

NbS Capacity Building – Session 1

Approaching Nature-based Solutions (NbS) in Riverine, Coastal and Marine Ecosystems

Sebastien GOETHALS

Climate Adaptation & NbS Expert

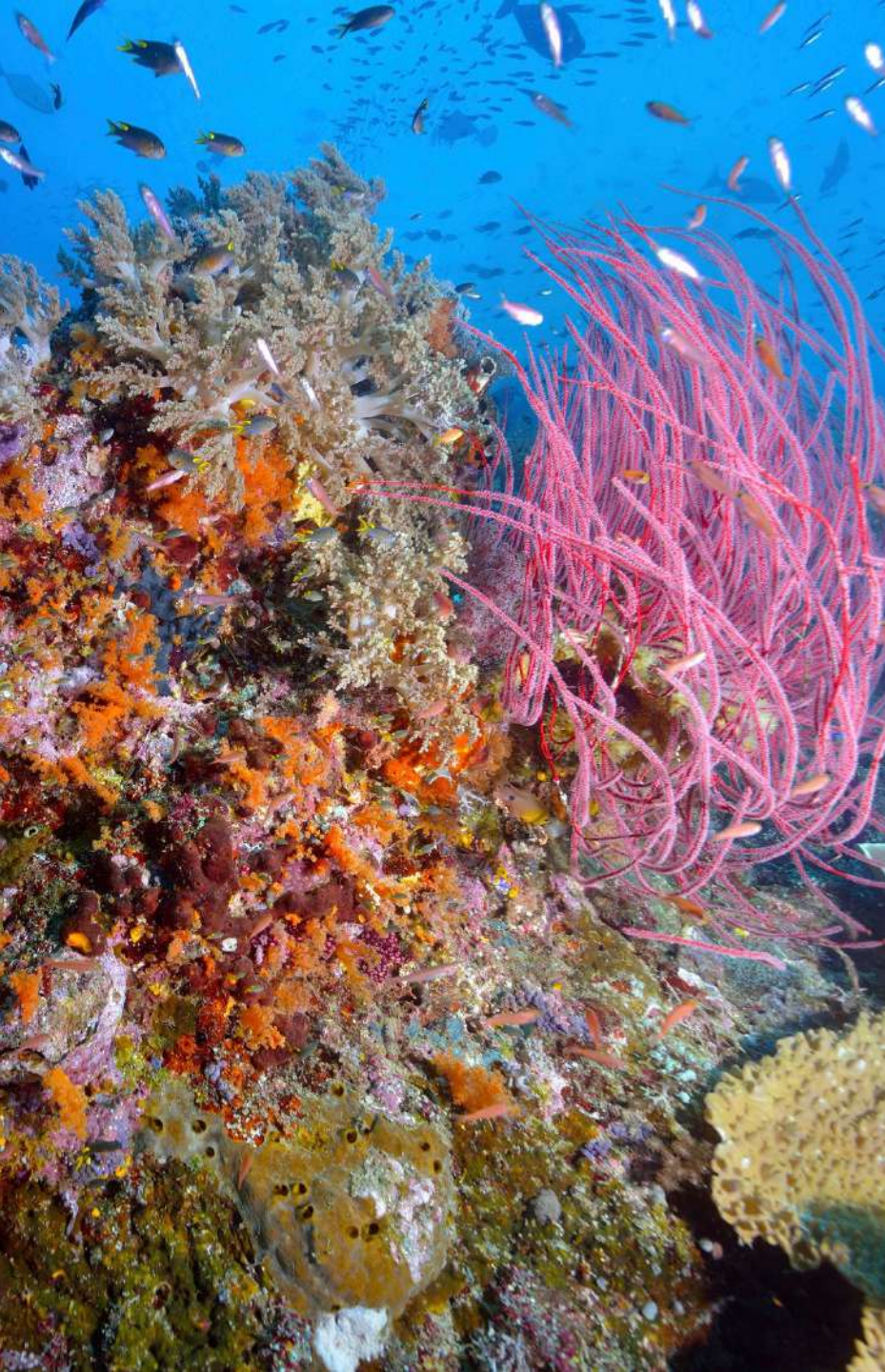
Regenerative Landscape Planning & Design

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**Technical Assistance Facility to
the Green Team Europe Initiative (TAF-GTEI)**

TAF-GTEI is a project funded by the European Union in partnership with ASEAN



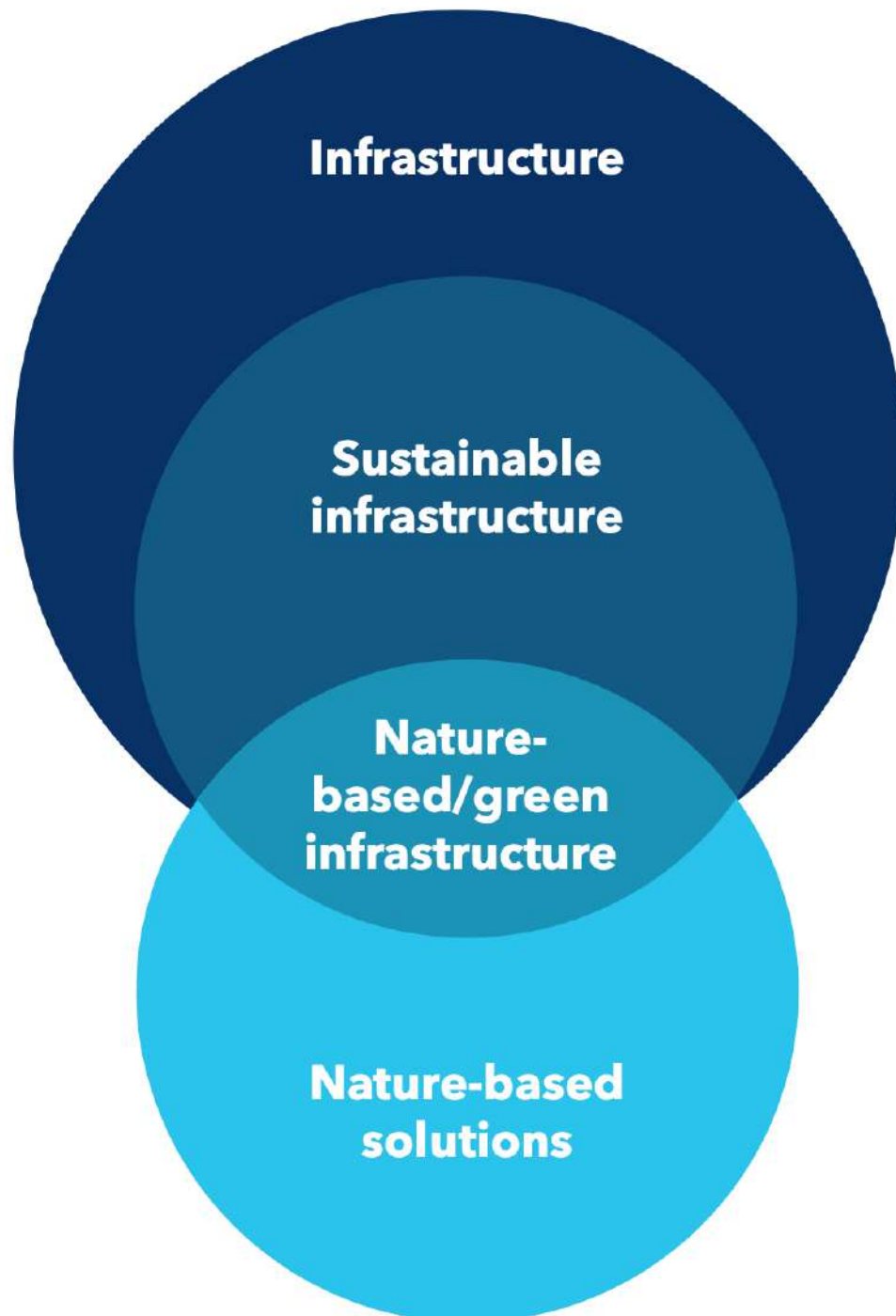


Nature-based Solutions (NbS) are

“Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits”

IUCN





The “Grey to Green Transition”

“Green Infrastructure (GI) is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services.

It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings.”

European Commission, 2013





The ASEAN NbS Catalogue, 2025

9 Landscape-based Climate Adaptation Strategies

70 Nature-based Solutions Practices developed into double-pagers guidance

PUBLICATION SET

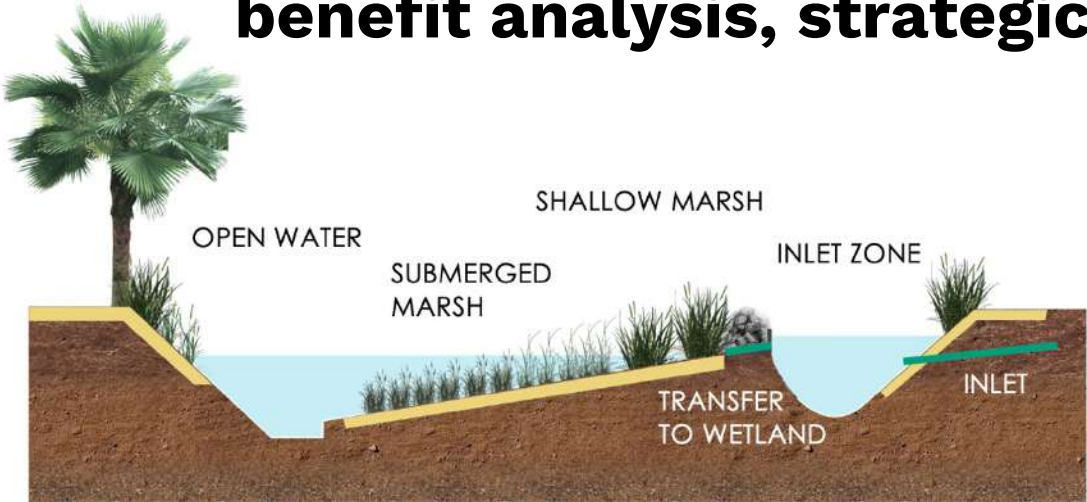
Nature-based Solution Studies in ASEAN Member States



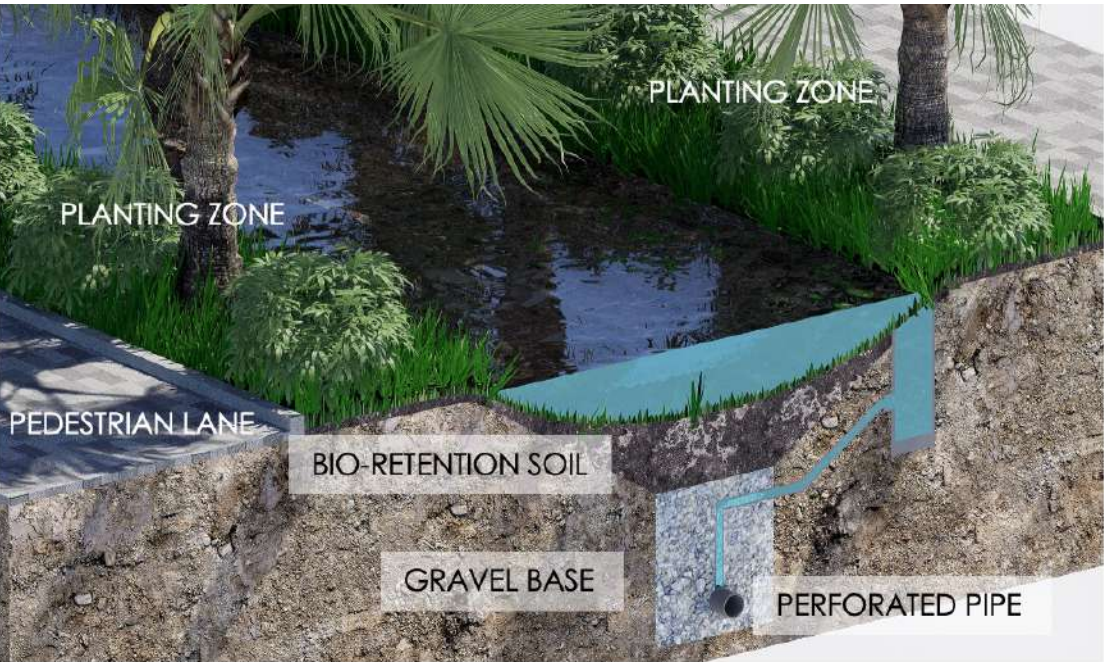
Access reports here



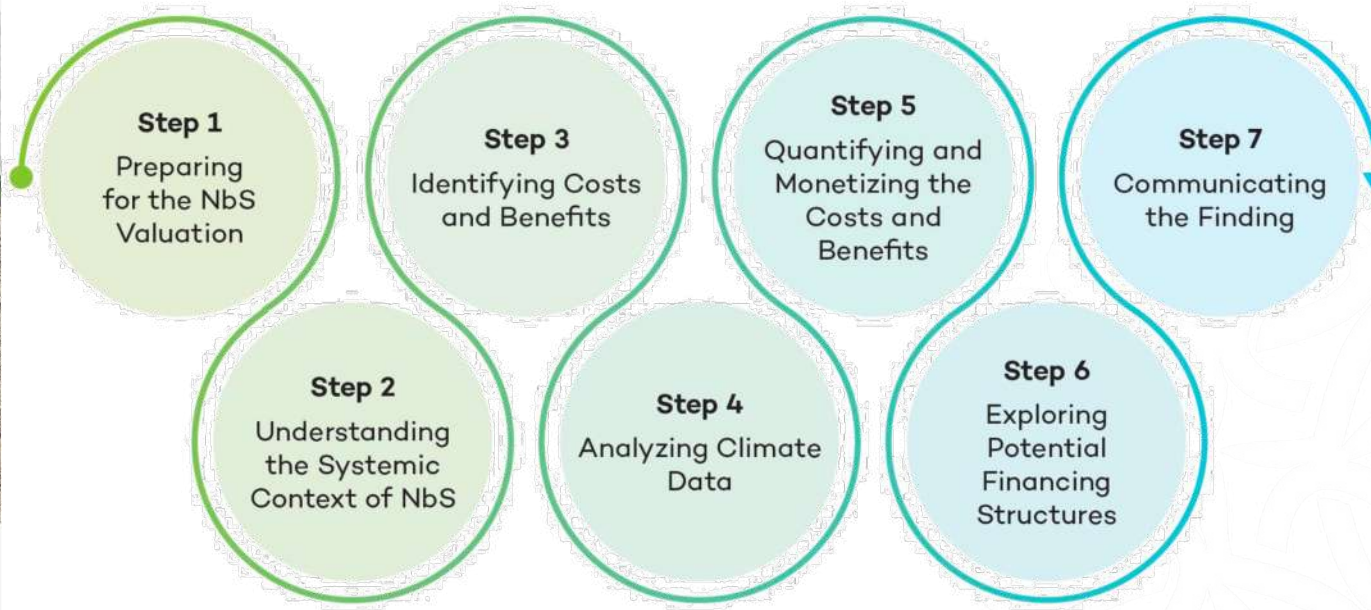
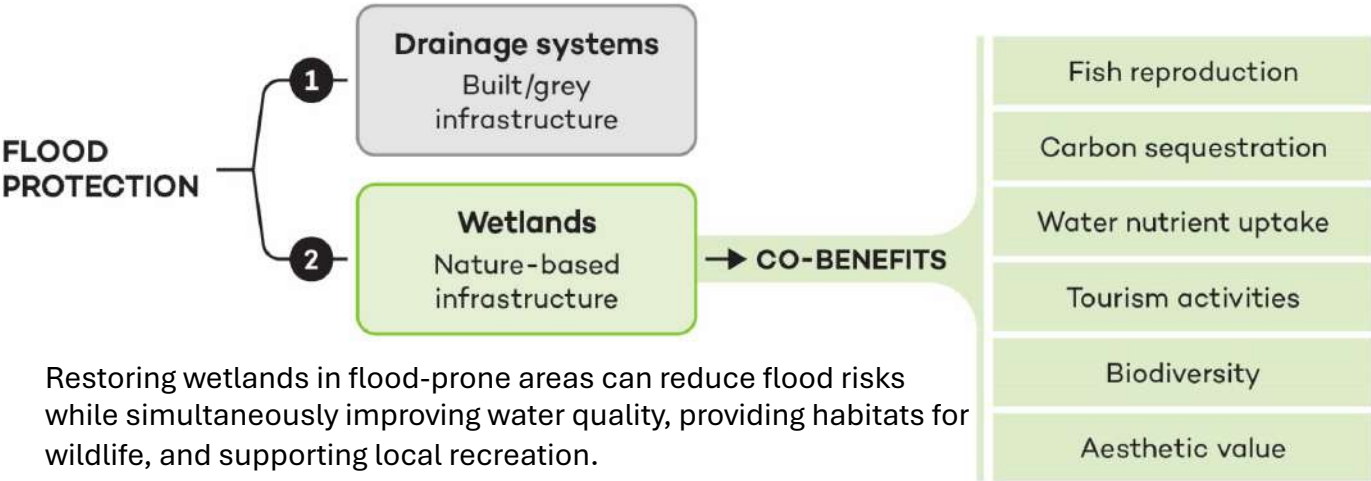
Approaching an NbS Project: Identifying co-Benefits, Conducting a cost-benefit analysis, strategic roadmap and scaling-up phases



Constructed wetland for storm water management - section



Bioswale typical section. Source: Citilinks



NbS-35: MANGROVE AS PROTECTIVE SHIELD FOR AQUACULTURE



The Coastal Mangrove Shield in synergy with Sustainable Fisheries acts as a natural barrier against tidal waves, coastal erosion, and storms, reducing the energy of incoming waves and stabilizing shorelines through their dense root systems. This NbS not only protects vulnerable coastal aquaculture sites, villages, and towns from severe weather impacts but also boosts biodiversity by providing habitat for fish and shellfish, which are crucial for local fisheries. Mangroves support sustainable fishing practices by offering nursery grounds and shelter for marine life, increasing fish stocks, and supporting the livelihoods of coastal communities.

ECOSYSTEM SERVICES AND ACTIONS

SUPPORTING

- Supports critical habitats for fish, crustaceans, and birds
- Nursery grounds for fisheries, protected by the mangrove

PROVISIONING

- Supplying wood, honey, and medicinal plants, balancing extraction with ecosystem health.

REGULATING

- Acting as a natural buffer, reducing wave energy, stabilizing sediment, and protecting shorelines from erosion and storm surges.
- Carbon Sequestration by absorbing and storing large amounts of carbon in biomass and soil.

SOCIAL BENEFITS

- Maintaining local economies and improve resilience for local communities.
- Mangroves lower disaster risk for nearby towns and villages, reducing infrastructure damage.

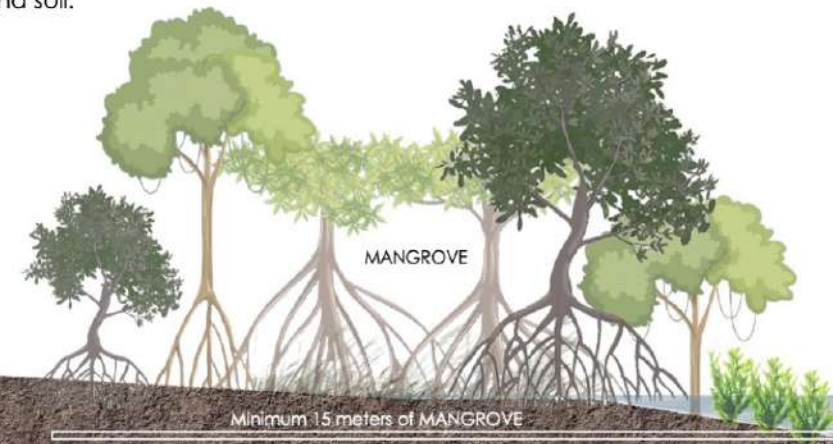
LANDSCAPES SUPPORTED



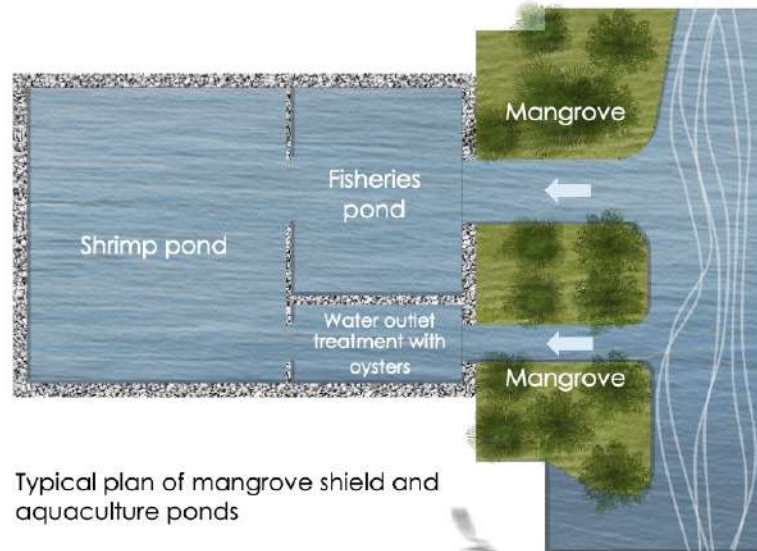
EbA (ECOSYSTEM-BASED APPROACHES)

- INTEGRATED COASTAL MANAGEMENT
- REFORESTATION
- COMMUNITY BASED MANAGEMENT
- BIODIVERSITY CONSERVATION
- SUSTAINABLE FISHERIES MANAGEMENT
- HABITAT CONNECTIVITY

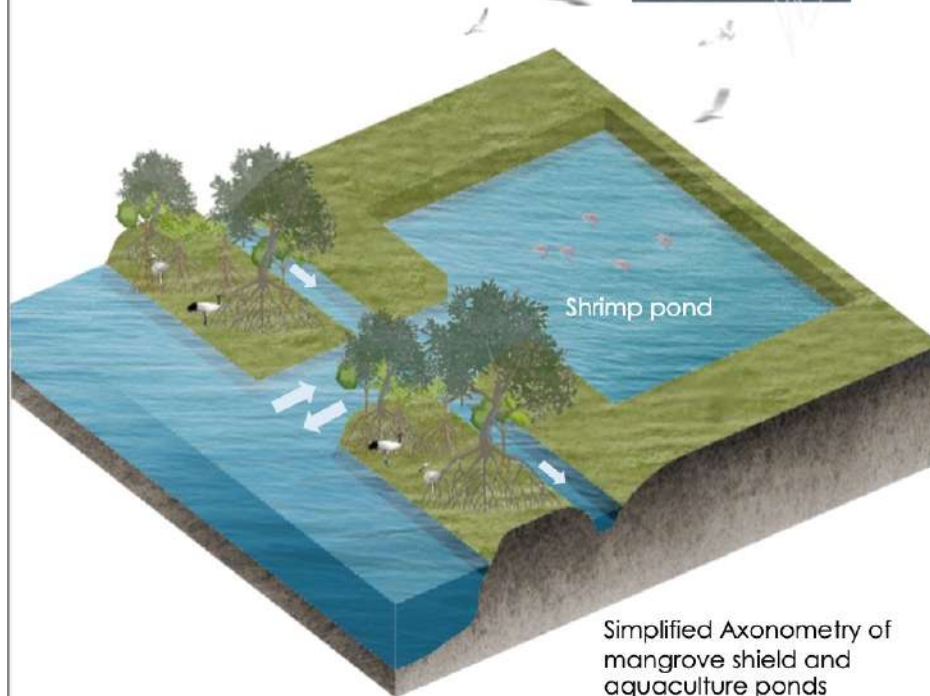
MAIN PROBLEMS ADDRESSED



NbS-35: MANGROVE AS PROTECTIVE SHIELD FOR AQUACULTURE



Typical plan of mangrove shield and aquaculture ponds



Simplified Axonometry of mangrove shield and aquaculture ponds

PROJECT'S CHALLENGES & RISKS

- ❖ **Funding Gaps:** Long-term maintenance and monitoring often lack sustained funding.
- ❖ **Land Use Conflicts:** Due to potential competing interests (e.g., agriculture, aquaculture).
- ❖ **80% of Mangrove Restoration fail:** As the soil characteristics, density of plantations and rhythm of plantation will determine the success of the project.
- ❖ **Scaling up Coastal Fisheries:** Requires adequate land management and governance to avoid intensive coastal land pressure from the agricultural sector.

NbS co-BENEFITS AND THEIR INDICATORS

- **Biodiversity Conservation**
Species richness and abundance of key species (fish, crustaceans, birds).
- **Climate Resilience**
Reduction in shoreline erosion rates, frequency, and intensity of flooding in nearby communities.
- **Carbon Sequestration**
Carbon stock assessment in above-ground biomass and sediment (tCO_2/ha).
- **Water Quality Enhancement**
Levels of nitrates, phosphates, heavy metals, and sedimentation in water samples.
- **Livelihoods and Economic Benefits**
Increase in sustainable fishery yields, in income from ecotourism, local jobs.
- **Social Resilience and Community Engagement**
Number of community members involved in mangrove protection initiatives.

COST ANALYSIS

- **Direct Costs**
Restoration (0.40 USD/ m^2), infrastructure (fencing, access points), maintenance and monitoring.
- **Indirect Costs**
Opportunity costs if land is repurposed from other uses.
- **Time Horizon and Discount Rate**
10-30 years to capture full ecological and economic benefits, adjusted to account for long-term environmental and social benefits.
- **Direct Benefits**
Reduced storm damage costs, revenue from sustainable fisheries, carbon credit revenue.
- **Indirect Benefits**
Increased biodiversity, improved water quality, reduced health costs due to cleaner environment.
- **Risk Assessment**
Evaluation of factors such as climate change impacts on growth rates, potential for disease, and community engagement level.

REFERENCES:

Indonesia, Bogorame-Timbuloko Mangrove Shield, Demak.
Bedono Village Mangrove Regrowth.

IMPLEMENTATION OPPORTUNITIES:

Thailand, Western coastlines of Mekong Delta.
Vietnam, Ca Mau Peninsula.
Indonesia, Borneo, Java, Papua, Sumatra coastlines.

9 Climate-sensitive Landscape Categories ready for NbS Application and Scale-up in Synergy

1



Flood responsive
Riverine and Deltaic
Landscapes

2



Adaptative Sandy
Shorelines

3



Adaptative Coastal
Mangroves

4



Climate-smart and
Resilient Cities

5



Green & Blue Eco-
Industrial Areas
and Ports

6



Regenerative
Agriculture

7



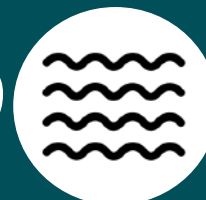
Healthy Forests
and Natural
Habitats

8



Wildlife Corridors for
Ecological
Connectivity

9



Regenerative
Seascapes and
Marine Habitats

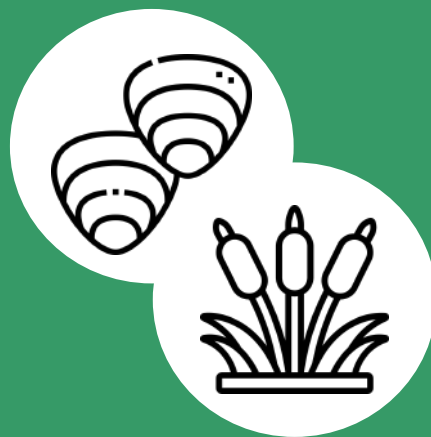
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**Water-Sensitive
Riverscapes :
Integrated River
Management Through
Nature-based Solutions**



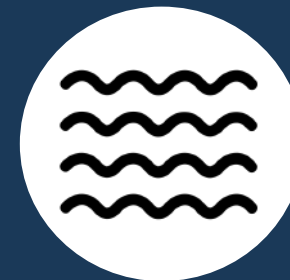
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**Nature-based
Solutions supporting
Integrated Coastal
Management (ICZM)**



3

**Nature-based Marine
Restoration:
Designing and
Scaling NbS for
Regenerative
Seascapes and Blue
Carbon Systems**





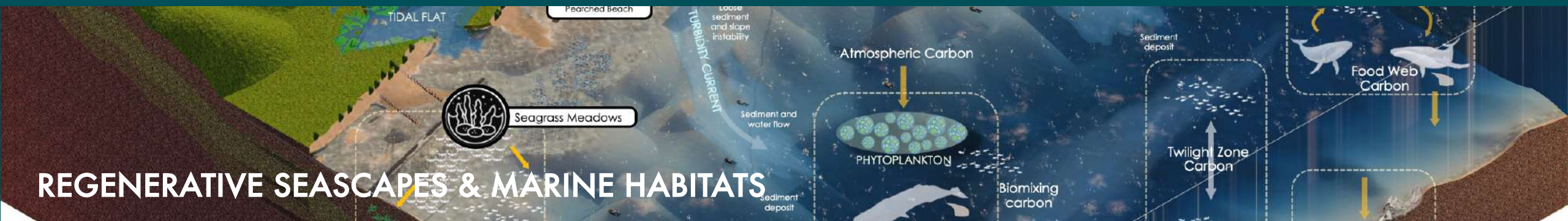
FLOOD RESPONSIVE RIVERINE LANDSCAPES



COASTAL MANGROVES



SANDY SHORELINES



REGENERATIVE SEASCAPES & MARINE HABITATS

(37 of 70) Waterscape-based NbS Practices presented in the ASEAN NbS Catalogue

NbS supporting mainly Inland and Freshwater Systems

1. Inland Natural Wetlands
2. Constructed Wetlands
3. River Levee Setbacks
4. Reconnecting Oxbow Lake and River
5. Riverbank Stabilisation
6. Sediment Capture Traps
7. Riparian Buffer Zone, Bed Renaturation
8. Gully Plugging
9. Plastic Waste Capture Biofence
10. Managed Aquifer Recharge (MAR)
11. Bioretention Ponds and Swales
12. Phytofiltration Basins & Water Bunds
13. Small Sand Dams
14. Terraced Green Riverfronts
15. Log Terracing (Water-Delay Infrastructure)
16. River Stream Restoration and Daylighting

NbS supporting mainly Coastal and Marine Systems

17. Salt Marsh Restoration
18. Tidal Flat Nourishment
19. Artificial Seagrass Meadows
20. Mangrove Forest Restoration
21. Paludiculture Associated Peatland
22. Planting Mats and Rich Revetments
23. Coral Reef Restoration and Nurseries
24. Coastal Reforestation (Shield)
25. Artificial Oyster Reefs

NbS supporting mainly Coastal Protection and Sediment Management

35. Coastal Mangrove Shield and Fisheries
36. Grassed Waterways
37. Beach Nourishment
38. Frontal Dune
39. Constructed Perched Beach
40. Natural Timber Groyne
41. Constructed Nature Island
42. Sand Trapping Fences
43. Windbreaks and Shelterbelts

NbS supporting mainly Marine and Deep-Sea Solutions

67. Vertical Dock Reefs
68. Artificial Floating Reefs
69. Marine Sedimentation Basins for Bioturbation
70. Mesopelagic Fauna Deep-Sea Sequestration

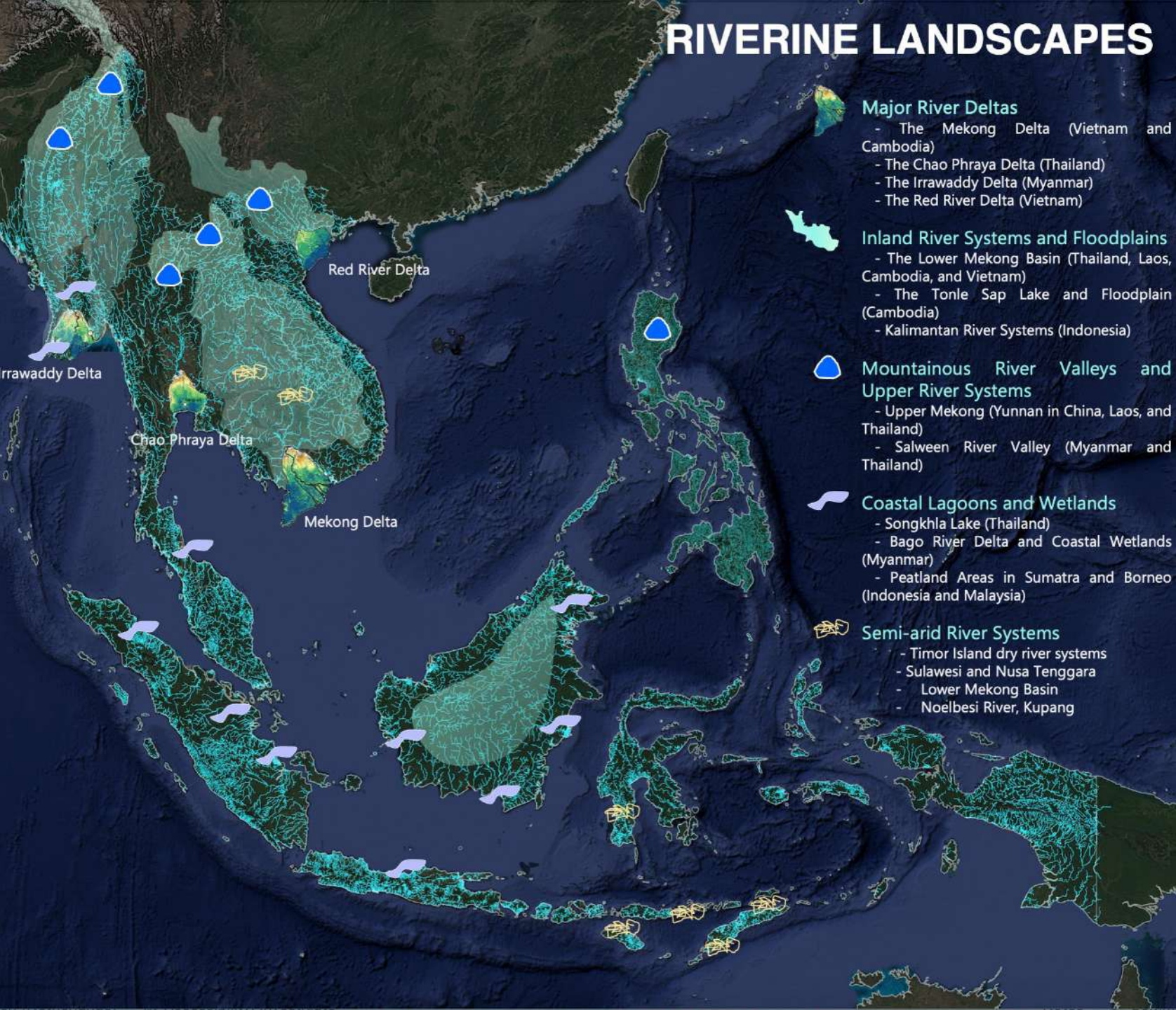
Water-Sensitive Riverscapes : Integrated River Management Through Nature-based Solutions



CSL01a Flood responsive Riverine and Deltaic Landscapes

CSL01b Dry Riverine Landscapes

RIVERINE LANDSCAPES



Major River Deltas

- The Mekong Delta (Vietnam and Cambodia)
- The Chao Phraya Delta (Thailand)
- The Irrawaddy Delta (Myanmar)
- The Red River Delta (Vietnam)

Inland River Systems and Floodplains

- The Lower Mekong Basin (Thailand, Laos, Cambodia, and Vietnam)
- The Tonle Sap Lake and Floodplain (Cambodia)
- Kalimantan River Systems (Indonesia)

Mountainous River Valleys and Upper River Systems

- Upper Mekong (Yunnan in China, Laos, and Thailand)
- Salween River Valley (Myanmar and Thailand)

Coastal Lagoons and Wetlands

- Songkhla Lake (Thailand)
- Bago River Delta and Coastal Wetlands (Myanmar)
- Peatland Areas in Sumatra and Borneo (Indonesia and Malaysia)

Semi-arid River Systems

- Timor Island dry river systems
- Sulawesi and Nusa Tenggara
- Lower Mekong Basin
- Noelbesi River, Kupang

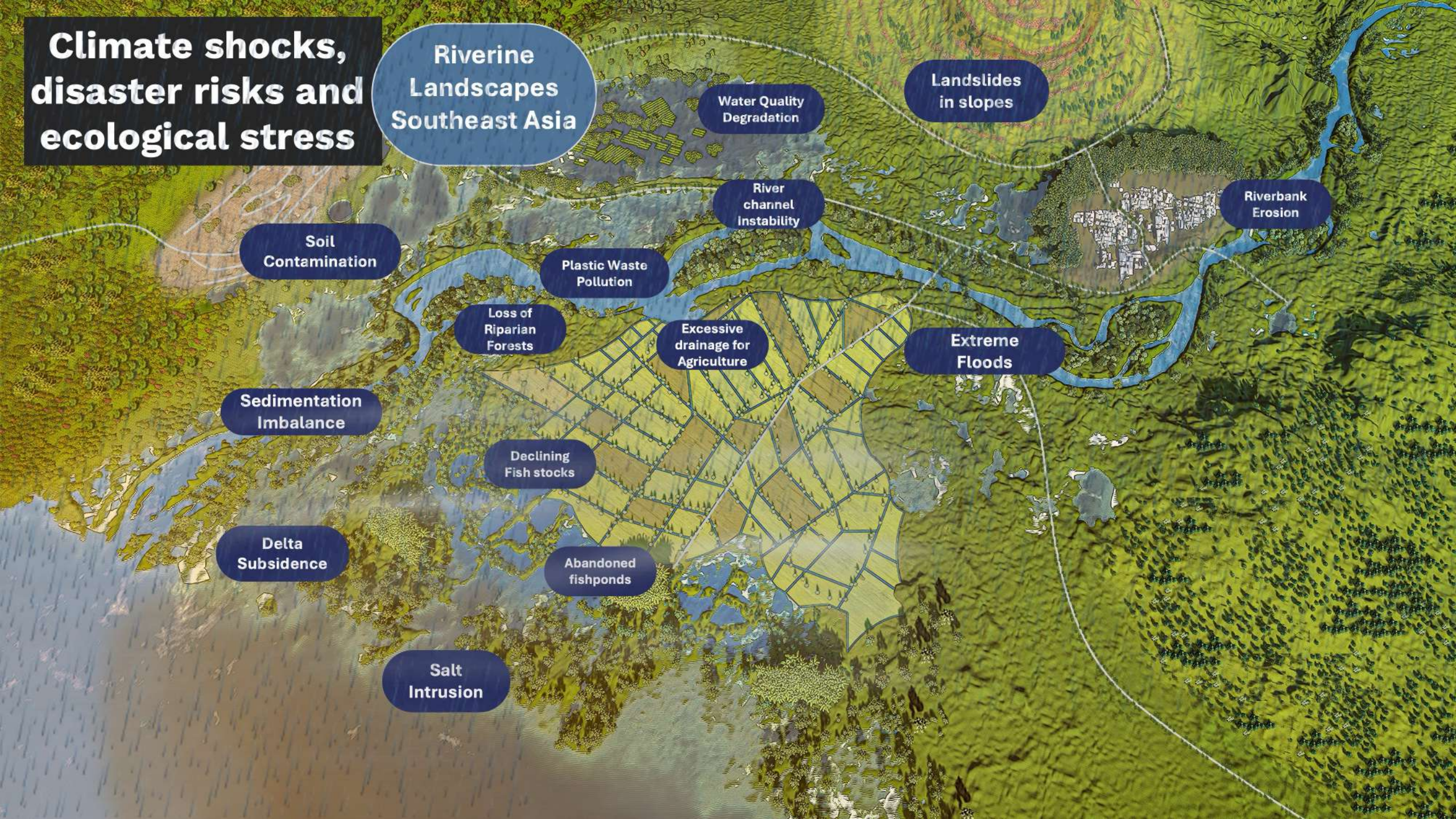
Water-Sensitive Riverscapes : Integrated River Management Through Nature-based Solutions



Mekong River, Vietnam

Climate shocks, disaster risks and ecological stress

Riverine Landscapes Southeast Asia



Water Quality
Degradation

Landslides
in slopes

Riverbank
Erosion

River
channel
Instability

Extreme
Floods

Excessive
drainage for
Agriculture

Plastic Waste
Pollution

Loss of
Riparian
Forests

Declining
Fish stocks

Abandoned
fishponds

Salt
Intrusion

Sedimentation
Imbalance

Delta
Subsidence

Soil
Contamination

Riverscape Integrated NbS in Synergy



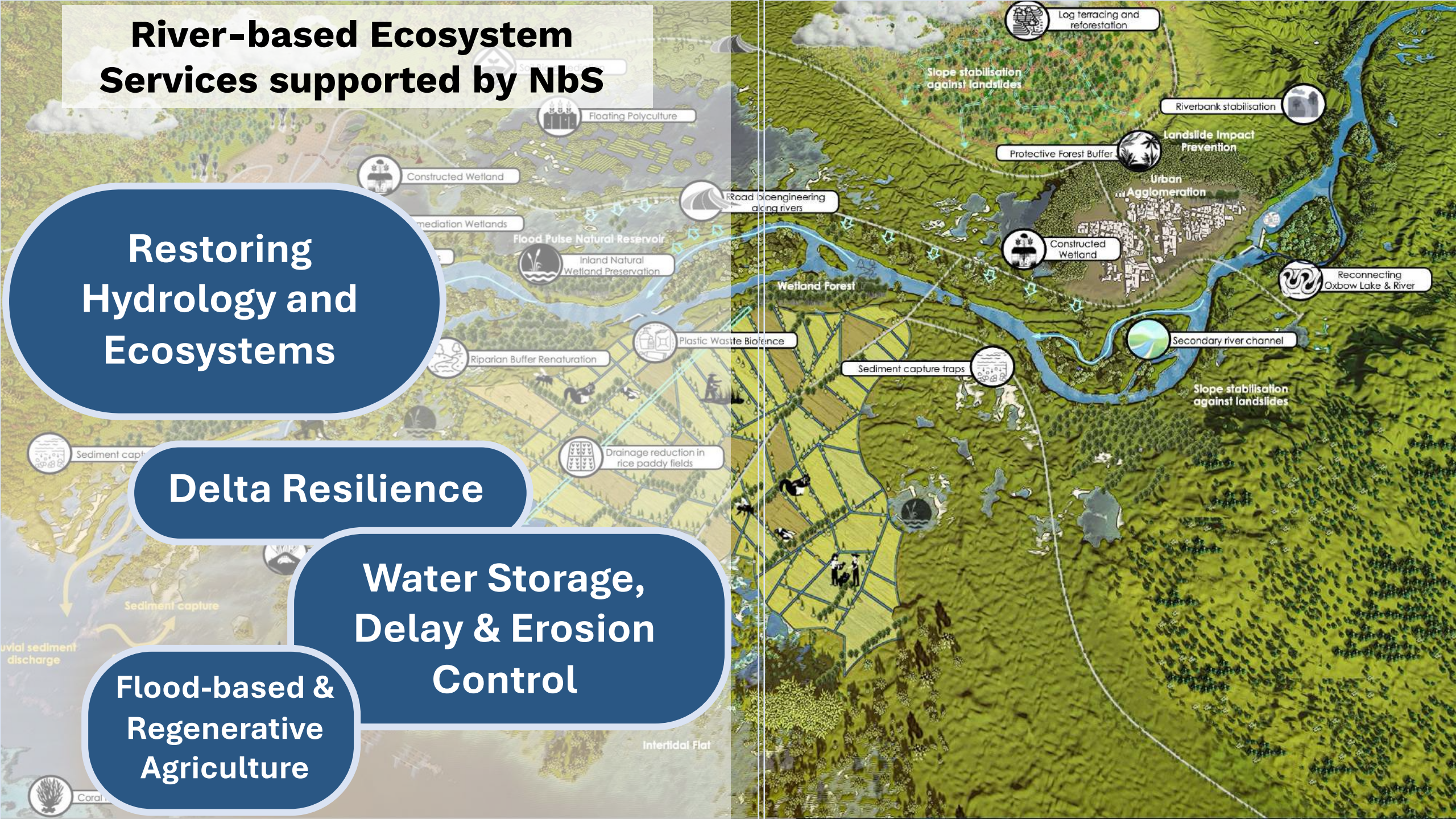
River-based Ecosystem Services supported by NbS

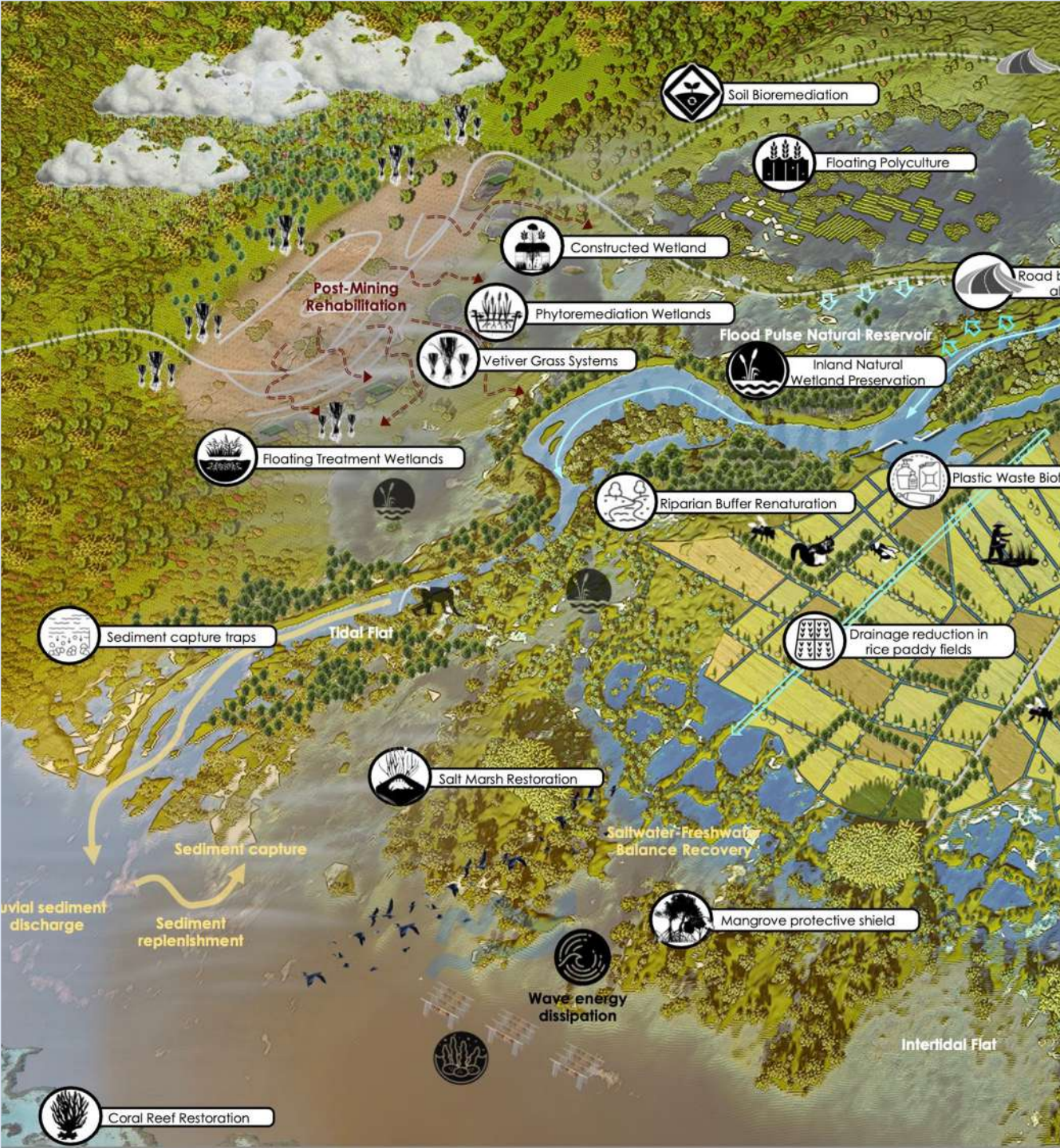
Restoring
Hydrology and
Ecosystems

Delta Resilience

Water Storage,
Delay & Erosion
Control

Flood-based &
Regenerative
Agriculture





Enablers

Multi-River Basin Governance

Ecological Connectivity

Land Use Planning / Watershed Zoning

Integrated Water Resource Management (IWRM)

Transboundary Coordination

Economic Valuation & Finance Mechanisms

River-based Ecosystem Services supported by NbS

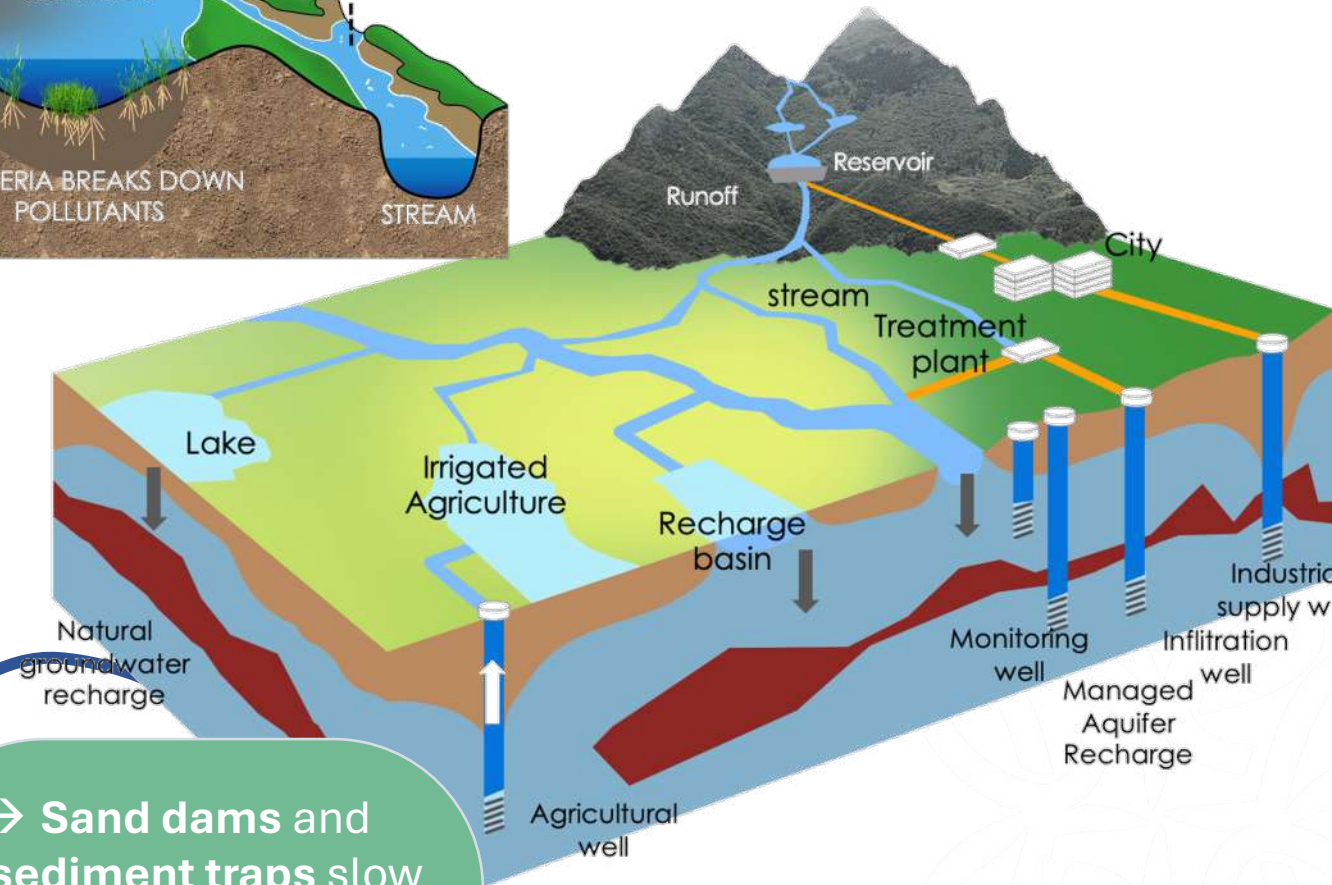
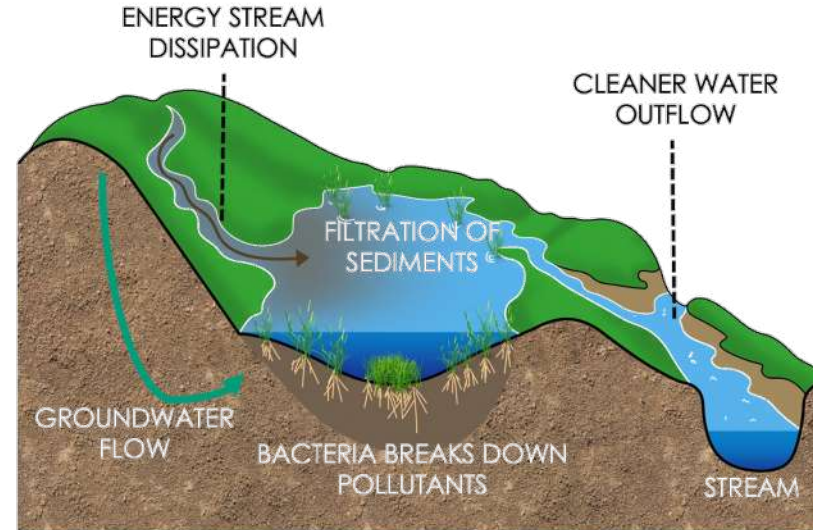
1 Restoring Hydrology and Ecosystems

→ Restore **riparian forests** and **wetlands** to reduce erosion and store floodwater.

→ Manage **seasonal floodplains** and **capture water surpluses** for groundwater aquifer recharge, fisheries, and agriculture.

→ Use **check dams** and **re-vegetation** in dry zones to prevent sediment loss and retain water.

→ **Sand dams** and **sediment traps** slow runoff and increase infiltration



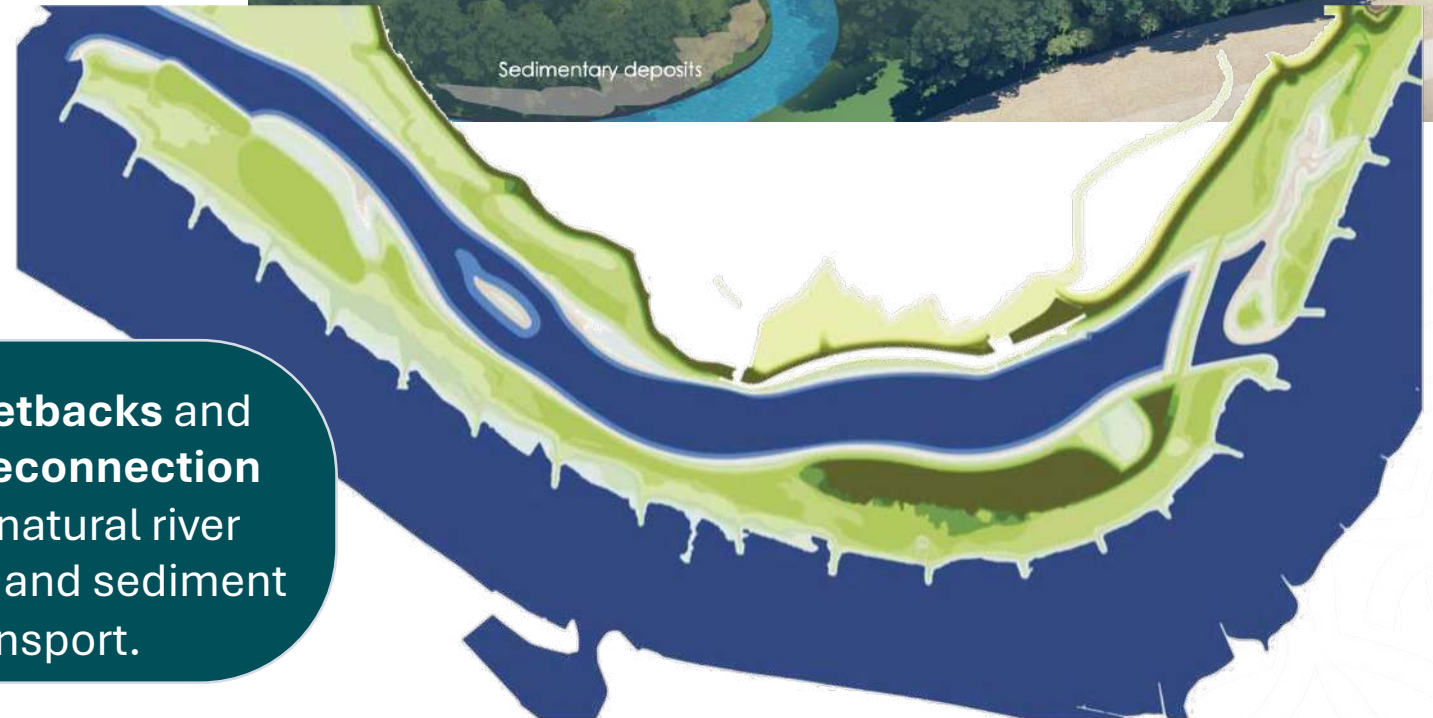
River-based Ecosystem Services supported by NbS

Restoring
Hydrology and
Ecosystems

2 Delta Resilience

Wetland restoration mitigates floods, supports biodiversity, and improves water quality.

Levee setbacks and oxbow reconnection restore natural river dynamics and sediment transport.



River-based Ecosystem Services supported by NbS

Restoring
Hydrology and
Ecosystems

Delta Resilience

Water Storage,
3 Delay & Erosion
Control

Bioretention ponds,
swales, and aquifer
recharge zones balance
flood and dry-season water
needs.

Integrate **freshwater–
saltwater management**
to support agriculture and
aquaculture.

Implement **riparian
buffers, brushwood
mattresses, log terracing.**

Plastic-waste biofences
reduce pollution and
stabilise riverbanks.



River-based Ecosystem Services supported by NbS

Restoring
Hydrology and
Ecosystems

Delta Resilience

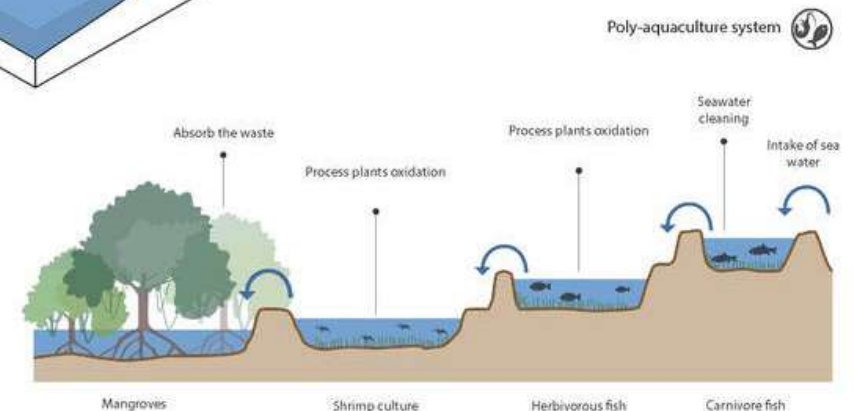
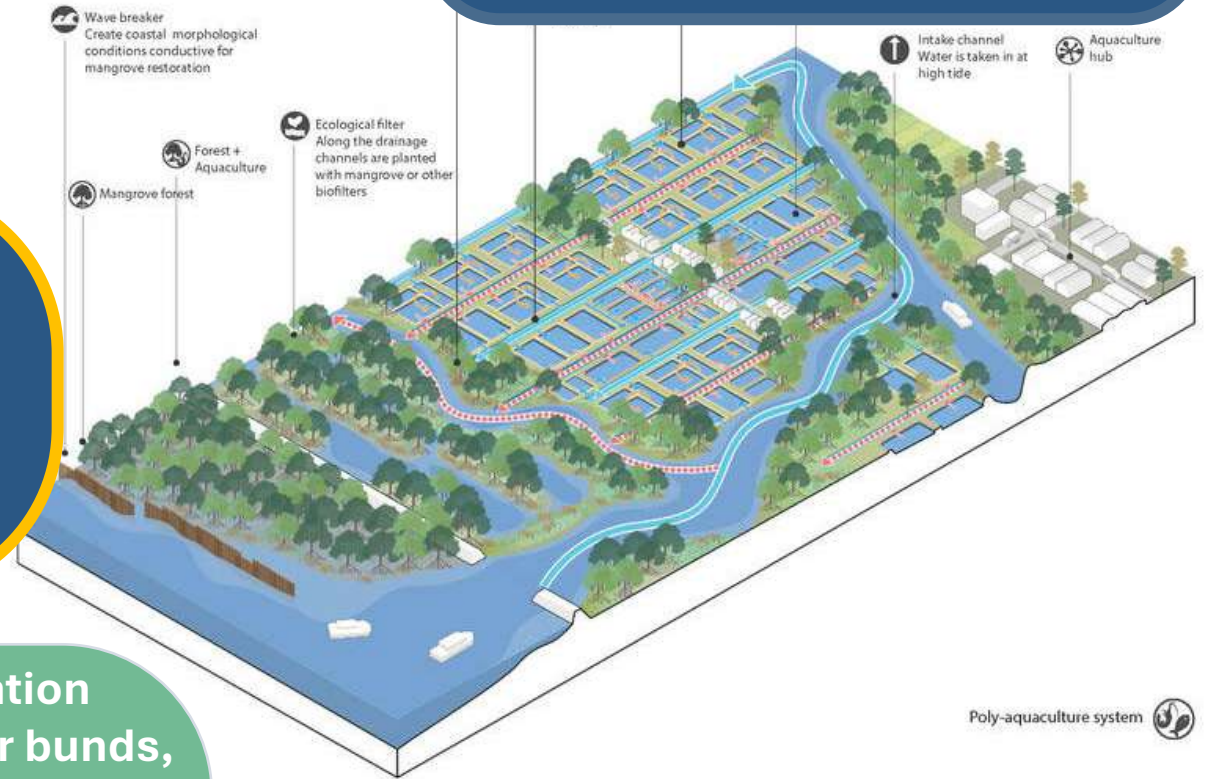
4

Flood-based &
Regenerative
Agriculture

→ Floodplain farming,
Riparian Sylviculture,
Small Sand Dams,
Drainage reduction

→ Phytofiltration
(basins), water bunds,
sediment traps, log
terracing and levee
setbacks

Water Storage, Delay &
Erosion Control



Nature-based Solutions supporting Integrated Coastal Management (ICZM)

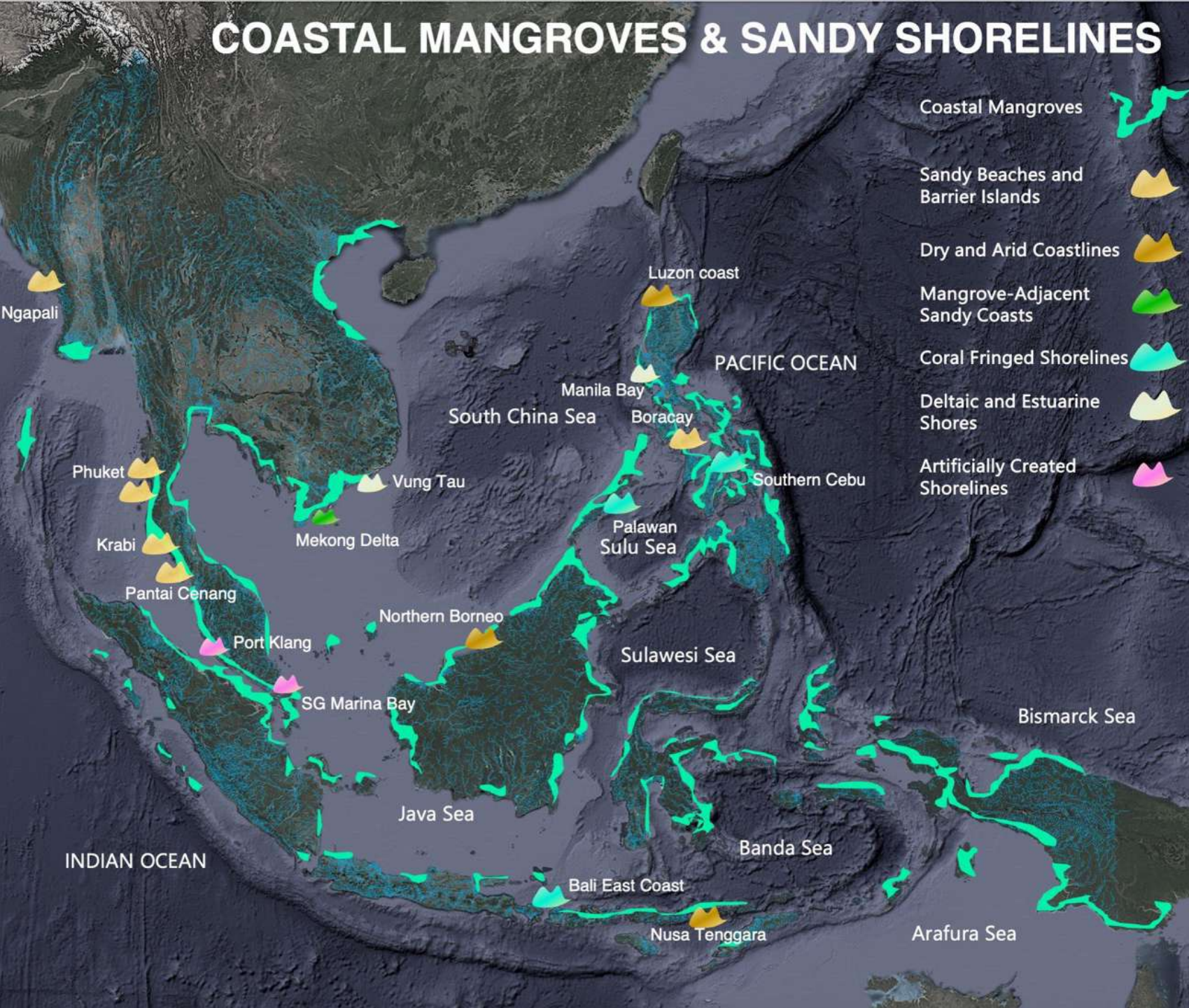


CSL02/ Adaptive Sandy Shorelines

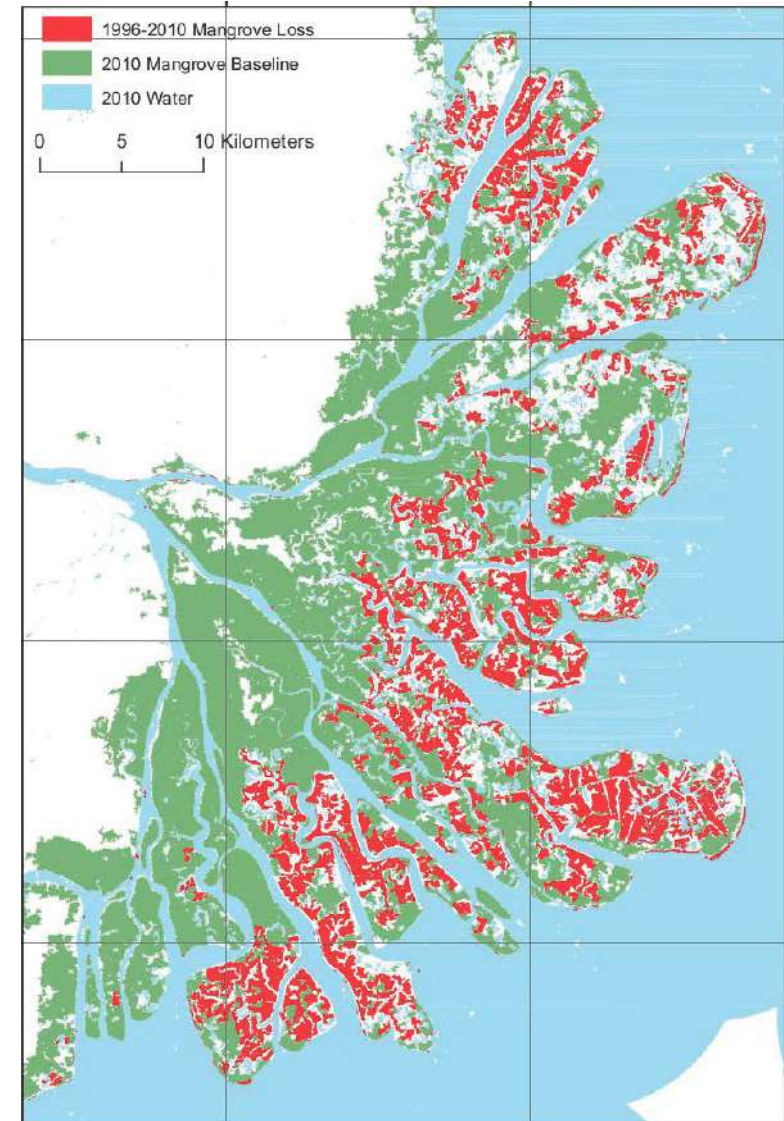


CSL03/ Adaptive Coastal Mangroves

COASTAL MANGROVES & SANDY SHORELINES



Nature-based Solutions supporting Integrated Coastal Management (ICZM)



Climate shocks, disaster risks and ecological stress

Coastal Mangroves Southeast Asia

Soil
Contamination

Plastic Waste
Pollution

Salinity
Stress

Changing
Hydrology

Storm surges and
Typhoons Impacts !

Riverine-
Coastal Flood
Interaction

Delta
Subsidence

Declining
Fish stocks

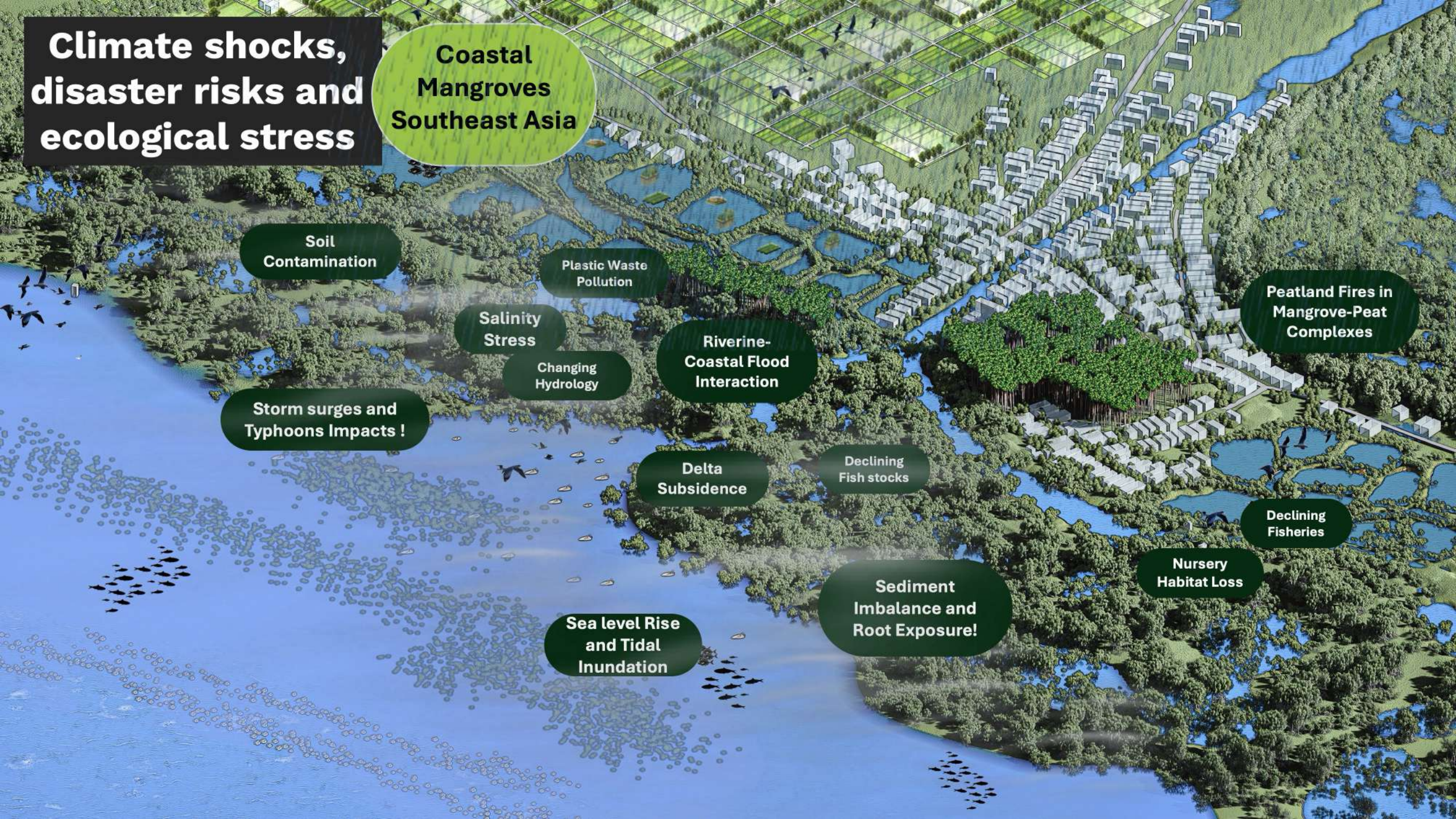
Peatland Fires in
Mangrove-Peat
Complexes

Declining
Fisheries

Nursery
Habitat Loss

Sediment
Imbalance and
Root Exposure!

Sea level Rise
and Tidal
Inundation



Restoring Mangroves with NbS in Synergy



Coastal Mangroves in Southeast Asia

**Extreme Winds
and Dune
Destabilization**

Sea-Level Rise

**Plastic Waste
Pollution**

**Sediment
Disruption and
Reduced Sand
Supply**

**Delta
Subsidence**

**Coral Reef
and Seagrass
Degradation**

**Storm surges and
Typhoons Impacts !**

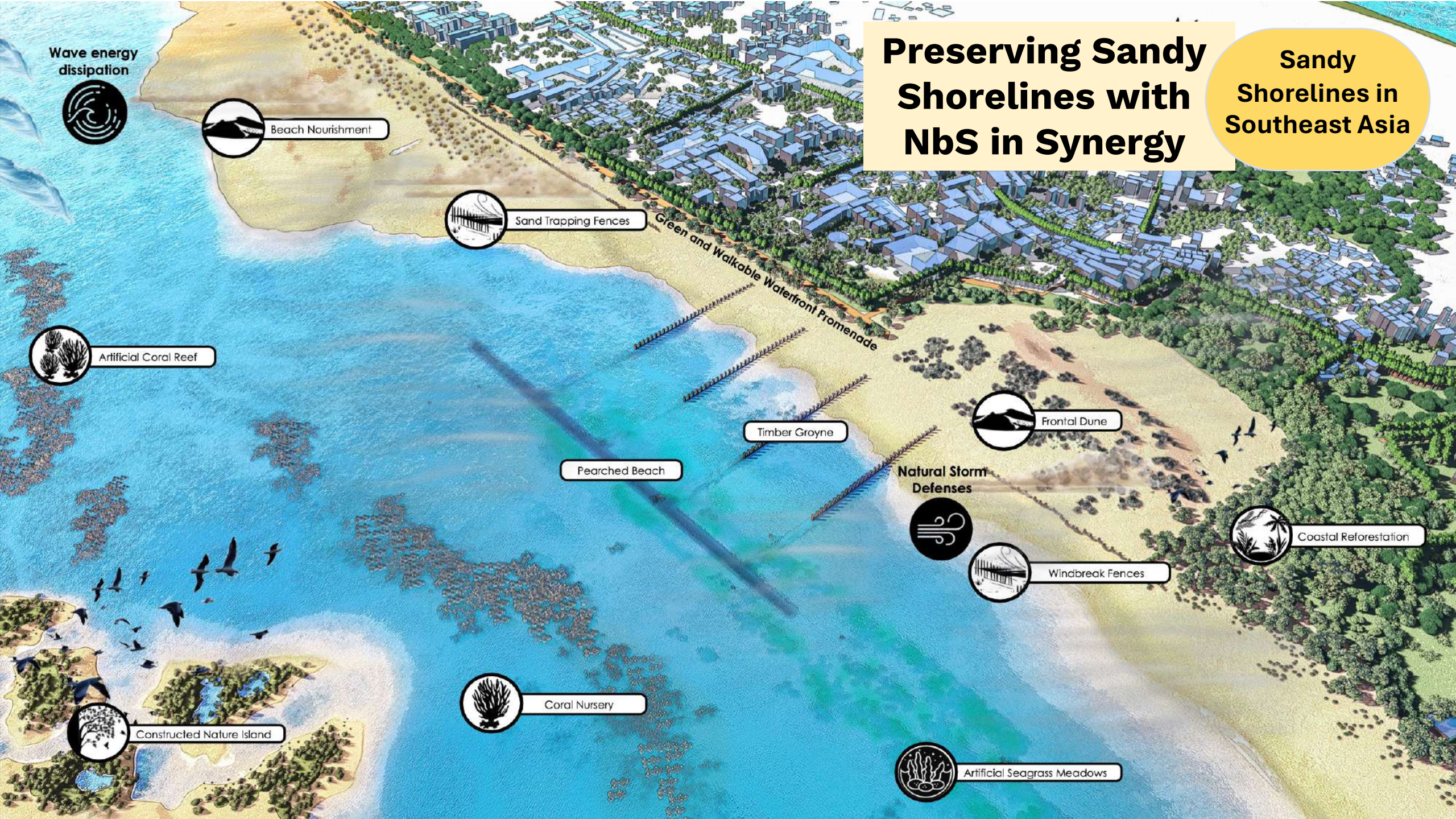
Climate shocks, disaster risks and ecological stress

**Sandy
Shorelines
Southeast Asia**

**TOURISM
PRESSURE**

**Biodiversity
Loss in Coastal
Vegetation**

**Coastal Erosion
and Coastline
Retreat**



Wave energy
dissipation



Beach Nourishment



Sand Trapping Fences

Green and Walkable Waterfront Promenade

Timber Groyne

Peached Beach



Frontal Dune

Natural Storm
Defenses



Windbreak Fences



Coastal Reforestation



Coral Nursery



Constructed Nature Island



Artificial Seagrass Meadows

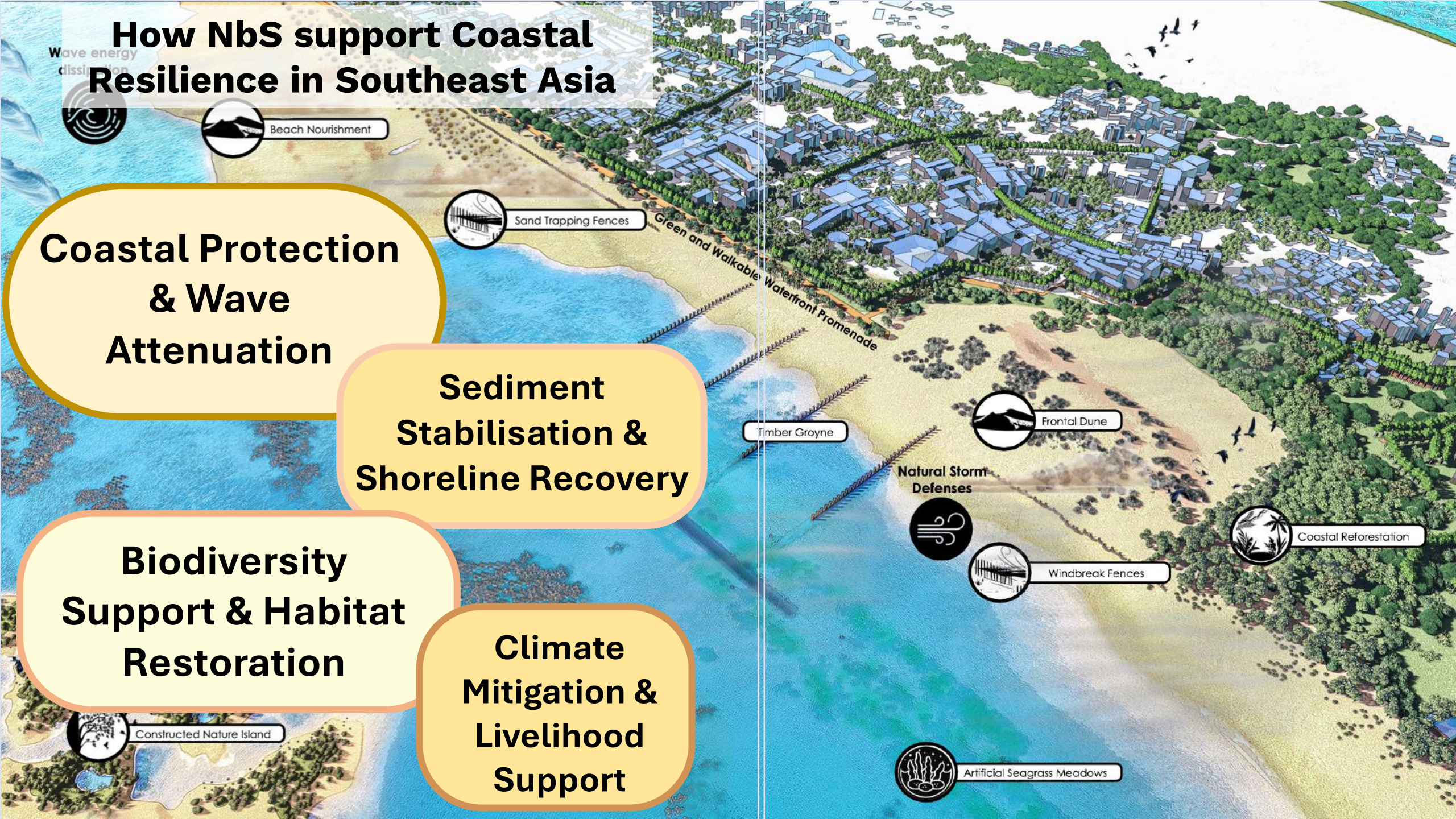
How NbS support Coastal Resilience in Southeast Asia

**Coastal Protection
& Wave
Attenuation**

**Sediment
Stabilisation &
Shoreline Recovery**

**Biodiversity
Support & Habitat
Restoration**

**Climate
Mitigation &
Livelihood
Support**



Wave energy
dissipation

Beach Nourishment

Sand Trapping Fences

Green and Walkable
Waterfront Promenade

Timber Groyne

Frontal Dune

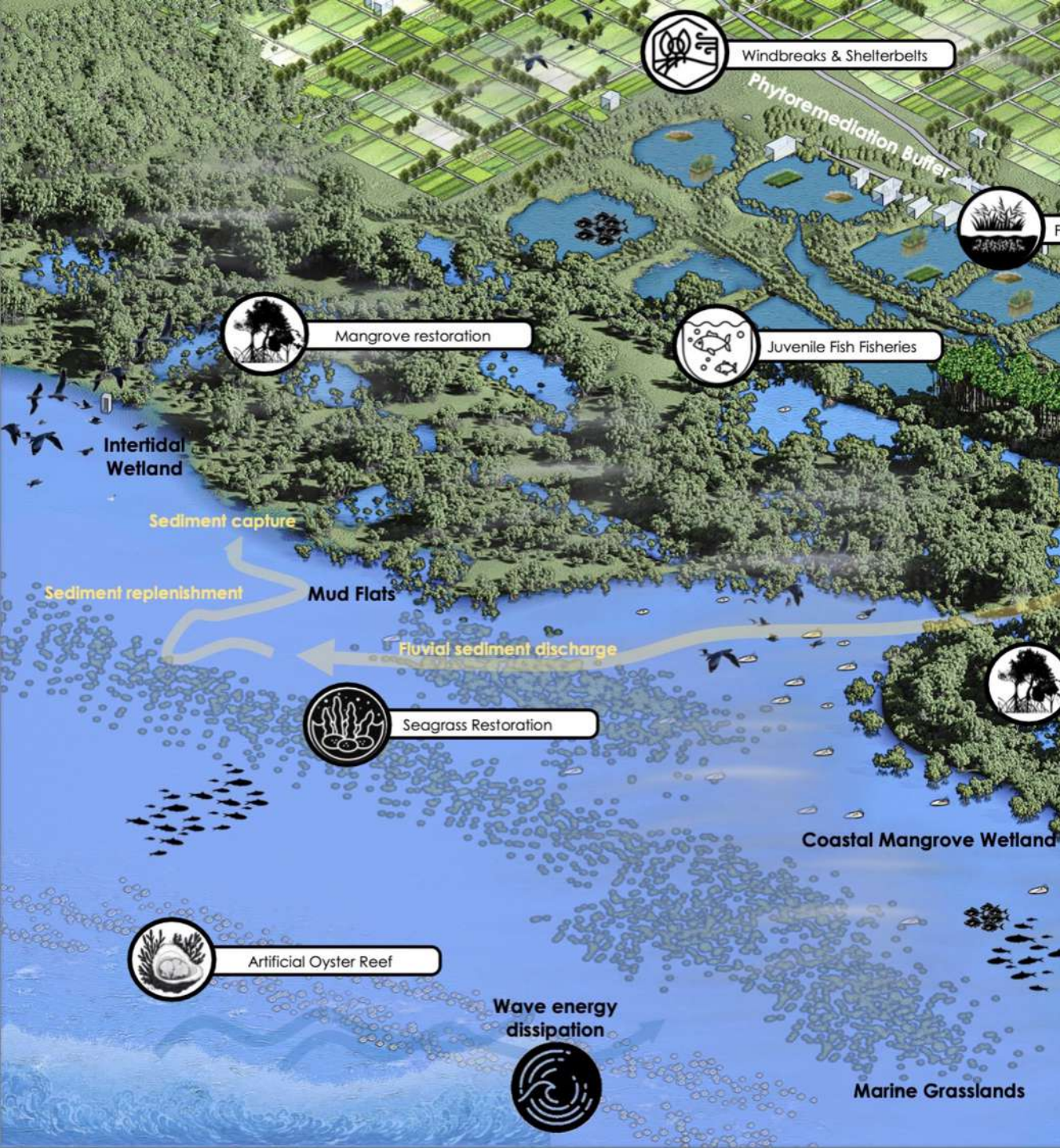
Natural Storm
Defenses

Coastal Reforestation

Windbreak Fences

Artificial Seagrass Meadows

Constructed Nature Island



Enablers

Integrated Coastal Governance

Long Term Planning

Institutional Capacity

Community Engagement

Economic Instruments & Sustainable Finance

Cross-border Cooperation

How NbS support Coastal Resilience in Southeast Asia

Coastal Protection & Wave Attenuation

→ Mangrove protective shields, salt marshes, seagrass meadows

→ Perched beaches, oyster reefs and artificial coral reefs reducing wave energy and buffering storm surges.



Artificial Coral Reef



Perched beach 3D section

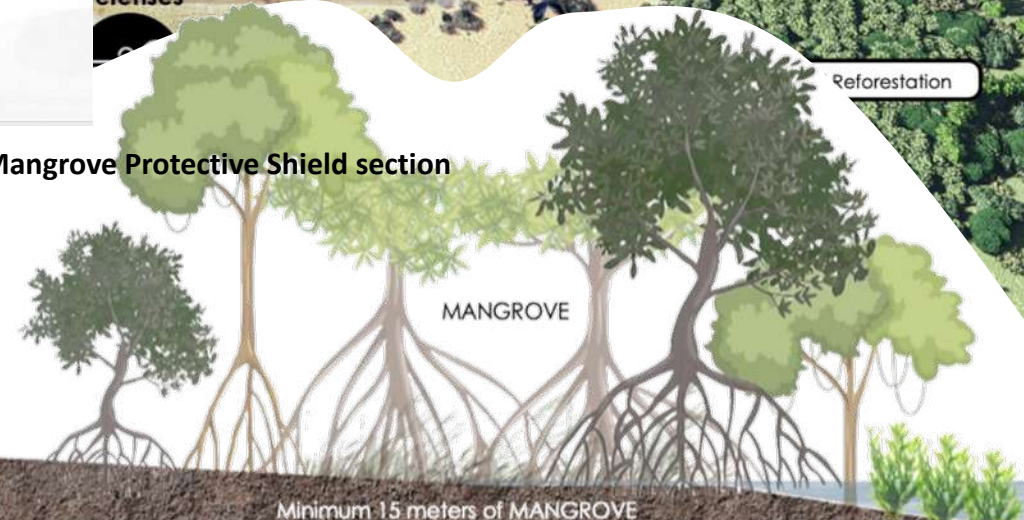


Frontal Dune

Natural Storm defenses

Reforestation

Mangrove Protective Shield section



MANGROVE

Minimum 15 meters of MANGROVE



SHRIMP POND

FISH POND (17 m long)

Water treatment (oysters)

Minimum 30 to 50 meters long

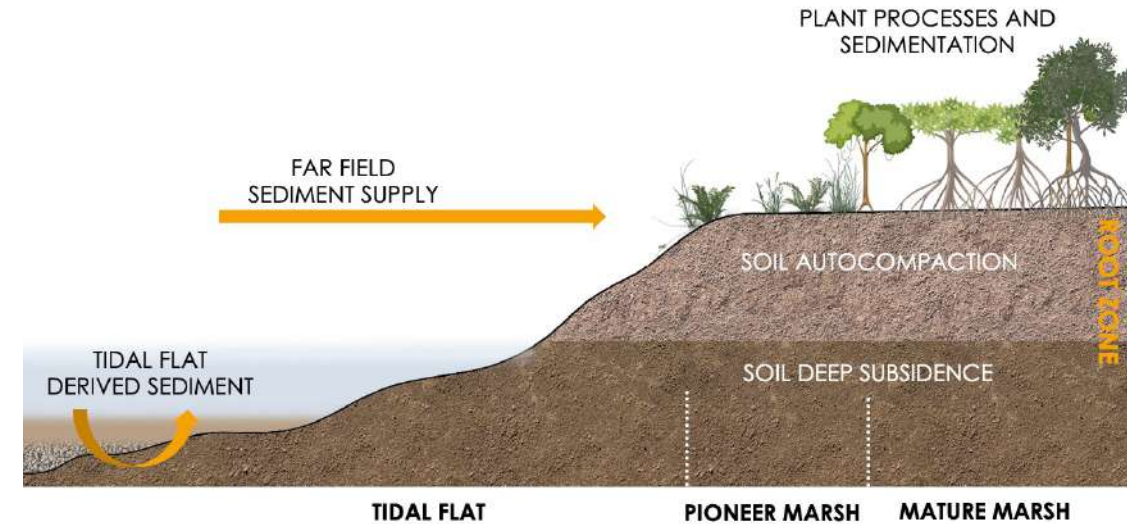
How NbS support Coastal Resilience in Southeast Asia

**Coastal Protection
& Wave
Attenuation**

**Sediment
Stabilisation &
Shoreline Recovery**

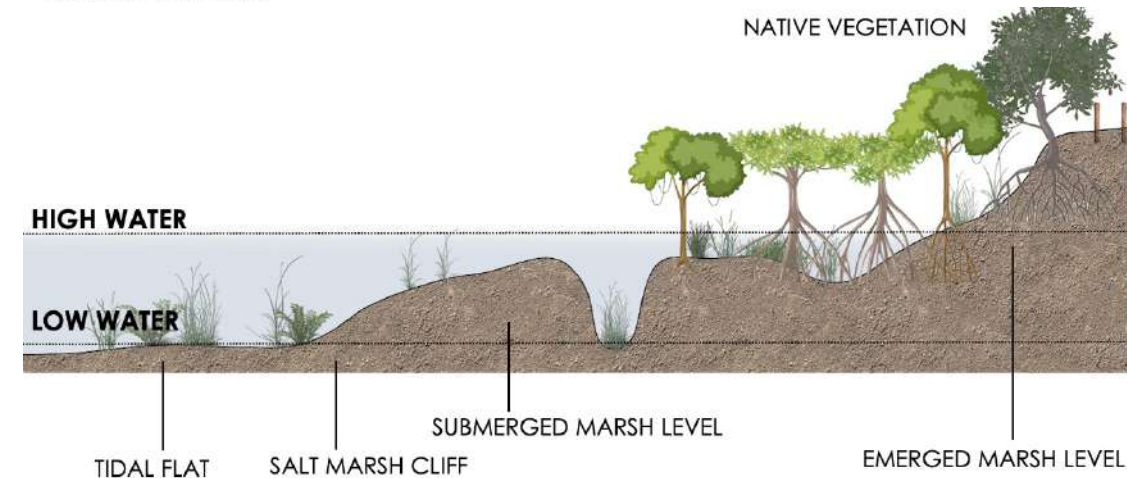
→ Tidal flat nourishment,
sediment traps and fine
sediment capture and
replenishment for
mangroves

→ Sand fences, dune
restoration and timber
groynes to maintain
natural sediment cycles



Process of saltmarshes, dynamic interactions between vegetation and sedimentation.

Source : CITILINKS



Profile of a saltmarsh and mudflat with local vegetation

Source : CITILINKS

How NbS support Coastal Resilience in Southeast Asia

**Coastal Protection
& Wave
Attenuation**



Sand Trapping Fences

Green and Walkable



Artificial Coral Reef

**Sediment
Stabilisation &
Shoreline Recovery**

Peached Beach



Constructed Nature Island

**Biodiversity
Support & Habitat
Restoration**



Coastal forest restoration, Labrador nature reserve Singapore
Source : USDA, Climate Change Impacts to Coastal Forests



How NbS support Coastal Resilience in Southeast Asia

**Coastal Protection
& Wave
Attenuation**

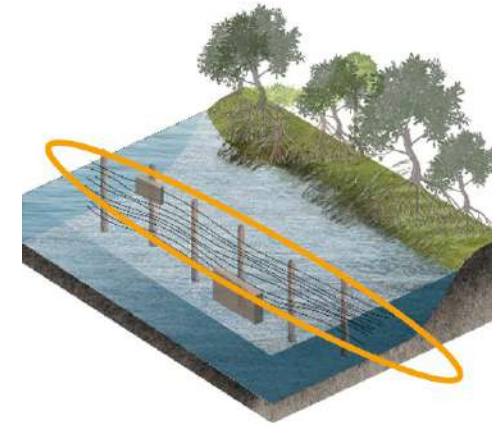
**Sediment
Stabilisation &
Shoreline Recovery**

**Biodiversity
Support & Habitat
Restoration**

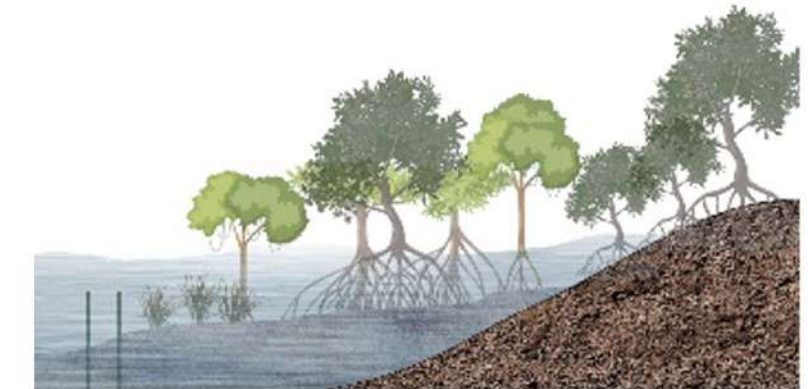
**Climate
Mitigation &
Livelihood
Support**

→ Integrated Mangrove-Aquaculture Systems, Nipa palm production, Eco-Tourism

→ Blue carbon sequestration by mangroves, peatlands, seagrass systems; Strengthening of climate adaptation



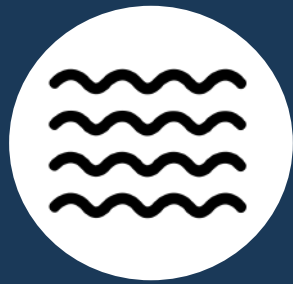
Small water permeable dams filter sediment, creating a fertile environment for mangrove trees to grow and develop. They are semi permeable and made from wooden pole and mesh.



Over time, there is sediment deposition regain that allows mangrove to grow and expand. The mature mangrove belt can then better protect the coastline.

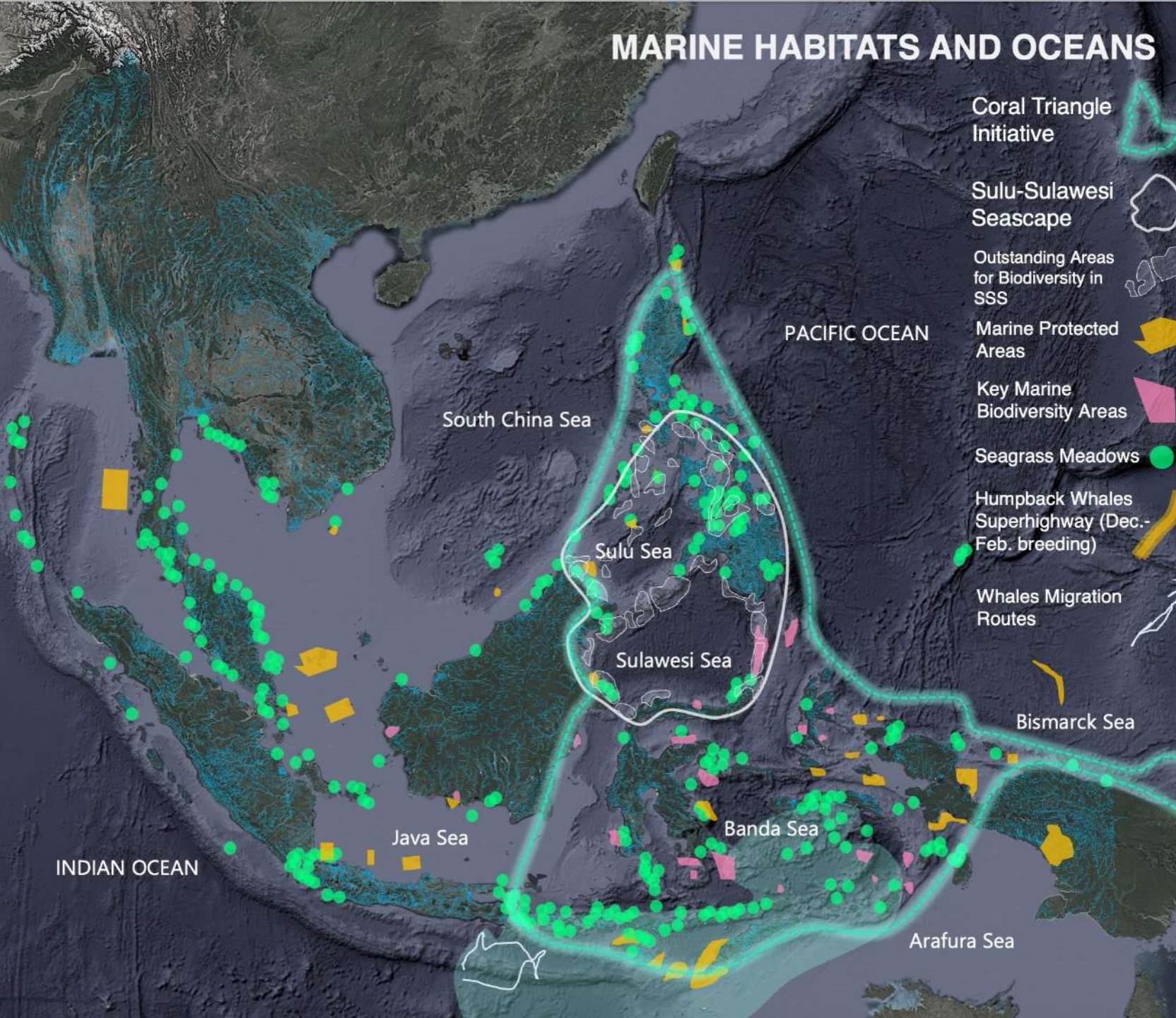
Mangrove forest restoration and growth.
Source : Citilinks

Nature-based Marine Restoration: Designing and Scaling NbS for Regenerative Seascapes and Blue Carbon Systems



CSL09/ Regenerative Seascapes and Marine Habitats

MARINE HABITATS AND OCEANS



Nature-based Marine Restoration: Designing and Scaling NbS for Regenerative Seascapes and Blue Carbon Systems



Climate shocks, disaster risks and ecological stress

Marine Ecosystems Southeast Asia

Coastal and
Offshore
Erosion

Invasive Marine
Species

Dead Zones &
Eutrophication

Marine
Pollution

Typhoons and
Extreme Storm
Events

Overfishing
Practices

Coral
Bleaching from
Marine
Heatwaves

Seagrass Loss &
Decline of Blue
Carbon Ecosystems

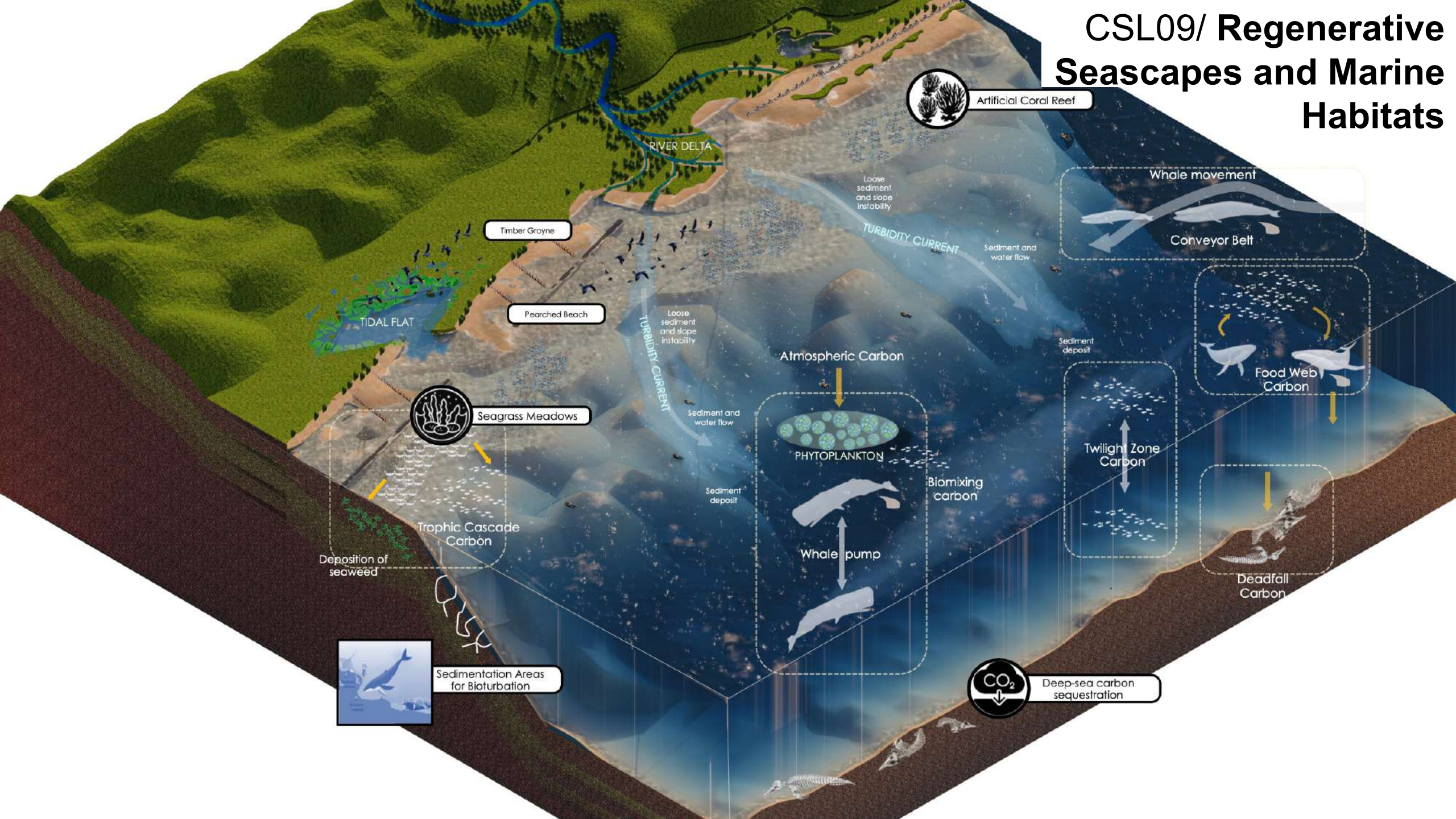
Habitat
Fragmentation

Ocean
Acidification

Coral Reef
and Seagrass
Degradation



CSL09/ Regenerative Seascapes and Marine Habitats



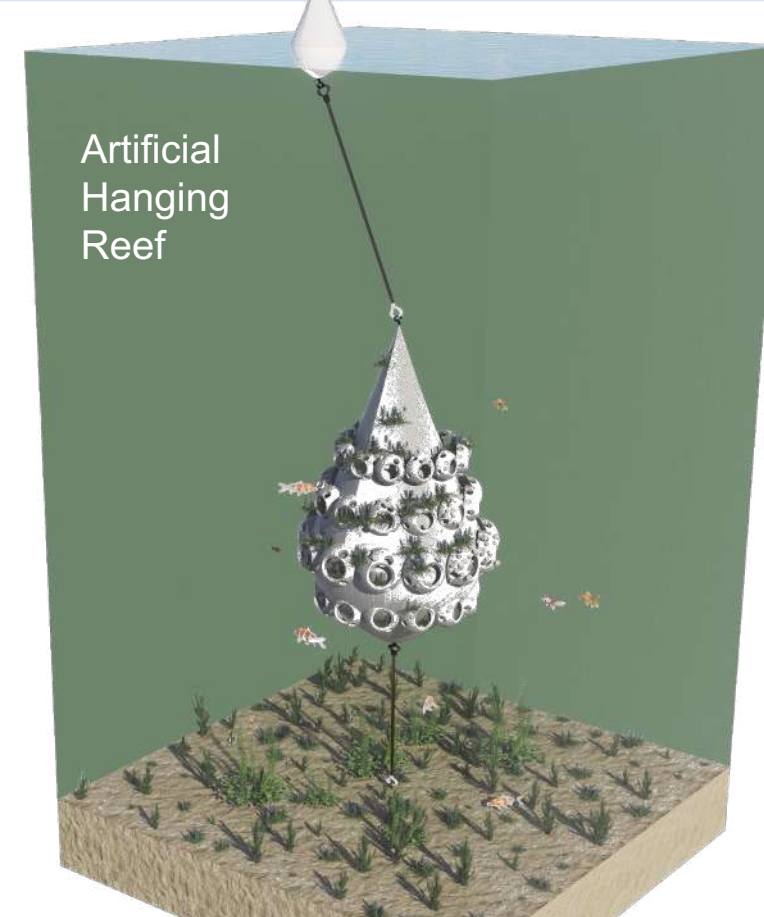
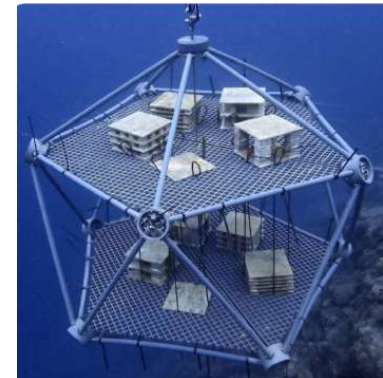
How NbS support Regenerative Seascapes in Southeast Asia

**Blue Carbon
Storage & Climate
Regulation**

**Coastal Protection
and Disaster Risk
Prevention**

**Sustainable Fisheries
and Livelihood
Support**

**Water Quality
Improvement and
Habitat
Regeneration**



Thank you for your attention!

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