*UPLB Centennial Professorial Chair*

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***Agriculture and Development Seminar Series* (ADSS) of SEARCA**

# Mangroves and Climate Change:

## *Prospects and Challenges in Blue Carbon Governance in the Philippines*

**May 10, 2018 ; Drilon Hall, SEARCA**


**Dixon T. Gevaña**

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SEAMEO SEARCA

# Outline

- Mangrove 101
- Blue carbon concept
- Blue carbon estimates: regional and national
- Blue carbon potential  of a mangrove plantation
- Blue carbon in the International Climate Change Agreements (Prospects and Challenges)

RENAMING RITES

# Duterte to visit Philippine Rise, launch research study

Philippine Daily Inquirer / 07:22 AM May 09, 2018

President Rodrigo Duterte will visit Benham Rise on May 15-16 to celebrate the first anniversary of his renaming the underwater land mass Philippine Rise.

While at Philippine Rise, the President will also lead the launching of the country's first scientific exploration of the 13-million-hectare, resource-rich underwater plateau located off the coast of Aurora province.

Presidential spokesperson Harry Roque said on Tuesday that 50 Filipino scientists would carry out the study.

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Malaysia (2014)

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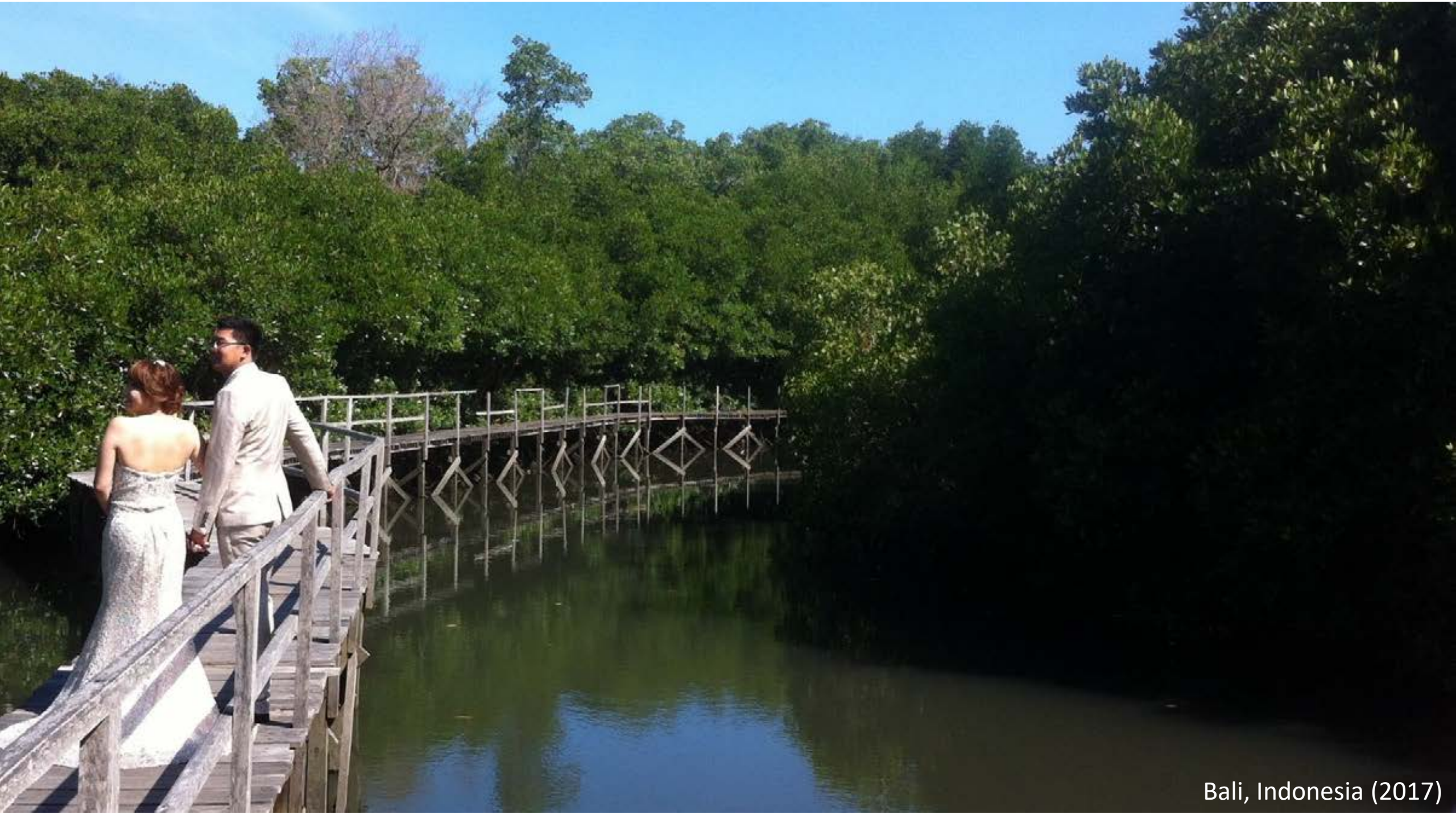

Bali, Indonesia (2017)

Leganes, Iloilo (2018)


Iloilo City (2018)

# Park project killed mangrove cover in Iloilo River

By: Nestor P. Burgos Jr. - @inquirerdotnet Inquirer Visayas / 05:22 PM August 07, 2017

ILOILO CITY – A government-funded lateral park meant to showcase the beauty and cleanliness of the Iloilo River has resulted in the dying of at least four dozens of grown mangrove trees.

The mangroves near the Iloilo Bridge along the Sen. Benigno S. Aquino Jr. Avenue have died and or dying after these parts of the river bank have been diked, according to retired scientist and mangrove specialist Jurgenne Primavera.

“The trees are submerged and cannot breath,” Primavera, who was cited in 2008 by Time magazine as one of its “Heroes of the Environment” for her work on environmental and mangrove protection, said.

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# Mangrove 101

# Mangrove

- **forest ecosystem** along coastal sediment and brackish river habitats exclusive in tropic and subtropic regions (latitudes 25° N and 25° S)

- **landuse** between terrestrial and marine communities, which receive a daily input of water from the ocean (tides) and freshwater, sediments, nutrients and silt deposits from upland rivers

- halophytic or **salt tolerant plants** in 12 genera, eight (8) families and 110 species





Source: AKECOP-UPLB

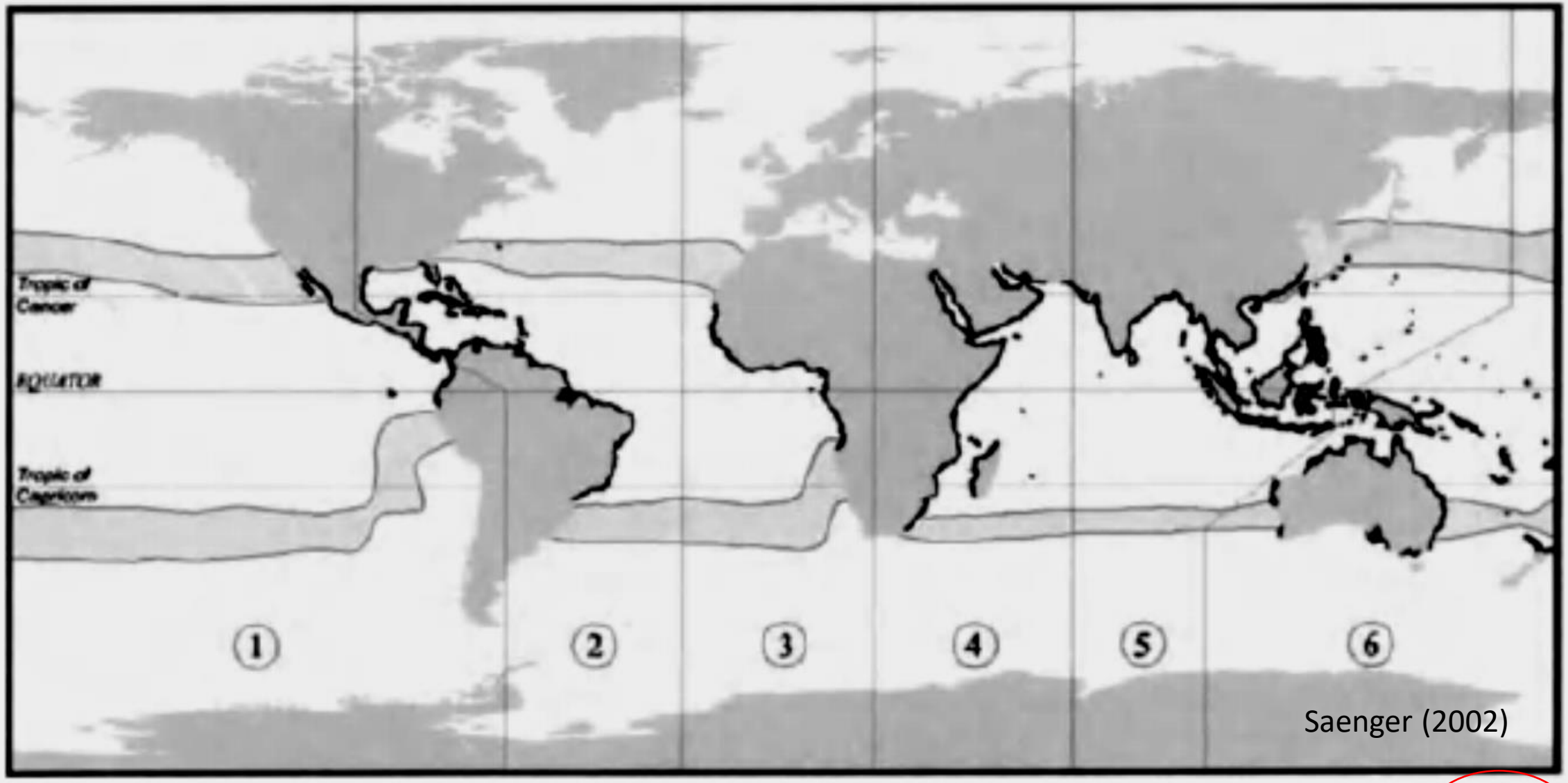



**Fig. 1.2 World distribution of mangroves showing the relationship to the range of 20°C water temperature isotherms in summer and winter and the bioregions 1 to 6 used to describe the distributions of individual species (see Table 2.1).**

# Mangrove environment

- Mangroves grow in relatively shallow water as seedlings cannot become anchored in water deeper than 20-30 cm at mean low water.

- If relatively sheltered conditions prevail, the sediments will be enriched by organic matter which, because of waterlogging, will become anoxic.

- Anoxia - high concentrations of sulfide, ferrous and manganous ions. Reduced ions are toxic to plant.

*Sonneratia alba* (1.5 m depth) – Getafe, Bohol

**Overwash:** These are small mangrove islands frequently formed by tidal washings
**Riverine :** These are luxuriant patches of mangroves existing along rivers and creeks (Kathiresan, 200)

## Riverine mangrove

## Over-wash mangrove


Source: Cabahug (2016)

**Coral atoll** mangroves growing at the bottom of coral sand or in platform reefs
**Lagoon-basin** influence of both tidal and alluvial conditions, lagoons formed behind wave-built barriers where mangrove grow under the (Kathiresan,2012):

Coral atoll mangrove

Lagoon-basin mangrove

Source: Cabahug (2016)

**Fringing barriers with lagoons** (high wave energy conditions with autochtonous sediments of fine sand and mud)
**Basin** mangroves located along the interior side of the swamps and in drainage depressions (Kathiresan,2005)

**Fringing barrier with lagoons**

**Basin mangrove**

Source: Cabahug (2016)

# **Scrub mangrove forests: These form dwarf mangrove** settings along flat coastal fringes (Boaden, 1993)

## Scrub mangrove forests

## Dwarf mangrove forests

Source: Cabahug (2016)

# Importance of Mangrove

- Habitats, spawning grounds, nurseries and nutrients for a number of marine fauna.
- Timber and non-timber products (medicine, tannins, alcohol, etc)
- Food and income: fish and shellfish of about 90 kg to 225 kg per hectare (FAO, 1994)
- Ecotourism with potentially valuable and sustainable source of local livelihood
- Prevent and reduce coastal erosion
- Protection against harsh effects of wind, waves and water currents
- Global worth of US$ 180.9 billion with average monetary value is estimated to US$ 10,000 $ha^{-1}$ $yr^{-1}$ (FAO 2007; Mithapala 2008)
- **Carbon storage and sequestration**

DISASTER RECOVERY

# A town saved by mangroves

Palompon could've been any other devastated town after Super Typhoon Haiyan ravaged the area, but the town was spared; all thanks to their mangroves

When Haiyan struck, Palompon faced storm surges of up to 3.6 meters high. The highest structures in the town's shoreline were only 2 stories (approximately 6.6 meters) tall.

A mangrove plantation, located in an island a few hundred meters from the shoreline buffered the full impact of the waves.

"The mangroves saved us," Oñate said.

GMA NEWS ONLINE
YOUR NEWS AUTHORITY

# Gov't-mandated 'coastal greenbelts' eyed to protect typhoon-prone areas

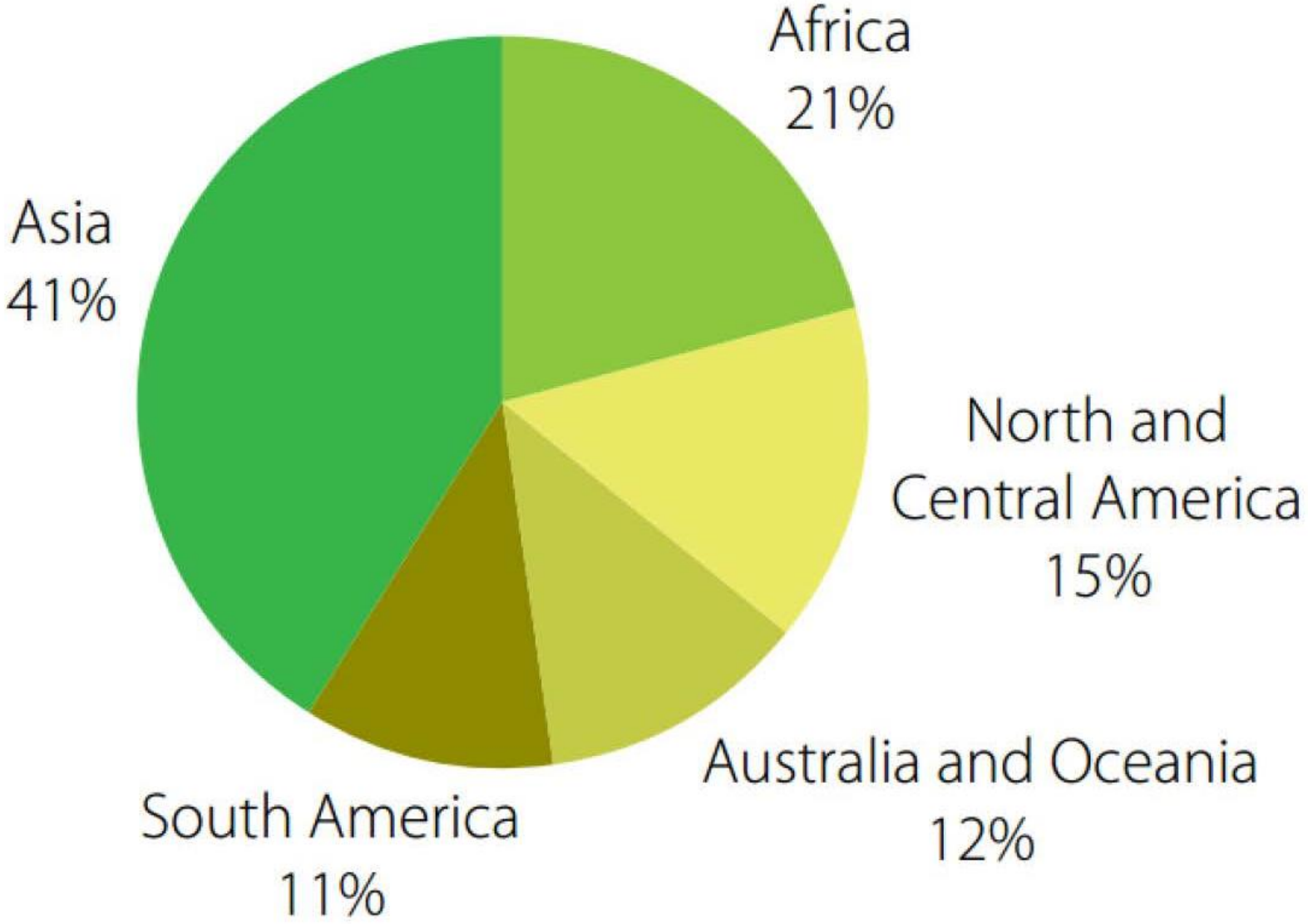
**Published** November 2, 2015 12:04pm

By XIANNE ARCANGEL, GMA News

A lawmaker from Bicol—one of the provinces hard
recommending the creation of mangrove buffer zo

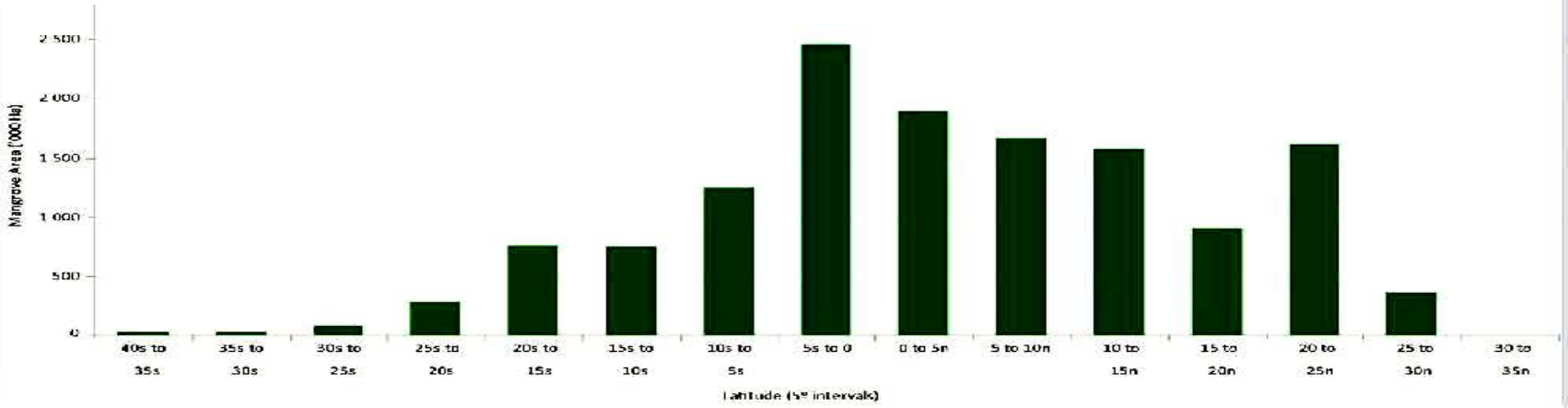
With several typhoons affecting the country each y
forests along coastlines may help mitigate the dan

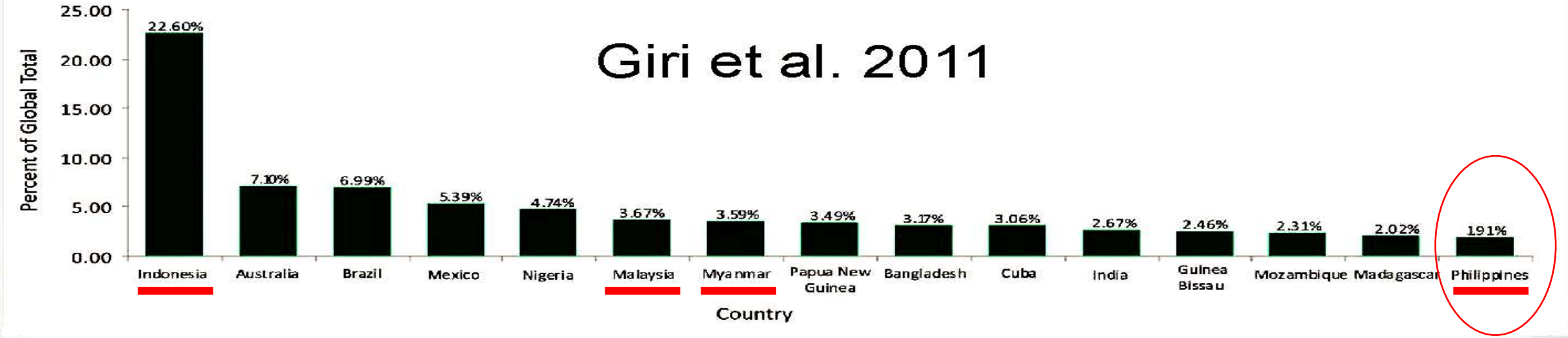
# Trends and Distribution




Source Giri (2017)

# Trends and Distribution




Source Giri (2017)

# Rates and Loss

- Mangroves are being lost globally at a mean rate of 1-2 per cent per year (Duke et al., 2007; FAO, 2007), and rates of loss may be as high as 8 per cent per year in some developing countries (Polidoro et al., 2010).
- Spalding et al. (2010) report losses of over 20 per cent in all regions except Australia over a 25-year period (1980-2005).
- Two areas have shown the greatest per cent loss between 1980 and 2005: the Indo-Malay-Philippine Archipelago (IMPA) with 30 per cent reduction, and the Caribbean, with 24-28 per cent reduction in mangrove area (McKee et al., 2007b; Gilman et al., 2008; Polidoro et al., 2010).

# Mangrove of Southeast Asia: Cover and trend

| Country | Mangrove Cover in Year 2015 ('000 ha)* | Mangrove Loss between 2000-2012 (%)** |
|---|---|---|
| Indonesia | 2244 | 1.7 |
| Myanmar | 299 | 5.5 |
| Malaysia | 521 | 2.8 |
| Thailand | 240 | 1.4 |
| Philippines | 356 | 0.5 |
| Cambodia | 50 | 2.3 |
| Vietnam | 270 | 0.3 |
| Brunei | 18 | 0.4 |
| Timor-Leste | 2 | 0.2 |
| Singapore | 1 | 0.0 |
| Southeast Asia | 4,001 | 2.1 |

*based on FAO (2015) ; ** based on Richards and Friess (2016)

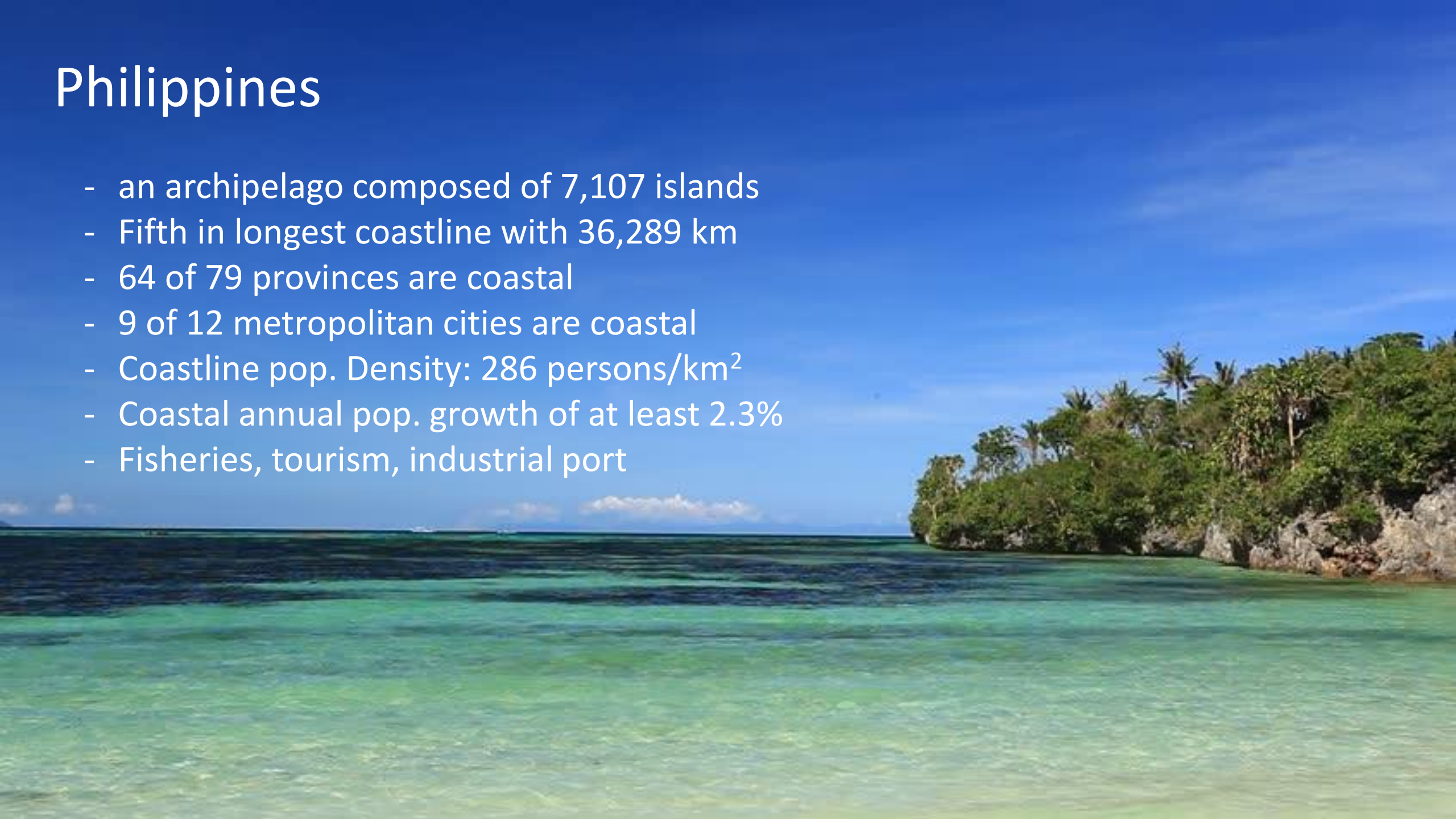




Major threats to mangroves (Gevaña et al 2018)

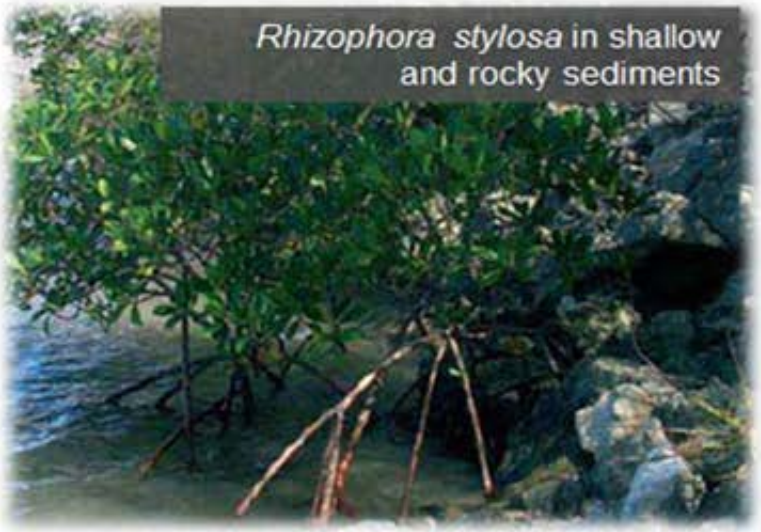
# Philippines

- an archipelago composed of 7,107 islands
- Fifth in longest coastline with 36,289 km
- 64 of 79 provinces are coastal
- 9 of 12 metropolitan cities are coastal
- Coastline pop. Density: 286 persons/$km^2$
- Coastal annual pop. growth of at least 2.3%
- Fisheries, tourism, industrial port

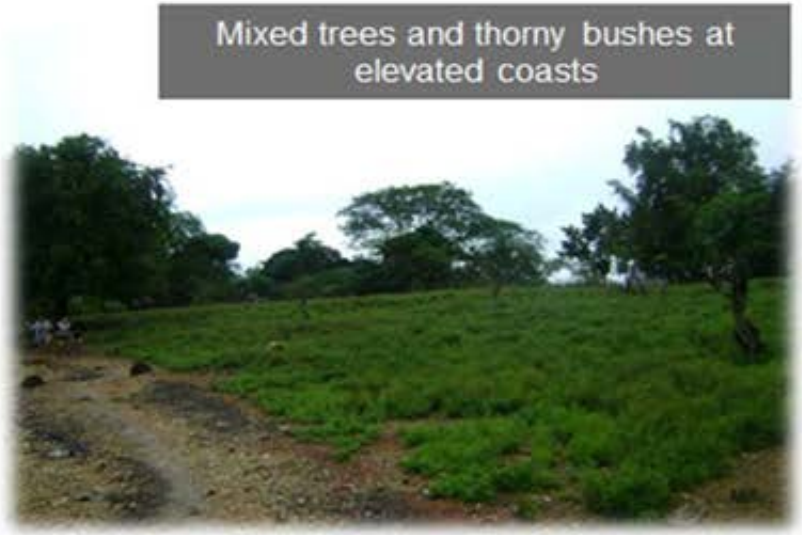


# Common mangrove stand types in the Philippines







# Philippine Mangrove Trend


- From **500,000 ha in early 1900s** to about **310,500 ha** (Brown and Fischer 1920; Chapman 1976; Primavera 2000; FMB 2010, FMB 2015).
- **Trend is now improving** with the recognition of biodiversity and ecotourism values and with implementation of community-based forest management

# DENR continues to push for mangrove planting

by UNTV News | Posted on Wednesday, September 6th, 2017

*FILE PHOTO: Mga bakawan o mangroves (ALLAN MANANSALA / Photoville International)*

**MANILA, Philippines** — The Department of Environment and Natural Resources (DENR) is continuously pushing for the periodic planting of mangrove in the country.

For this year, the DENR targets to plant mangrove in the more than 5 thousand hectares of swamps, especially in areas that are frequently hit by typhoons.

After the onslaught of typhoon Yolanda, more than 50,000 hectares have been planted with mangroves from 2013 to 2015.

The DENR said mangroves along the coastlines help decrease, by a big percentage, the dangers brought by typhoons, storm surges or even tsunamis.

Mangrove planting is part of the National Greening Program wherein the government spends P50,000 per hectare.

"Mangroves provides shelter and protection to the community. In fact study shows they a kilometer wide of mangrove areas can reduce the tsunamis by 70% when it comes to strength," said Henry Adoraro, director of Ecosystem Research and Development Bureau. – **UNTV News & Rescue**

# Mangrove Policies at a Glance…

**Cutting is not allowed** in all mangrove areas of the Philippines

**National Policy:**

- **Presidential Proclamation No. 2151 of 1981** whereas mangrove forests are declared as wilderness area.
- **Republic Act 7586** or *National Integrated Protected Areas System Act* (NIPAS of 1992) whereas, all wilderness areas became protected areas.
- **Republic Act 7161** or *Act of Incorporating Certain Sections of the National Revenue Code* in 1991 whereas cutting and selling of mangrove wood is banned

**Department / Ministry policy:**
**DAO 10 (1998):** Guidelines on the establishment and management of **Community-based Forest Management** (CBFM) Project within mangrove areas whereas **Section 3 allows cutting on planted mangroves.**

# Local communities and mangroves

Philippines has 1.6 million ha of forest lands that are under CBFM tenure agreement.  Of these, 10.7% of the total forest lands are being managed by 1,900 Peoples Organizations (FMB 2010).

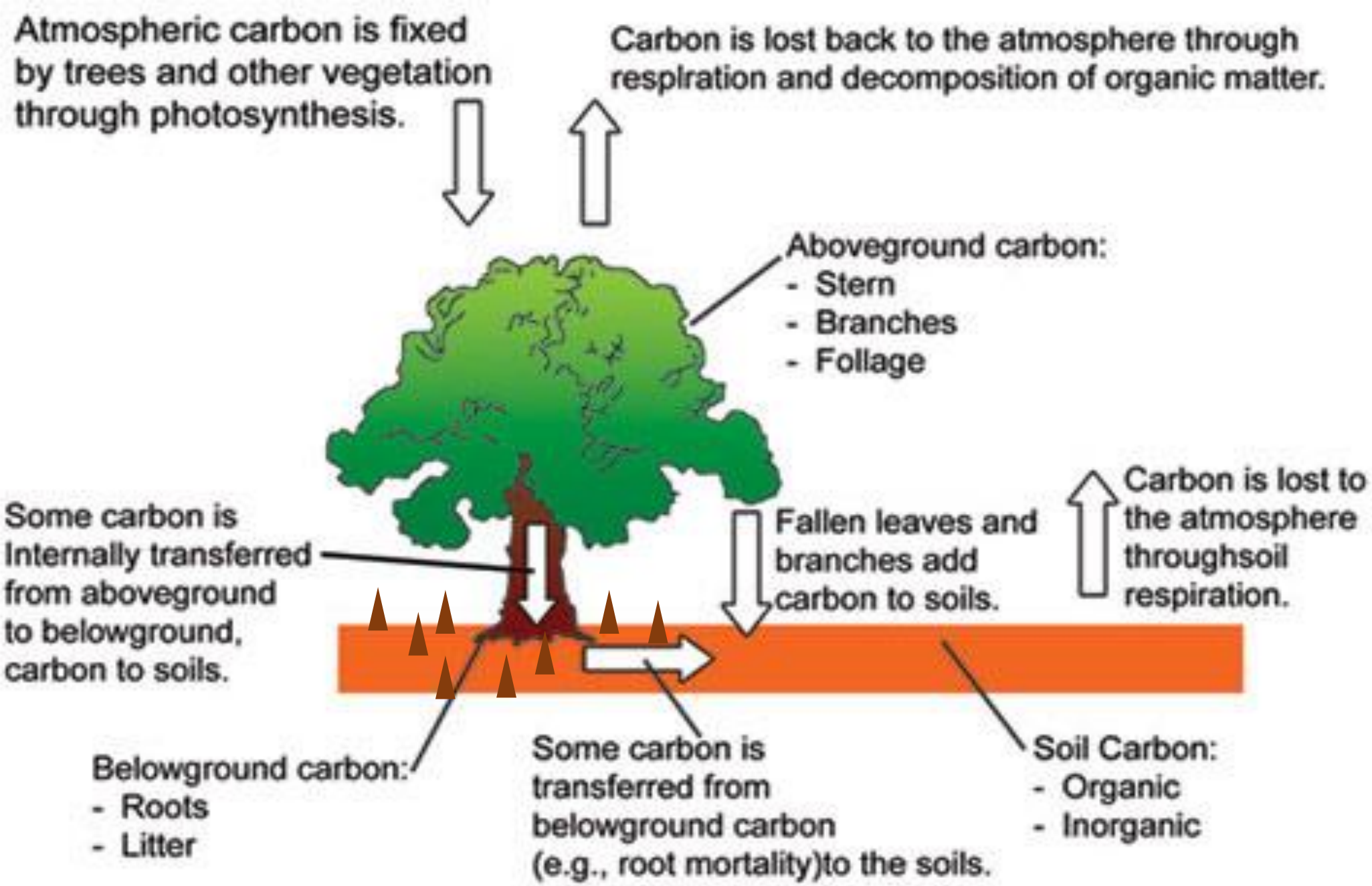
**Roughly 15% of CBFM projects are situated in mangrove forests.**

CBFM provides local communities with:

- Access and occupancy rights on mangrove forests
- Livelihodd development projects
- Employment opportunities through reforestation
- Co-benefits of forest conservation such as fuelwood and marine food

# Blue Carbon Concept

# Carbon Sequestration Process



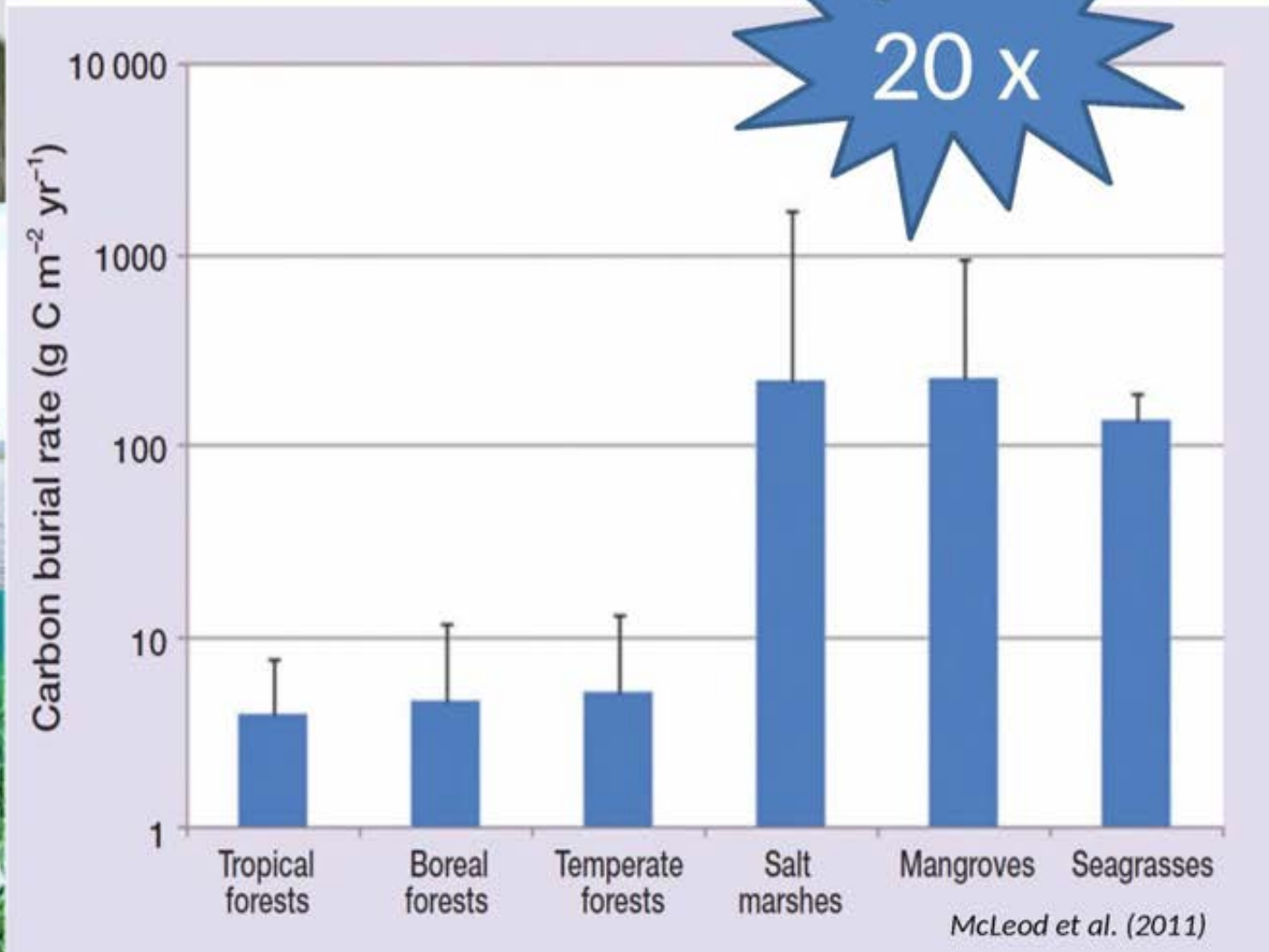

Source: Phyo Si Thu Trading (nd)

# What is Blue Carbon?

- **Blue Carbon** includes *ocean blue carbon* that represents carbon stored in open ocean carbon pools.
- **Coastal Blue Carbon** – The carbon stored in tidal wetlands, which includes tidally influenced forests, mangroves, tidal marshes and seagrass meadows, within soil, living biomass and non living biomass carbon pools.

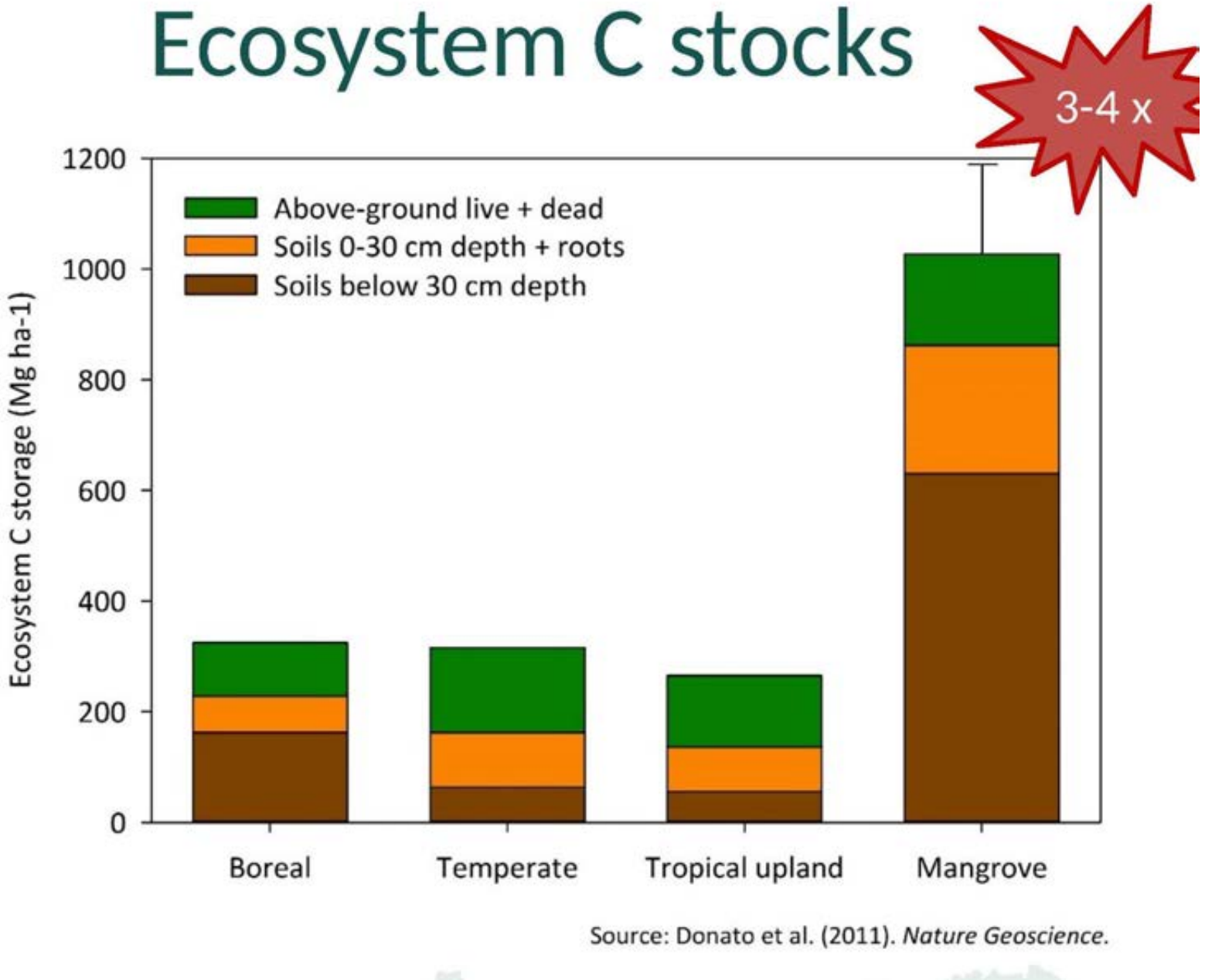
Source: Murdiyarso (2017)

# Carbon burial rates

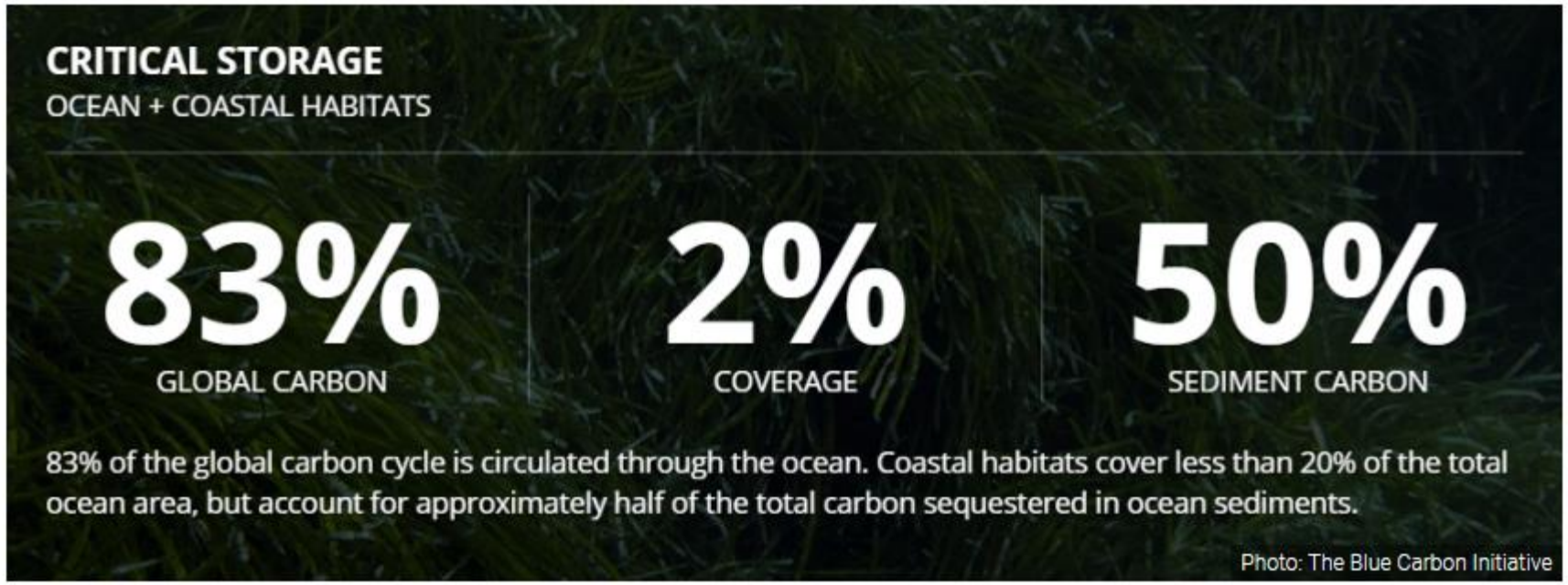



Source: Murdiyarso (2017)

# Ecosystem C stocks




Source: Murdiyarso (2017)




Ocean covers 71% of the earth's surface

The 2009 UNEP "Blue Carbon" report noted that 55% of atmospheric carbon captured by living organisms is captured by marine organisms;  and between 50% to 71% of that is captured by ocean vegetated habitats

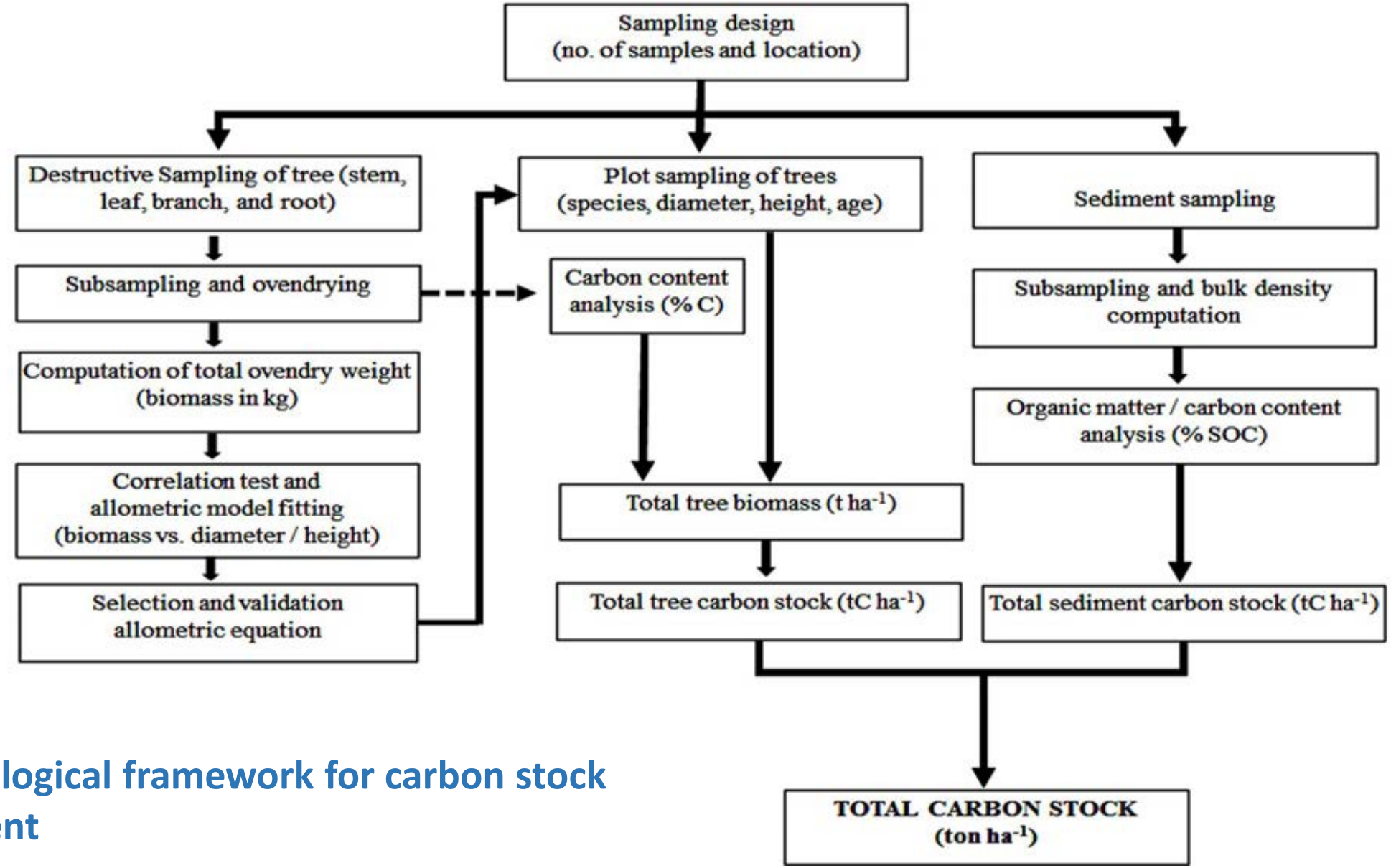
# Background

- It rapidly became clear from publications produced around 2009 that national carbon accounting efforts showed a substantial ‘blue carbon gap’ between knowledge of these carbon sinks and the actions being taken by governments to safeguard their futures. (Laffoley & Grimsditch, 2009; Murdiyarso et al., 2009; Herr et. al. 2017 )

- A full article is reserved for the Parties' commitment to ‘conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases’, with a specific reference to Article 4.1 (d) of the United Nations Framework Convention on Climate Change (UNFCCC), which lists ‘biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems’.

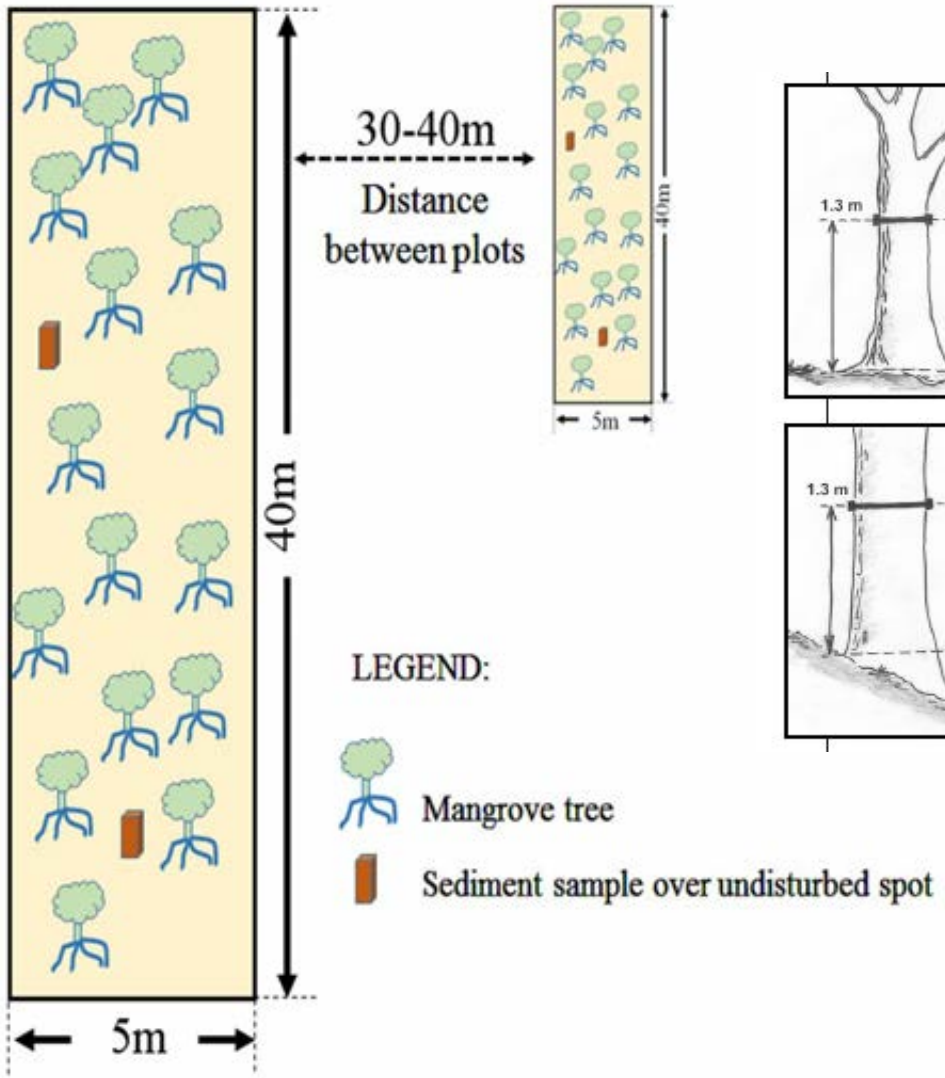
# Mangrove Carbon pools

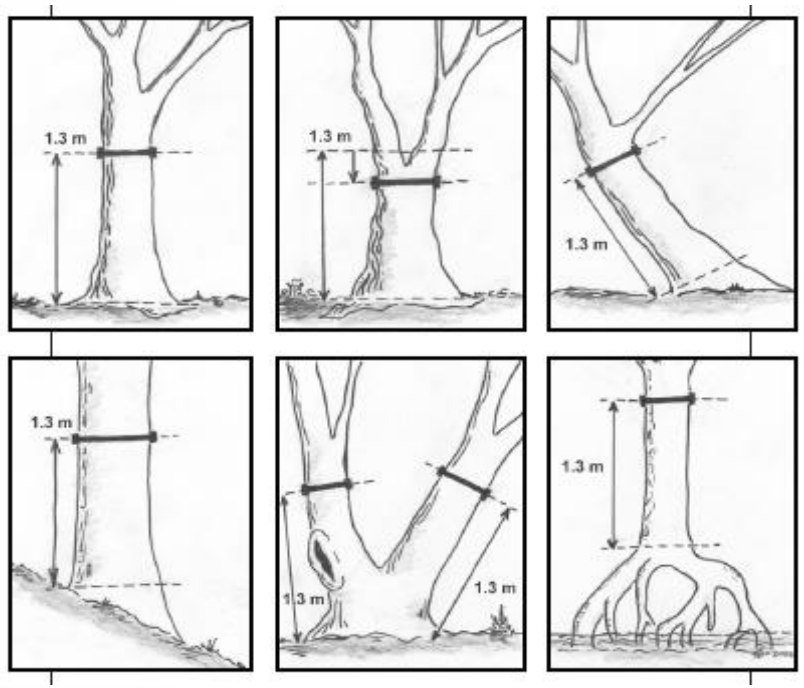
# Biomass and carbon stock assessment




**Methodological framework for carbon stock assessment**

# Field sampling




# Selected Mangrove C-stock Studies and Estimates in the Philippines

# Allometric / Biomass Modelling

THE MALAYSIAN FORESTER 2016, 79 (1 & 2), 39-53

## ALLOMETRIC MODELS FOR *RHIZOPHORA STYLOSA* GRIFF. IN DENSE MONOCULTURE PLANTATION IN THE PHILIPPINES

D.T. GEVANA[1*] AND S. IM[2]

[1]College of Forestry and Natural Resources, University of the Philippines Los Banos, College, Laguna, Philippines 4031
[2]Department of Forest Sciences, College of Agriculture and Life Sciences, Seoul National University, Seoul, Korea 151-921
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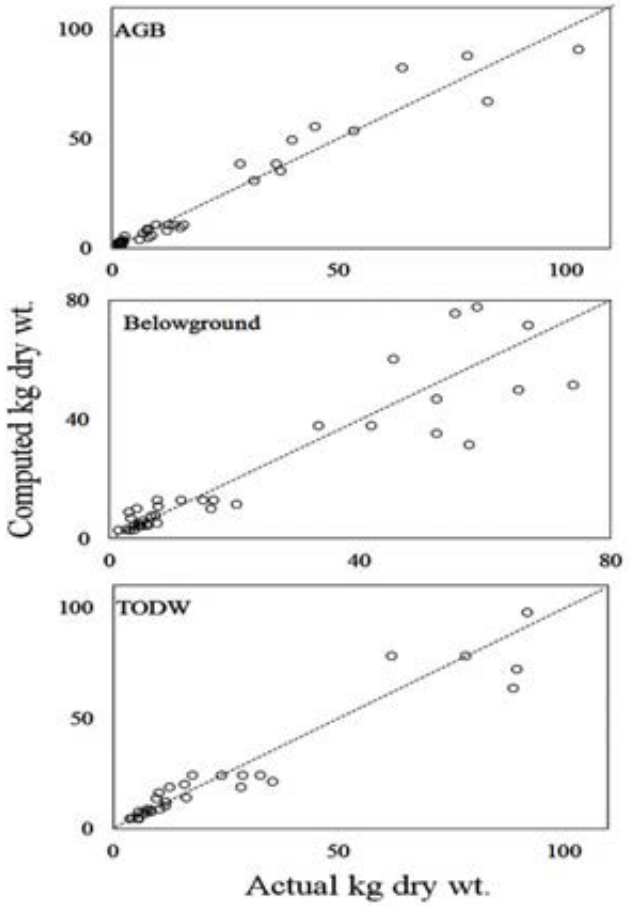
**Abstract:** Tree samples (stem, branch, leaves and roots) for biomass assessment were taken from *Rhizophora stylosa* plantations in Banacon Island, Bohol, Philippines. Large portion of the biomass was observed in belowground (roots) than aboveground (stem, branch and crown). Diameter and height of each tree were measured. Best-fit allometric models were formulated by correlating diameter and height values with tree biomass. *Full model* utilizes both diameter and height variables in allometric model formulation while *reduced model* solely depends on diameter values. Both forms yielded high coefficient of determination ($R^2$) values thus indicating their reliability to predict tree biomass. *Full model* was however preferred over *reduced model* since diameter and height variables were found strong and significantly correlated with one another. To validate, actual biomass values were compared with computed values using allometric models. Results yielded no significant difference between the two sets of data hence denoting the reliability of the *full models* to estimate tree biomass that were grown in monoculture plantation.

**Key words:** allometry, biomass model, mangrove, plantation, *Rhizophora*




TODW (kg) = $y = 0.178 * D^{2.586}$

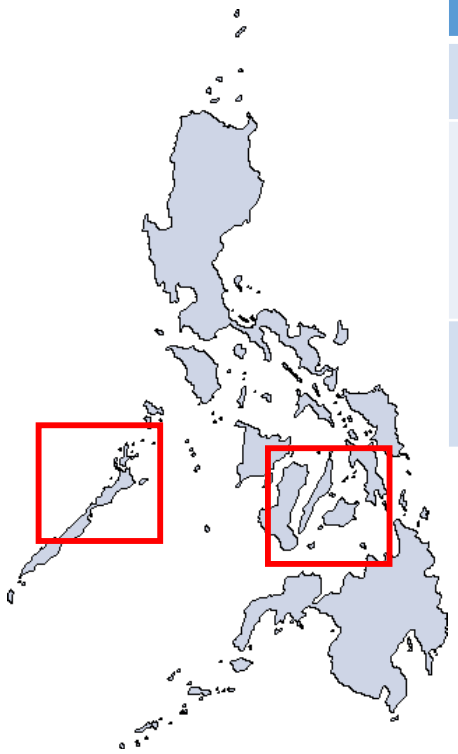
# Carbon Stocks of Natural Mangrove Stands

# Natural Mangrove Stands

| SIte | Est Age (yr) | Carbon Stock (tC/ha) | | | CO2e (tCO2/ha) | Source |
|---|---|---|---|---|---|---|
| | | Vegetation | Sediment | TOTAL | | |
| P. Burgos, Quezon | Mixed (<35) | 111.34 | 17.55* | 128.9 | **472.6** | ENFOR (2009) |
| P. Burgos, Quezon | Mixed (<40) | 174.6 | - | 174.6 | **640.2** | OJCB (2015) |
| San Juan, Batangas | Mixed (<35) | 103.5 | 11.95* | 115.5 | **423.5** | Gevana & Pampolina (2009) |
| Batangas City | Mixed (<40) | 95.4 | 125.6 | 221.0 | **810.3** | SESAM (2016) |

*Soil depth: 30 cm only

# Natural Mangrove Stands



| SIte | Est. Age (yr) | Carbon Stock (tC/ha) | | | CO2e (tCO2/ha) | Source |
|---|---|---|---|---|---|---|
| | | Vegetation | Sediment | TOTAL | | |
| Kamuning, Puerto Princesa | Mixed (50) | 239.3 | - | 239.3 | **877.4** | AKECOP (2009) |
| Northern Bohol | Mixed (<30) | 44.2 | 214.1 | 258.2 | **946.7** | Gevana et al (2014) |


# Some Estimates from Southeast Asia

| Site/ Country | Type* | C-stock (t/ha) | Reference |
|---|---|---|---|
| Karimunjawa, Thailand | N | 269.9 | Wicaksono et al. (2015) |
| Bali, Indonesia | N | 90.7 | Kusumaningtyas et al. (2014) |
| Java, Indonesia | N | 586.0 | Murdiyarso et al. (2009) |
| Sulawesi, Indonesia | N | 939.3 | Murdiyarso et al. (2009) |
| Ayeyarwady, Myanmar | P | 240.0 | Thant et al. (2012) |
| Kelantan, Malaysia | N | 305.34 | Nazri (2017) |
| Samut, Songkram, Thailand | P | 40.1 | Kridiborworn et al. (2012) |
| Surat Thani, Thailand | N | 22.6 | Sathirathai (1998) |
| Thammarat | P | 121.7 | Sriladda and Puangchit (2009) |
| Ranong, Thailand | N | 155.0 | Jachowski et al. (2013) |
| Batangas, Philippines | N | 115.5 | Gevana and Pampolina (2009) |
| Aklan, Philippines | N | 562.5 | Thompson et al. (2014) |
| Quang Ninh, Vietnam | N | 26.6 | Vu et al. (2014) |
| Mui Ca Mau, Vietnam | N | 768.7 | Tue et al. (2014) |
| Brunei Bay, Brunei | N | 169.4 | Verwer and van der Meer. (2010) |
| East Dili, Timor Leste | N | 221.5 | Alongi and Carvalho (2008) |
| Palau Semakau, Singapore | N | 36.6 | Friess et al. (2015) |
| Pasir Ris, Singapore | N | 105.4 | Friess et al. (2015) |

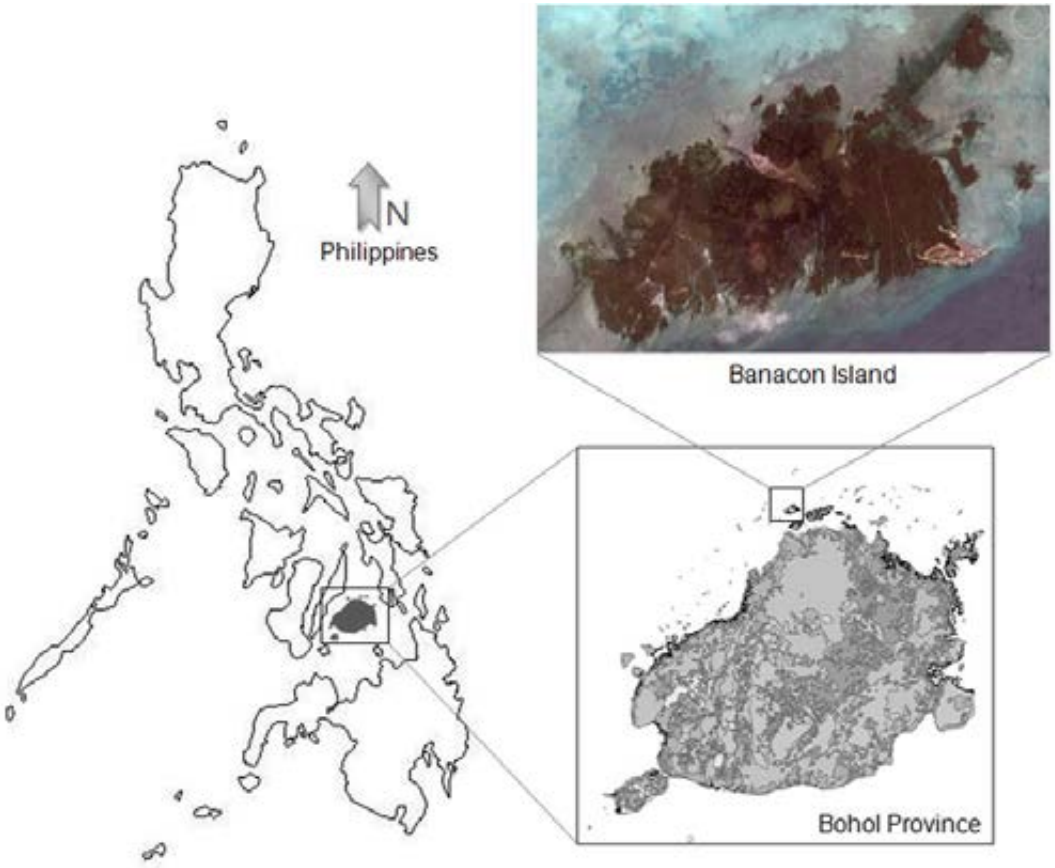
N: natural stand ; P: plantatiion

Gevaña et al (2018)

# Carbon Stock of Mangrove Plantation in Banacon Island, Getafe, Bohol

Some insights on stand density management for pursuing carbon offset project

# Banacon Island, Bohol, Phils.




Location: Bohol Province, Philippines
10º 03’ 30” to 10º 15’ 30” N and
124º 03’ 30 to 124º 14’ 30” E
Area: 660 ha (max: 1400 ha)
Climate: No distinct dry season
(Mean annual rainfall: 1500mm)

Unique features:
a. forms part of *Danajon Double Reef*
b. one of the largest mangrove plantations in Asia
c. community-initiated mangrove planting

Population: at least 300 households

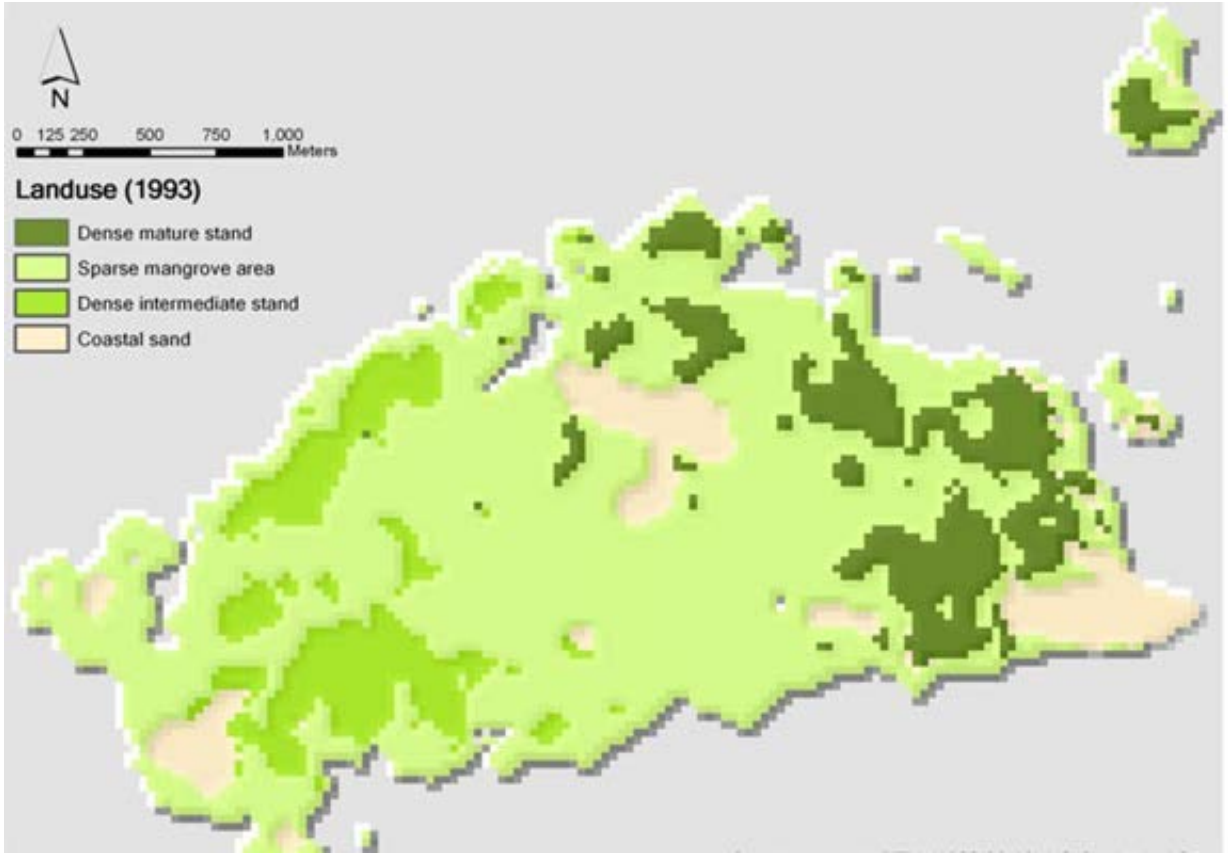
Major livelihoods: fishing, seaweed farming and shrimp catch

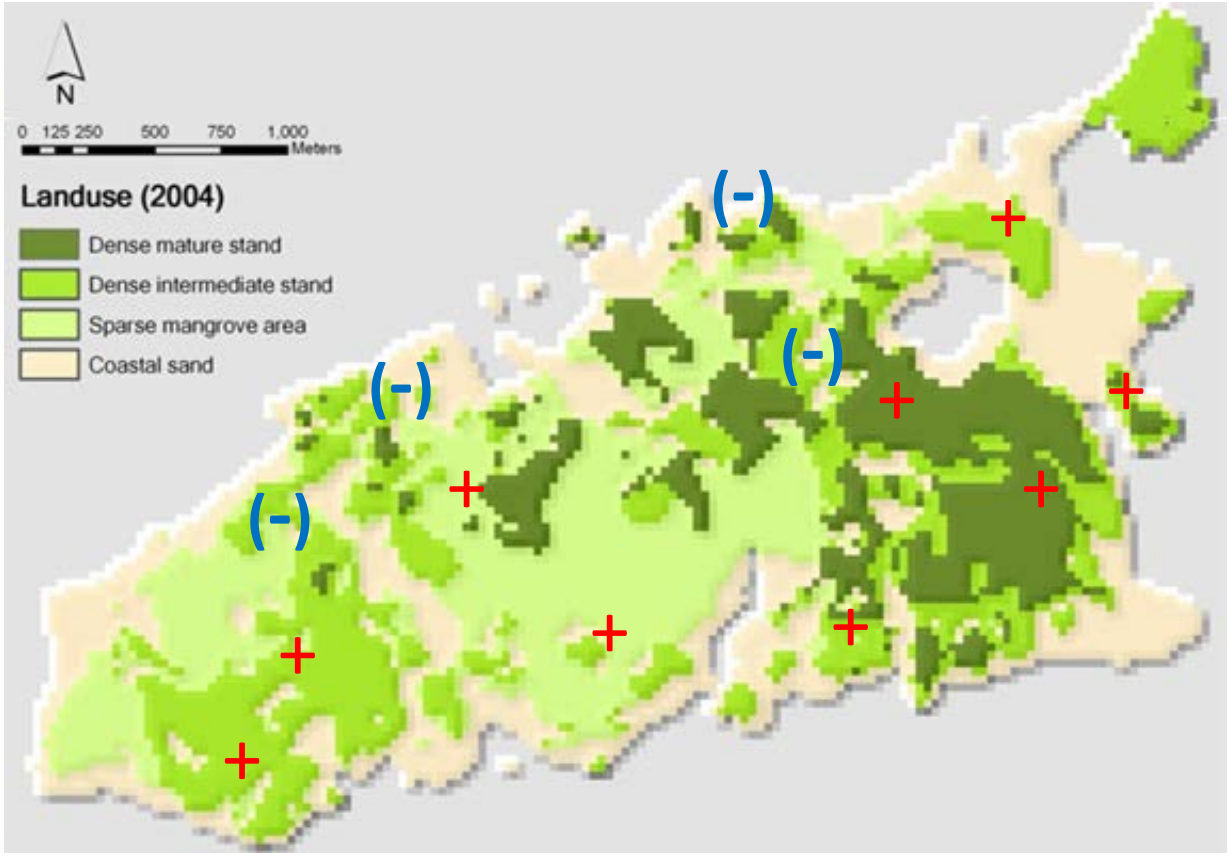



- Successful community-initiated mangrove development
- Multi-awarded mangrove rehabilitation project
- Conservation is critical since it is part of Sulu Sulawesi Biodiversity Seascape
- Huge potential for future carbon offset
- Management issue: poor floristic diversity (monoculture)

  no cut policy vs. local interest to utilize their plantations

# Success of plantation development




**Planting has compensated cutting**

- dense mature stand (+1.4 ha $yr^{-1}$)
- dense intermediate stand (+7.5 ha $yr^{-1}$)

**+ gain (-) loss**

**forest cover increased from 146.5 ha to 285 ha**

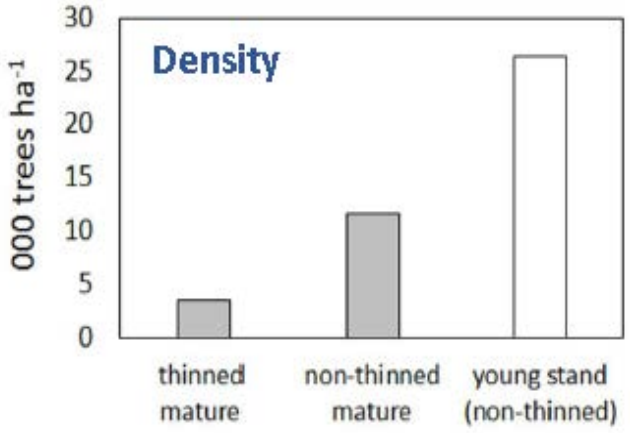
Source: Gevana et al (2015)

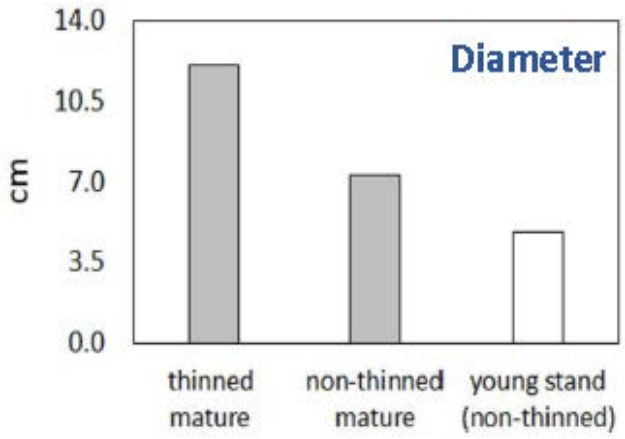
# Biometric description of plantations

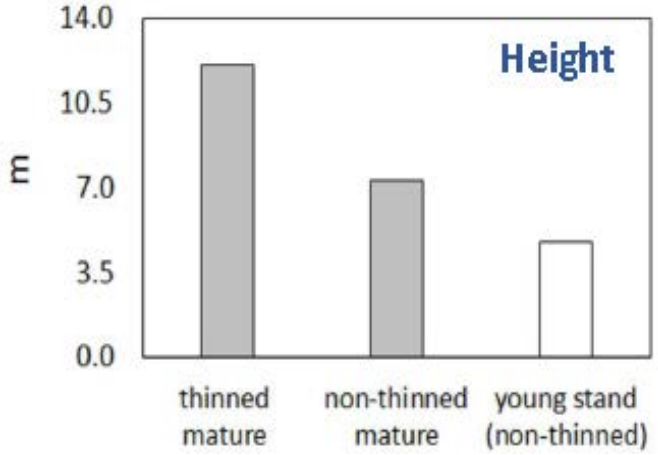

thinned mature stand
Age: 50 to 55 yrs
Area: 35 ha
Initial spacing 0.5m x 0.5m


non-thinned mature stands
Age: 50 to 55 yrs
Area: 20 ha
Initial spacing 0.5m x 0.5m

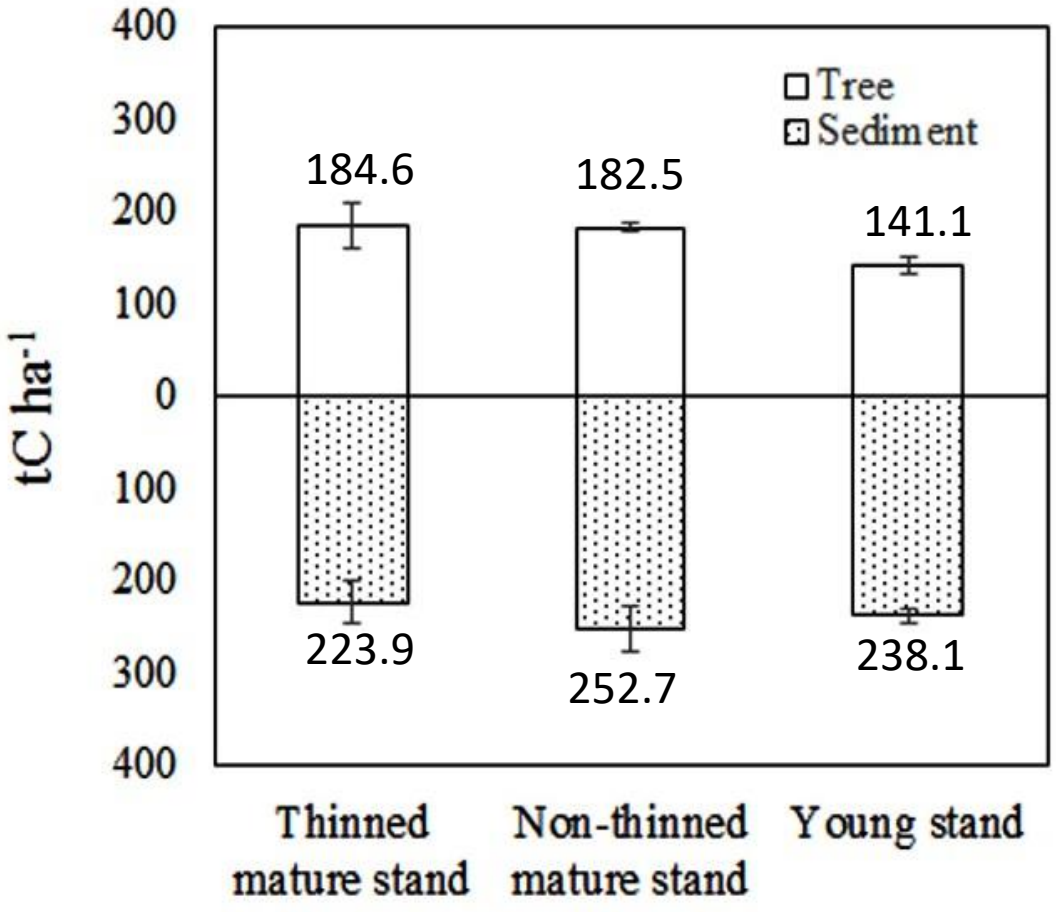

young stands (non-thinned)
Age: 20 yrs
Area: 150 ha
Initial spacing 0.5m x 0.5m



# Carbon stock distribution

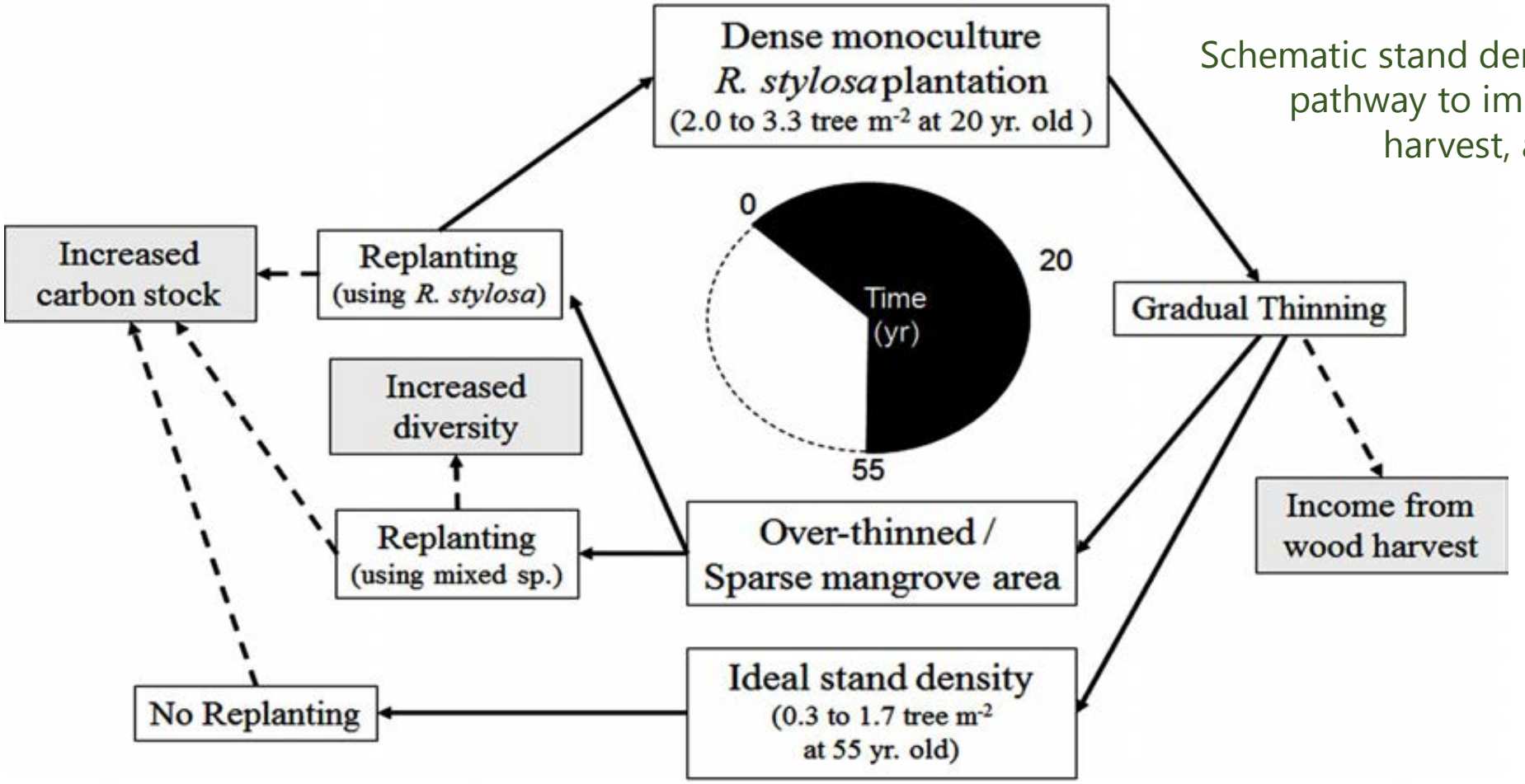



| | Thinned mature stand | Non-thinned mature stand | Young stand |
|---|---|---|---|
| Total: | **408.5±30.0** | **435.2±29.1** | **379.2±11.9** |

- More than half (55% to 63%) of C stock is stored in sediment
- slight but significantly larger tree carbon stock (2.1 tC $ha^{-1}$) were observed in *thinned* than in *non-thinned* stands indicating that selective harvesting may improve tree carbon stock production
- No significant difference in sediment carbon stock of two mature stands
- Likewise, no significant difference in total carbon stock between two mature stands which suggests that:

*thinning* could be a favorable option since it can produce almost similar carbon stock capacity with *non-thinning*

# Onwards sustainable carbon offset project




Schematic stand density management pathway to improve stock, wood harvest, and plant diversity

Source: Gevana D, Camacho L, Camacho S. 2017. Stand Density Management and Blue Carbon Stock of Monospecific Mangrove Plantation in Bohol, Philippines. Journal of Forestry Studies 66:75-83.

# *Prospects and Challenges within the International CC Framework*

The UNFCCC includes coastal and marine ecosystems in Article 4(d), which states that all parties shall "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all GHGs.

Countries that have signed the UNFCCC are obligated to submit annual National Inventory Submissions ("NIS"); these inventory submissions record the country's greenhouse gas emissions from anthropogenic activity, of which Land Use an Land Use Change and Forestry (LULUCF) is a major component.

Unfortunately, Blue carbon ecosystems are not yet accounted for under LULUCF, and thus not included in UNFCCC.

*Grimsditch (2011)*

# *Prospects and Challenges within the International CC Framework*

The Intergovernmental Panel on Climate Change (IPCC) should sufficiently amend the LULUCF guidelines in order to include blue carbon.

However, IPCC operates based on peer-reviewed science, hence current scientific gaps (particularly blue carbon fluxes – loss and take) need to be addressed first through hard publications; likewise protocols need to be established.

**Robust science is needed.**

*Grimsditch (2011)*

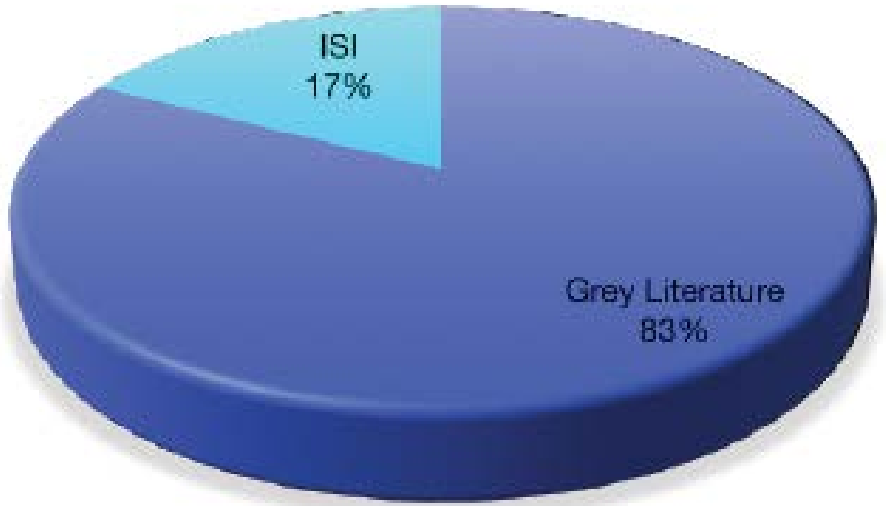
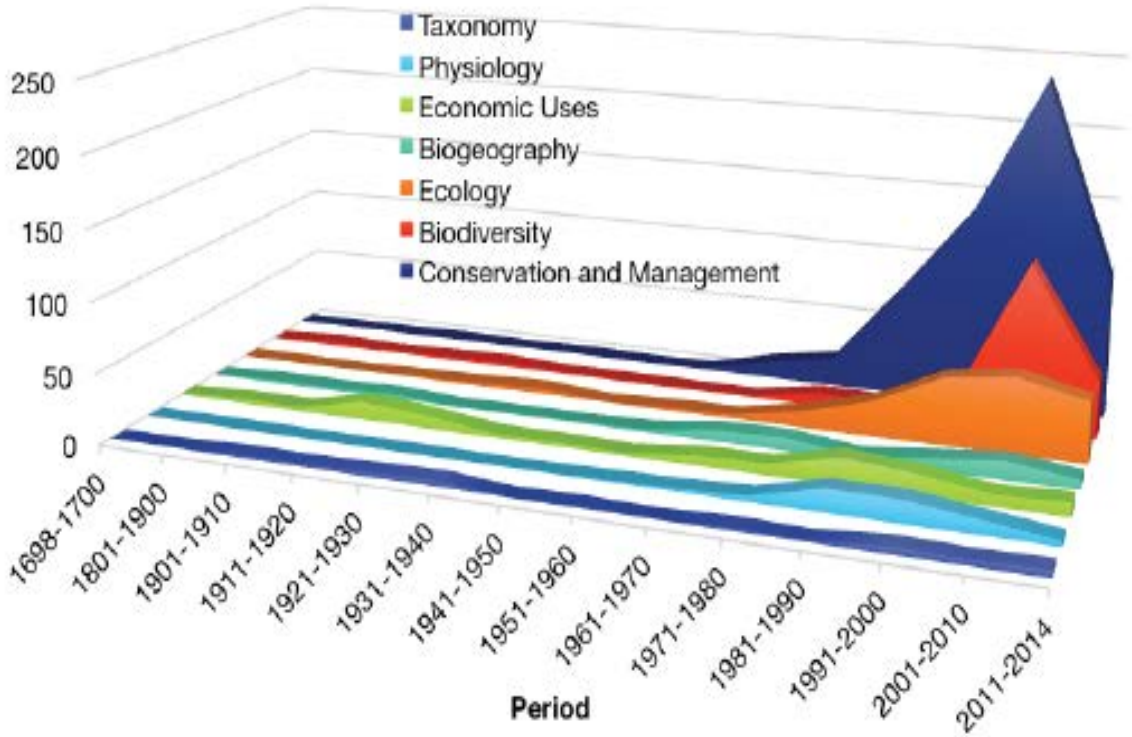



**Figure 28.** Number of ISI-indexed and grey literature in mangrove studies in the Philippines (1698–2014; Fortes & Salmo, in press).

**Figure 27.** Distribution of literature on mangroves in the Philippines among the seven major research topics and at decadal periods from 1698–2014 (Fortes & Salmo, in press).




Source: *https://journals.ateneo.edu/ojs/index.php/smnl/article/download/2503/pdf_22*

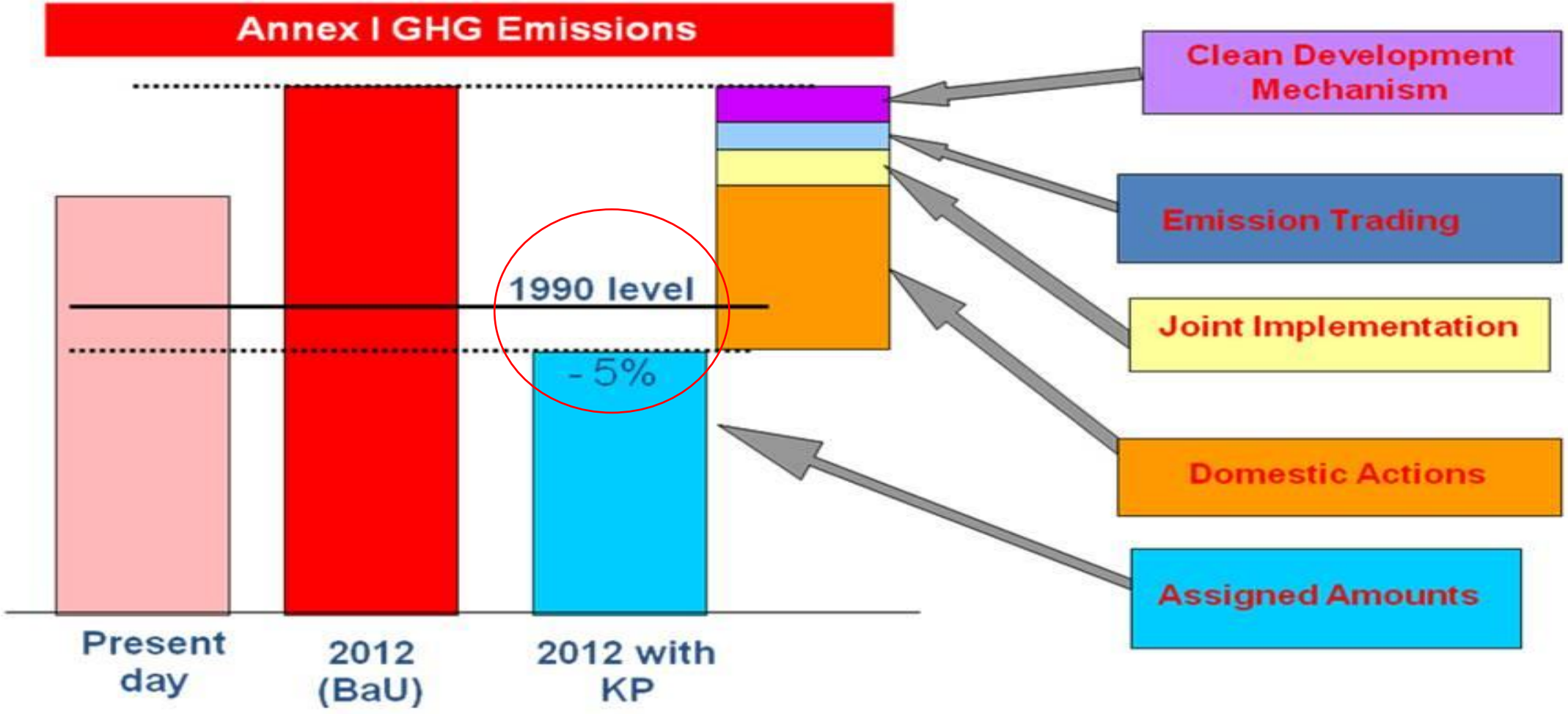
# Blue carbon in Kyoto Protocol's CDM

## Clean Development Mechanism (CDM)

- allows governments or private entities in industrialized countries (Annex 1) to implement emission reduction projects in developing countries and receive credit
- contains legally binding emissions targets for Annex I (industrialized) countries
- Annex 1 countries commit themselves to reducing their collective emissions of six key greenhouse gases by at least 5%.
- The UNFCC established a CDM Executive Board that will approve project designs and methodologies, approving CERs, and administering project auditors

# Kyoto Protocol: Flexibility Mechanisms

(Source: Yap. 2004)



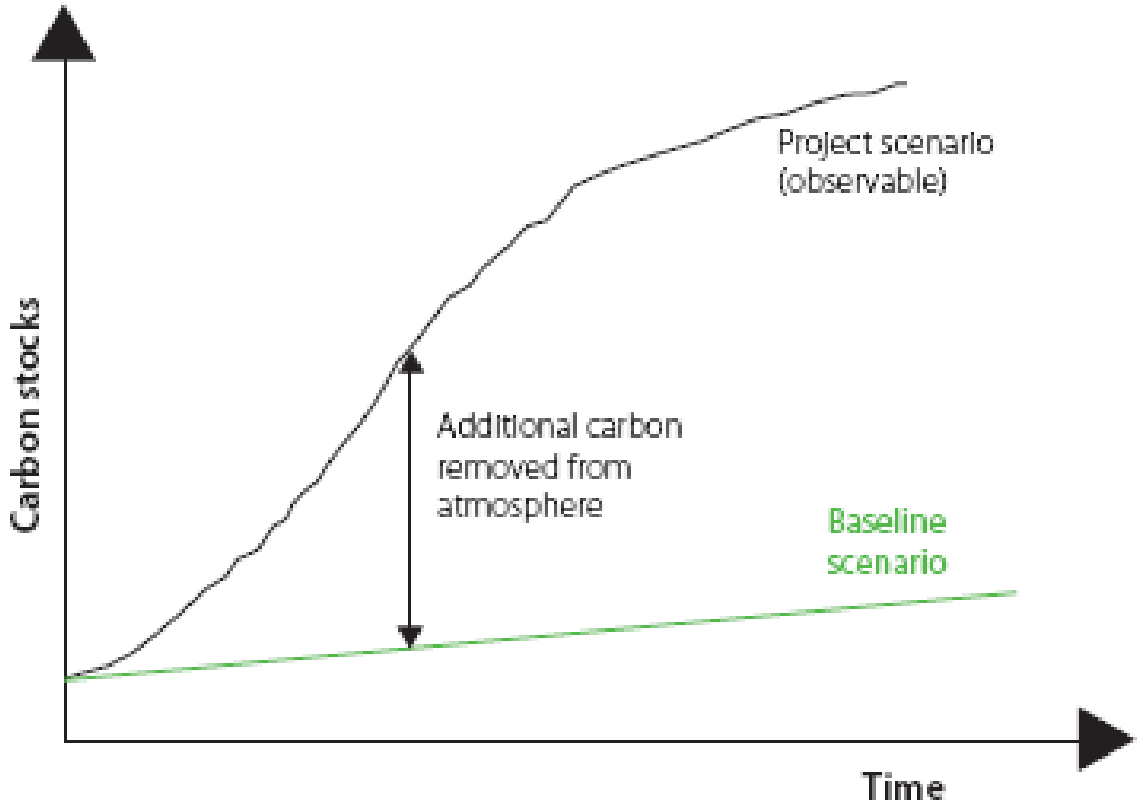
# Important considerations in CDM

**Additionality** - The proposed afforestation or reforestation project activity under the CDM is additional if the actual net greenhouse gas removals by sinks is increased above the sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the registered CDM afforestation or reforestation project activity.

Simply, How much carbon is being sequestered as a direct result of the CDM transaction?

# Important considerations in CDM

**Baseline** - “in the absence of afforestation or reforestation project” scenario. Basically deals with the amount of GHGs present or expected without CDM



# Important considerations in CDM

**Leakage** - Some projects will be successful in sequestering more carbon within the project area, but the project activities may change activities or behaviours elsewhere. These changes may lead to reduced sequestration or increased emissions outside the project boundary, negating some of the benefits of the project.

Ex. continuous deforestation on adjacent CDM site

# Important considerations in CDM

**Permanence** – continuous recognition of carbon credits based on two types of CERs: temporary (5 year commitment period, renewable every 5 years); and long-term

# Blue Carbon in Cancun Protocol's REDD

## **R**educing **E**mission from **D**eforestation and forest **D**egradation

***Deforestation***

- natural or anthropogenic process that **converts forest land to non-forest land**" (IPCC, 2007).

"It is the conversion of forest land use or the long term reduction of the tree canopy cover below the minimum 10 percent threshold" (FAO, 2005).

***Degradation***

"refers to changes within the forest that **negatively affect the structure or function of the system or site**, and thereby lower the capacity to supply products and /or services" (FAO, 2005).

Rationale:

- "Deforestation produces between 12-20% of global $CO_2$ emissions, primarily due to the loss of tropical forests (Van der Werf*et al*., 2009; CAIT, 2010).
- Only 5% of tropical forests are under Sustainable Forest Management SFM (ITTO, 2009)." (p. 2)
- Reducing deforestation is currently the most cost effective way to reduce GHGs (Stern, 2006).

# REDD vs. REDD+

- **REDD** originally referred to "reducing emissions from deforestation in developing countries (just forest protection)
- **REDD+** (or **REDD-plus**) refers to "reducing emissions from deforestation *and forest degradation* in developing countries, and the role of *conservation, sustainable management of forests, and enhancement of forest carbon stocks* (through tree planting and rehabilitation of degraded forest lands) in developing countries“ (forest protection + reforestation)

# Major Consideration in REDD's MRV

Measurement, Reporting and Verification (MRV) of greenhouse gas emissions by sources and removals by sinks.

Measurements of carbon sequestration and carbon emissions due to habitat degradation need to be developed and approved by appropriate international bodies, such as the Voluntary Carbon Standard (VCS) – uses similar criteria with CDM.

# In sum,

- Mangrove has very huge economic and ecological potential for a carbon offset project.
- Philippine mangroves: Area: 356,000ha > 200 tC/ha > 261.3 $MtCO_2$

**Total Est. Vaue: 26.7 Million USD**

- What should be done: continue providing science (more collab. researches)
- Explore other local / community-based incentive schemes such as PES, ecotourism enterprise.

Ang Pulo, Calatagan, Batangas (PO-led)

Leganes, Iloilo (LGU-led)

Banacon Island, Bohol (Individual Initiative)

Banacon Nature Park ©

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# Thank you.

To God be all the glory.


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