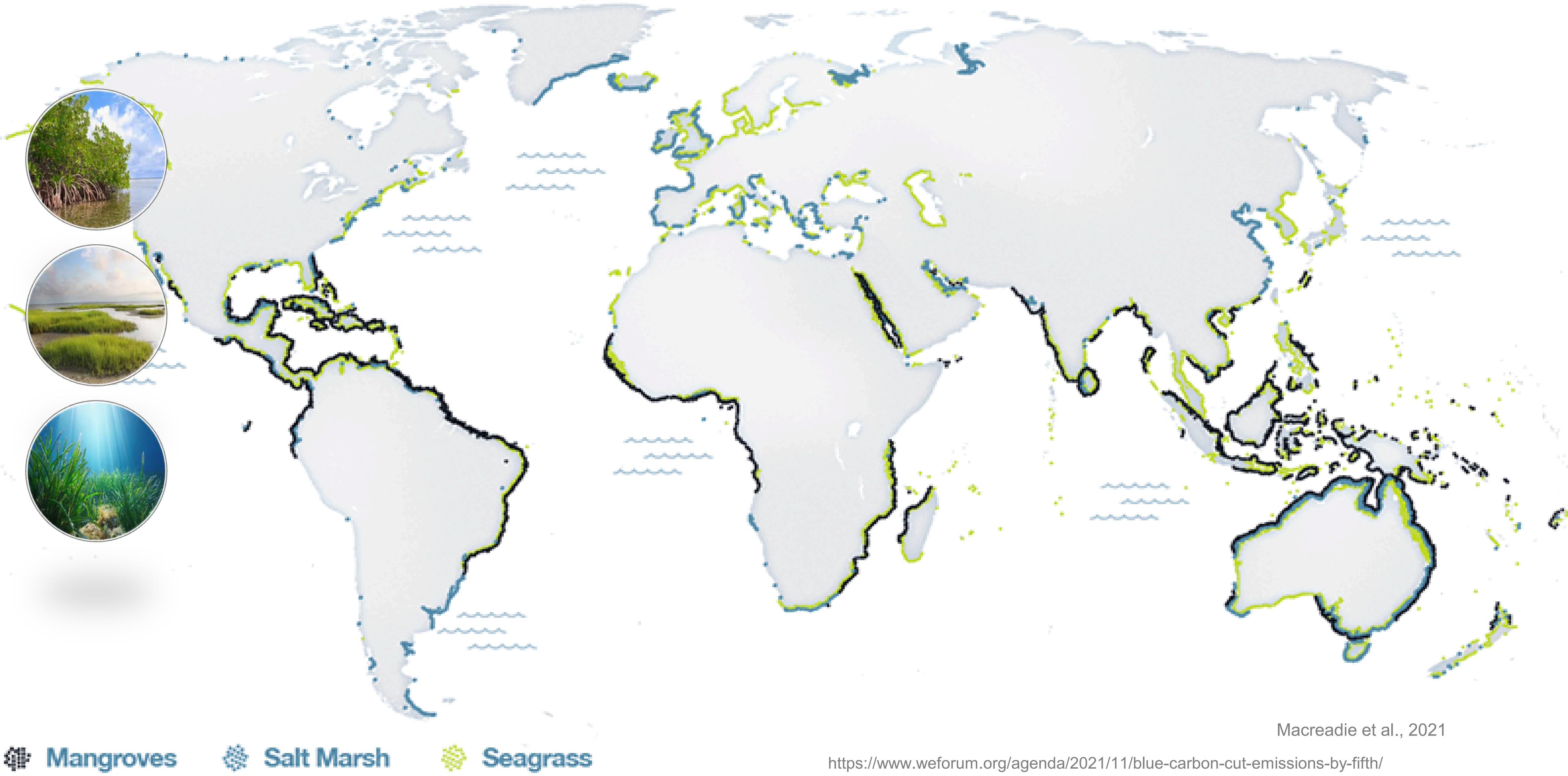
CAPTURE ATMOSPHERIC CO_2 30-50 TIMES FASTER THAN TERRESTRIAL FORESTS



Terrestrial forest

Slide Credit: Jennifer Howard, Conservation International https://estuaries.org/bluecarbon/blue-carbon-science-projects/

Global Distribution of **Blue Carbon Ecosystems**



Macreadie et al., 2021

https://www.weforum.org/agenda/2021/11/blue-carbon-cut-emissions-by-fifth/

Global Distribution of Blue Carbon Ecosystems

- ~48% of C sequestration to long-term sediment storage across the entire ocean occurs within just 2% of the area hosting BCE
- >30 Pg C across ~(36-185) M ha
- ~3% of global emission offset by BCE conservation
- >50% of world population lives within 200km of the coast, drawn to the services provided by these ecosystems

Mangroves Salt Marsh Seagrass

Macreadie et al., 2021

https://www.weforum.org/agenda/2021/11/blue-carbon-cut-emissions-by-fifth/

Global Distribution of Blue Carbon Ecosystems

Recreation

BCEs are targeted by birdwatchers and fishers. In two popular bays, seagrasses provided a non-market value of $33.1 million to recreational fishing, whereas tidal marshes and mangroves provided $158 per visit

Coastal protection

BCEs can reduce wave energy by 37–71%, providing $2.7 billion in value in avoided damages to coastal property:

BCE	$ million
Seagrass	82.7
Tidal marsh	702
Mangrove	1,870

Fisheries enhancement

BCEs provided 61% of diet for coastal fish targeted by fishers. BCEs enhanced fish abundance relative to unvegetated areas:

	Number of fish per hectare per year	$ million
Seagrass	55,589	31.5
Tidal marsh	1,712	
Mangrove	19,234	14.9

Mangroves Salt Marsh Seagrass

Macreadie et al., 2021

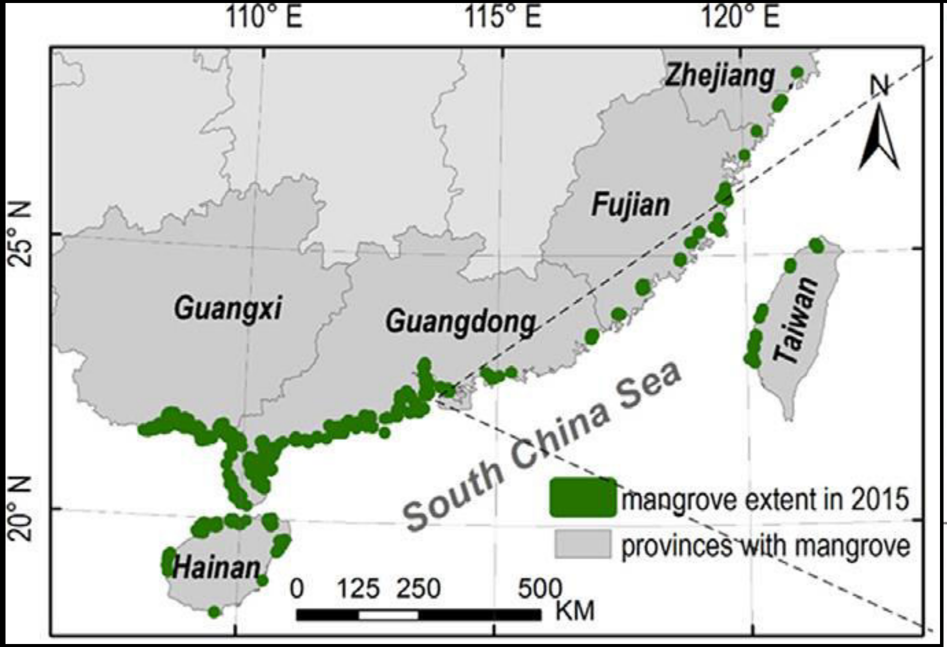
https://www.weforum.org/agenda/2021/11/blue-carbon-cut-emissions-by-fifth/

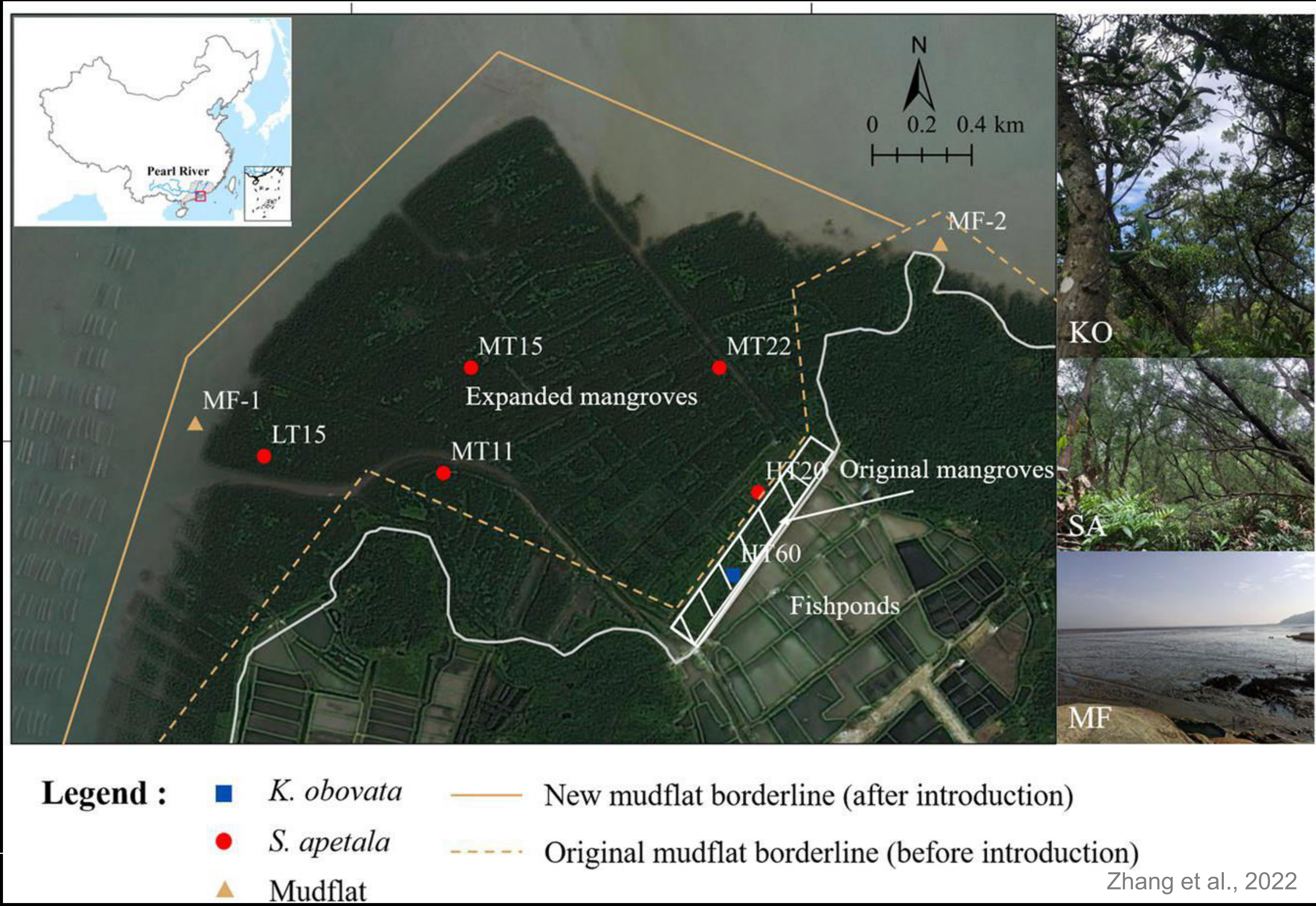
Carbon sinks and emissions

Zhang Z, Wang Y, Zhu Y, He K, Li T, Mishra U, Peng Y, Wang F, Yu L, Zhao X, Zhu L, Zhu X, **Qin Z***. Carbon sequestration in soil and biomass under native and non-native mangrove ecosystems, ***Plant and Soil***, 2022. 479, 61-76.

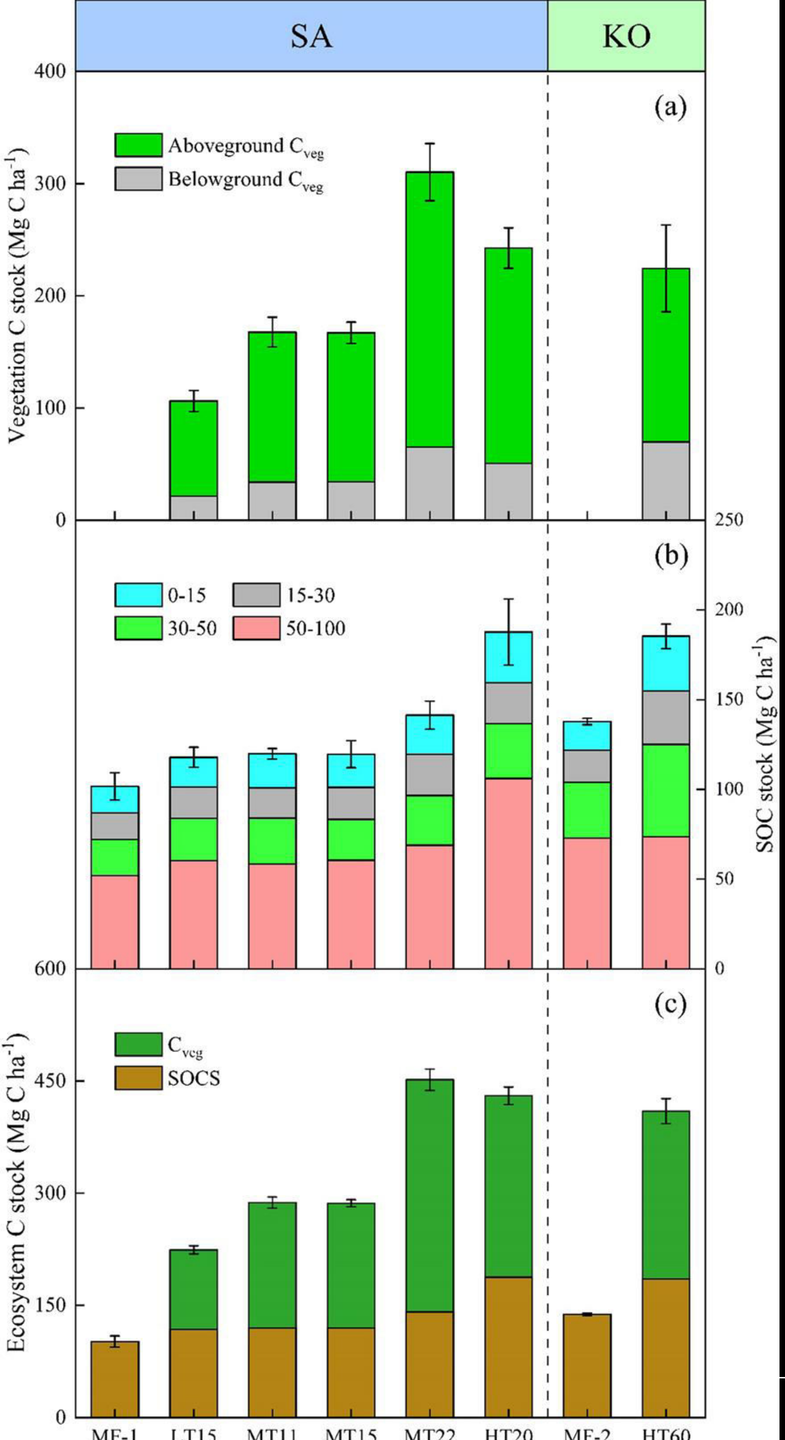
Zhu X, Sun C, **Qin Z**. Drought-Induced Salinity Enhancement Weakens Mangrove Greenhouse Gas Cycling. ***Journal of Geophysical Research: Biogeosciences***. 2021, 126(8):e2021JG006416.

Mangrove carbon dynamics

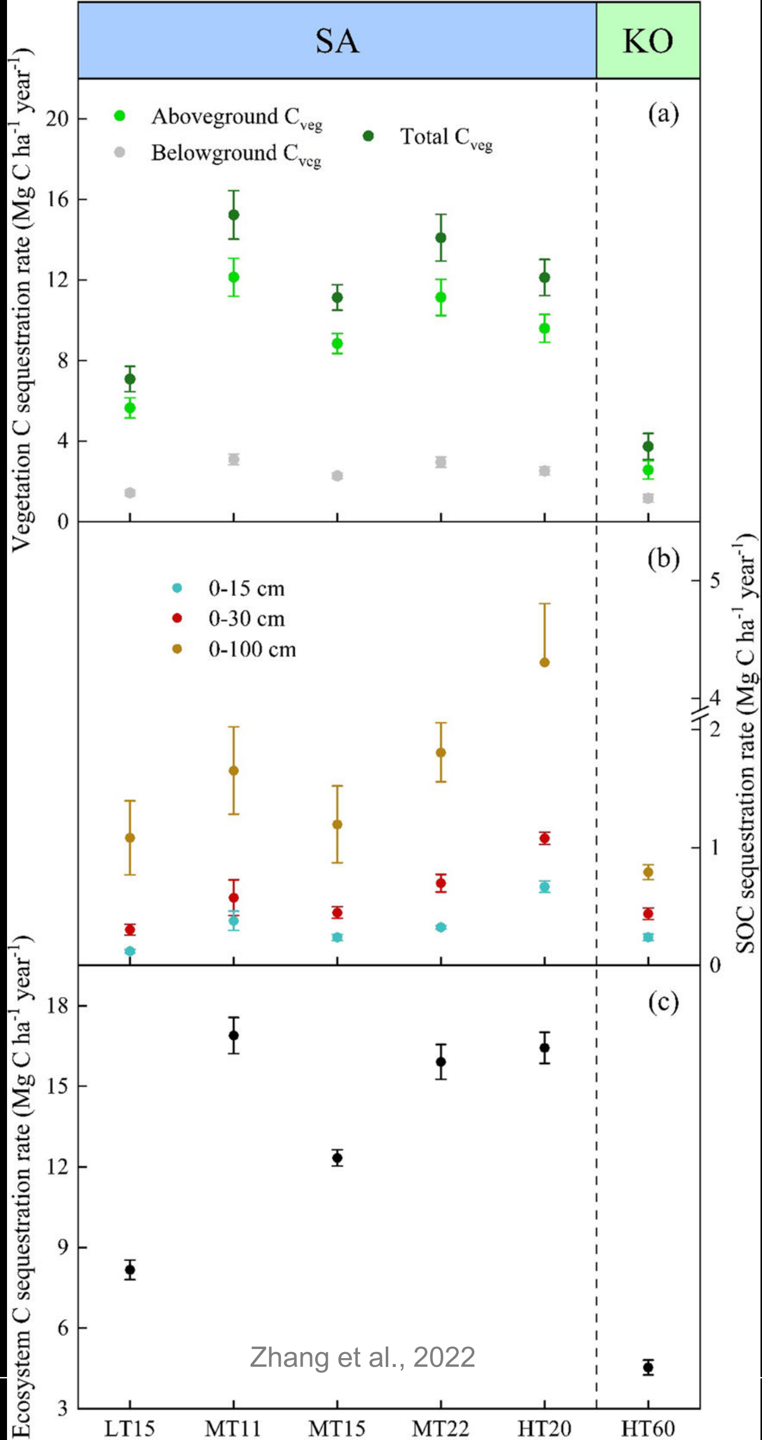




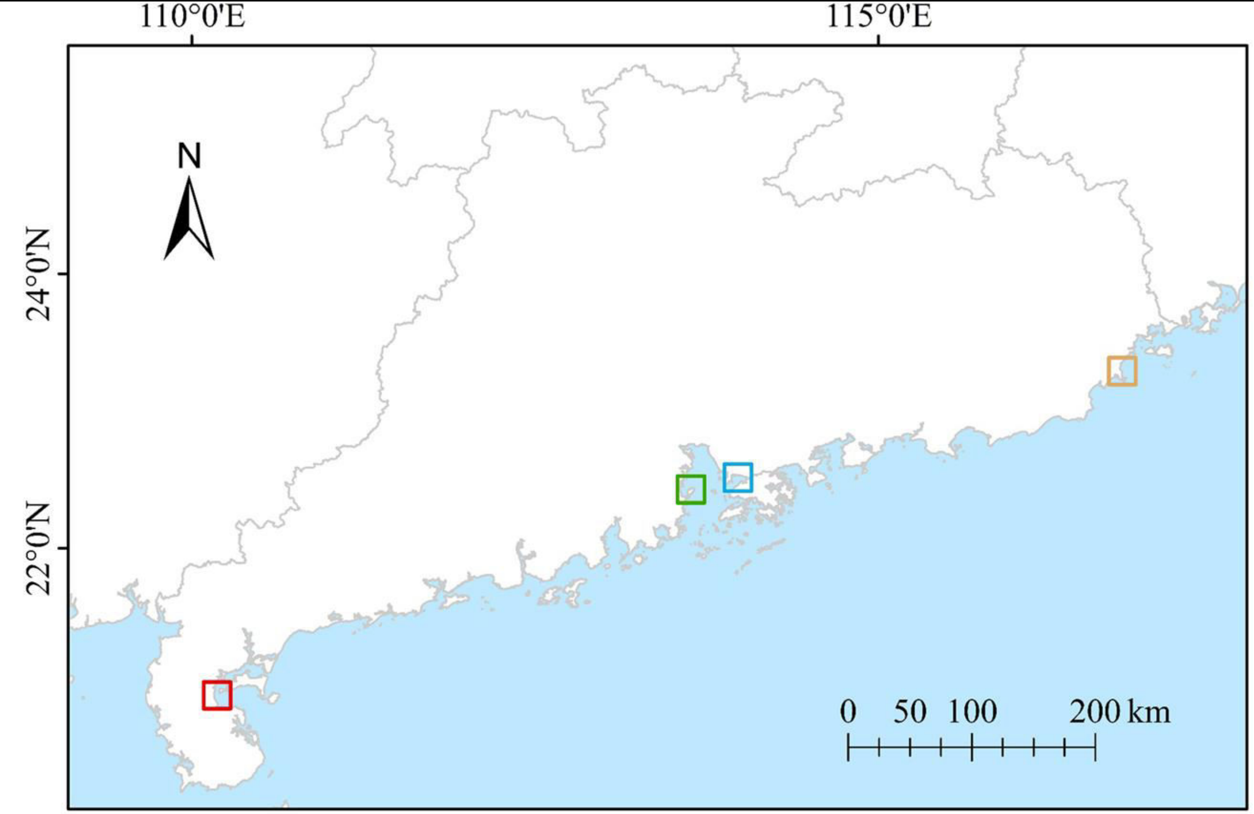
Zhang et al., 2022

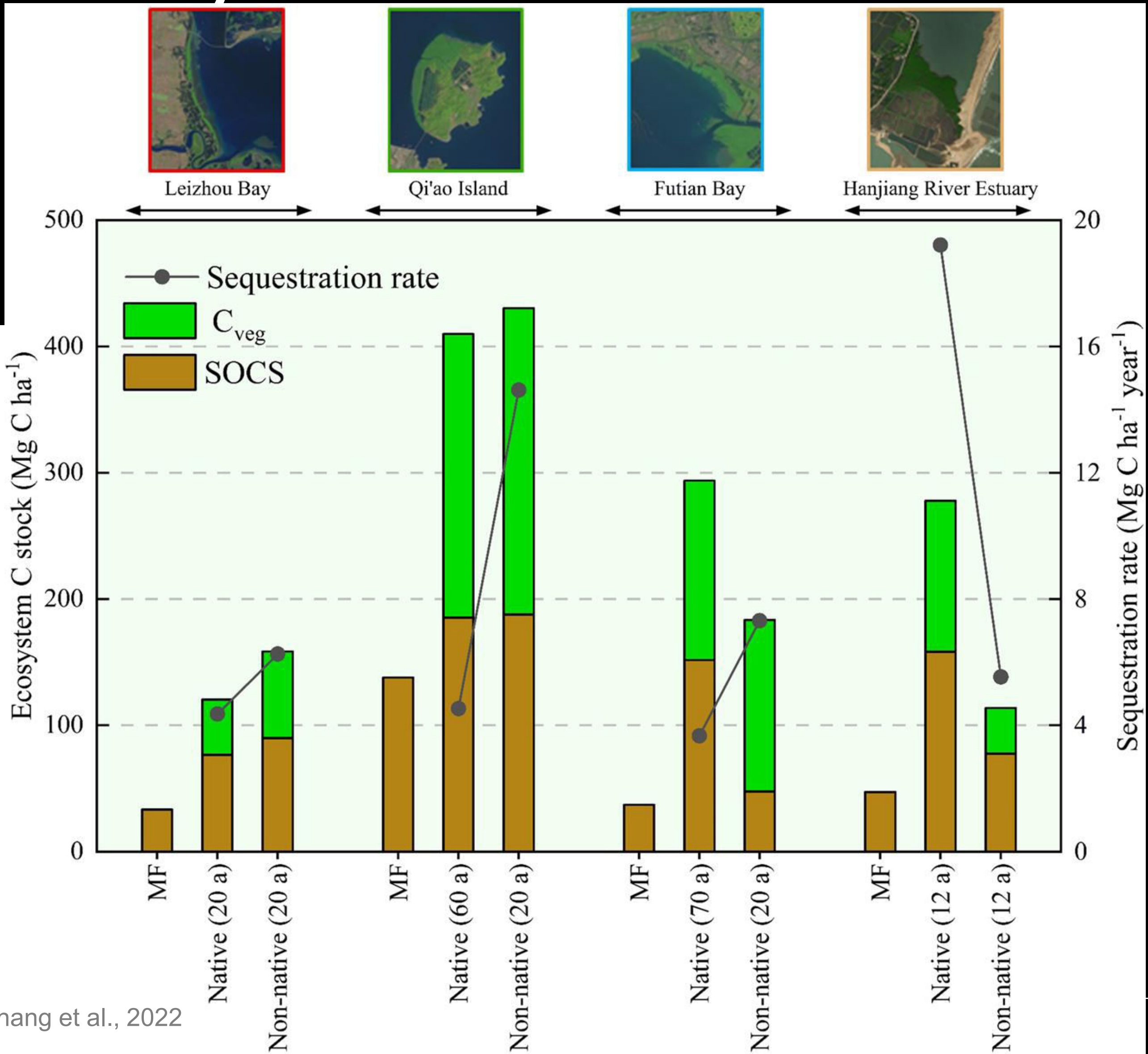


- Carbon stocks are high in BCE (mangroves)
- The speed/rate of carbon sequestration varies significantly (native vs. non-native)
- Vegetation dominates overall carbon stocks



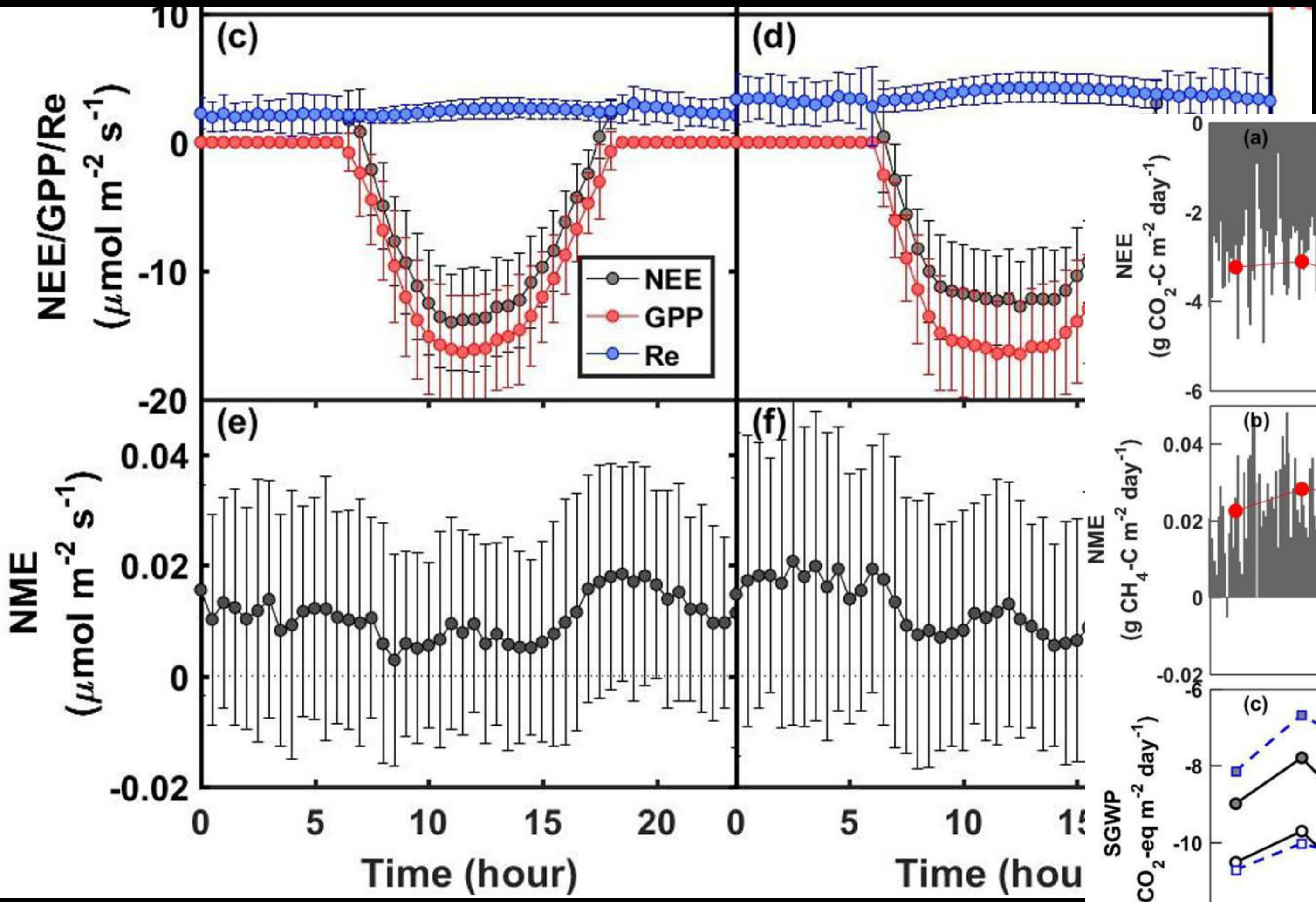
Carbon dynamic varies by location too

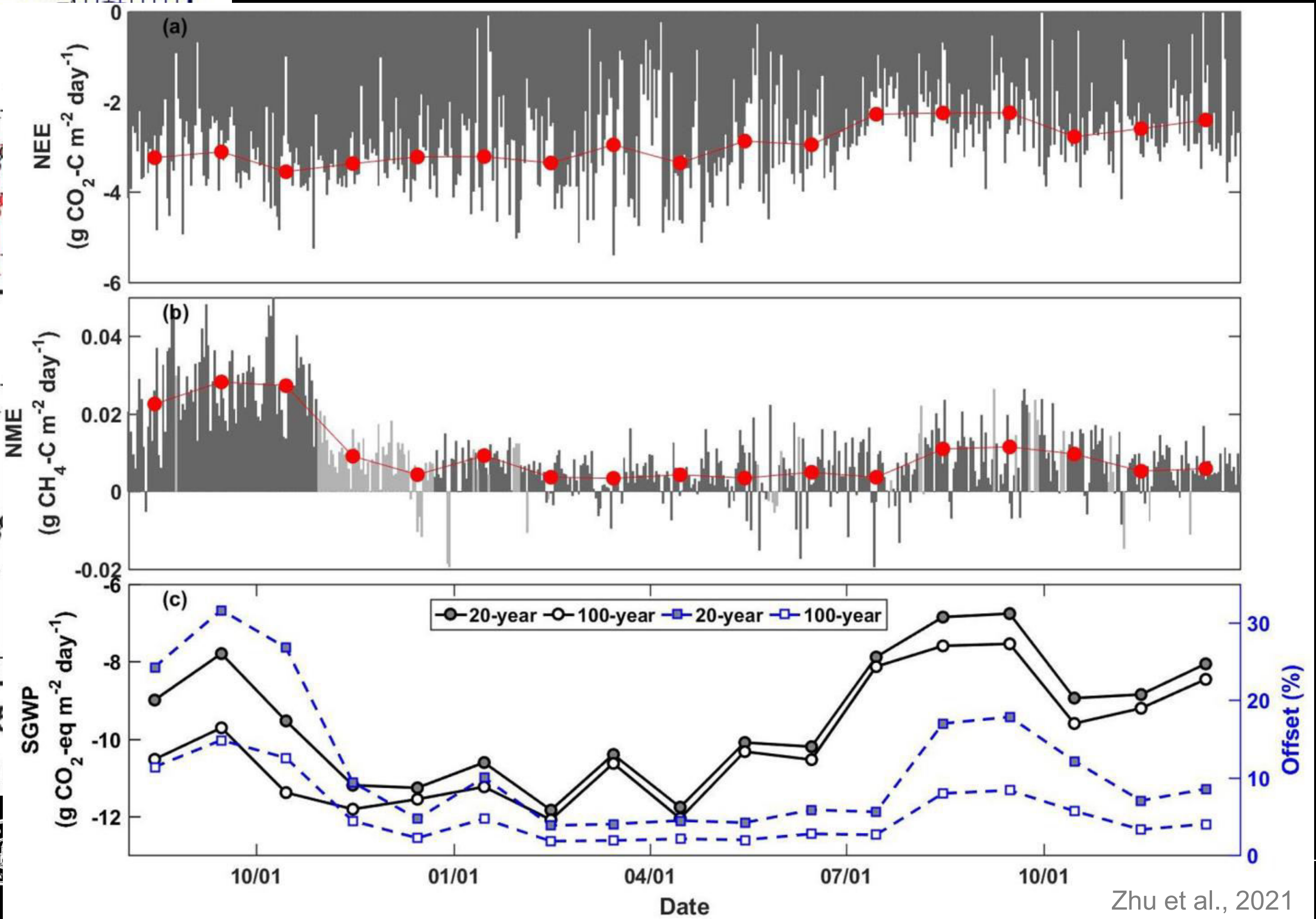




Zhang et al., 2022

Carbon sequestration is offset by CH4 emissions, but still show overall net sink





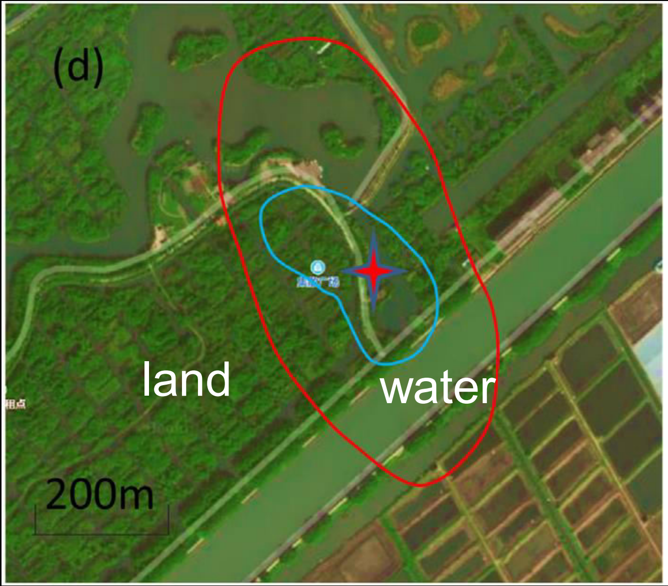
Zhu et al., 2021

Land-water-emissions nexus

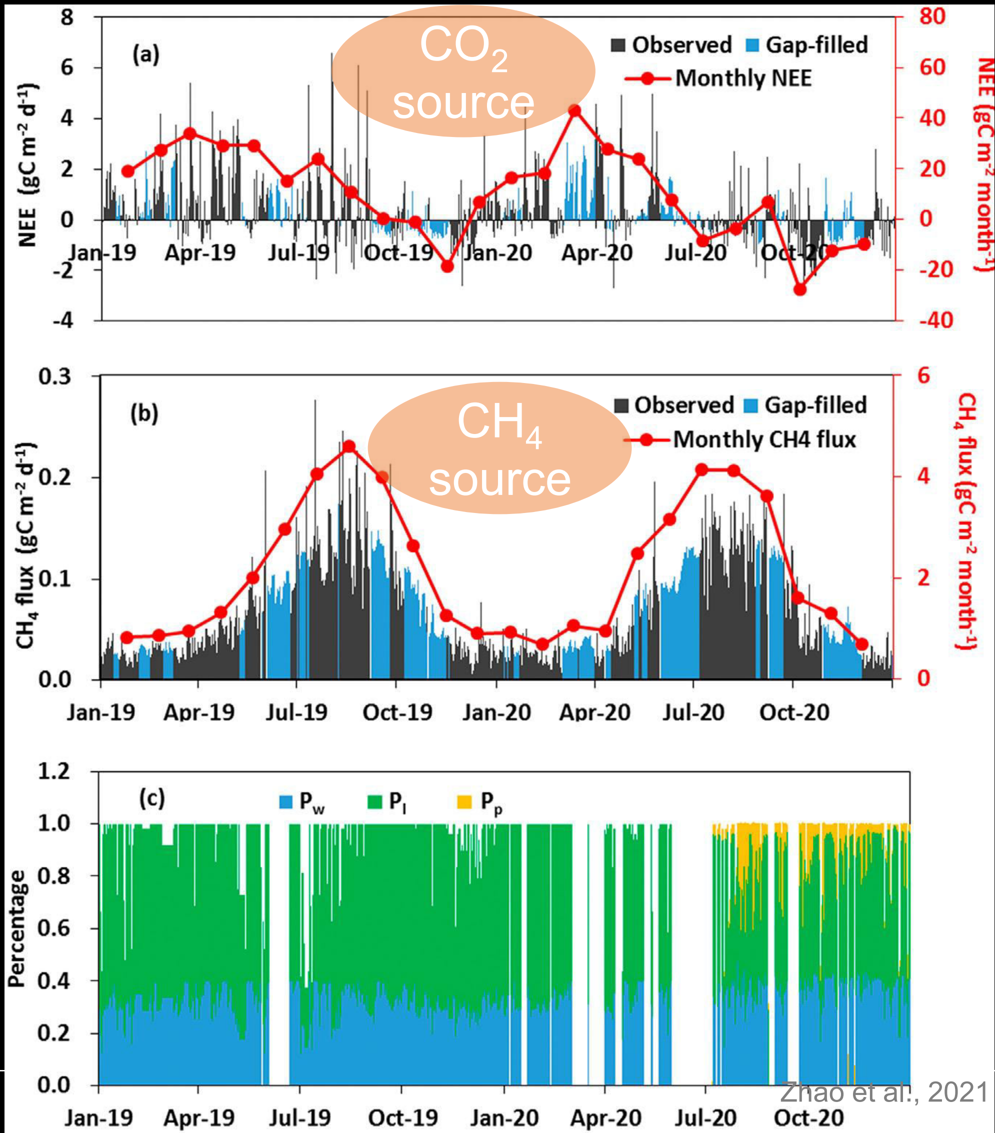
Zhao X, Wang C, Li T, Zhang C, Fan X, Zhang Q, Zhang Q, Chen X, Zou X, Shen C, Tang Y, **Qin Z**. Net CO2 and CH4 emissions from restored mangrove wetland: New insights based on a case study in estuary of the Pearl River, China. ***Science of The Total Environment***. 2021,12:151619.

Zhu X, **Qin Z**, Song L. How Land-Sea Interaction of Tidal and Sea Breeze Activity Affect Mangrove Net Ecosystem Exchange?. ***Journal of Geophysical Research: Atmospheres***. 2021, 126(8):e2020JD034047.

The role of water…



Restored mangroves



Zhao et al., 2021

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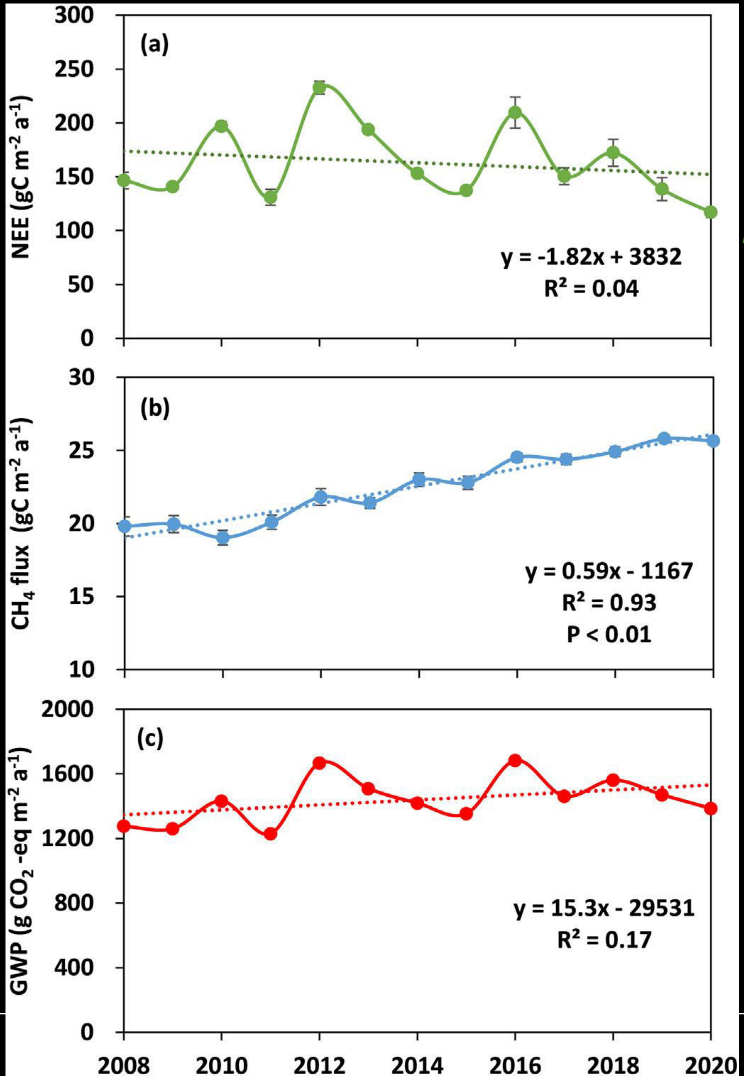
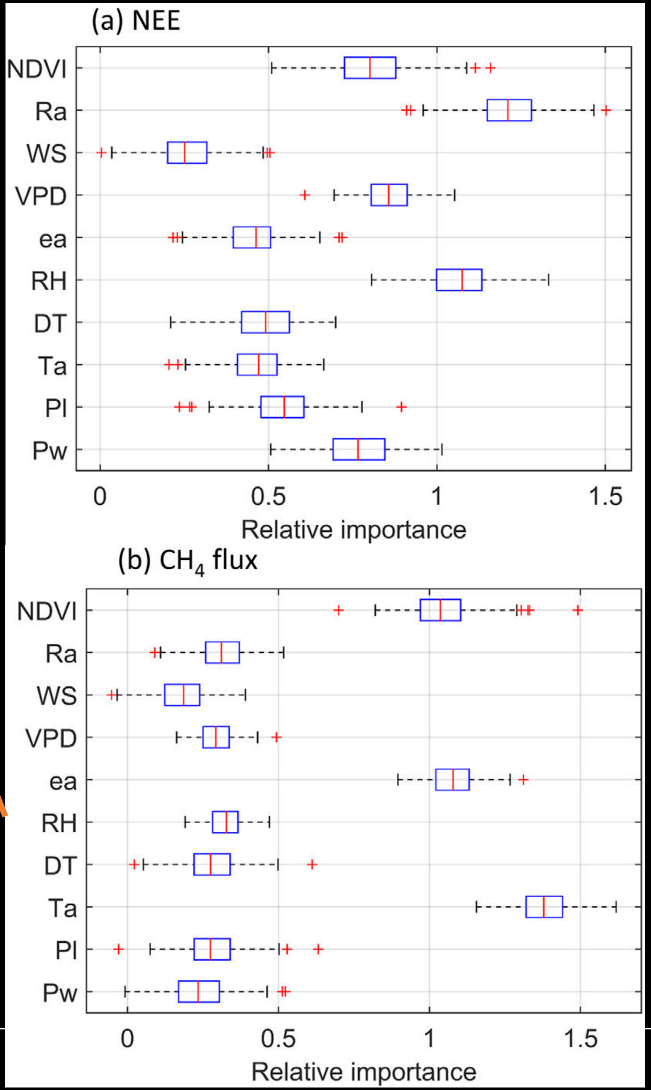
The role of water…



Long-term source of GHGs

Driven by low GPP and high Re, due to large water body coverage



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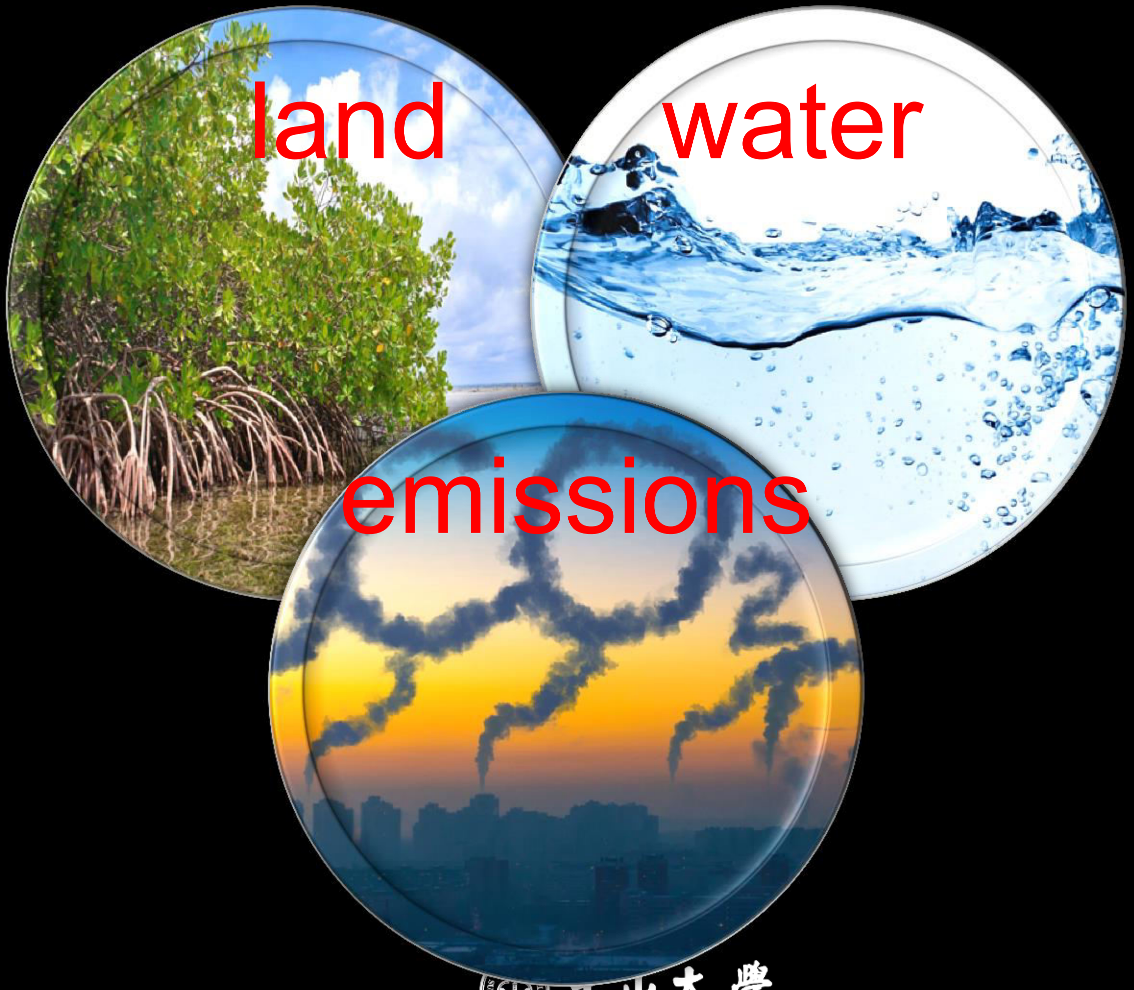
The BCE land-water-emissions nexus and beyond…

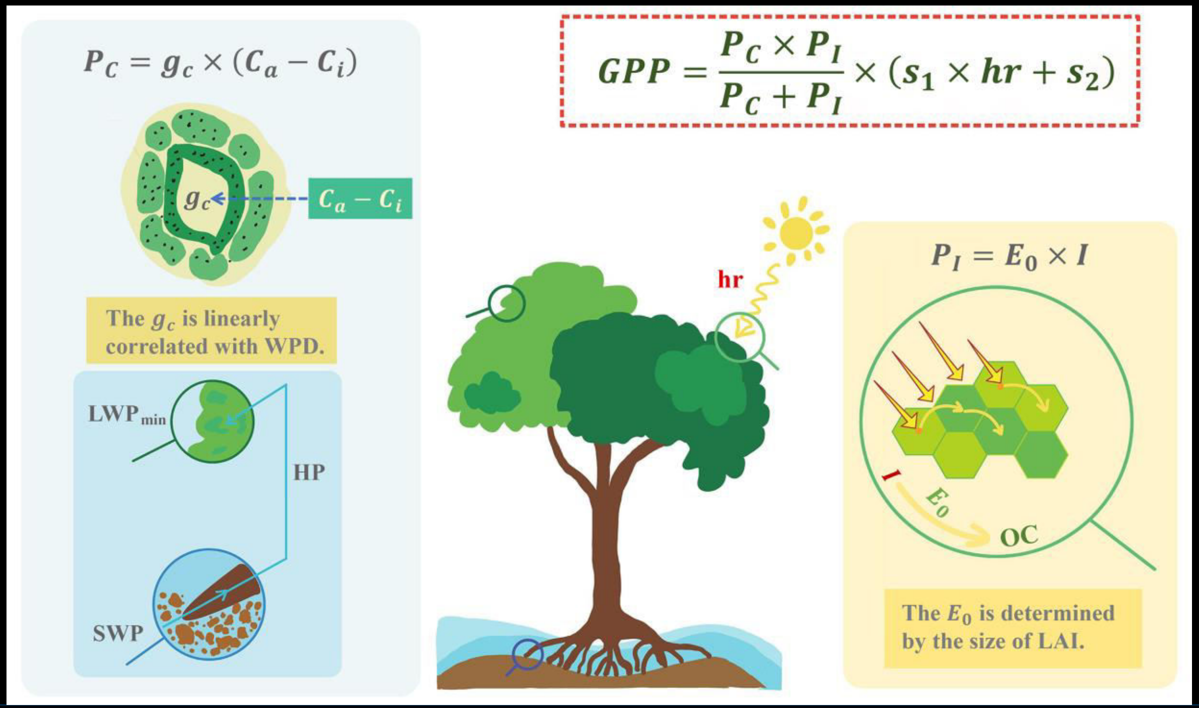


So what…

Any implications to mangrove management or restoration…

Developing models for regional application

Mango-GPP
A process-based biogeochemical model for simulating daily GPP of mangroves

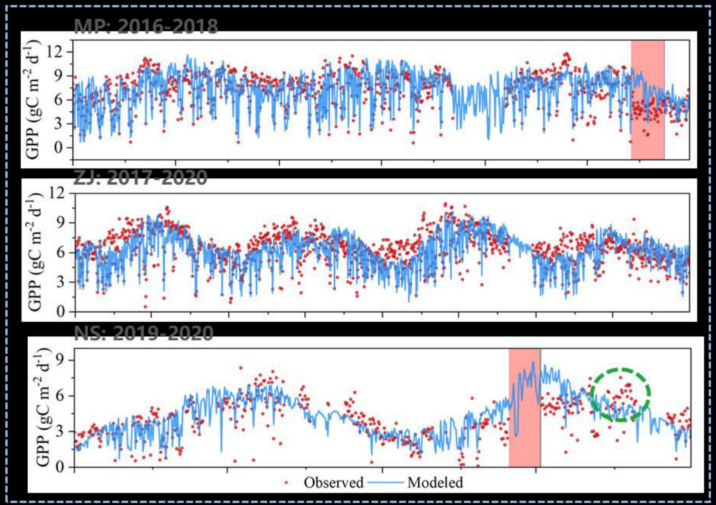


模型概念图
(GPP, gC m^{-2} day^{-1})

Rectangular Hyperbolic Equation

CO_2-limited Photosynthetic Rate

Light-limited Photosynthetic Rate



Tang…Qin, 2023 in revision

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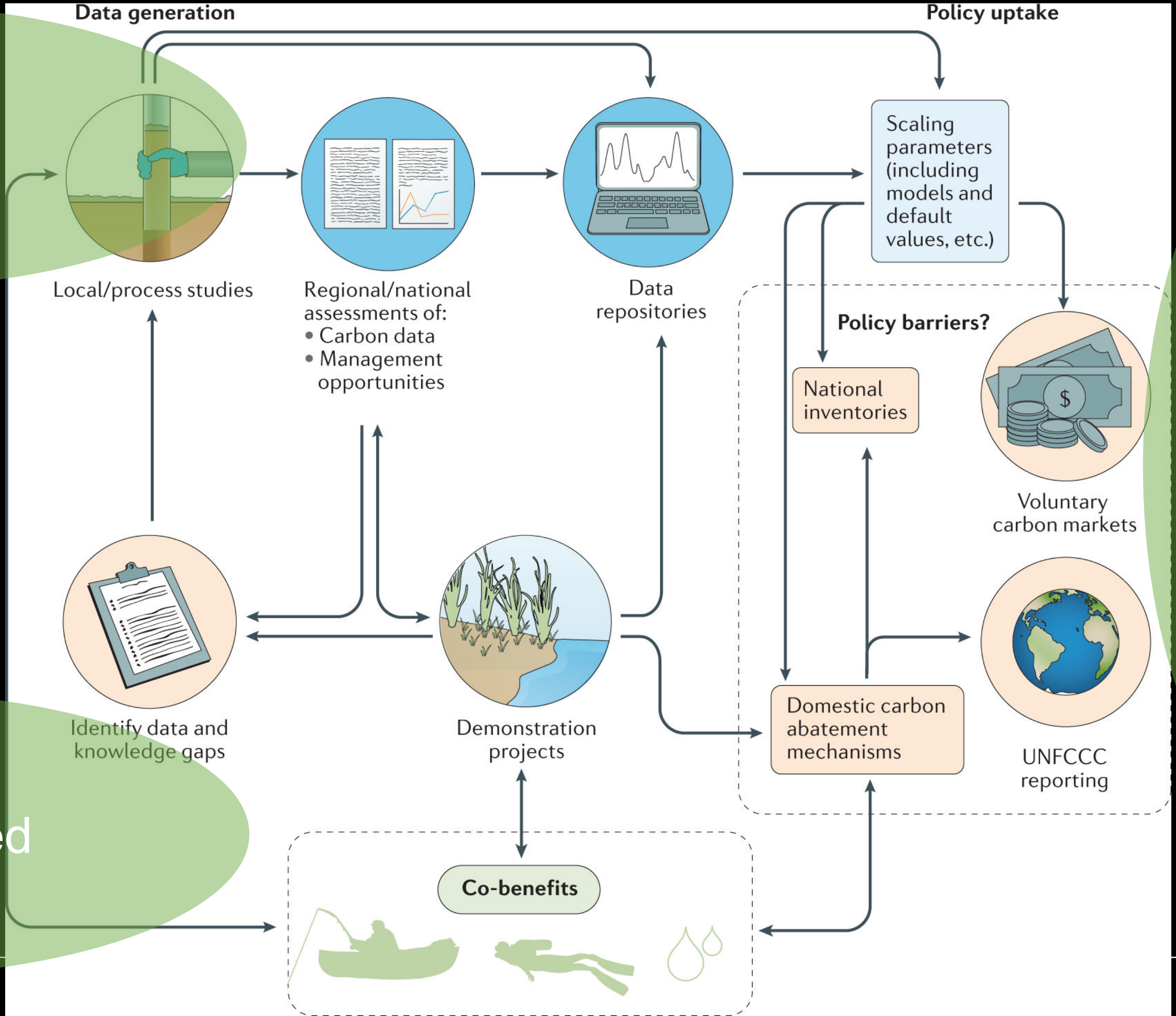
Blue carbon ecosystem conservation

Data-driven

Science-based

Policy-stimulated



Macreadie et al., 2021

Thanks!

- BCEs (incl. mangroves) are important natural ecosystems that deserves special attention
- BCEs should be well protected and managed for their ecosystem services
- BCEs restoration to be further examined: where, how, to what extent?

Please contact Qlab at:
qinzhangcai@mail.sysu.edu.cn