KQ2: How do we manage the key factors that influence the blue carbon stock in the East Asian Seas?

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Coral triangle as highly threatened coastal area

High population pressure in coastal zones

Various land-based loads, unsustainable tourism development, excessive & destructive fisheries, etc.

Climate change

- More than 85% of reefs are rated as threatened, with 45% at high or very high risk
- Mangroves have lost 70% of their cover in the last 70 years
- Seagrass bed loss ranges from 20-60% in the last 50 years

(WRI., 2012, etc.)
Multiple Environmental stresses

- Coral Reef
- Seagrass Bed
- Mangroves

Developments in Land

- Terrestrial Runoff
- Watershed

- SLR
- SST Rise
- Coral bleaching
- Ocean acidification

- Over/destructive fishing
- Unsustainable Tourism development

- Bigger Typhoons
- Ocean
- SLR

Outbreak of COTS

Unsustainable Tourism development
Chronic stresses:
- Sedimentation/ siltation
- Excessive nutrient discharge
- Pesticide/ herbicide/ bacteria
- SLR, water temp increase
- Ocean acidification, etc.

Episodic disturbances:
- Massive coral bleaching
- COTS outbreak
- Typhoons/cyclones/hurricanes
- Tsunami, etc.

Chronic stresses may exacerbate some episodic disturbances!
Global Climate Change

Terrestrial Impacts
- Sedimentation
- Nutrient discharge
- Fish/shrimp ponds development
- etc.

Direct human impacts by over-fishing, tourism, etc.

Coastal Ecosystem

Oceanic Impacts
- High water temp.
- Sea level rise
- Acidification
- Typhoon & Storms
- etc.

Grazing by COTS, etc.
Mangrove deforestation between 2000 and 2012

Fig. 1. Mangrove deforestation between 2000 and 2012. Deforestation is summarized within each 1 decimal degree square.

(Richards and Friess, 2016, PNAS)
Dominant land uses of deforested areas in 2012

Fig. 2. Percentage mangrove deforestation between 2000 and 2012, and dominant land uses of deforested areas in 2012. Land uses are summarized as the converted land use with the greatest area within each 1 decimal degree grid square. Circles are located in the center of each grid square, and circle size represents the percentage of the mangrove area in 2000 that has been lost.

(Richards and Friess, 2016, PNAS)
Fallen mangrove trees caused by Typhoon Haiyan (2013)

Caluait Island, Busuanga (April 23, 2017)

*How much intensified in mangrove gaps by future bigger typhoons?*

*Risk assessment/prediction of mangrove damages under super typhoon*
What should we know as “BC”?

BC stock

BC stock change dynamics under changing environments

Example: Seagrasses around Panay Island have largely been lost by siltation caused by deforestation in the uplands, etc.
Major pathways of blue-carbon sequestration to the outer ocean

(Based on the figure by T. Miyajima)

More extensive scope is needed for accurate understanding of blue carbon dynamics!
Terrestrial OC sources
(Green Carbon)

- mangroves
  - import
  - export/import
  - export
  - production/decomposition/trapping/resuspension

- Seagrass beds
  - import
  - export
  - production/decomposition/trapping/resuspension

- Macroalgae
  - production/export

- Corals
  - production/export
  - calcification, production, export, etc.

- Outer sea
  (Blue + green carbon mixture pool)
“Green + Blue” Approach

• For properly understanding the BC ecosystem dynamics, especially its changes due to terrestrial impacts

• For implementing proper conservation and restoration policies/actions
High Turbidity in Banate Bay & its Possible causes

Sources of sediments
- Farmland
- Upland area
- Fishpond

Several rivers

Banate Bay
Fish catch decline

- Recent fish catch decline by 80% compared to that in 1970’s.
- In contrast, number of fish per unit weight increased.

(BBBRMCI, 2008)
"Atmosphere-Land-Coastal-Ocean" coupling model

(Yamamoto and Nadaoka, 2018)
Atmospheric model outputs

10m surface wind & 2m surface air temperature

February 2003

August 2003
Seasonal and spatial variation in atmospheric condition

Monthly rainfall (March 2003)
Monthly rainfall (September 2002)

Dynamic atmospheric data affect hydrology in watersheds.
Sediment transportation by current
Sediment is originated not only from the adjacent rivers, but also from outside the Bay.

[Rainy season]

We need to take into account the environmental loads from the Strait-scale multiple watersheds!
Banate Bay as Source and Sink of Sediments

Southwest monsoon

Northeast monsoon

28%
31%
16%
17%

54%
41%
4%
“Stress Connectivity Matrix”

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Useful for expressing complicated Strait-scale connectivity of stresses
Enhanced Improvement by Introducing a Soil Erosion Prevention Practice in Strait-scale Integrated Watersheds

Current condition

Case 1
Prevention practice only in Banate area

Case 2
Prevention practice also in distant watersheds

Need of implementing “inter-watershed” initiative for effectively reducing turbidity
Thank you!