Mitigation of climate change through more effective rehabilitation of degraded and deforested mangroves

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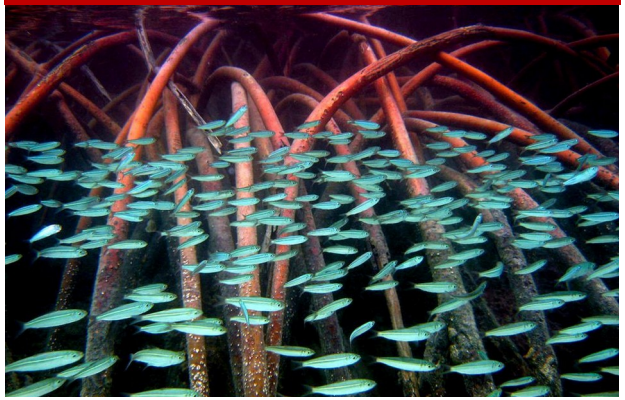
Mangrove Ecosystem Services

FISHERIES HABITAT



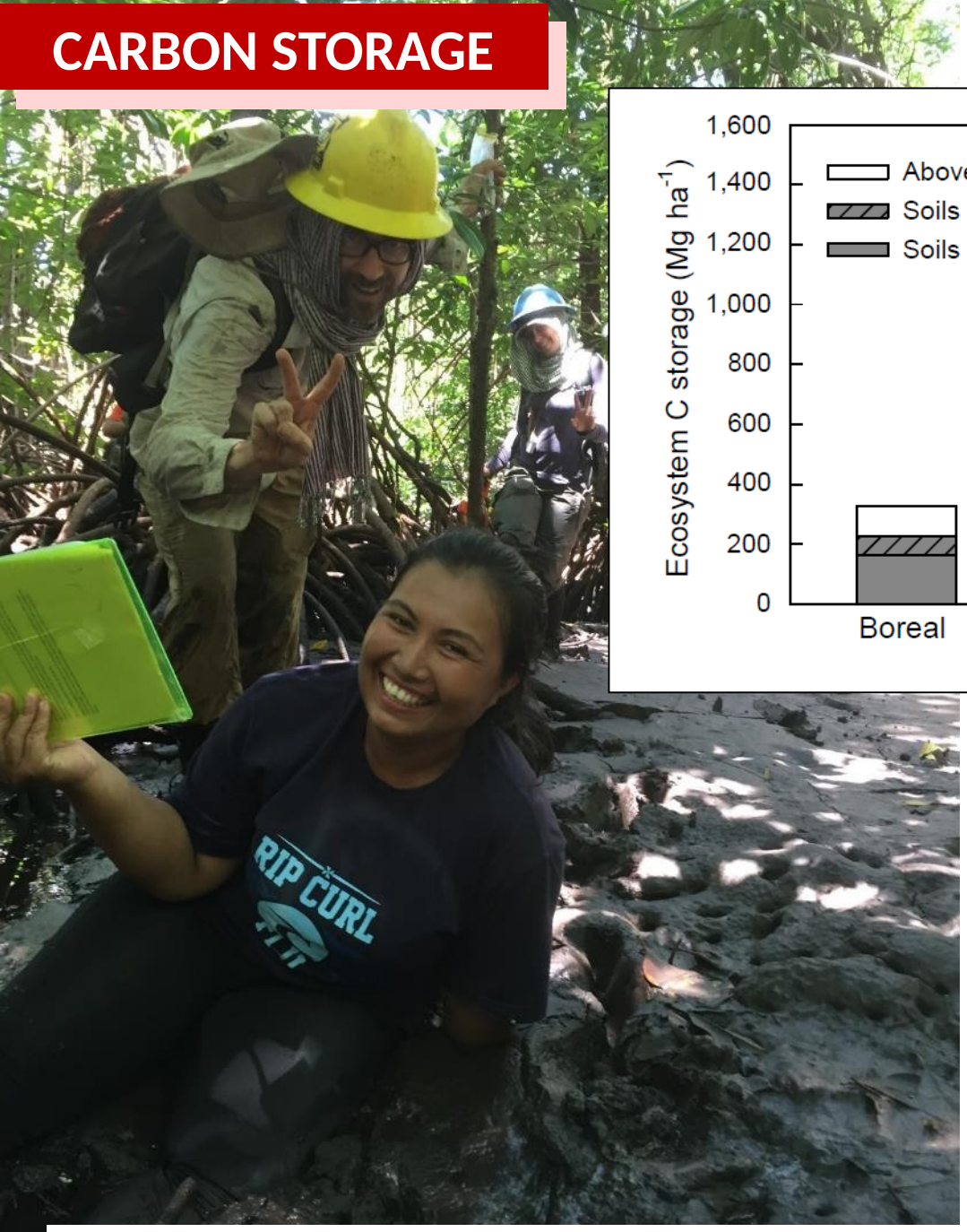
WILDLIFE HABITAT

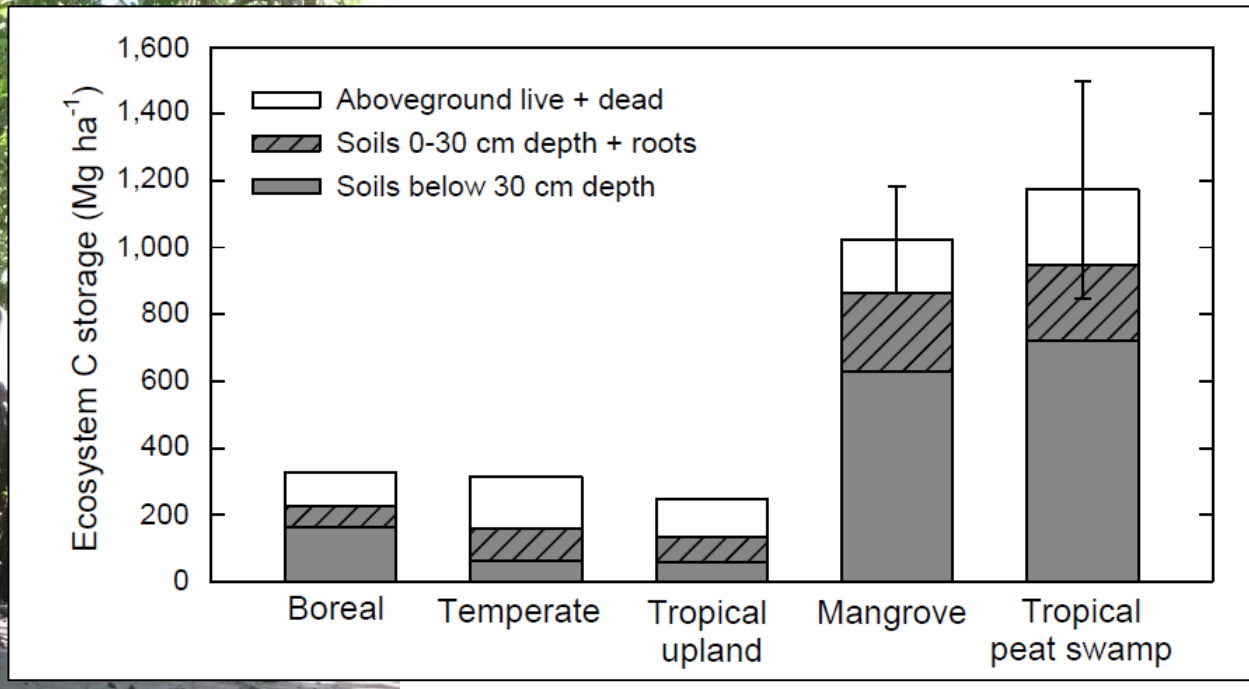
CARBON STORAGE

WATER QUALITY

STORM PROTECTION

CARBON STORAGE

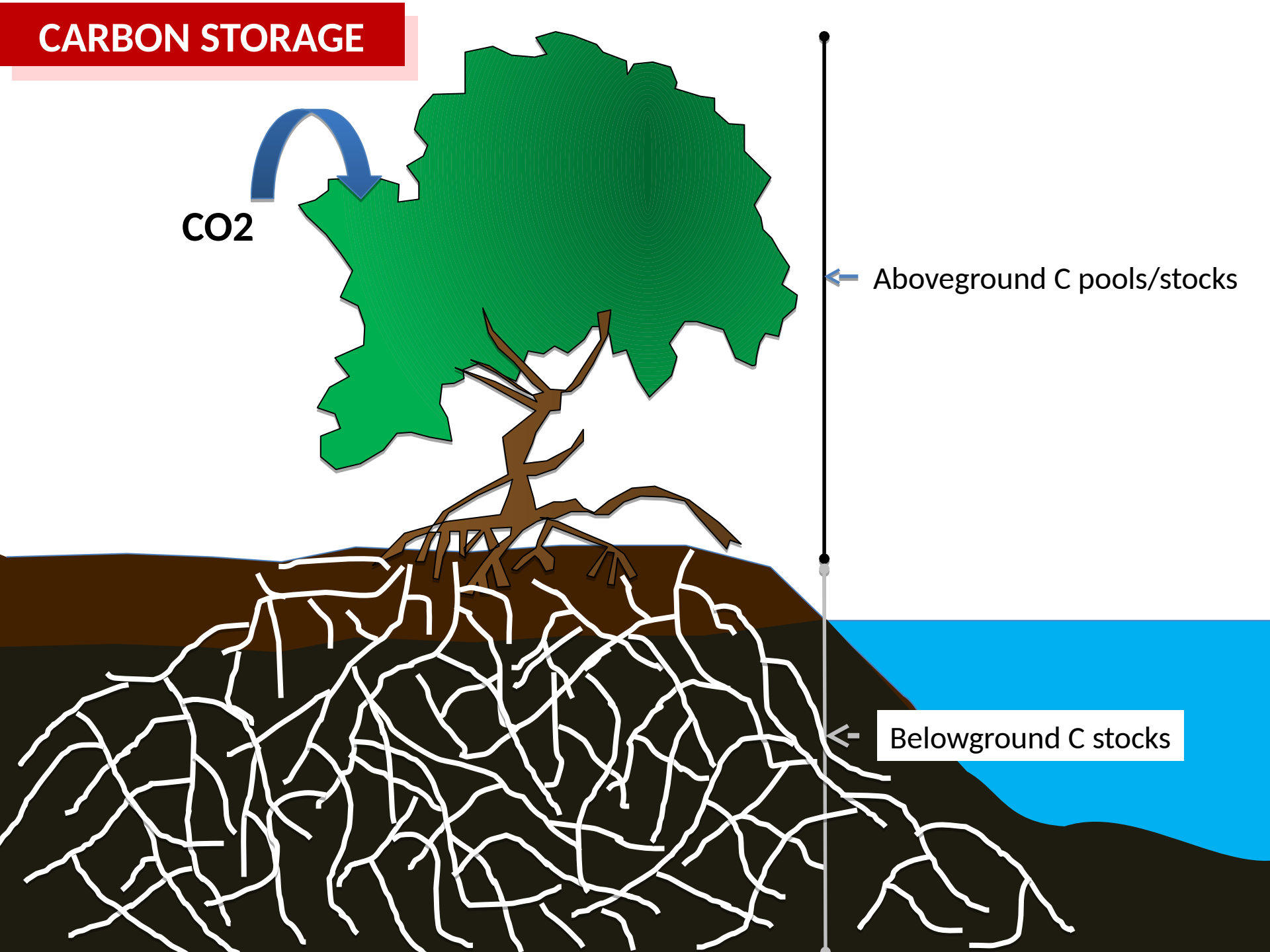




- Mangroves and tropical wetlands store 3-5x more carbon than any other tropical or temperate ecosystem
- Waterlogged sediments lack the oxygen needed for processes that breakdown carbon.

(Donato et al. 2012, Donato et al. 2014, Murdiyarso et al. 2016, Nam et al 2016, MacKenzie et al. 2016, Sharma et al in preparation)

CARBON STORAGE



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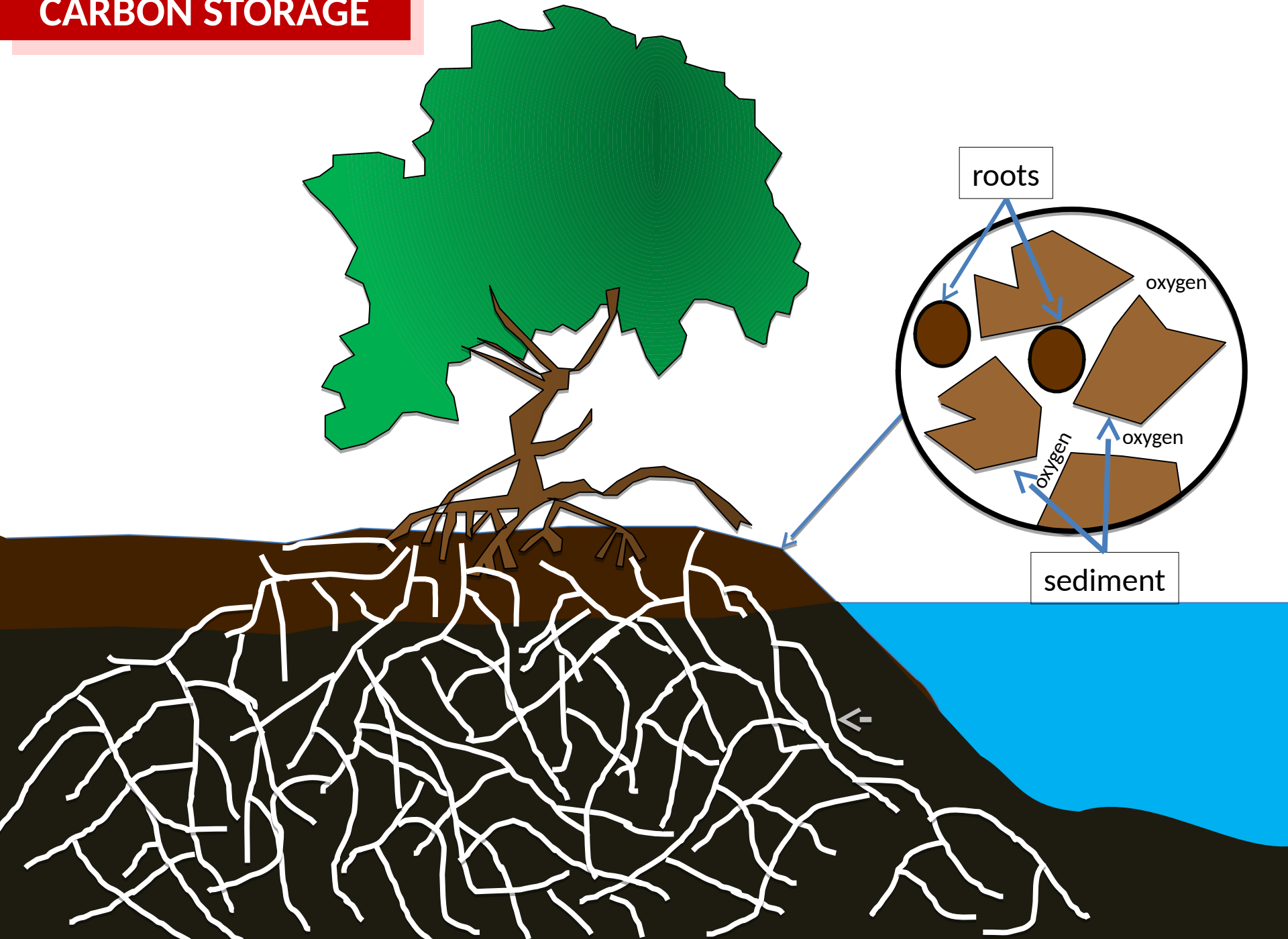

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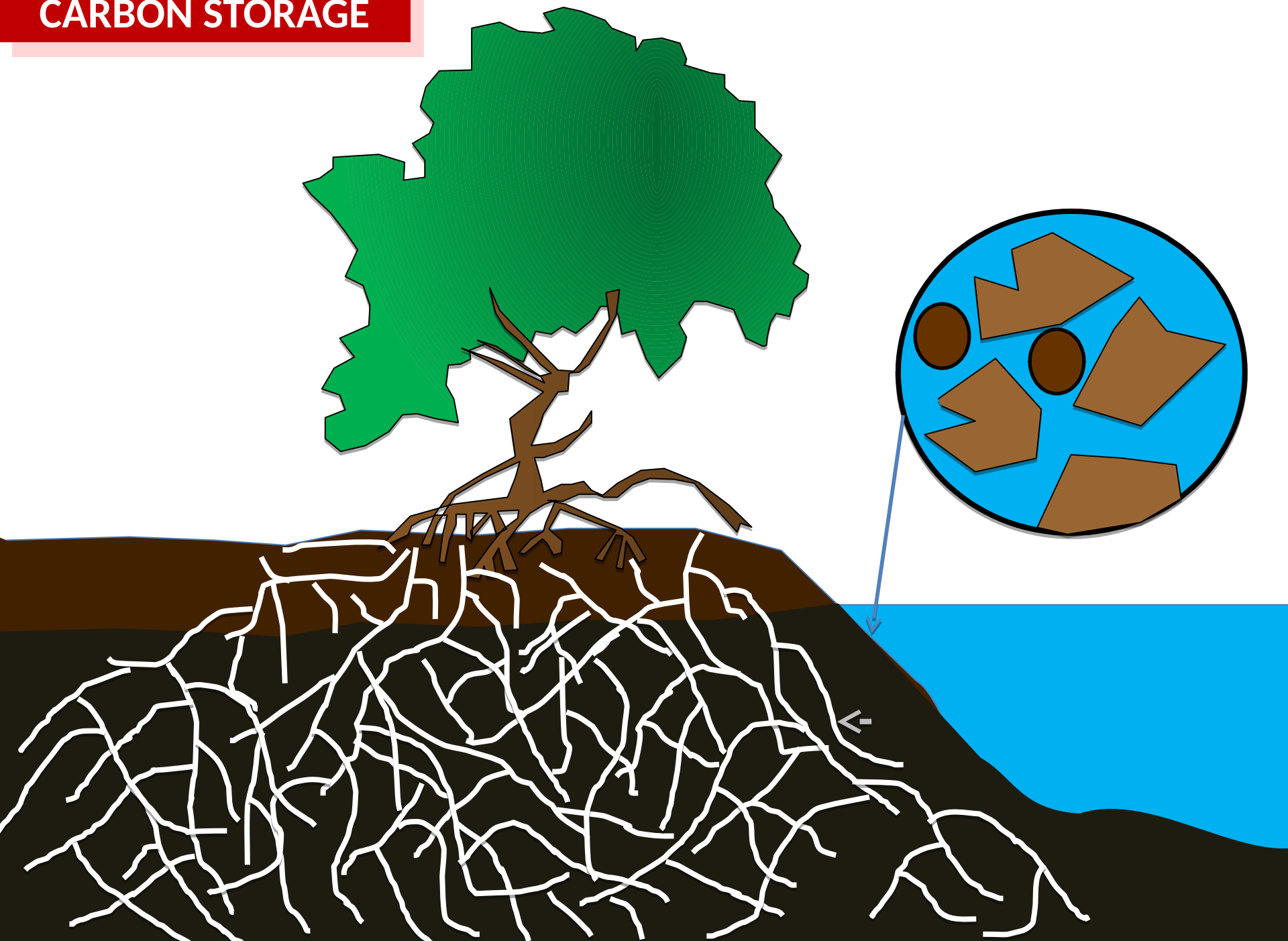
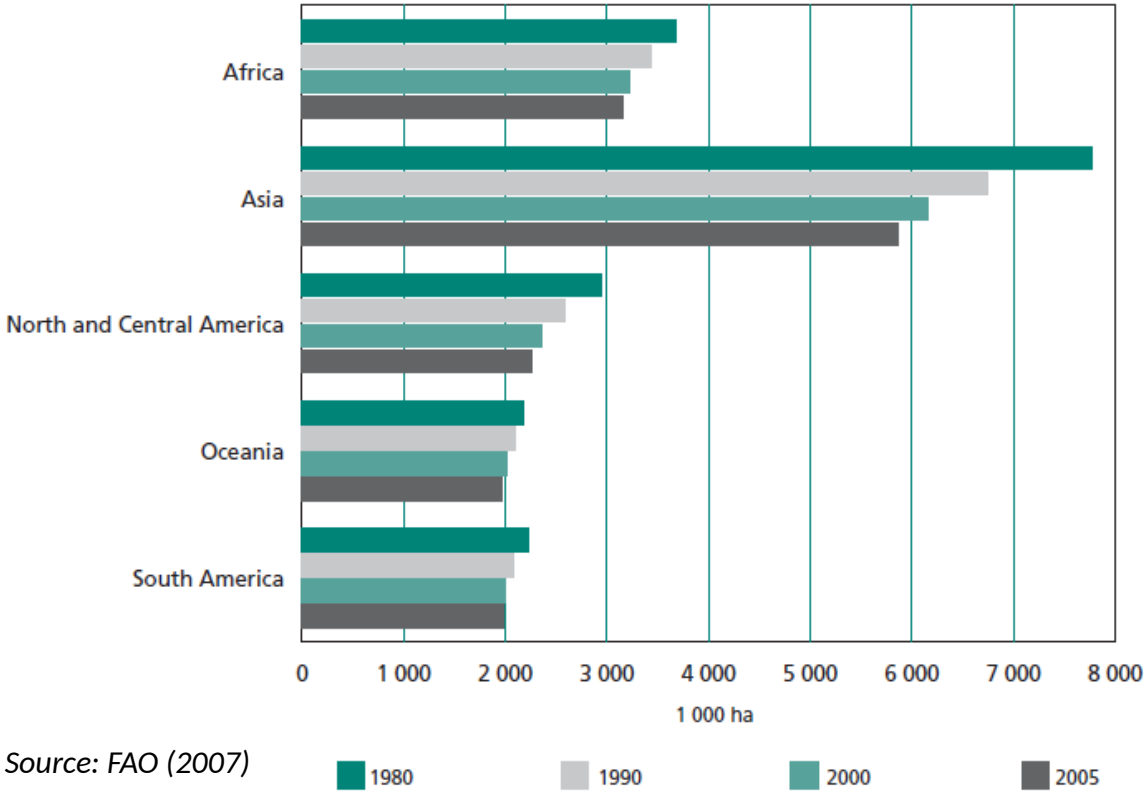


Threats to mangroves



Source: FAO (2007)

Despite these value, nearly 50% of the world's mangroves have been lost due to deforestation for development, aquaculture, or charcoal production. Future threats include increased development and SLR.

Mangrove restoration - plantations

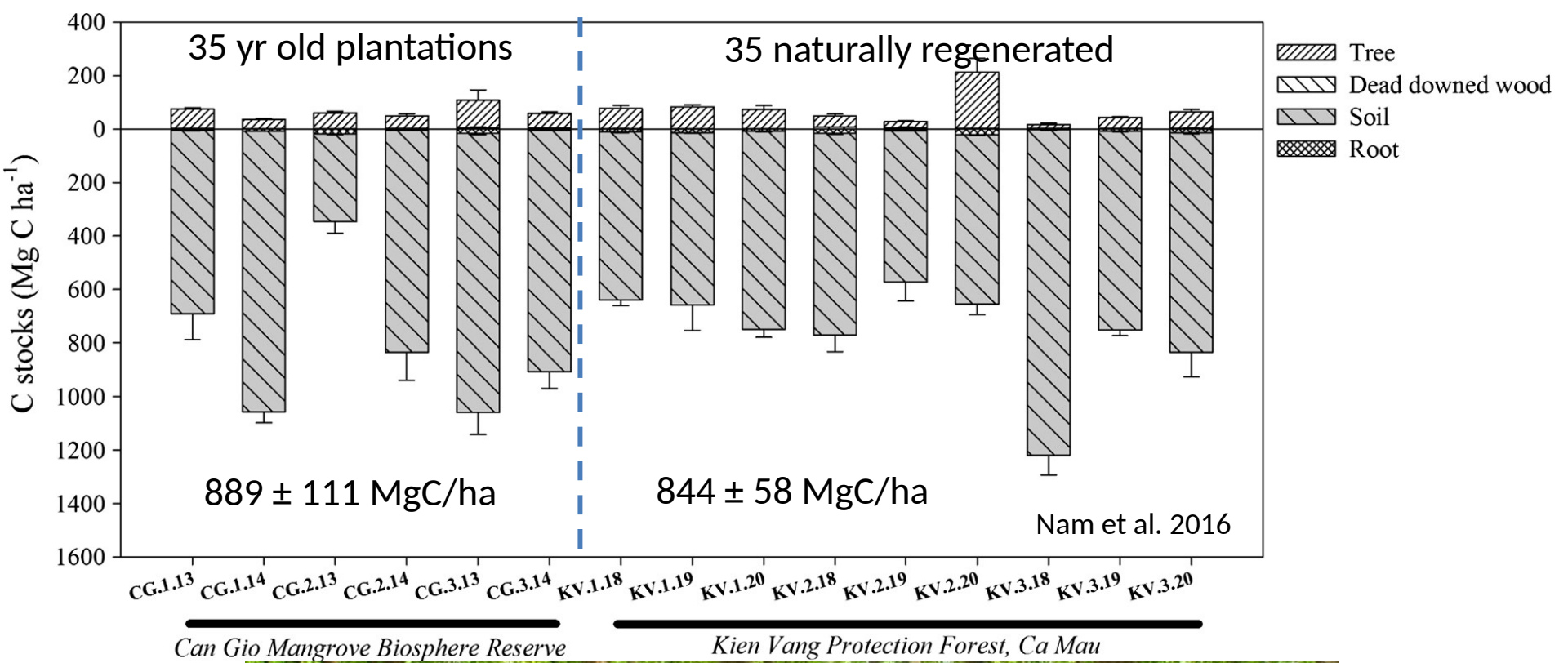
- Massively funded projects have attempted to offset mangrove losses, to increase C stocks, or provide storm protection
- Many projects often fail as mangroves are planted in wrong areas and cannot survive (90% failure in S. Sulawesi (B. Brown, pers comm.); 80-90% failure in Philippines (Samson and Rollon 2008; Primavera and Esteban 2008)
- Projects also fail because the do not consider governance land tenure issues.

Mangrove restoration - EMR

- Restoring hydrological connection in areas once colonized by mangroves (e.g., shrimp ponds) is an effective solution
- Propagules from nearby mangroves naturally colonize these areas
- Successful projects involve local communities and understanding land tenure

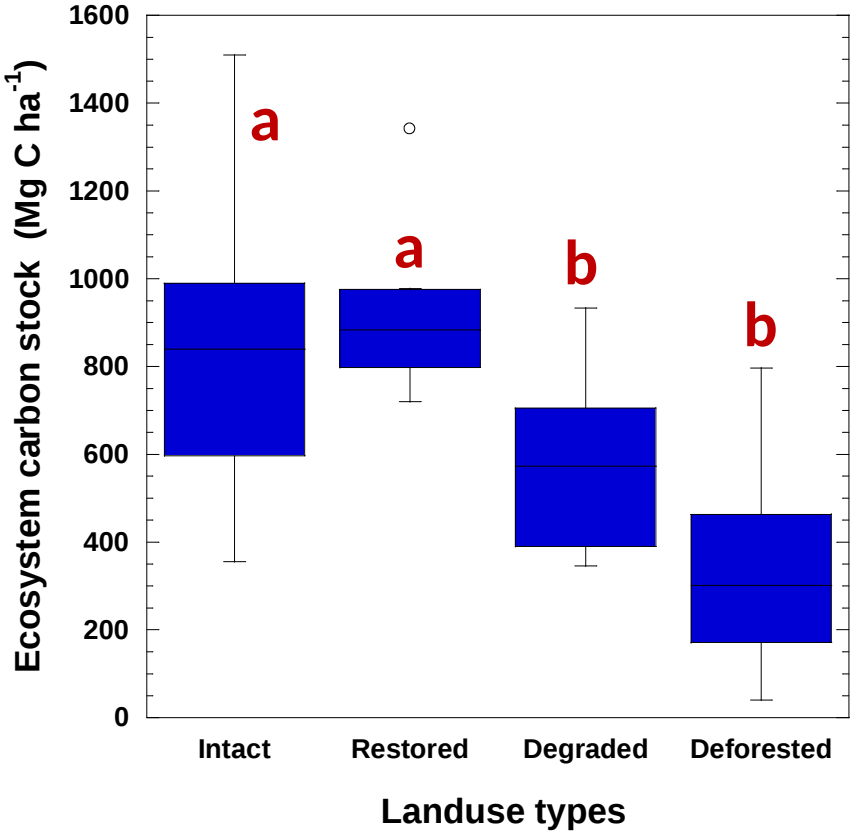
20 hectares cleared in 1991 for shrimp ponds prior to declaration of Bunaken National Park

How effective are restored mangroves at providing similar levels of ecosystem services as intact mangrove forests?


35 yr old plantations
35 naturally regenerated
Tree
Dead downed wood
Soil
Root
C stocks (Mg C ha-1)
400
200
0
200
400
600
800
1000
1200
1400
1600
889 ± 111 MgC/ha
844 ± 58 MgC/ha
Nam et al. 2016
CG.1.13
CG.1.14
CG.2.13
CG.2.14
CG.3.13
CG.3.14
KV.1.18
KV.1.19
KV.1.20
KV.2.18
KV.2.19
KV.2.20
KV.3.18
KV.3.19
KV.3.20
Can Gio Mangrove Biosphere Reserve
Kien Vang Protection Forest, Ca Mau

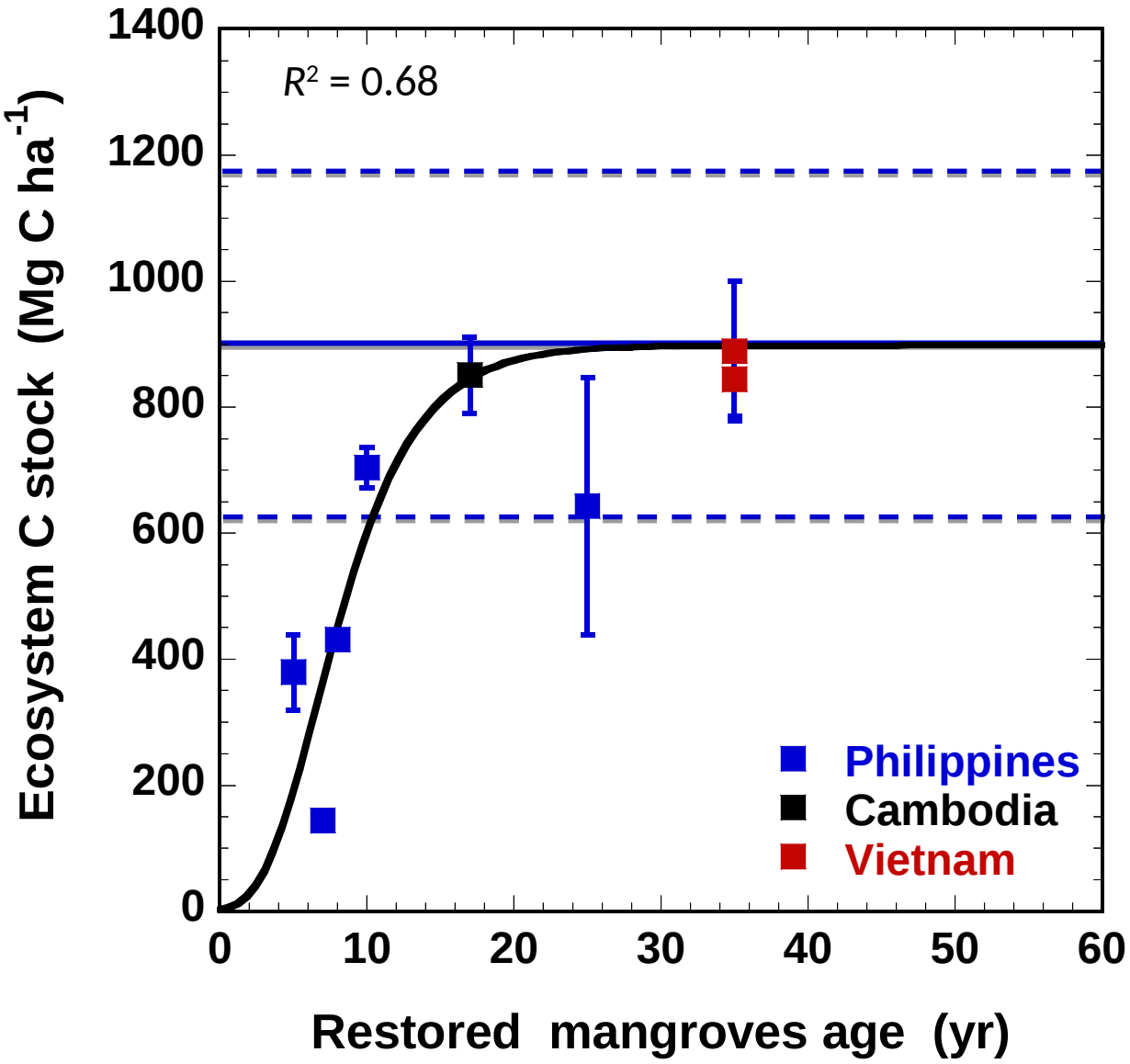

Vietnam

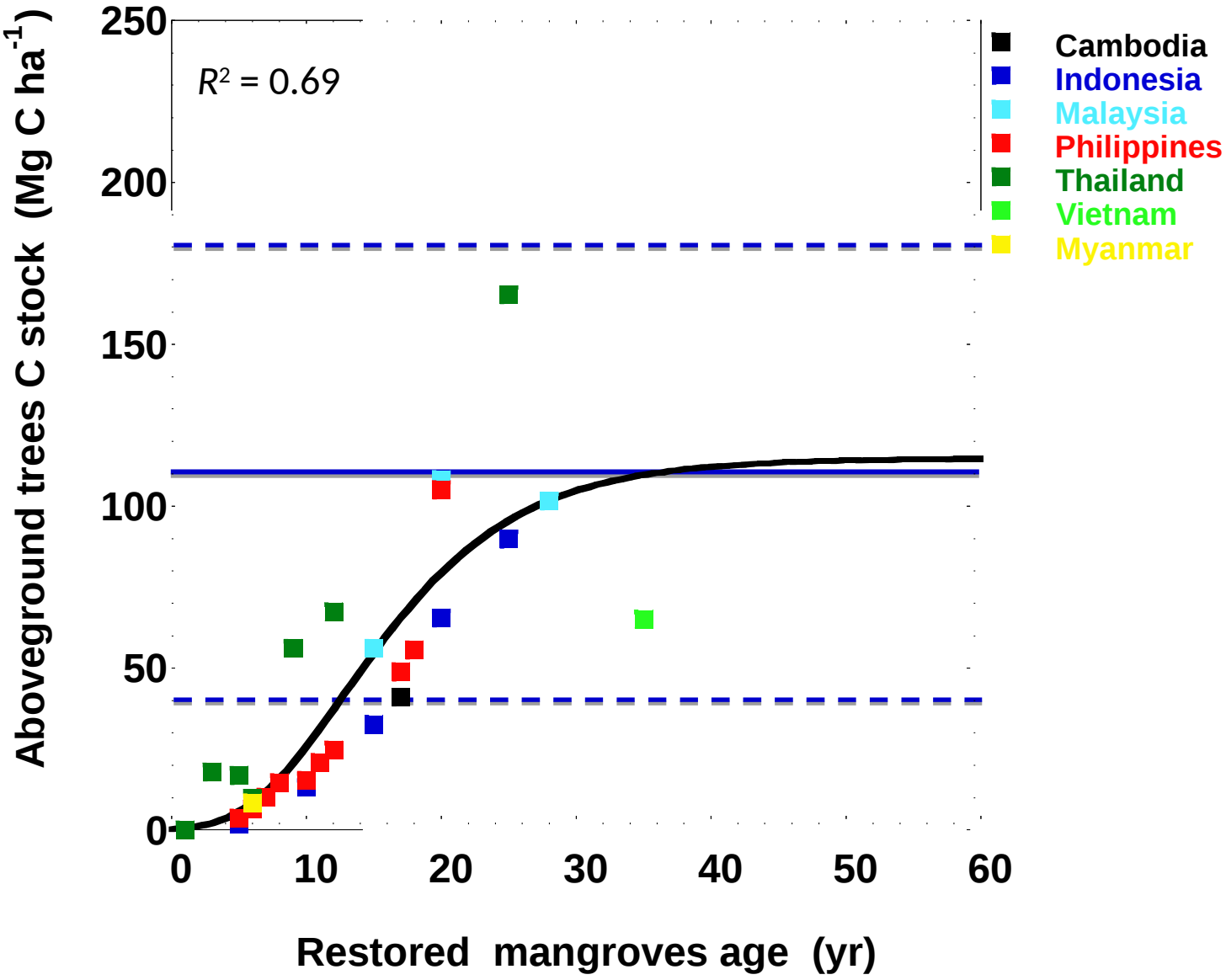
osystem Carbon stock in different land use typ

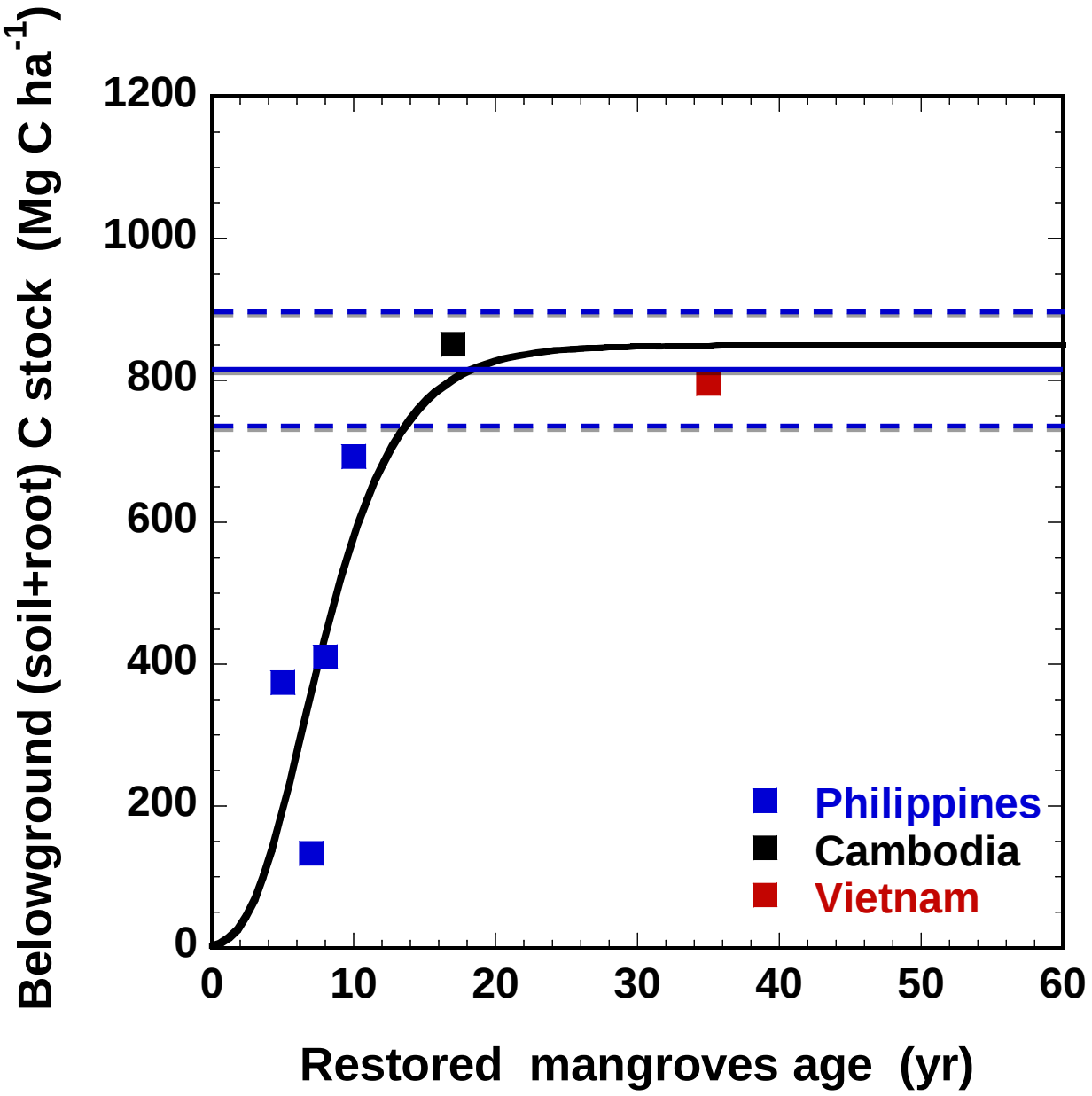


Land use type	Tree density (ha^{-1})	Basal area (m^2 ha^{-1})	Canopy cover (%)
Intact	2076 ± 164 ^{a}	24.22 ± 1.69 ^{a}	69.18 ± 3.40 ^{a}
Degraded	1496 ± 211 ^{a}	21.43 ± 1.88 ^{a}	71.03 ± 5.07 ^{a}
18 yr Plantation	1802 ± 207 ^{a}	19.96 ± 1.65 ^{a}	70.87 ± 7.02 ^{a}

Sharma et al., in review


R^2 = 0.68
Ecosystem C stock (Mg C ha^{-1})
1400
1200
1000
800
600
400
200
0
0
10
20
30
40
50
60
Restored mangroves age (yr)
Philippines
Cambodia
Vietnam


R^2 = 0.69
Aboveground trees C stock (Mg C ha^{-1})
Restored mangroves age (yr)
0
50
100
150
200
250
0
10
20
30
40
50
60
Cambodia
Indonesia
Malaysia
Philippines
Thailand
Vietnam
Myanmar


Belowground (soil+root) C stock (Mg C ha-1)
1200
1000
800
600
400
200
0
0
10
20
30
40
50
60
Restored mangroves age (yr)
Philippines
Cambodia
Vietnam

R^2 = 0.74

What about other ecosystem services?

Quantifying fish habitat value and economic/food value benefit of restored mangroves and wetlands

Tonle Sap, Cambodia

Measuring sedimentation rate, carbon burial, and accretion in restored mangroves

Kendari, IN

Assessing Mangrove Forest Landscape Rehabilitation (MFLR) Opportunities in SE Asian Nations

TBD (Bangkok?) 2017 or 2018

OBJECTIVES

- Identify critical economic, governance and land-use planning factors for applying science-based approaches for mangrove restoration;
- Present cost-effective restoration techniques (e.g., EMR, ROAM), visit successful restoration sites in the field, and discuss with key local stakeholders how these techniques fit in the wider socio-economic context
- Improve effectiveness and success of mangrove restoration through better decision making.
- Develop a strategy to assess restoration success of sites and thus increase the accountability of future restoration projects (e.g., for MRV).

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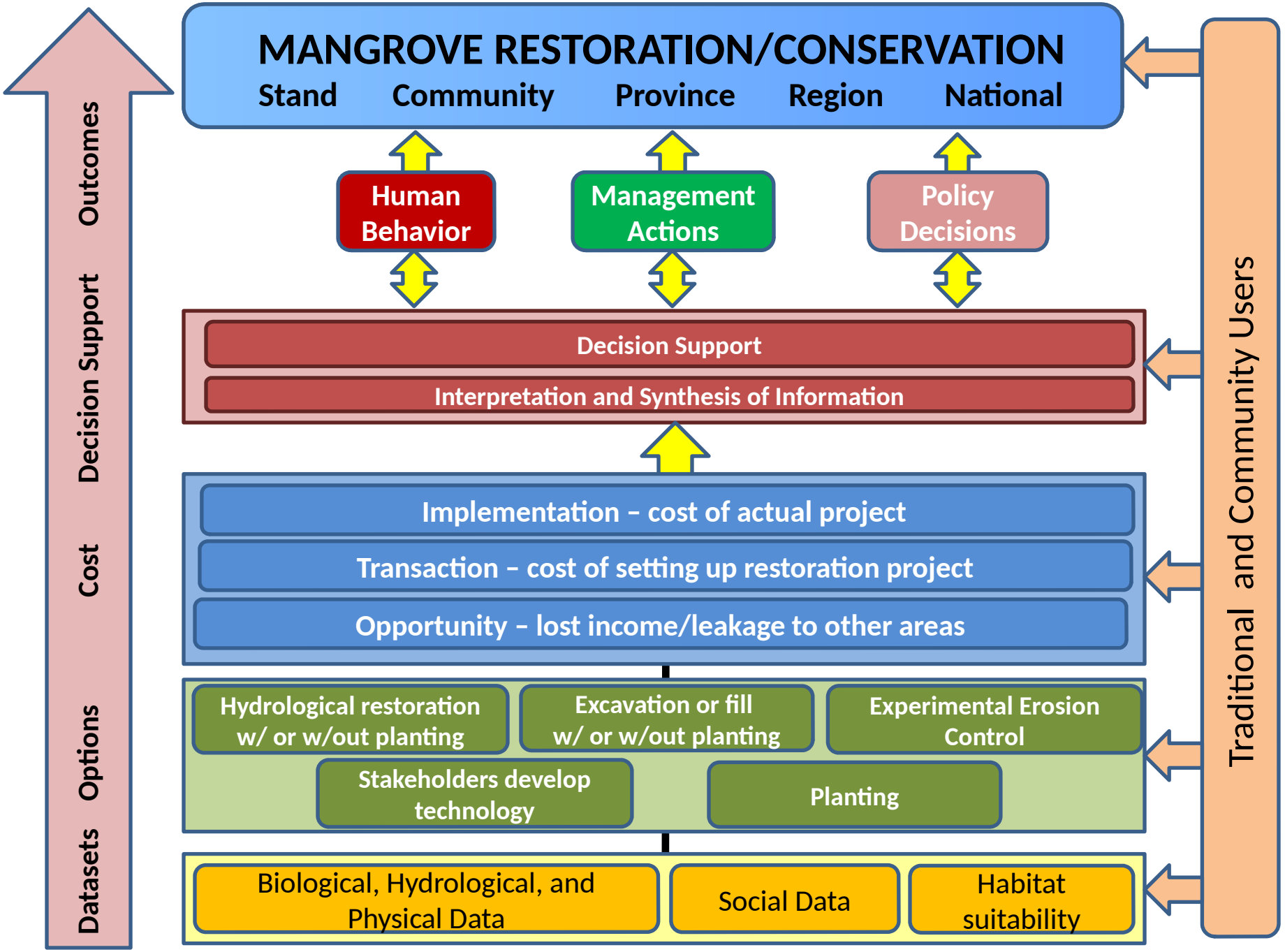
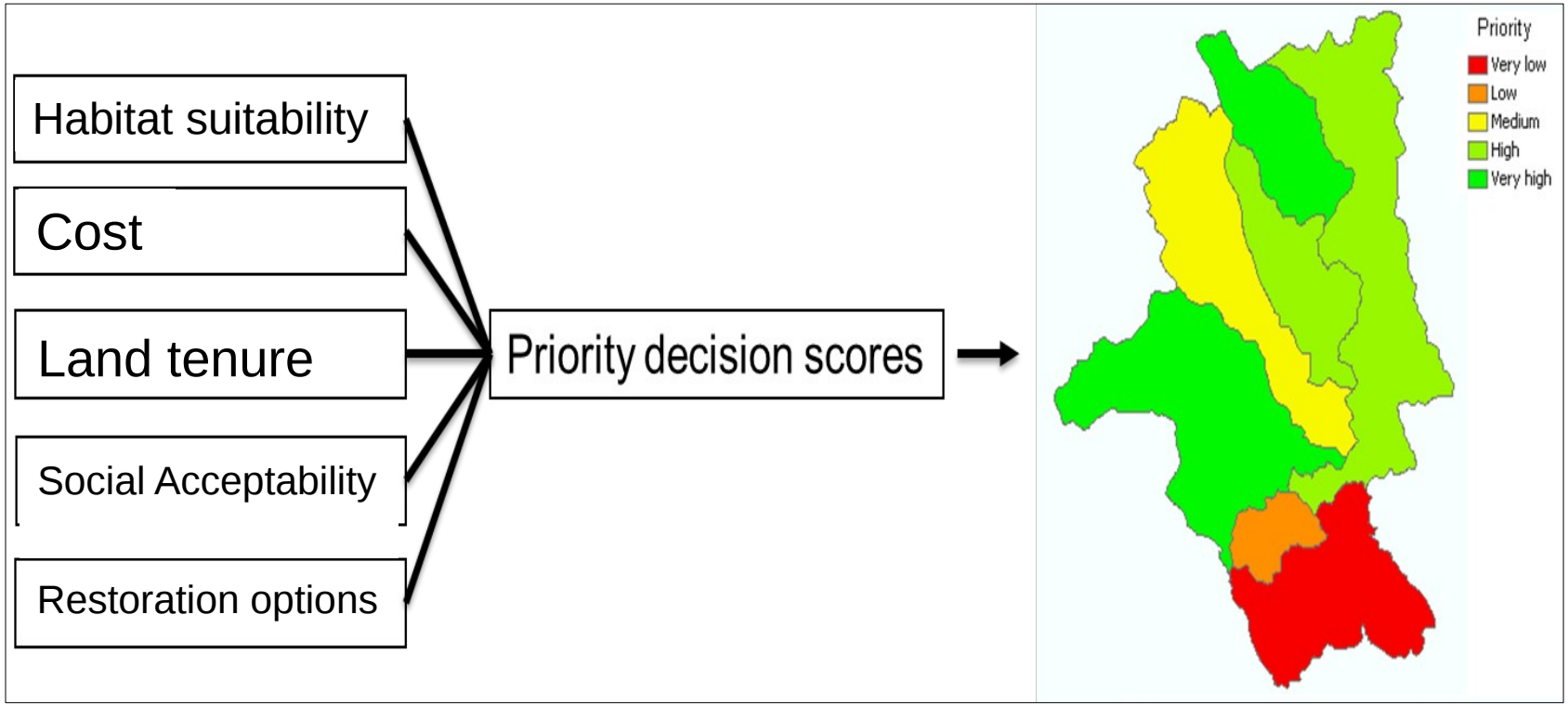
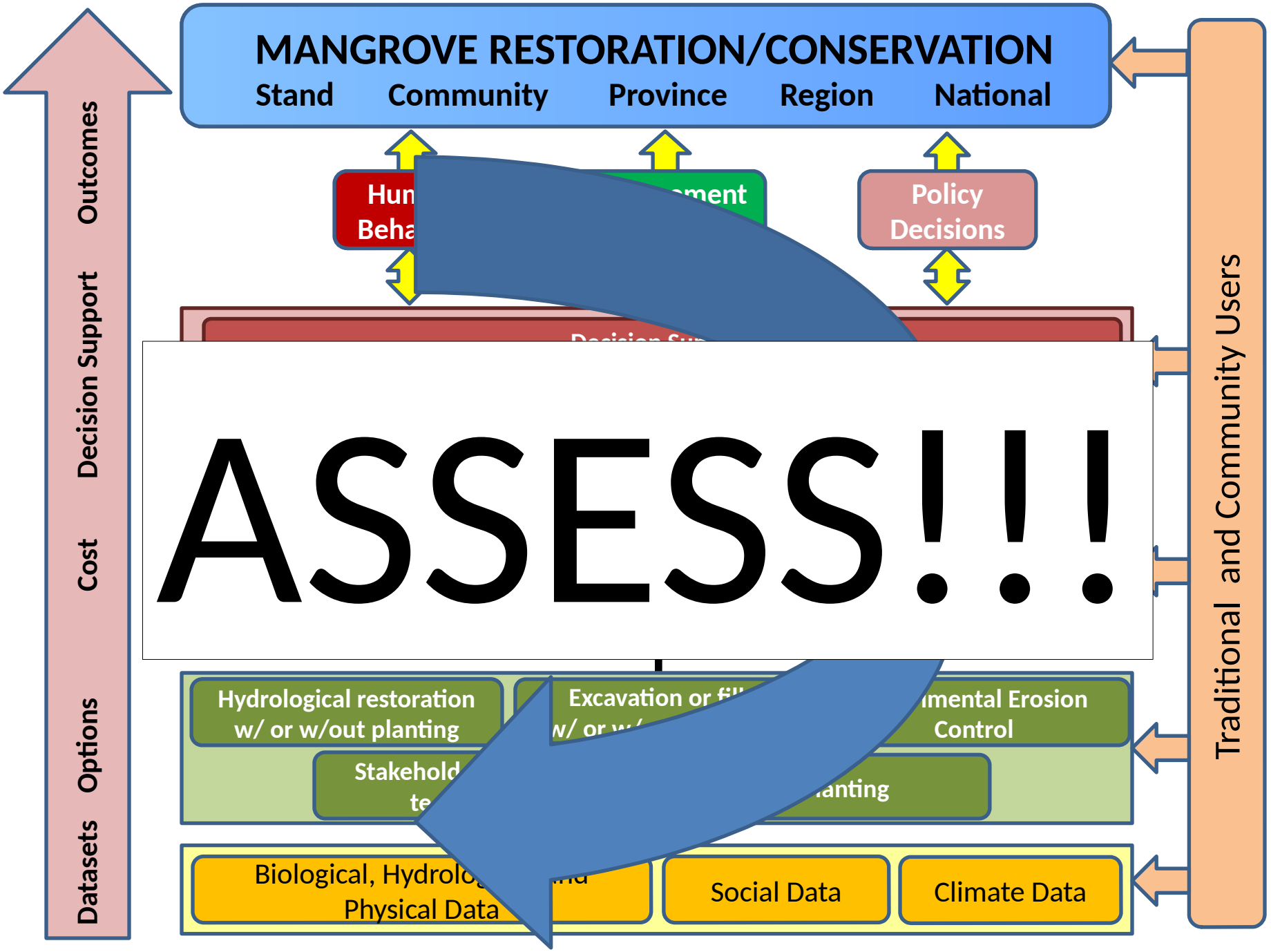

MANGROVE RESTORATION/CONSERVATION
Stand
Community
Province
Region
National
Human Behavior
Management Actions
Policy Decisions
Decision Support
Interpretation and Synthesis of Information
Implementation – cost of actual project
Transaction – cost of setting up restoration project
Opportunity – lost income/leakage to other areas
Hydrological restoration w/ or w/out planting
Excavation or fill w/ or w/out planting
Experimental Erosion Control
Stakeholders develop technology
Planting
Biological, Hydrological, and Physical Data
Social Data
Habitat suitability
Traditional and Community Users
Outcomes
Decision Support
Cost
Options
Datasets

Improved mangrove restoration through better decision making



A decision model prioritizes areas for mangrove restoration by integrating habitat suitability analysis with social with logistical considerations such as cost, social acceptability (ease of access, ease of protection), restoration options, and other important factors related to land tenure.


MANGROVE RESTORATION/CONSERVATION
Stand
Community
Province
Region
National
Policy Decisions
ASSESS!!!
Hydrological restoration w/ or w/out planting
Biological, Hydrolo
Physical Data
Social Data
Climate Data
Traditional and Community Users
Outcomes
Decision Support
Cost
Options
Datasets


Mangrove restoration cannot be done by one person or organization….
Thank you!
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Royal University of Agriculture in Cambodia (RUA)
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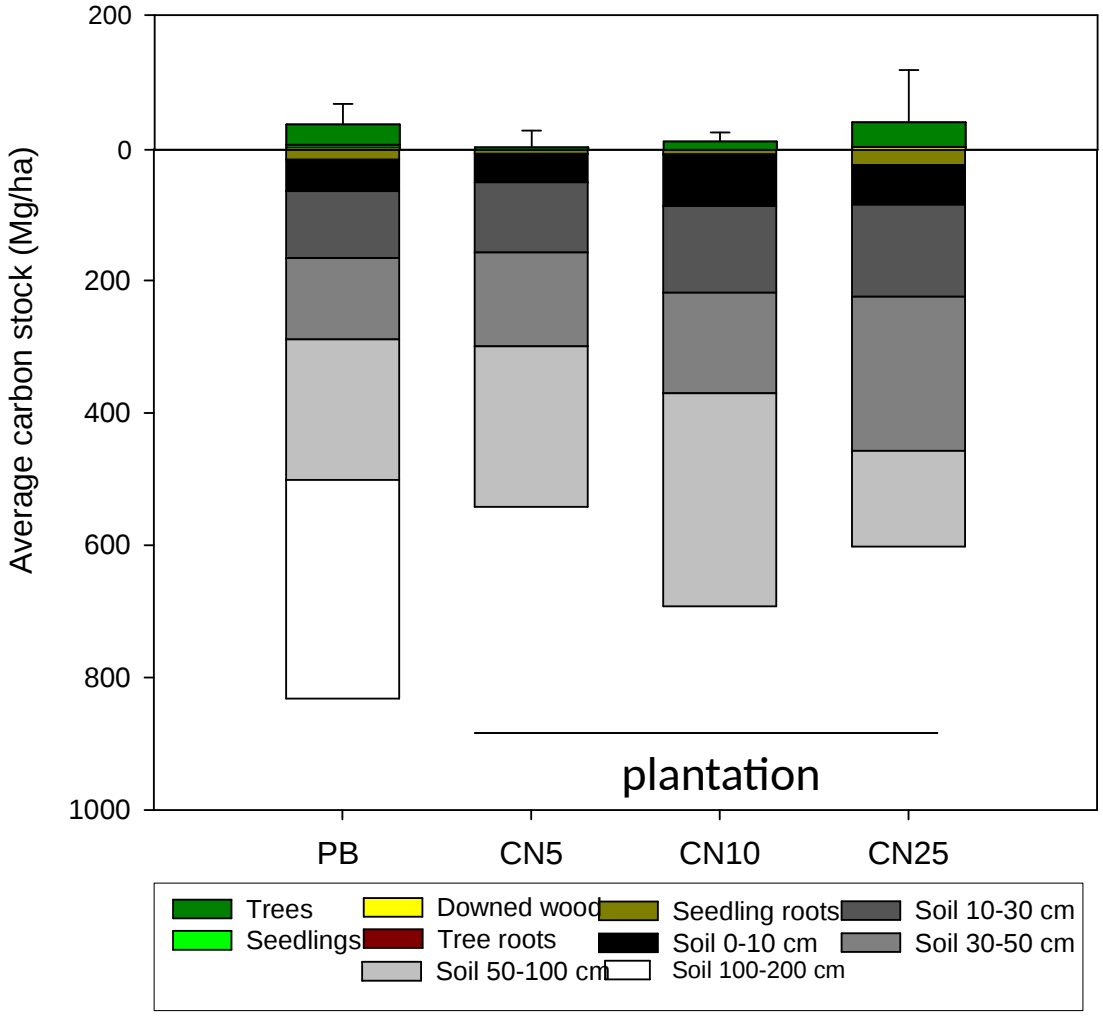
USAID Cambodia
USAID LEAD program
USAID Washington
US Forest Service

THANK YOU

Philippines C stock assessment



PB (Intact mangrove)

CN (plantation)

ctors affecting ecosystem carbon stock variab