PEMSEA

BC/WS/2025/001

Proceedings of the Training on Integrating Blue Carbon into the Integrated Coastal Management (ICM) Framework

25 -27 February 2025,

Chonburi, Thailand

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Introduction

I. The PEMSEA Network of Learning Centers (PNLC), Burapha University and the PEMSEA Resource Facility co-organized the "Training on Integrating Blue Carbon into the Integrated Coastal Management (ICM) Framework" in March 2025 in Chonburi, Thailand. The training, co-sponsored by Burapha University and the University of Hawai'i, with support from the Ministry of Higher Education, Science, Research and Innovation of Thailand, Thailand Science, Research and Innovation (TSRI), Henry Luce Foundation, and the Center for Southeast Asian Studies-University of Hawai'i, brought together PNLC participants and Chonburi Province coastal management stakeholders to enhance the understanding of Blue Carbon concepts and explore how the Network can support PEMSEA's regional Blue Carbon program. The training had the following objectives:

1. Gain foundational understanding of ICM and its role in coastal resource management.

2. Learn about the impacts of climate change on coastal ecosystems and communities.

3. Understand the concept of Blue Carbon and its significance in climate change mitigation.

4. Acquire the knowledge to integrate blue carbon principles into coastal management strategies, ensuring more sustainable and resilient coastal zones and harness the potential of blue carbon ecosystems as nature-based solutions for climate action.

5. Identify work areas, in terms of knowledge, capacity and technical assistance, PNLC members need to strengthen to enable them to better support government and local community efforts in managing their coastal areas and associated blue carbon ecosystems.

The three-day training addressed ICM challenges and examined how East Asian Seas Region ICM experiences can incorporate blue carbon initiatives. Discussions focused on methodologies, collaboration opportunities, and aligning Blue Carbon plans with commitments, including the SDS-SEA, UNSDGs, and Post-2020 Biodiversity Framework. A key objective was identifying technical expertise the Network can provide to PEMSEA partner countries to enhance regional ICM implementation. The workshop was attended by a total of 39 participants, composed of 19 PNLC Members from Cambodia, China, Hong Kong, Indonesia, Lao PDR, Philippines, Thailand, Timor-Leste, and Vietnam and 20 local participants from the Department of Marine and Coastal Resources, the local government of Saensuk Municipality, Burapha University, King Mongkut's University of

Technology, The International Emergency Management Society (TIEMS), The Pacific Disaster Center (PDC).

II. Supporting documents may be found in the Annexes:
   A. Annex 1 - Provisional Programme
   B. Annex 2 - List of participants
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   D. Annex 4 - Presentations, Photos, and Posters
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DAY 1

1. Opening Program

1.1. Dr. Wansuk Senanan of Burapha University welcomed the participants to Burapha University and provided the rationale for the training, highlighting the need to understand blue carbon concepts and how it can contribute to addressing climate change. She outlined the sessions of the training and emphasized the importance of fostering collaboration amongst the PNLC members to further blue carbon studies and initiatives.

1.2. Mr. Woranop Sukparangsi, Vice Dean of the Faculty of Science of Burapha University highlighted that integrating blue carbon strategies into coastal management is essential for building resilience and achieving the Sustainable Development Goals. He further emphasized that the training is an excellent chance to exchange ideas, develop skills and develop strategies to advance blue carbon initiatives in the East Asian Seas (EAS) region.

1.3. Dr. Brian Szuster from University of Hawai'i at Manoa, and Prof. Dr. Yonvitner President, PEMSEA Network of Learning Centers (PNLC) / IPB University additionally welcomed the participants to the meeting and expressed their appreciation to PEMSEA Resource Facility for leading the organization of the training.

1.4. Ms. Isdahartatie, PNLC Secretariat, introduced the course overview to the participants, covering the training objectives, expected outcomes, syllabus, process, approach, and the participants' roles.

2. Understanding Climate Change and the Role of Integrated Coastal Management (ICM)

2.1. Dr. Szuster provided an overview of the impacts of climate change on coastal and marine areas and how Integrated Coastal Management (ICM) can address these challenges.

2.2. *On Climate change and its impact on coastal ecosystems*

- Climate change is threatening our coastal regions, where rising global temperatures are melting polar ice and causing sea levels to rise by 23cm since the late 9th century. The oceans, now absorbing over 90% of heat emissions, face devastating consequences, including coral bleaching, acidification, and potential complete coral reef destruction by 2100.

- Additionally, climate change also exacerbates marine biodiversity loss as aquatic species migrate towards cooler waters, while the degradation of coral reefs and mangrove ecosystems is projected to increase exponentially. These climate-induced risks manifest in increasingly destructive storms, deadly natural disasters, coastal

erosion, and landslides, creating a cascade of interrelated environmental challenges that coastal communities must urgently address.

- Losses in the environmental integrity of coastal ecosystems due to climate change have impacts on humans. Climate change affects human settlements, wherein residential areas and infrastructure face long-term damage from intensifying storms, floods, and coastal erosion. It also increases the challenges to food security as rising marine acidity and sea surface temperatures cause coral bleaching, degraded marine resources, and reduced marine life productivity, threatening coastal food systems. Coastal economies likewise struggle with negative impacts from extreme weather, coastal erosion, and loss of biodiversity, affecting key vulnerability hotspots in fisheries, tourism, and agriculture sectors due to their direct exposure to climate change.

- Ocean warming has a significant impact in Southeast Asia, which is one of the regions most vulnerable to climate change, given that a significant number of cities are predominantly coastal. As climate change worsens, these coastal cities will become more susceptible to a variety of extreme weather events, sea level rise, and increasing biodiversity loss.

2.3. *On Coastal Ecosystems in the East Asian Seas*

- Humans rely heavily on coastal and marine resources for their well-being, with nearly 10% of the global population living within 5 km of the coast and over 2 billion in broader coastal regions. These ecosystems offer vital social and economic benefits, such as fisheries for food and livelihoods, coastal habitats for storm protection, and tourism for economic growth.

- East and Southeast Asia are considered global centers of marine biodiversity, housing 31% of the world's mangroves, 33% of its coral reefs, and significant seagrass beds. The region has a significantly higher marine fish species diversity (est. 2,500 species) compared to other major marine ecosystems and accounts for 83% of global aquaculture outputs and about 60% of the world's capture fisheries.

- Coastal ecosystems also include blue carbon ecosystems (BCEs), which include mangroves, seagrass beds, salt marshes, sequester and store carbon effectively for long periods of time. They capture carbon from the atmosphere and sequester it to the coastal sediments.

- BCEs also provide multiple services, such as provisioning (food, water), regulating (flood control), cultural (recreation) and supporting services (nutrient cycling). In terms of the global carbon storage potential, the East Asian Seas region is quite critical. In particular, Indonesia houses a significant portion of BCEs in the world, which has been observed to have a high sequestration potential.

- The vulnerability of these coastal ecosystems to anthropogenic impacts such as overfishing, pollution, ecosystem degradation, and climate change is closely linked with poverty, particularly in coastal cities with high population densities. This is further exacerbated by the fact that many governments prioritize management of terrestrial ecosystems compared to coastal ecosystems.

2.4. *On Integrated Coastal Management (ICM)*

- Human activities are major drivers of climate change, degradation, and the loss of marine and coastal ecosystem services. These ecosystems are deteriorating faster than many others, with most of the services derived from them being degraded and used unsustainably.

- ICM is therefore a crucial tool to arrest the impacts of anthropogenic activities and move toward sustainable approaches that preserve resources, services and ecosystems. It is an ecosystem-based framework that employs an integrative, holistic management approach and interactive planning process to address complex coastal and marine issues.

- The goal of ICM is to preserve the functional integrity of ecosystems through effective coastal and ocean governance through integrated planning and management with interagency, multi-sectoral collaboration and partnership to improve standards of living, maintain/ improve functional integrity and health of ecosystems, and promote efficient, equitable, and blue economic growth.

- ICM has evolved since 1965 to present with increasing national policies and legislations supporting its implementation. By 2022, approximately 40% of East Asian coastlines have implemented some form of ICM management.

- ICM follows a six-stage cycle: preparing, initiating, developing, adopting, implementing, and refining/consolidating (Figure 2).

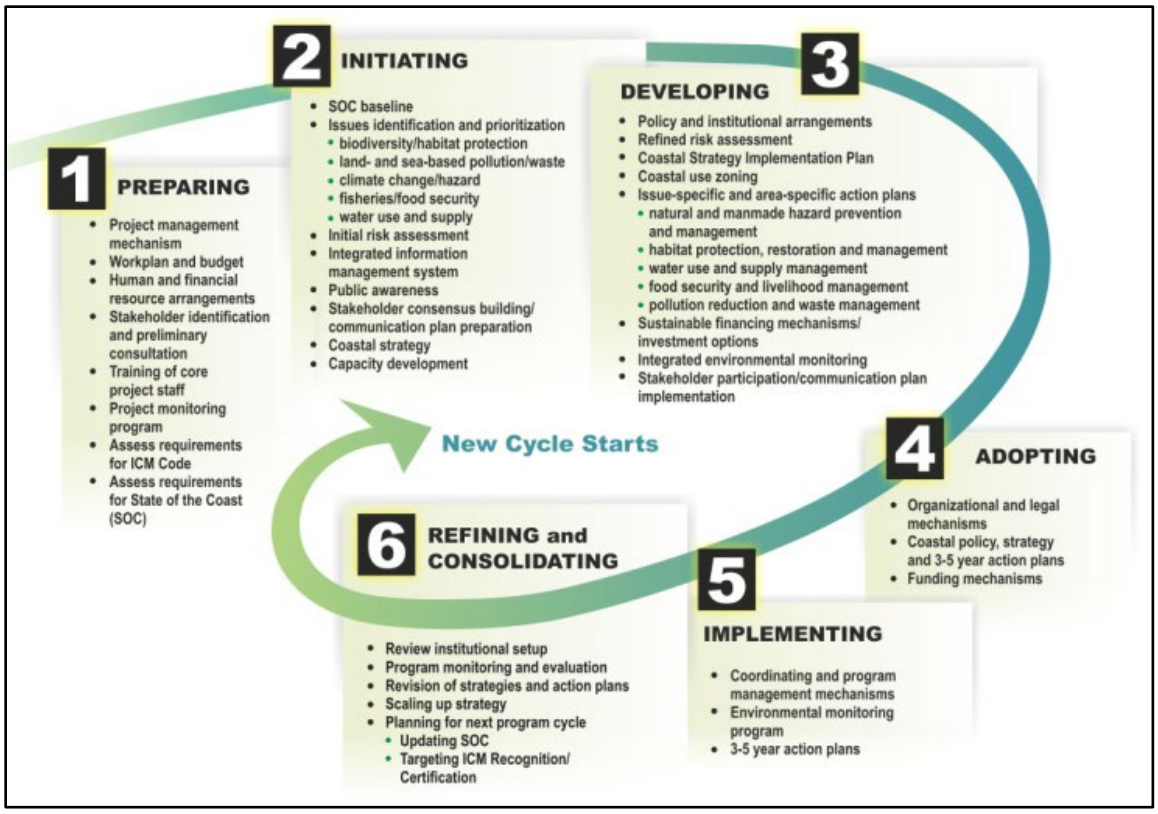

Figure 2. ICM Process

- ICM is anchored in the principle that the state of ecosystems is consistent with a shared vision and socio-cultural-economic values of the society. An example includes the ancient Hawaiian Ahupua‘a ICM system, where Pacific Islanders recognized they lived in a closed system with limited resources, a concept shared by many traditional societies. In contrast, modern societies often fail to recognize this reality, leading to the degradation of coastal resources, which meant certain death for the ancient Hawaiians. They understood that sustainably managing these limited resources in an integrated way—from the mountains to the sea—was not only the right approach but also essential for their survival.

- ICM operates in various boundaries and has different paradigms and approaches (Figure 3.0) spanning across different spatial coverages across the source-to-sea continuum.

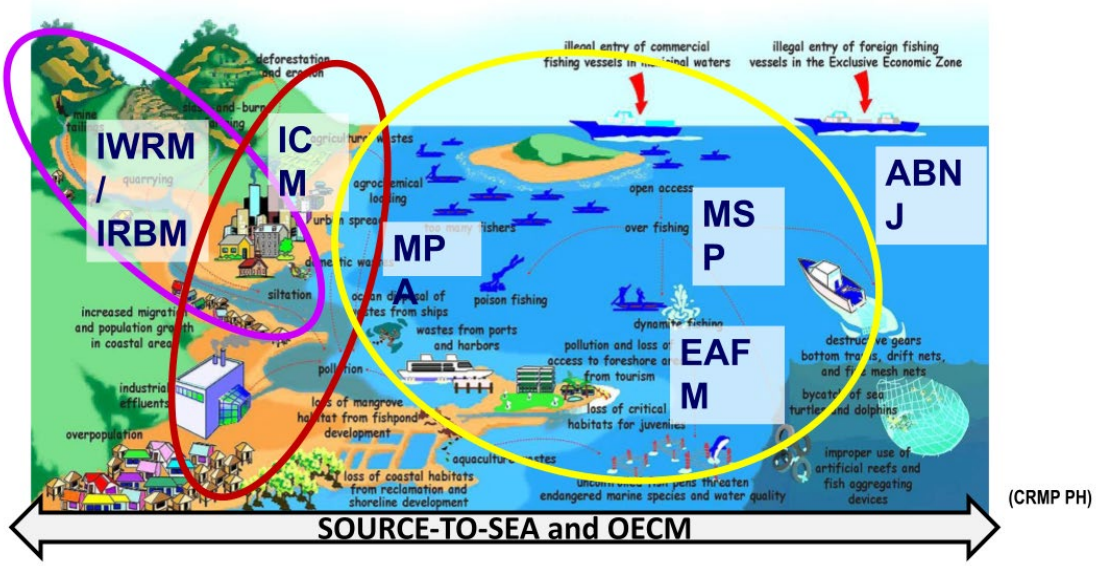

Figure 4.0 ICM Paradigms and Approaches

- ICM is differentiated based on Sector/Subject Plans and Integrated Plans based on Spatial Coverage. Sectoral/ Subject Plans are developed for a variety of issues and spatial scales (e.g., resource exploitation, key ecosystem components, or infrastructure management). They are similar to spatial plans at the site scale but are not typically applied at higher planning levels. Sector-specific plans are usually driven by well-defined information needs and focus on particular sectors, often triggered by emerging issues or conflicts. These plans can result in integrated plan outcomes (action documents) and may serve as the foundation for future integrated planning processes (knowledge-gathering exercises).

- Integrated Plans Based on Spatial Coverage, on the other hand, have different levels of planning or spatial scales.
  - **International:** highly strategic, insures international cooperation on common goals, can be voluntary (eg. International Coral Reef Initiative), statutory (eg. MARPOL) or regional (eg. UNEP Regional Seas Programme)
  - **National:** primarily focus on administering planning frameworks and providing strategic guidance (e.g. identifying national goals, objectives, priorities). Can direct development of lower levels plans in subsidiary jurisdictions (e.g. US CZMA)
  - **Regional:** addresses problems that span large geographic areas (up to 1000 km of coastline) spatially oriented and typically non-statutory, provides a bridge between national objectives and local needs/issues
  - **Local:** content varies according to nature of local issues, plan area between 10-100 km, plan objectives tangible, community input critical
  - **Site:** detailed plans that address specific problems in small areas such as parks or recreational areas (integrates planning, design and engineering to achieve tangible results

- ICM has three foundational principles:
  - **Integration and Coordination:** This involves both functional and policy integration to ensure all relevant sectors and stakeholders work together effectively.
  - **Ecosystem-Based Management:** This principle focuses on the protection and restoration of ecosystems, emphasizing the connectivity within and between land and sea systems.
  - **Adaptive Management:** This approach highlights the importance of learning by doing and gaining experience, with the flexibility to act in response to uncertainty, policy changes, political intervention, and shifts in public opinion.

- Individuals, groups, organizations that participate in ICM include:
  - Rights, interests or needs affected by the management process (e.g., local communities, fishers, traders, farmers, tourism operators, developers)
  - Influence, authority or power relevant to the management process (e.g., elected officials, local, provincial and national government)
  - Expertise or resources relevant to the management exercise (e.g., govt. agencies, universities, international organizations, NGOs, donors)

- Political commitment is essential to the effective implementation of ICM. ICM enhances local governance and supports the implementation of management programs aligned with local visions of sustainability. This, in turn, fosters stronger political commitment and facilitates the mainstreaming of ICM into local government mechanisms and processes.

- Successful examples of ICM implementation in the region include:
  - Cambodia (Koh Rong): First large-scale Marine Fisheries Management Area, increased fish biomass and coral cover
  - Indonesia (Tangerang): Implemented coastal community development with mangrove restoration (700,000 trees planted)
  - Philippines (Batangas): 54 marine protected areas, increased biodiversity protection, and tourism-related livelihood
  - Thailand (Saensuk): Implemented coastal erosion management using mathematical modeling and soft engineering approaches

2.5. The key challenges that ICM implementation faces today include:
- Weak coastal governance due to policy failures or inadequate planning and management;
- Limited coordination at various government levels;
- Lack of sufficient local capacity for ICM implementation, and
- The need for strong political will for multi-sectoral collaboration and partnerships.

2.6. **Q&A**

Question/Comment	Speaker's Response
Considering the discussion on climate change, what is the difference between climate adaptation and climate mitigation?	Mitigation refers to fixing the problem of carbon emissions, such as finding solutions to reduce carbon emissions in the atmosphere. Adaptation refers to strategies on how to make sure that the impacts of [climate change] will not affect coastal cities any further.
Indonesia is a big country with more than 1400 islands. It faces several challenges such as high costs of living and transportation which causes inequalities socially and economically and poses challenges in implementing actions to mitigate climate change effectively. [How can ICM help address these challenges?]	Many of the problems we face come down to the unsustainable use of energy - given that we predominantly use fossil fuels to make most of the things we currently use and consume. While we have made initiatives to address this, such as renewable energy, we have to modify our consumption habits in a way that is more sustainable and equitable for the environment. Our economic systems require growth but our environment cannot sustain this. We want development but sooner or later we realize that our resources have limits. Our job is to live within our limits. Our job is how to do things sustainably; a functioning environment that can support living. ICM has a very good potential to provide a framework on how to be able to manage the way we use energy in a more sustainable manner. And blue carbon is one of the tools we can start with to deal with this.

3. Case Study: ICM Implementation in Indonesia

3.1. Prof. Dr. Yonvitner, President of the PEMSEA Network of Learning Centers and Director of the Center for Coastal Marine Resource Studies of the IPB University in Indonesia presented an overview of the ICM implementation in Indonesia, focusing on case studies from Bontang City and Tangerang Regency.

3.2. Indonesia's coastal areas face significant climate change impacts, with climate projections showing that by 2050, numerous regions will be facing potential inundation due to sea-level rise. From 2021-2050, the estimated potential economic losses due to climate change alone amount to Rp 110.38 to 577.01 trillion to Rp 4,328.38 trillion (including ecosystem damage and disasters such as marine pollution) based on the country's 2020 GDP.

3.3. Marine and coastal ecosystems provide crucial services valued at 16.22% of GDP historically, with projections suggesting this could increase to 31.72% with proper management. Analysis of coastal biomes indicated that while some terrestrial ecosystems would experience losses under climate change scenarios, mangrove ecosystems could substantially increase area and economic value.

3.4. *ICM Framework in Indonesia*

- Upon its commitment to PEMSEA as a country partner, Indonesia has strived to adopt the ICM framework as an approach towards the holistic management of its coastal ecosystems. The ICM framework builds upon six essential elements:
  - legitimacy and political acceptance, or securing legal backing and political support of ICM initiatives;
  - targeted investment and technical knowledge building;
  - adaptive, science-based learning-by-doing, or the flexible application of scientific principles based on local contexts;
  - Accountability, through transparent management and reporting mechanisms;
  - Conformity, through adherence to established standards and protocols, and
  - Collaborative partnerships, involving engagement across government, academia, private sector, and communities.

3.5. The presentation highlighted several aspects of how ICM was developed in coastal cities in Indonesia:

- **Policy Development**: The presentation addressed governance gaps created by Law No. 23/2014 on Regional Government, which shifted marine management authority to provincial levels, creating potential coordination challenges.

- **Planning Process**: Following policy development, a three-tiered approach was described through a bottom-up process at the provincial and district level:
  - Planning was done through the development of a Coastal Strategic plan at the provincial level, utilizing both coastal strategy and coastal and marine spatial planning;
  - To implement this, a Coastal Management Implementation Plan was developed at the district level which includes monitoring and evaluation of targets to ensure that the Coastal Strategic Plan is effectively implemented;

    - An Action Plan at the district level was also developed to provide a procedural implementation of the coastal strategy.

- **Ecosystem-Based Planning**: To ensure the responsiveness of the Marine and Coastal Plan, risks of various ecosystems were reviewed using multiple planning frameworks, including Fisheries Management Areas, Marine Spatial Planning, and Regional Marine Spatial Planning. These were utilized to inform the actions and strategies identified in the coastal strategy.

- **Integration of Ecology-Economy**: ICM development in Indonesia emphasized connections between ecosystem functions and socioeconomic systems, demonstrating how supply and demand of ecosystem services are interconnected.

- **Stakeholder Participation**: A methodical process was outlined for engaging stakeholders in coastal management planning, from preliminary surveys through implementation and evaluation. The process showed that extensive consultations and consistent coordination with stakeholders are essential to be able to develop an inclusive and responsive plan.
- **Strategic Approach**: The Integrated Coastal Management Strategy adopted six strategic pillars: Preserve, Protect, Develop, Implement, Communicate, and Sustain.

3.6. Dr. Yonvitner presented case studies on implementing ICM in Bontang City and Tangerang Regency.

3.7. The ICM Implementation in Bontang City, East Kalimantan Indonesia began in 2015 upon its formal designation as a scaling-up location for the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) implementation. From 2017-2018, IPB University supported Bontang City in developing coordination mechanisms and working groups to implement ICM. Dr. Yonvitner explained that the process of establishing ICM governance mechanisms took a while because of differing concerns of various institutional stakeholders. He emphasized that communication and levelling-off with stakeholders is essential to find a balance on which concerns need to be addressed.

3.8. Following the establishment of policies and governance mechanisms, the city worked with the academe and local stakeholders to establish marine conservation areas with specific zoning:
- Core protection Zone (12.68%)
- Sustainable Fisheries zone (63.57%)
- Limited-used tourism zones (22.75%)

3.9. The establishment of these zones built on existing protected areas and were expanded based on the results of ecosystem assessments.

3.10. Measurable outcomes of the initiative included improved social capital, increased economic returns from seaweed cultivation (177% increase from 2015), and environmental benefits including enhanced ecosystem services.

3.11. In the case of Tangerang Regency, the “Gerbang Mapan” or Coastal Community Development Program was initiated in 2014, and included the integration of coastal management across eight (8) sub-districts with 25 coastal villages. The effort resulted in a significant expansion of mangrove coverage between 2014 - 2023 and the development of the Katabang Urban Aquaculture Initiative, which combines urban aquaculture operations with mangrove conservation and restoration activities. It also resulted in the establishment of a mangrove-based economy with educational implements.

3.12. The program successfully integrated mangrove conservation with community development through a comprehensive and integrated approach addressing ecosystem degradation, environmental management, and community empowerment.

3.13. Dr. Yonvitner emphasized that for both case studies, it was observed the successful implementation of ICM plans and programs were realized through:

- Continued and inclusive engagement of local stakeholders through participatory consultations, capacity building, and knowledge sharing;
- Ensuring commitment and ownership of local governments by navigating tradeoffs on balancing ecological preservation with local economic development, through adaptive and inclusive management approaches.

3.14. Q&A

Question/Comment	Speaker’s Response
Is there any successful bottom-up implementation of ICM that can support decision-making at the local level?	There are five learning sites in Indonesia, but only two have complete and consistent implementation of ICM. It is important to get buy-in from local governments (LGs) by showing them the economic benefits towards protecting coastal ecosystems. Political commitment to ICM is key to ensure its sustainability. Therefore, it is necessary to constantly coordinate and showcase ICM impacts at the local level to gain confidence from local governments. Furthermore, the contribution of the private sector, and other financing mechanisms for ICM is important to engage LGs.
A lot of universities have conducted researches on climate change and coastal management. How can we effectively	Work with local departments. Consider relating studies to local culture to gain understanding and ownership of local

collaborate with practitioners and local stakeholders to engage the universities' research?	stakeholders.
In Tangerang Regency's case on mangrove conservation and restoration, what was the process for increasing the mangrove area in such a time? In Thailand, 1 or 2 species were planted. What species were planted in Indonesia and what was the process?	The process for increasing mangrove area in Tangerang Regency involved a multi-faceted approach centered on balancing ecological conservation with economic development. The key elements of this process included: *Community engagement through economic integration*: The initiative demonstrated to local communities how mangrove conservation could directly support the local economy, particularly through silvoaquaculture practices where aquaculture operations are integrated with mangrove forests. *Infrastructure development*: Construction of supporting infrastructure was implemented to facilitate both conservation activities and economic utilization of the mangrove areas. *Demonstrating tangible benefits*: The program showed concrete benefits to community members, including infrastructure support and local livelihood enhancement that could directly accompany mangrove conservation and restoration efforts. As an example, we supported fishermen's wives in building their capacities in fish processing enabling them to contribute to family income. . *Coupled development approach*: Community development was deliberately paired with economic development initiatives, creating a synergistic relationship where ecological restoration supported economic growth rather than competing with it. Working with NGOs, private sector and local governments played a crucial role in the success of these initiatives.
How do you deal with the different levels and powers of ministries who have their own mandates and plans to empower communities and implement ICM?	Indonesia has 26 national-level institutions, not including those at the local level. Evaluating each institution's contributions and participation presents a challenge. Recognizing this, we focus on working directly

	with local governments to support community initiatives. Building partnerships takes time, but aligning policies with local targets, while considering international and national frameworks, is essential. Budget constraints is a consideration, so we prioritize efforts at the local level, where implementation is more feasible. Engaging partners to support local programs and governments is a key strategy. For instance, in infrastructure projects, we seek financing through partnerships to strengthen local initiatives. Indonesia's local autonomy plays a crucial role, as the power of regional and city governments significantly impacts development outcomes. By leveraging local governance structures, we create more effective and sustainable programs.

4. Climate Adaptation and Mitigation through Blue Carbon Ecosystems

4.1. Following Prof. Dr. Yonvitner's presentation and Q&A, Dr. Keita Furukawa, Technical Session Chair of the East Asian Seas (EAS) Partnership Council (PC), presented on climate adaptation and mitigation through blue carbon ecosystems. His presentation was structured into three key areas: (1) Science – The Role of Blue Carbon Ecosystems, (2) Practice – The Role of Blue Carbon Ecosystems, and (3) The Management Framework.

4.2. ***Scientific Foundations of Blue Carbon Ecosystems***

- Material Cycling: Blue Carbon ecosystems facilitate essential material support processes through water movement. Water's unique properties - existing in three states (liquid, gas, and solid) with high specific heat and solvent capacity enable it to transport nutrients, sediments and energy throughout coastal ecosystems.

- Productivity Patterns: Coastal ecosystems exhibit extraordinarily high primary productivity (10-25×10² kcal/m²/year), surpassing most terrestrial systems. This productivity forms the foundation for diverse marine food webs and substantial carbon sequestration.

- Food Web Complexity: Multi-layered food chains forming intricate webs exist within coastal ecosystems. These networks feature production pathways (solar energy plus nutrients creating organic matter), consumption mechanisms (organisms utilizing organic matter), and decomposition processes (returning organic matter to nutrient forms).

- Ridge-to-Reef Connectivity: Water-mediated connections link upland, riverine, and marine systems through material flows. This connectivity necessitates integrated management approaches that transcend traditional administrative boundaries.

4.3. ***Blue Carbon Ecosystem Dynamics and Function***

- Flux Measurements: Sediment and nutrient flux (calculated as Discharge × Concentration) provides crucial metrics for evaluating ecosystem connections. The presentation demonstrated how discharge calculations (Velocity × Depth × Width) help quantify material movement through system components.

- Ecosystem Classification: Different coastal environments exhibit distinctive carbon dynamics: (1) Stock-dominated ecosystems (e.g., forests) primarily store carbon in biomass; (2) Flow-dominated ecosystems (e.g., coastal wetlands) actively transport and process carbon, (3) Balanced ecosystems (e.g., enclosed bays) maintain equilibrium between storage and transport functions.

- Biodiversity Dimensions: Blue carbon systems support multiple biodiversity aspects such as genetic diversity within species populations, species diversity across taxonomic groups, functional group diversity supporting ecosystem processes, community/ecosystem diversity creating habitat mosaics, and landscape-level diversity connecting ecosystem patches.

- Ecosystem Services Framework: Following the Millennium Ecosystem Assessment model, blue carbon ecosystems deliver valuable services across categories such as:

    - Provisioning: food, fresh water, fuel, genetic resources
    - Regulating: climate stabilization, water purification, natural hazard mitigation
    - Cultural: spiritual significance, aesthetic value, traditional knowledge
    - Supporting: primary production, nutrient cycling, soil formation

4.4. ***Case Studies in Blue Carbon Management***

- Community-Based Mangrove Restoration (Pedada Bay, Philippines): This successful coastal protection initiative demonstrated dramatic ecosystem recovery between 2011-2018 through effective community engagement. The framework illustrated how mangroves provide critical ecosystem services that enhance local wellbeing and reduce poverty in coastal communities. Success depended on managing both direct environmental factors (wave patterns, sedimentation) and indirect governance mechanisms through Local Government Unit and People's Organization

collaborations. This approach created a sustainable cycle where improved ecosystems strengthened community resilience, which in turn fostered better environmental stewardship through participatory governance.

- Sediment Management (Ngeremeduu Bay, Palau): The case study demonstrated effective sediment management in response to coastal development pressures. Comprehensive analysis integrated high-resolution bathymetric mapping with hydrological assessments of the bay's three primary rivers (Ngermeskang, Ngetpang, and Tabecheding), revealing sediment transport dynamics through mangrove systems. Field measurements using strategically placed sediment traps quantified deposition rates, while computer modeling simulated sediment pathways under various scenarios. The study documented how mangrove ecosystems naturally filtered approximately 1,477 tons of sediment annually, with only 176 tons reaching the ocean. This evidence-based approach enabled precise prediction of how upland development activities, particularly the Compact Road construction, would impact sediment distribution patterns. Results informed targeted management interventions including erosion control measures, protection of critical sediment-filtering ecosystems, and construction site management protocols.

- Climate Adaptation Research (Pohnpei Island): The study illustrated how BCEs detailed sediment transport analysis demonstrates how they serve as dynamic buffers against climate change impacts, with their sediment management capacity directly affected by sea level rise scenarios—highlighting the importance of BCE conservation as a natural climate adaptation strategy. The study identified four interconnected sediment transport mechanisms: rainfall-induced inland processes, tidal sheet flows, pelagic processes, and coastal wave interactions. Micro-topographic studies showed differential sedimentation patterns between forest floors (which displayed asymmetric inflow/outflow patterns favoring accumulation) and creek areas (which exhibited more balanced sediment exchange). Continuous monitoring during spring tides, neap tides, and rainfall events quantified how BCEs naturally trap terrestrial sediments while managing marine inputs, with forest sections demonstrating varying filtration efficiency based on tidal conditions. Climate change modeling indicated potential erosion rates of several centimeters annually with a 10cm sea level rise. However, the presentation noted that increased rainfall associated with climate change may partially offset these impacts through greater sediment delivery.

4.5. ***Management Framework Development***

- Policy Evolution: International policy has progressed from viewing oceans as unlimited resources to domains requiring committed stewardship, indicating an acknowledgment of marine vulnerability and essential ecosystem services. Key frameworks guiding blue carbon management include the Paris Agreement (blue carbon accounting), Kunming-Montreal Global Biodiversity Framework (enhanced

protection of coastal habitats), and SDG 14 of the UN Sustainable Development Goals, which connect environmental protection with socioeconomic sustainability.

- Institutional Arrangements: Blue carbon management requires coordination across scientific assessment, policy development, and implementation. Scientific bodies like IPCC and IPBES translate research into actionable guidance, establishing the evidence foundation for policy decisions. At national levels, implementation crosses departmental boundaries, requiring collaboration between forestry departments (mangroves), environmental agencies (regulation), marine authorities (seagrass), and climate ministries (carbon accounting). This complexity demands clear coordination mechanisms to avoid management gaps or overlaps.

- Regulatory Approaches: Blue carbon governance operates through a multi-tiered structure, with distinct yet complementary roles at each level:
  - Global level: International frameworks like UNFCCC and CBD establish voluntary commitments and guidelines rather than binding regulations. These platforms create common principles, methodologies, and goals aligning diverse jurisdictions. Though lacking direct enforcement, they drive accountability through transparency requirements and reporting cycles. Recent advances include enhanced blue carbon accounting guidelines and the High Seas Treaty extending governance to previously unmanaged waters.

  - Regional level: Regional bodies translate global principles into contextually appropriate frameworks while facilitating cross-border cooperation. These frameworks often achieve greater specificity than global agreements, such as PEMSEA's Sustainable Development Strategy for the Seas of East Asia. Regional entities drive capacity development, knowledge sharing, and often manage funding mechanisms supporting blue carbon science and implementation.

  - National level: The strongest regulatory tools emerge nationally through enforceable standards and legal protections. Implementation occurs via coastal management laws, environmental protection acts, fisheries regulations, and forest conservation statutes establishing protected areas, impact assessments, permitting processes, and compliance measures. Approaches vary by legal tradition and many nations adapt existing frameworks rather than creating new ones.

4.6. **Implementation Mechanisms:** Effective implementation requires practical tools addressing key dimensions.

- Financing tools: Sustainable funding necessitates innovation beyond government budgets. Blue carbon markets, multilateral funds, blended finance mechanisms, conservation trust funds (like Seychelles' marine protection endowment), and biodiversity offsets all provide emerging pathways to resource conservation efforts.

- Stakeholder engagement: Success depends on inclusive governance recognizing diverse coastal interests. Public awareness campaigns, formal consultation processes, and co-management arrangements with coastal communities ensure local knowledge informs protection strategies and builds essential support for conservation measures.

- Capacity development: Programs address uneven distribution of technical capabilities through focused training, South-South partnerships for knowledge transfer, and regional centers of excellence that disseminate best practices. The Blue Carbon Initiative exemplifies this approach with standardized monitoring protocols and targeted training across tropical coastal regions.

4.7. The integration between climate action and biodiversity conservation is essential, and there has been a marked shift from earlier approaches that pursued these goals separately. Joint assessments have identified key areas of alignment:

- Co-benefits: Many strategies deliver simultaneous climate and biodiversity advantages. Mangrove protection sequesters carbon while maintaining nursery habitats for fisheries. These win-win solutions offer efficient pathways maximizing conservation returns. New assessment methodologies quantify these multiple benefits, strengthening economic arguments for protection.

- Trade-offs: Not all interventions yield universally positive outcomes. Some climate-focused approaches may inadvertently harm biodiversity, as when mono-culture replanting prioritizes carbon sequestration over habitat complexity. Recognizing these tensions enables better design through spatial planning, species selection, and adaptive management. Emerging frameworks provide decision support tools helping policymakers navigate complex interrelationships to optimize outcomes.

4.8. **Q&A**

Question/Comment	Speaker's Response
When we visit the coastal community in West Bangka, Indonesia, we promote the value of blue carbon ecosystem services or coastal ecosystem services to the coastal community like fishermen. Land cover changed in their area. In the 1960s, the trend was to convert mangrove forest to shrimp farming. Now the land cover change is from mangrove forest to oil palm crop	Maybe the certification is important for the private companies or private sector. But that provides very short-term benefits for them. If we convince the people who look after the land in the long-term, we can ask them if it is important to get a certificate and lose the biodiversity, or we cannot get the certificate but we can conserve the biodiversity for the long-term. We need to engage all the stakeholders to think about the targeted

estate. The first man says, 'Why do you convert mangrove to palm oil?' Their response is, 'If we have the certificate of land on palm oil, we can keep the land for several generations; but if we work as fishermen, we don't have tenurial rights over the sea or the coasts. So how can we explain this issue? *Note from PRF secretariat: The certification referred to above does not refer to a certification that verifies the validity of carbon credits used to offset emissions, but the term is used to refer more to tenurial rights of land use/occupant.*	vision for the area, and maybe we should find a co-benefit for the developer or private sector. The science field and the academy can help a lot for the evidence-based or science-based discussion.
Given the concerning trends of mangrove forests being converted to shrimp aquaculture and oil palm plantations, what strategies can be implemented to help coastal communities recognize and prioritize the long-term value of intact Blue Carbon Ecosystems over short-term economic gains? How can we demonstrate that the ecosystem services provided by mangroves—such as storm protection, nursery habitats for fisheries, and carbon sequestration—outweigh the perceived benefits of conversion to alternative land uses?	While certification programs offer private sector benefits for coastal communities in the short term, we must take a broader view of blue carbon ecosystems. The long-term importance of BCEs extends far beyond immediate economic advantages. These ecosystems require a holistic approach that engages all stakeholders—from local communities to governments and businesses—to develop a targeted vision for coastal area management. Successful BCE projects identify and leverage co-benefits that connect ecosystem services with development goals. By focusing on these synergies, coastal communities can balance conservation with sustainable economic growth, ensuring these valuable ecosystems continue to provide carbon sequestration, coastal protection, fisheries support, and biodiversity preservation for generations to come.
Local stakeholders often fail to recognize the added value of co-benefits of BCE ecosystem services. What communication strategies and examples can be employed to effectively demonstrate the added value	Effective communication of Blue Carbon Ecosystem (BCE) co-benefits to local stakeholders requires a gradual, strategic approach beginning with targeted dialogue and capacity building focused on a single

of these co-benefits to local communities and decision-makers? What successful cases exist where communities have come to appreciate and protect these ecosystems after better understanding their multifaceted benefits?	stakeholder group, such as fisherfolk who directly experience the benefits of healthy coastal ecosystems. Once this initial group understands the value these ecosystems provide to their livelihoods, they can become powerful champions who help engage other stakeholder groups by sharing their firsthand experiences and newfound knowledge. This peer-to-peer advocacy is often more persuasive than external education efforts alone, allowing appreciation for BCEs to spread organically throughout the community and leading to greater support for conservation and sustainable management practices.

5. Blue Carbon Financing and Market Opportunities: World Bank Experience on Innovative Blue Financing and Seascape Management

5.1. Ms. Waraporn Hirunwatsiri of the Environment and Natural Resources Unit, World Bank outlined the importance of blue carbon ecosystems and blue finance as sustainable pathways to achieve net zero emissions.

5.2. Points discussed on the critical role of blue carbon ecosystems in climate change mitigation and adaptation:

- Blue carbon ecosystems are recognized as critical carbon sinks (Article 21 in COP 26 of the UNFCCC). These ecosystems—comprising mangroves, seagrasses, etc.—are capable of sequestering and storing vast amounts of carbon within their soils. However, despite their climate mitigation potential, only 43 out of 113 countries that have submitted greenhouse gas inventories or Nationally Determined Contributions (NDCs) have included blue carbon ecosystems in their mitigation efforts. Integrating these ecosystems into national accounting systems presents an opportunity to enhance global climate action.

- Mangrove forests play a significant role in carbon sequestration, capturing atmospheric carbon dioxide and storing it within their biomass, including leaves, wood, and roots. Additionally, mangroves trap organic matter and floating debris, which settle on the seafloor, further increasing their carbon storage potential. However, global mangrove coverage has declined by 4% from 151,000 km² in 1996 to 145,000 km² in 2010, followed by a smaller decline of less than 1% from 2010 to 2015. The main drivers of mangrove losses include conversion of mangrove forests for aquaculture, oil palm plantations, and coastal development.

When degraded or cleared, mangroves release their stored carbon back into the atmosphere, significantly increasing CO_2 emissions, particularly when soils are excavated for shrimp aquaculture ponds.

- Seagrass meadows also contribute significantly to carbon sequestration, with one hectare absorbing as much carbon dioxide annually as 15 hectares of rainforest. During storm events, seagrass ecosystems transport carbon to the deep sea, where it settles into ocean floor sediments, providing long-term carbon storage. Despite their ecological importance, seagrass meadows face ongoing threats from habitat destruction, water pollution, and climate change. Currently, 35 million hectares of existing seagrass can be protected, while 14.2 million hectares—lost due to degradation over the past century—can be restored. Furthermore, an estimated 143 million hectares of potential habitat could support new seagrass growth through targeted planting and restoration initiatives.

5.3. On the growing financial opportunities for Blue Economy:

- The ocean economy is projected to experience substantial growth, with its total value expected to double to US$3 trillion over the next decade, supporting an estimated 40 million jobs. Generating US$2.5 trillion annually, the blue economy stands as the seventh-largest economy in the world, with an asset value reaching $24 trillion. However, despite its immense worth, investments in sustainable projects remain critically low, with only 1% (US$13 billion) of the ocean's total value allocated toward sustainability initiatives as of 2010.

- Funding for blue carbon initiatives has also remained marginal. Between 2009 and 2019, philanthropic contributions to blue carbon-related projects accounted for just 0.34% of total ocean grants, distributed across 175 grants. A disproportionate share of this funding has been directed toward mangrove restoration, while broader blue carbon ecosystem restoration remains significantly underfunded. Estimates indicate that achieving the full restoration potential of carbon ecosystems would require anywhere from $425 billion to $60 trillion USD, underscoring the vast financial gap that must be addressed to unlock the benefits of blue carbon solutions.

5.4. There are various approaches to developing a blue economy, including:

- Marine Economy Assessment: Measuring the size of the marine economy (GDP contribution, job creation, value added) and assessing its sustainability, with a focus on setting growth targets.
- Spatial Planning: Using coastal and marine spatial planning as a foundation for blue economy development.
- Sustainable Investment: Investing in both traditional and emerging ocean industries, prioritizing sustainability, science, technology, and research.

- Climate and Low-Carbon Solutions: Exploring innovative climate solutions and pursuing a transition to low-carbon practices.

5.5. In the case of Thailand, blue economy has a critical economic value. Sustaining the development of coastal resources plays a crucial part in Thailand's tourism sector, which alone contributed 18% of the country's GDP during 2017-2019. Fisheries are one of the country's key agricultural sub-sectors and one of Thailand's leading sources of foreign currency earnings at more than $3-6 billion per annum. In total, the ocean-related Gross Provincial Product (GPP) in 23 coastal provinces contributed up to 29.6% of Thailand's GDP, covering up to 26.2% of the country's employment

5.6. However, the development of the blue economy in Thailand is affected by the increasing vulnerability of its coastal ecosystems. Over the past 3 decades, up to 30% of Thai coastlines have suffered from coastal erosion, resulting in total land lost up to 126.4 million sq.m, a land value loss of more than US$1.3 billion exclusive of other economic losses and damages. Such high economic value areas as Bangkok and Eastern Economic Corridor are at risk of sinking. The country's marine catch has been steadily declining since 2000 due to overfishing and increasing oil prices. Critical pressures on the coastal and marine resources are mainly habitat degradation, pollution, over-development, carrying capacity, and multiple resource-use conflicts.

5.7. To be able to reduce the vulnerabilities of these ecosystems, it is necessary to enhance access to financial mechanisms to support initiatives in maintaining and restoring the ecological integrity of BCEs.

5.8. She also discussed Blue Financing and how there is insufficient and declining government funding for marine and coastal resource management in Thailand. Private sector plays a significant role in the recovery of the blue economy while enabling industries to generate new investments. Momentum is building for innovative blue finance, among investors, financial institutions, and issuers globally. She emphasized how blue bonds and blue loans are financial instruments that earmark funds exclusively for ocean-friendly projects and critical clean water resources protection.

5.9. The World Bank has established several trust funds to support blue economy initiatives, such as the PROBLUE trust fund. Under PROBLUE, the World Bank is working to help the Government of Thailand develop a blue bond - a financial instrument that earmarks funds exclusively for ocean-friendly projects and critical coastal resource protection.

5.10. The key pillars of the World Bank's approach to supporting blue economy development in Thailand include improving fisheries governance, addressing marine debris and plastic pollution, integrating seascape management, and mobilizing innovative blue financing.

5.11. For the blue bond initiative in Thailand, the World Bank is conducting a study to identify eligible project categories that can guide the government's investments to support the

blue economy in line with international best practices. The goal is to develop a pipeline of relevant blue economy projects that can be financed through the blue bond.

5.12. In terms of the challenges, Ms. Waraporn Hirunwatsiri noted that in Thailand, the fiscal budget allocation for the Department of Marine and Coastal Resources (DMCR), the key agency responsible for managing coastal and marine resources, is very limited at only 0.05% of the total annual budget. This underscores the need to explore alternative financing sources like the blue bond.

5.13. She also highlighted the importance of developing robust monitoring and evaluation frameworks, as well as integrating ocean accounting into marine spatial planning efforts, to provide the necessary data and indicators to attract private sector investment into blue economy projects.

5.14. The presentation was followed by a Q&A session, where participants raised questions about the World Bank's engagement with non-governmental organizations and the private sector in blue financing initiatives, as well as the challenges around building the capacity of policymakers and parliamentarians to support enabling policy and regulatory frameworks for blue economy development.

5.15. **Q&A**

Question/Comment	Speaker's Response
Is the Blue Bond project a combination of blue carbon and marine spatial planning or is it just focusing on marine protected areas, or does it have connections with other marine activities such as ecotourism?	The World Bank project currently does not have a fully developed marine spatial planning framework for Thailand yet, but they are working on establishing a framework. The goal is to integrate considerations around blue carbon ecosystems, critical coastal habitats, as well as emerging marine activities like offshore renewable energy, into the marine spatial planning process. This framework is crucial to avoid conflicts and ensure sustainable development of the blue economy.

The World Bank typically works with the government, but are there also opportunities to work with the private sector or non-governmental organizations, given that some capacity building initiatives don't fit the World Bank's model.	The World Bank has access to various trust fund mechanisms like PROBLUE and PROGREEN that can support both analytical work as well as implementation projects. For bank-executed trust funds, the World Bank can directly engage with partners like NGOs, but for recipient-executed trust funds, the funds have to go through the government, specifically the Public Debt Management Office under the Ministry of Finance.
Firstly, in Indonesia, we are also developing an impact bond process, but the main focus is on the coral reef ecosystem, not so much on blue carbon ecosystems like mangroves. I'm curious if you have any experience related to impact bonds and other financing mechanisms. Secondly, a main difficulty we face is in the regulatory policy space, where we find the capacity of the parliament is limited. We need support from other institutions to increase the capacity of the parliament to produce effective regulations in this area.	Ms. Waraporn Hirunwatsiri acknowledged the participant's points. Regarding impact bonds, she shared that the World Bank has experience working on this in Indonesia, where they defined an assessment module and monitoring processes related to the biomass of coral ecosystems to offer data and methodologies to the private sector. On the challenge of building parliamentary capacity, Ms. Waraporn Hirunwatsiri agreed that this is a critical issue. She provided the example of a project in Thailand where she was able to turn a proposed bridge construction into a dolphin conservation initiative by engaging with high-level policymakers. She emphasized the importance of translating conservation plans into economic value and benefits to get buy-in from decision-makers. She stressed that working across different government agencies and levels, from local to national, as well as with the private sector and communities, is key to developing the necessary enabling environment and capacity for effective blue economy policies and regulations.
	National ocean accounting is very important where indicators and guidelines are needed.

DAY 2

6. Legal Framework for Blue Carbon

6.1. Mr. Yinfeng Guo of the National Marine Hazard Mitigation Service (NMHMS)-Ministry of Natural Resources (MNR), China discussed the topic on 'Developing an Enabling Legal and Policy Framework for Blue Carbon in the South East Asian Region for Synergistic Implementation of Multilateral Environmental Agreements (MEA)'. The session aimed to demonstrate how blue carbon ecosystem conservation and restoration can support the synergistic implementation of multiple Multilateral Environmental Agreements (MEAs) and global frameworks when integrated into Integrated Coastal Management (ICM) practices.

6.2. Mr. Yinfeng Guo divided his session into four parts. First, he discussed international commitments and frameworks relevant to coastal blue carbon ecosystems. Second, he explained how coastal blue carbon ecosystems, as ocean-based climate solutions, are integrated into the Implementation Plan 2023-2027 of the SDS-SEA. Third, he facilitated a question-and-answer session, allowing participants to discuss national legislation and policies of PEMSEA Country Partners in support of blue carbon ecosystems. Lastly, he presented case studies on local legislation and policies related to blue carbon ecosystems, featuring insights from Chonburi participants and other PNLG members.

6.3. **Key points:**

6.4. **Alignment and Coherence Framework**

- There is a need for alignment and coherence across four levels of governance. At the global level, MEAs and global commitments (Ramsar Convention, UNFCCC, CBD, etc.) mention the importance of blue carbon ecosystems and how their conservation and protection can help address the triple planetary crisis; at the regional level, the SDS-SEA Implementation Plan 2023-2027 outlines specific targets on blue carbon management; at the national level, national laws, policies, countries' Nationally Determined Contributions (NDCs), National Biodiversity Strategy and Action Plans (NBSAPs), etc. are important pathways to integrate blue carbon; and at the local level, local regulations, Ramsar sites, MPAs, and priority restoration sites support the protection of such ecosystems.

6.5. **Relevant MEAs and Global Frameworks**

- Ramsar Convention (1971): Recognition of coastal blue carbon ecosystems in Strategic Plan 2016-2024, with targets for increasing under-represented types (Target 6) and restoration of degraded wetlands (Target 12). Resolutions XIII.13 and XIII.14 specifically call for incorporating blue carbon protection and restoration in NDCs.

- UNFCCC and Paris Agreement: Recognition of coastal and marine ecosystems as carbon sinks, with Ocean and Climate Dialogues emphasizing the need to integrate mitigation and adaptation actions for coastal ecosystems into NDCs and NAPs. The 2013 IPCC Wetlands Supplement provides methodologies for including all three coastal blue carbon ecosystems in national GHG inventories.

- Convention on Biological Diversity: The Kunming-Montreal Global Biodiversity Framework includes targets related to coastal and marine ecosystems restoration (Target 2), conservation (Target 3), and using nature-based solutions for climate change mitigation (Target 8).

- World Heritage Convention: UNESCO's 2021 assessment of World Heritage marine sites highlighted their blue carbon value and potential for carbon credit financing.
- Convention on Migratory Species: Relevant goals for habitat maintenance and restoration, with target 2.2 addressing protection and effective management of important habitats for migratory species.

- Sendai Framework for DRR 2015-2030: Promotes mainstreaming of disaster risk assessment and management into development planning for coastal areas, recognizing ecosystem functions in risk reduction.

- SDGs 2015-2030: Multiple relevant targets under SDG 6 (water ecosystems), SDG 13 (climate action), SDG 14 (marine resources), and SDG 15 (terrestrial ecosystems).

- UN Decade Initiatives: Both the Ecosystem Restoration Decade and Ocean Science Decade include blue carbon objectives, with the Decade Programme for Blue Carbon (GO-BC) specifically endorsed by IOC-UNESCO.

6.6. Regional Implementation Through SDS-SEA IP 2023-2027

- The PEMSEA SDS-SEA Implementation Plan 2023-2027 includes several components directly addressing blue carbon:

- Regional Mechanism: Establishing reporting systems to track progress
- National Policy Development: Supporting implementation of ocean policies, legal instruments, and institutional improvements
- Capacity Development: Training, research, and knowledge exchange on ICM and blue carbon
- Biodiversity Conservation: Incorporating KMGBF targets into NBSAPs
- Climate Change Adaptation: National platforms for blue carbon assessment with standardized protocols
- Disaster Risk Reduction: Integration of blue carbon ecosystems into DRR planning
- Blue Investments: Promoting nature-based solutions for carbon sequestration

6.7. **National and Local Implementation**

6.8. The session reviewed the status of national legislation supporting blue carbon initiatives across PEMSEA Country Partners, highlighting varying levels of development and implementation.

6.9. China, RO Korea and Japan demonstrate the most comprehensive policy frameworks, with China's recently adopted carbon trading rules (2024) and technical standards for coastal ecosystem carbon accounting providing a particularly robust foundation. Similarly, Korea's establishment of a dedicated National Blue Carbon Center and its Blue Carbon Bank pilot project represent leading regional initiatives. Japan has made considerable progress with its J-Blue Credit system specifically designed for carbon offsetting from seaweed and seagrass restoration, while Indonesia's dedicated Blue Carbon Strategy and Action Plan and ambitious mangrove rehabilitation target (600,000 hectares by 2024) reflect strong governmental commitments.

6.10. The Philippines, Vietnam, and Malaysia show substantial progress in policy integration, with the Philippines and Malaysia notably incorporating ICM approaches directly in their NDCs. Vietnam's extension of its REDD+ Program to include blue carbon ecosystems represents an innovative approach to leveraging existing frameworks. In contrast, while Singapore has included mangrove and seagrass conservation targets in its Green Plan 2030, its limited coastline has necessitated a more intensive approach to conservation rather than extensive restoration.

6.11. Legislative frameworks vary significantly across countries, with some like Thailand (Marine and Coastal Resources Management Act) and Indonesia (Presidential Regulation establishing the Peatland and Mangrove Restoration Agency) creating specialized instruments, while others integrate blue carbon considerations into broader environmental legislation. The maturity assessment of ICM legislation (updated from 2015) revealed that climate change policy integration has advanced most rapidly in Vietnam, Philippines, and Indonesia, though implementation challenges persist throughout the region.

6.12. Financial mechanisms show perhaps the greatest disparity, with Korea, Japan, and China developing sophisticated carbon market regulations that include provisions for blue carbon, while other countries remain in earlier phases of development. Similarly, monitoring and assessment capacity varies widely, with China, Korea, and Japan possessing more advanced technical standards and methodologies than their regional counterparts.

6.13. At the local level, innovative approaches are emerging across the region regardless of national policy maturity. Chonburi Province's mangrove conservation ordinances, Batangas Province's integrated approach to mangrove protection and livelihood programs, Xiamen's blue carbon assessment system, and Preah Sihanouk's community-based management schemes all demonstrate that local governments can advance blue carbon initiatives even where national frameworks are still developing.

6.14. The session provided the following findings and recommendations:

- *Integration into National Planning*: It is essential to incorporate blue carbon ecosystems into NDCs, NAPs, NBSAPs, and DRR strategies to ensure policy coherence and maximize co-benefits.

- *Standardized Assessment*: There is a need to establish platforms for blue carbon assessment using standardized protocols for sampling and analyzing carbon stocks and fluxes to ensure scientific validity through comparable data across sites and timeframes, enable carbon market participation by meeting verification requirements, provide the robust evidence needed for national GHG inventories, build investor confidence through reliable measurements, streamline reporting across multiple international conventions, and promote cost efficiency by reducing duplication of methodological development efforts.

- *Ecosystem Restoration Targets*: At least 30% of degraded coastal and marine ecosystems should be under effective restoration by 2030 (aligned with KMGBF Target 2). Restoration delivers multiple co-benefits beyond carbon sequestration, including enhanced coastal protection against storms and sea-level rise (valued at hundreds of billions of dollars annually), improved fisheries productivity, biodiversity conservation, and sustainable livelihood opportunities for coastal communities.

- *Community Engagement*: Local communities should be engaged in conservation and rehabilitation of blue carbon ecosystems to ensure sustainable outcomes.

- *Carbon Finance Mechanisms*: There is a need to develop frameworks for blue carbon accounting and trading to unlock finance for conservation.

- *Regional Coordination*: Blue carbon policies should be coordinated at the regional scale, addressing the currently limited cooperation among countries.

- *Multiple-Benefit Approach*: Management should consider not only carbon sequestration but also biodiversity conservation, disaster risk reduction, and sustainable livelihoods.

- *Knowledge Gaps*: Critical scientific and methodological gaps remain, particularly in monitoring and assessment of blue carbon ecosystems.

6.15. A short Q&A followed the presentation:

Question/Comment	Speaker's Response
On the review result on maximum sustainable yield (MSY) for fisheries: The participant noted that the presentation mentioned the recommendation to incorporate	Mr. Guo explained that the graph showing the MSY issue was developed by the Institute of Fishery Research under China's Ministry of Agriculture and Rural Affairs. The presenter

maximum carbon sequestration, not just maximum sustainable yield, in fisheries management. The participant wondered why aquaculture was not included in this discussion.	acknowledged the participant's point that aquaculture development may now surpass capture fisheries in many regions and emphasized that this is an important consideration that should be factored into integrated assessments of blue carbon potential, not just focusing on wild-caught fisheries.
During the discussion, a participant mentioned an important finding from their recent research on the importance of seaweed farming . The research showed that the carbon deposition and sequestration occurring beneath seaweed farming areas can be considered as a form of blue carbon sequestration. The rate of carbon deposition under seaweed farming was found to match the levels seen in other blue carbon habitats like mangroves and seagrass beds. This means that the carbon sequestration benefits of seaweed farming, not just the carbon captured in the seaweed biomass itself, should be accounted for when evaluating the blue carbon potential of seaweed aquaculture. This is an important finding that should be acknowledged and incorporated into assessments and policies related to blue carbon and the role of seaweed farming in climate change mitigation.	
It's been emphasized that small island spaces are particularly vulnerable to climate change impacts. So there's a pressing need to integrate blue carbon economy and even finance. In our province, I also observed: many of these coastal communities are highly reliant	Mr. Guo used the example of a small coastal village in China to illustrate the importance of understanding the current capacity and not exceeding it, even when transitioning to new livelihoods. In this example:

on the coastal resource that gives them tangible results through fishing. But in certain cases, many of these communities are resistant to integrating some of the policies that lead to some reduction of their catch or fish catch. So how can we integrate, or are there any strategies that can lead to balancing the integration of the policies while at the same time they are not being reduced and that ecological perspectives are still in balance?	The village used to rely heavily on harvesting from the coastal fisheries. As the fishery resources became depleted, the villagers started turning to farming instead. The initial perception of the villagers was that more farming would lead to higher production and income. However, when outside scientific institutions visited the village, they advised the villagers to reduce their farming from 110 rows to 80 rows. After making this adjustment based on the scientific advice, the village saw an increase in both the quantity and quality of their harvest over the following years. Thus, without a good understanding of the current capacity of the ecosystem, exceeding that capacity through over-exploitation can lead to diminishing returns and less income in the long run.
If policies (presented in the discussion) are legally binding, what would be the sanctions of a country not following their international commitments?	I think this relates to the fundamental theory of international law. And I think that in international law, a state has a responsibility to fulfill the commitments they have made. At the same time, in many of the negotiations, you can see quite often the syntax mentioned “consistent with the national priorities and national circumstances”. Because the level of understanding the science capacity, availability of capacity of countries is different. And for some countries, development is a priority, so implementation of commitments is more flexible. An example raised was the submission of Nationally Determined Contributions (NDC) to the UNFCCC. While it is mandatory to submit the NDC itself, it is not binding to report on a specific time and countries are given enough flexibility to be able to submit when they are ready.
What can we do to support Indonesia in submitting their NDCs for blue carbon ecosystems?	In each country, there is a coordination mechanism when it comes to reporting on

Indonesia has not yet submitted its NDCs specific to blue carbon ecosystems. As an academic institution, what can we do to support this process?	Nationally Determined Contributions (NDCs) under the Paris Agreement. Different sectors are looked at, and the lead agency may vary. Using China as an example: ● At the global level, 78% of emissions come from the energy sector, so that is a major focus - areas like cement, transport, aviation. ● In the case of methane emissions from livestock in the agriculture sector in China, this contribution is around 90 million metric tons. ● The methodology for reporting on this falls under the agriculture ministry, but the lead agency coordinating the overall NDC is the Ministry of Ecology and Environment. In terms of reporting blue carbon ecosystems in coastal areas in China, while these are recognized as potential contributors to emissions reduction, there is no standardized inventory methodology. Different research papers provide very different estimates, sometimes varying by as much as 10 times. Thus, countries are very cautious in their NDC reporting, as there is a principle of "no backsliding" - commitments that cannot be reduced/avoided later. To address this, it was suggested that there is a need for a few pilot sites to test standardized methodologies, compare results, and develop more interoperable data in terms of measurement approaches.

How can we apply blue carbon management approaches to unique local habitats with different cultures? Each small area or small group within the habitat, every single habitat and ecosystem is unique. They each have their own identity and their own local culture as well, even just a little bit. It becomes difficult, especially when we try to apply the model broadly. Do you have any suggestions, or ideas we could also propose?	The physical management approaches and ecosystem-based approaches need to be socially acceptable and aligned with the local culture. Each small area or habitat has its own unique characteristics, culture, and local context. Applying a one-size-fits-all model broadly can be difficult. The importance of understanding the social acceptability and integrating the local culture when implementing physical management and ecosystem-based approaches was emphasized and it is suggested to take an approach that is tailored to the specific local context, rather than trying to apply a generic model across all habitats. The key is to ensure the management approaches are socially acceptable and integrated with the unique local cultures and identities of each small habitat or ecosystem.

7. Assessment and valuation of Blue Carbon Resources

7.1. The second session, which dealt with the assessment and valuation of blue carbon resources was led by Dr. Keita Furukawa, who focused on the topic of 'Blue Carbon Contributions'. The session addressed specific methodologies for assessing and valuing blue carbon resources, including modeling, trade-off analysis for ecosystem services, blue carbon credits and trade, and co-sharing/management mechanisms. Dr. Furukawa's presentation provided practical approaches to quantifying the carbon sequestration capacity of blue carbon ecosystems and determining their economic value.

7.2. The discussion focused on three main aspects of BCEs:

- **Ecosystem Services,** including assessment methods for carbon capture and storage in blue carbon ecosystems and economic valuation approaches for coastal ecosystem services
- **Blue Carbon Credits, Trade, and Contribution to National Financing,** focusing on a comparison of compliance carbon credits vs. voluntary carbon credits and carbon trade mechanisms specific to blue carbon ecosystems; and

- **Co-sharing and Management Mechanisms of Blue Carbon Ecosystems,** discussing integration of ICM and Blue-Green (B-G) linkages and stakeholder engagement and long-term process management.

7.3. **Key discussions**

7.4. Blue carbon ecosystems are considered to be the "forests at sea" that serve as new sinks of CO_2. These include seaweed and kelp beds, seagrass beds, tidal flats, and mangrove forests. These ecosystems sequester carbon through various mechanisms, such as photosynthesis (converting CO_2 to carbon in plant material), carbon trapping within plant structures (e.g. roots, barks), dissolved carbon in water, and long-term carbon storage in sediments ("remaining matter").

7.5. *Measuring Carbon Sequestration Rates*

- Calculating blue carbon sequestration requires understanding carbon capture rates and long-term storage (refractory carbon) for different ecosystems. For forest ecosystems, the carbon sequestration rate is based on the growth and biomass accumulation of the trees over time, which can saturate after 10-20 years.

- Blue carbon ecosystems like seagrasses, mangroves, and tidal flats have a more continuous carbon sequestration process, as the carbon gets stored in the sediments and soils over long time periods (100-1000 years).

- To calculate the carbon sequestration, the key is to measure the remaining "refractory" or recalcitrant carbon that gets buried and stored long-term, not just the total biomass production.

- For seagrasses and seaweeds, a portion of the carbon gets dissolved in the water during photosynthesis, and the remaining refractory carbon in the sediments needs to be quantified. For mangroves, the carbon sequestration is calculated based on the aboveground biomass growth over time, as well as the belowground root biomass and peat/soil carbon storage.

- Sequestration rates of seagrasses and seaweeds can be included in greenhouse gas inventory reporting, such as the case of Japan, which is the first country to report seaweed and seagrass carbon sequestration in their National GHG inventory to the UNFCCC.

7.6. ***Integrating Ecosystem Services Valuation:***

- Beyond just carbon sequestration, blue carbon ecosystems provide a range of other ecosystem services like water purification, coastal protection, fisheries support, tourism, etc. The Integrated Evaluation Method for Coastal Ecosystem Service

(IMCES) is one example of a comprehensive framework for economically valuing blue carbon ecosystems.

- To comprehensively value these ecosystems, a contingent valuation method (CVM) can be used, where the value is assessed relative to the cost of providing alternative infrastructure or services. In evaluating the value of seagrass bed restoration, for example, the comparative evaluation method involves asking local stakeholders to choose between restoring the seagrass or constructing a new road or water supply facility.

- This allows deriving the relative value that the community places on the seagrass ecosystem services compared to more tangible infrastructure. The valuation can then be integrated using a weighted approach to derive a holistic economic value for the blue carbon ecosystems.

- Other methods also include market price approaches, increased fish catch valuation, CO_2 capture/sequestration credits, and travel cost methodologies. Dr. Furukawa demonstrated how valuation approaches fit within the broader Blue Economy framework, encompassing foundations (environmental conservation, resource management), industries (fisheries, tourism), services, and sustainable society outcomes.

7.7. *Blue Carbon Credit Mechanisms*

- Dr. Furukawa distinguished between compliance carbon credits (government-run programs like the Clean Development Mechanism) and voluntary carbon credits (NGO-run programs like the Gold Standard).

- **Compliance Carbon Credits** are Government-mandated programs operating under official regulatory frameworks such as the UN Clean Development Mechanism (CDM), EU Emissions Trading System, and national cap-and-trade programs. These credits are used by companies to meet legally-binding emission reduction targets, have standardized verification protocols, typically command higher prices, and often operate at larger scales.

- **Voluntary Carbon Credits** are non-governmental programs like the Gold Standard, Verified Carbon Standard, and Climate Action Reserve that allow businesses and individuals to offset emissions voluntarily rather than to meet regulatory requirements. These tend to be more flexible, can accommodate smaller projects, often include stronger social co-benefits, and are more accessible for community-based initiatives.

- Different carbon offset programs use various labels for their credit units, such as Certified Emission Reductions (CERs) for CDM, Verified Emission Reductions (VERs) for the Gold Standard, and Climate Reserve Tonnes (CRTs) for the Climate Action Reserve.

- Compliance programs typically operate at national or regional levels (e.g., California Compliance Offset Program in the United States), while voluntary programs often have international scope (e.g., Verified Carbon Standard), offering different opportunities for blue carbon projects.

7.8. **Co-sharing and management of BCEs**

- **Hinase Case Study**: Dr. Furukawa shared the 30-year seagrass restoration success story from Hinase, Japan, documenting how seagrass area changed from 590 ha in the 1950s to just 12 ha in 1985, before restoration efforts increased coverage to 250 ha by 2015. The critical role of the Hinase Fisheries Cooperative Association (HFCA) was highlighted, with special mention of Kazuo Honda, former Chair of HFCA, who championed the restoration initiative.

- The initiative involved a systematic restoration process developed by local fishermen: flower shoots collection in spring, seed maturation through summer, seed selection, and sowing in autumn.

- **Cultural Value Addition**: The Bizen Satoumi-Satoyama Brand Committee was presented as an example of how blue carbon restoration can be linked to economic value creation through branded local products.
- Dr. Furukawa also emphasized the importance of scaling-up stakeholder participation, citing efforts in Japan where seagrass restoration expanded from initial fishermen-led efforts to broader community involvement, including students and the general public.

- Dr. Furukawa outlined a three-phase approach: awareness raising → collaboration → co-production, emphasizing that deeper engagement develops over time. He identified five key stakeholder groups essential for successful blue carbon management: government agencies, industries/corporations, NGOs, academia, and the public/local communities.

- He emphasized how these diverse stakeholders have varied interest and influence when it comes to managing BCEs, and that stakeholder engagements need to be tailored to address each stakeholders' specific priorities, while also balancing their interests. He also emphasized the importance of effective facilitation between "rights holders" (community members) and "duty bearers" (government agencies) as critical for successful co-management.

- Information and communication technology (ICT) and scientific research are also essential in supporting the governance process by providing evidence for decision-making.

8. Breakout session: Status of BCE Assessment in PEMSEA Countries

8.1. Following the lecture, participants engaged in a breakout activity to assess the current status of blue carbon ecosystems (BCEs) in their respective countries. The discussion focused on inventory status, assessment protocols, progress levels, capacity needs, and knowledge products available through PNLC member universities. This exchange highlighted significant variations in national approaches and progress across the region.

8.2. **Cambodia** reported being in early stages in BC development, with no specific policies for BCEs but they do have existing national policies on carbon emission control. The country has standardized methods for assessing mangroves, seagrass, and seaweed, though these appear to be primarily research-based rather than nationally mandated protocols. Mapping efforts are underway but not completed, indicating a foundational phase of BCE assessment.

8.3. **China** demonstrated more advanced progress, having developed group (stakeholder), sector, and industry standards for blue carbon storage accounting, including survey, accounting, and monitoring protocols currently being implemented. While China lacks comprehensive national mapping, significant work has been conducted on wetland assessment and provincial-level evaluations of blue carbon potential. The country's contributions to research are substantial, with published papers in Nature on sustainable development of global blue carbon and related economic benefits. China's progress is further evidenced by active carbon trading projects involving blue carbon.

8.4. **Philippines** has made significant strides in BCE assessment and policy development, with the National Mapping and Resource Information Authority (NAMRIA) completing nationwide mapping of mangroves and ongoing efforts for seagrass ecosystems. The country's Expanded National Integrated Protected Areas System (ENIPAS) Act provides legal protection for many blue carbon habitats, while the updated NDC explicitly includes blue carbon ecosystems in mitigation strategies. The Philippines has developed national protocols for blue carbon assessment through collaboration between the Department of Environment and Natural Resources (DENR) and academic institutions, with particular progress in mangrove carbon stock assessment. The University of the Philippines Marine Science Institute has been at the forefront of BCE research, producing comprehensive knowledge products on seagrass and mangrove ecosystems and contributing to regional capacity building. Despite this progress, participants noted challenges in sustained monitoring and local implementation capacity, especially in remote coastal areas.

8.5. **Vietnam** is advancing rapidly in policy development, with a Prime Minister-approved Net Zero program and research on blue carbon markets receiving high-level government support. The country aims to finalize its legal framework for carbon markets by July 2025, with a second phase planned to set emission quotas and identify pilot carbon credit projects. Vietnam has published a national action plan emphasizing wetland conservation and sustainable use, and is exploring innovative approaches such as AI solutions for

mangrove management. However, participants identified significant challenges in human resources, technology, and policy implementation monitoring.

8.6. **Indonesia** has made substantial progress on the policy front, with specific guidance on carbon valuation for mangroves and seagrass, GHG inventory methodologies, carbon trading handbooks, and national standards for GHG calculation. The country's assessment of mangroves is robust, though seagrass assessment remains largely confined to research settings. A notable challenge is the fragmented management of different BCE types across various ministries, complicating data consolidation. Indonesia has developed national maps for seagrass and mangrove above-carbon biomass scheduled for imminent launch, and is actively facilitating blue carbon efficiency projects in collaboration with the Ministry of Fisheries and UNDP Indonesia.

8.7. **Thailand** has focused primarily on mangrove and seagrass beds, though much of this work remains in independent research rather than coordinated national programs. The country's Marine Coastal Resources Promotion Act (2558 B.E.) provides some policy foundation, alongside commitments to international conventions including Ramsar and CBD. Thai researchers have established baselines on biodiversity, rehabilitation success, and biomass estimation, and have created systems for monitoring rehabilitated BCE health, though these efforts remain largely academic-led rather than institutionalized.

8.8. **Lao PDR**, despite being landlocked, reported ongoing work on wetland ecosystems, demonstrating the broader relevance of ecosystem-based carbon sequestration approaches beyond strictly coastal nations.

8.9. The breakout session discussions revealed that while scientific capacity and understanding are advancing across all participating countries, significant gaps remain in standardization, comprehensive mapping, institutional coordination, and systematic monitoring. Most countries identified similar capacity needs, including:

- Technical training for Blue Carbon methodologies
- Skills in data collection, analysis, and use of mapping software
- Workshop and training for wider groups of researchers
- Harmonization between universities/learning centers and local communities
- Carbon sequestration integration with marine biology & environmental science curriculum
- Funding and sustainability for programs

8.10. Several country-specific needs were also identified. For example, Vietnam (Da Nang University) mentioned the need to build capacity in Human resources, research & technology capacities, international collaboration and community outreach.

8.11. Indonesia (IPB University) identified the need for blue carbon market expertise for Southeast Asia, blue carbon expertise for policy and carbon trading, advanced lab analysis (like CHRL), remote sensing and technology resources.

8.12. Thailand (Burapha University and Prince of Songkla University) identified practical training for researchers new to BC topics, regional standardization, technical personnel (currently limited to 3-5 at Burapha University), better lab facilities. Some knowledge products were also identified, including research and publications from Thailand such as research on mangroves in Gulf of Thailand and Andaman Sea; biodiversity baseline studies; and biomass estimation; and China which have research publication through CDMI; national/provincial projects for wetlands assessment; and research on carbon density in tidal wetlands.

8.13. Common needs amongst all participants also showed several educational opportunities within the PEMSEA Network of Learning Centers::

- Existing curriculum for measuring BC mangrove and seagrass in some countries
- Internships & on-the-job training opportunities mentioned by PNLC
- Inter-university organizations could support capacity training for Blue Carbon sequestration

8.14. In general, key challenges identified from the workshop gleaned the following:

- On standardization of methodologies, there is a lack of unified national protocols and harmonized methodologies;
- There are limited technical personnel and expertise in blue carbon assessment within the Network;
- There is Insufficient funding for research, technology, and implementation;
- There is a need for better connection between universities, government agencies, and local communities;
- On Technology, there is limited access to advanced lab analysis, remote sensing capabilities amongst learning centers present in the training.

8.15. Based on the status presented, the participants identified PNLC's potential role in facilitating blue carbon initiatives, which include:

- Supporting capacity training through inter-university organizations;
- Sharing resources and funding amongst universities;
- Integrating carbon sequestration into relevant curricula;
- Accepting internships and on-the-job training for university students;
- Harmonizing protocols on blue carbon and aligning common initiatives; and
- Improving data availability for assessment

9. Blue Carbon Financing and Market Opportunities

9.1. In the afternoon session, Dr. Fururkawa shared the development of a blue carbon market and monitoring carbon credits using Japan's experience in establishing a blue carbon credit market through the Japan Blue Economy Association (JBE).

9.2. Japan possesses diverse coastal ecosystems with varied seagrass and macro algae species distributed throughout its coastline. These ecosystems are influenced by major ocean currents including the Kuroshio, Oyashio, Tsushima, and Liman currents, which create distinctive marine habitats. Various coastal views and ecosystems can be found across Japan, from the tidal flats of Ariake Bay to the diverse coastal areas of Iriomote Island, Kashiwa Island, Sendai Bay, Hinase in Okayama, and Hiranai Bay.

9.3. The Tokyo Bay case study illustrates the environmental challenges faced by Japan's coastal ecosystems, such as pollution due to industrial development. Legal frameworks such as the Water Pollution Prevention Act of 1970 established a framework for pollution control through Total Load Control (TLC) policies set by the Ministry of Environment, implementation by local governments, regulation of industrial wastewater, and guidance for small businesses and households.

9.4. Long-term monitoring data of Chemical Oxygen Demand (COD) levels from 1980 to 2002 showed significant water quality improvement. However, ecological data revealed that while water quality improved, fisheries production declined dramatically from the 1950s to 2000s, correlating with increased land reclamation activities that reduced natural habitat.

9.5. Japan has implemented several ecosystem restoration initiatives, including seagrass restoration through stakeholder networks in Yokohama City, Kanagawa Prefecture, Recovery of seagrass beds in artificial sandy beaches (documented from 2005-2008), Restoration programs that have enabled the return of key species like eel grass (Amamo) and created habitat for species such as bigfin reef squid.

9.6. These initiatives recognize the connection between security and sustainability across multiple dimensions: traditional (National Defense), economic (Business, Energy, Disaster), Social (Life, Health, Food), and Environmental (Ecosystem, Biodiversity, Climate).

9.7. Recognizing the importance of blue carbon ecosystems, the The Japan Blue Economy Association was established with several core objectives:

- Raising national awareness about blue carbon ecosystems
- Quantifying partners' Environmental, Social, and Governance (ESG) efforts
- Determining carbon dioxide sequestration potential of coastal ecosystems

9.8. The JBE developed a voluntary carbon credit authentication system (J-Blue Credit) involving three main stakeholders:

- **Credit Creators** (NPOs, Citizens):
    - Implementing sequestration activities through ecosystem restoration
    - Gaining financing and social recognition for sustainability initiatives
- **Independent Organization** (JBE):
    - Providing certification, registry, guidance, and knowledge sharing
    - Ensuring publicness and neutrality in the credit system
- **Credit Buyers** (Private Companies):
    - Making commitments to reduce CO_2 emissions and support action
    - Gaining Corporate Social Responsibility (CSR) and branding benefits

9.9. The J-Blue Credit certification follows a four-step procedure:
- **Application**: Preliminary consultation, research, and submission
- **Judging and Certification**: On-site inspection and review
- **Administration**: Credit registration, issuance, and transfer procedures
- **Credit Utilization**: Carbon offset procedures

9.10. The system has shown significant growth since its inception. From minimal activity in 2020-2021 the system has now credited approximately 60 cumulative projects by 2024. Furthermore, cumulative certified carbon volume has reached nearly 9,000 t-CO_2 by 2024.

9.11. Multiple blue carbon projects have been implemented across Japan, including stakeholder cooperation networks in Yokohama, tidal flat restoration in Yamaguchi, habitat creation in canals in Hyogo, and utilization of coastal structures in Kita-Kyushu. Each project utilizes appropriate monitoring methods to verify carbon sequestration, including grid-based monitoring systems for seagrass beds and detailed habitat mapping techniques.

9.12. Dr. Furukawa also outlined market dynamics in the implementation of J-Blue Credit.

9.13. In the case of suppliers (credit creators), several priorities for market improvement have been identified, including:
- Expanded publicity for application opportunities
- Better utilization of credits for emissions reporting
- Extended application periods
- Online procedures to simplify participation
- Simplified certification processes

9.14. Surveys of credit buyers revealed their primary motivations, including preference to support activities in their local area, or organizations with existing relationships with respective credit buyers. Knowledge of specific projects, direct/indirect involvement, awareness-raising about decarbonization and initiatives in sustainability reporting have also been identified as areas of interest.

9.15. Japan's experience with blue carbon ecosystems and the J-Blue Credit system demonstrates how voluntary carbon markets can support coastal ecosystem restoration while creating economic benefits. The approach balances environmental, social, and economic concerns through a structured certification system that connects local restoration activities with corporate sustainability goals. For coastal managers, the Japanese model offers valuable insights into developing blue carbon initiatives within an ICM framework, particularly regarding stakeholder engagement, project certification, and creating economic incentives for ecosystem protection and restoration.

9.16. The success of the J-Blue Credit system shows that local ecological restoration can be effectively linked to broader climate goals and corporate sustainability needs through properly designed carbon credit mechanisms.

9.17. **Q&A**

Question/Comment	Speaker's Response
On carbon credit awarding in J-Blue. About the auction process - who obtains the auction and how the winners are categorized?	The auction is one way of selling the carbon credits, but they also use other methods like dividing the total credits and distributing to multiple applicants. In the auction, everyone can apply and the highest bidders get the credits. They tried the auction initially, but found issues with larger companies outbidding the intended local stakeholders. So they are exploring other mechanisms like fixed pricing and lotteries to distribute the credits more equitably.
How do you evaluate the ecosystem and engage stakeholders before setting up the application process?	The priority is to facilitate the local community action and stakeholder engagement first, before going through the formal application process. The community formation, vision setting, and actual rehabilitation/restoration work comes first. The application to the certification body (JBE)

	is a secondary step, to get the credits for the work already done by the local stakeholders. The preliminary consultation with JBE is to ensure the application aligns with their priorities, not just for obtaining credits.
How do you motivate companies to invest in the blue carbon projects, beyond just tax incentives?	Many companies are interested in supporting the local activities and environmental education for their employees, rather than just seeking tax benefits. The priority is to find companies aligned with the local restoration goals, rather than those just looking for offsets or credits. The mutual selection process between the project creators and companies is important - both sides need to find value in the partnership. Allowing flexibility in the certification process also helps engage a wider range of companies.

DAY 3

10. Overview of the Status of Blue Carbon Science in the Region

10.1. This session provided a comprehensive overview of the current state of blue carbon science across South and Southeast Asia, with particular focus on mangrove forests and seagrass meadows. Dr. Milica Stankovic of Prince Songkla University presented key findings from her regional research published in 2023, titled "Blue carbon assessments of seagrass and mangrove ecosystems in South and Southeast Asia: Current progress and Knowledge gaps" highlighting significant data gaps and opportunities for improved blue carbon assessment and management within Integrated Coastal Management (ICM) frameworks.

10.2. Key findings:

10.3. ***On research distribution and intensity***: A total of 140 study locations have been documented across both ecosystems in the region. Research intensity is highly variable with notable concentration in:

- Mangroves: India (162 studies), Indonesia (109 studies), Malaysia
- Seagrass: Thailand (29 studies), Indonesia (31 studies)

10.4. Most research has focused on mangrove blue carbon, with limited data available for seagrass ecosystems, especially in countries like Bangladesh, Sri Lanka, and Timor-Leste. In addition, seagrass data is missing in majority of the countries across the region.

10.5. ***On carbon stock assessment***:

10.6. Mangrove forests were found to have the highest documented carbon stocks, with Indonesian mangroves accounting up to 1,528.8 Mg/ha, and India and Philippines accounting for up to 1,301.48 Mg/ha.

10.7. Significant data on living biomass exists for most countries. However, sediment carbon data remains unavailable for Brunei, Timor-Leste, Bangladesh, Cambodia, Malaysia, Myanmar, Sri Lanka, Vietnam.

10.8. As for seagrass Meadows, the highest documented carbon stocks were recorded in India (up to 275.88 Mg/ha) and Thailand (up to 208.95 Mg/ha). Data is largely limited to a few countries (India, Thailand, Malaysia, Singapore, Indonesia) and there are significant gaps in biomass and sediment data for most countries.

10.9. ***On carbon sequestration rates***:

10.10. There are significant gaps in data on carbon sequestration rates and greenhouse gas emissions for both mangrove and seagrass systems. This indicates a major data gap, as carbon sequestration rates are crucial for quantifying the carbon additionality in blue carbon projects and crediting.

10.11. Mangrove Forests were found to exhibit the highest rates, with Indonesia (up to 1,722 g/m²/yr), Thailand (up to 1,263.3 g/m²/yr). However, data remains unavailable for multiple countries including Brunei, Cambodia, Myanmar, Philippines, Sri Lanka.

10.12. On the other hand, seagrass Meadows have very limited data available, with only Thailand recording up to 3.09 g/m²/yr sequestration. No sequestration rate data for most countries in the region.

10.13. The capacity and skills to measure carbon sequestration rates, especially for seagrass ecosystems, are still lacking in many countries in the region. The methods to extract and analyze seagrass carbon sequestration samples are more complex compared to mangroves, posing technical challenges. In addition, many countries have to send their samples to laboratories outside the region, like in Australia, which creates logistical and financial barriers.

10.14. Without robust carbon sequestration data, it is very difficult to develop effective blue carbon projects and access carbon financing mechanisms. Improving the data on

carbon sequestration rates was highlighted as a high priority to support the growth of blue carbon initiatives in the region.

10.15. There is a need to enhance regional collaboration and capacity building programs to train local researchers on the methods. These may include establishing regional or national laboratories and databases to centralize and share the carbon sequestration data, integrating traditional ecological knowledge of local communities to complement scientific data collection, and securing long-term funding to sustain monitoring and research on carbon sequestration in blue carbon ecosystems.

10.16. ***On GHG assessment***

10.17. CO_2 flux data is missing for multiple countries (Bangladesh, Brunei, Cambodia, Sri Lanka, Timor-Leste). Additionally, CH_4 flux data remains largely unavailable across both ecosystems in most countries. This presents a critical gap in comprehensive greenhouse gas assessments.

10.18. Many countries have little to no field-verified data on seagrass carbon stocks, sequestration rates, and greenhouse gas emissions. This data gap hinders the ability to develop effective blue carbon projects and policies for seagrass conservation and restoration.

10.19. ***Data quality and methodologies:***

10.20. For mangrove forests, majority of the countries have high-quality carbon data. Global mapping approaches with high-resolution data are available, but national-level remote sensing approaches remain scarce.

10.21. However, for seagrass meadows, Only some countries have high-quality data. There is also limited high-quality organic carbon stock data and significant methodological gaps in assessment techniques.

10.22. The quality of available data varies greatly, with only some countries having high-quality data that follows standardized protocols. Many countries still use cheaper but less reliable methods like wet oxidation for carbon analysis, leading to over or underestimation.

10.23. Standardizing data collection methodologies across the region was highlighted as an important step.

10.24. For methodologies, it was noted that remote sensing was used in only 27 studies (21 for mangroves, 6 for seagrass). Other technologies employed included satellites (most common), drones, and LiDAR and sonar (least common)

10.25. Methods were primarily focused on spatial changes in mangrove ecosystems. Temporal monitoring was also mostly limited to mangroves, with only a single study on seagrass.

10.26. ***Implications for ICM Implementation***

10.27. Data Gaps: The significant disparity in data availability across countries and ecosystems requires targeted research initiatives to support evidence-based ICM planning.

10.28. Methodological Standardization: The varied assessment approaches highlight the need for standardized blue carbon assessment methodologies to enable regional comparisons and policy development.

10.29. Technology Transfer: Limited use of advanced technologies (particularly for seagrass monitoring) presents an opportunity for capacity building and technology transfer across the region.

10.30. Ecosystem Differences: The more developed state of mangrove carbon science compared to seagrass indicates a need for balanced ecosystem attention in blue carbon initiatives.

10.31. Global/Regional Estimates: Caution should be exercised when applying global or regional carbon estimates, as these often over/underestimate actual carbon stocks for specific locations.

10.32. A short Q&A followed the presentation:

Question/Comment	Speaker's Response
On seagrass research: What methodologies are used to analyze the sediment? In Indonesia, LOI is not reliable for seagrass.	We use LOI, but we also have a CHN analyzer and have developed our own equations. The methodology and comparison of CHN and LOI results are included in our research.
On funding: Is there any BC funding for mapping activity? We can do this online.	There are some grants that include habitat mapping, but they are not long-term. We usually incorporate habitat mapping into broader grant proposals. Some grants also focus on technology development, integrating innovations such as satellite imagery and local/traditional knowledge.
When we study underground storage in seagrass, how deep should it be?	The standard depth is 1 meter. However, in some sites, you may not be able to reach that depth. In such cases, you sample as deep as possible—up to the point of refusal, such as rock-bottom.

10.33. This was followed by a seatwork activity using Mentimeter where participants were asked to rate and rank various aspects of blue carbon management in their respective countries to systematically assess and compare the status of blue carbon management

across the different countries represented in the workshop. The activity sought to identify the relative strengths, weaknesses, and gaps of learning centers in terms of working on blue carbon accounting.

Scenario/ Situation	Rate
Rate the urgency of collecting local field-verified data in seagrass meadows in your region	4/5
Rate how well the available BC data supports effective decision-making in your country	3.6/5
Rank the following methodologies based on how urgently they need development in your country for collecting carbon stock data. 1: field sampling methodologies 2. Remote sensing 3. Laboratory analysis 4. Capacity. 5. Other	No rating in the notes
Rate how effectively remote sensing is utilized in your country for monitoring BC ecosystems	3.9/5
Rate the current capacity within your organization/country to conduct or contribute to long-term (temporal) BC research	3.1/5
Rank the following challenges for longterm monitoring and remote sensing in your region from most to least significant (1 most significant challenge, 5-least significant):	1. Funding limitations 2. Lack of national priority 3. Technical expertise in remote sensing 4. Lack of long-term data 5. infrastructure
Rate the effectiveness of current methods used in your country to monitor spatial variability of BC ecosystems	3.7/5
Rank the following challenges to collecting and analyzing ecosystem variability data at the national level, from most to least significant (0: most significant, 5:least significant):	1st: data integration and management 2nd: technical expertise 3rd: financial resources 4th: data accessibility 5th: interpretation skills

10.34. Results of the activity showed that high priority was given to collecting field-verified seagrass data and utilization of remote sensing for monitoring blue carbon ecosystems. Moderate satisfaction was seen in the effectiveness of available data for decision-making and organizational capacity for long-term blue carbon research.

10.35. The activity was followed by a needs identification exercise where using metacards and prioritization stickers (pink for urgent but potentially less feasible items, green for both urgent and feasible), participants identified key needs across four blue carbon components: remote sensing and technology, data collection and field, collaboration and funding and capacity and skills. (The items are listed according to priority and feasibility ranking.)

10.36. Remote Sensing and Technology

- Remote sensing equipment
- Facilitating access to gain more easily satellite data and imagery for analysis and remote sensing
- Computer simulation
- Training/Workshops
  - Training on image interpretation
  - Training on image interpretation
  - Regional training for latest technology
  - Organize workshop about technical process of remote sensing data
  - Training for blue carbon on tidal flats
  - Workshop for remote sensing
  - Training and understanding
  - More training courses for remote sensing and also sampling data
  - Training on remote sensing and technology (Indonesia): (1) hard to define what seagrass meadow is (2) need data for how large area of seagrass meadow in each area

10.37. Data Collection and Field

- Training on carbon stock
- Impart knowledge to local people/fishermen/students in local for help collect monitoring data
- Create global /community data contribution portal
- (1) Inconsistent carbon stock measurements, (2) lack of carbon sequestration data
- Develop methods to estimate biomass and carbon storage / budgets for each habitat
- Include factual associates in estimates/carbon modelling
- Primary data collection location so far from our university. So, it has a high cost. Especially seagrass meadow ecosystem (Indonesia)
- A standardized methodology for data collection
- Citizen Science app for data collection and mapping
- Piston corer, biomass analysis kit or methods

10.38. Collaboration and Funding

- Establish national fund to be specifically used for BC
- Collaboration for research work
- Open access database /centralized database on Corg stock and sequestration data
- Regional collaboration, like PEMSEA, APBON
- Online access data
- Provide longterm funding mechanism
- Setting up “blue carbon laboratories’ that can take in analysis of samples and data collected from the field
- Insufficient investment in BC initiatives (2) fragmented institutional framework
- Partner with local universities and national environmental agencies
- Partnerships among academe (local unis) and local government for data collection (LGU) and analysis (unis) for BC monitoring
- Setting up collaborators that really stay in the field work areas in the long-term
- Building network: setting up a long-term network
- Data-sharing
- Open data portal on spatial and temporal changes
- Set up a regional data sharing platform
- More centralized data storage/management in the country (PH)
- Establish a formal website to integrate different countries data and to make public easy to access or research
- Local government units need annual field analysis and surveys to be long-term data
- Like-minded meetings and collaboration
- Collaborate with staff in MPA
- Setting of research funding sources that the research team can access (eg organization) or society to establish the long-term support
- Open crowdfunding sources for seagrass or nature enthusiasts
- A network of coordinated study sites for each ecosystem (mangrove seagrass, salt marshes, seaweed, seaweed farms, tidal flats) with baselines of agreed parameters on MRV and fluxes
- Engage more young career professionals
- Lobbying for funding opportunities to the national government
- (Indonesia) Establish platform for BC data sharing among researchers and scientists (regional and local)
- (Indonesia) The number of experts on seagrass ecosystem is more than 30 people. We need to facilitate for all experts on BCE to contribute to NDC submission. The data is not managed well because not all data is published in international journals.

10.39. Capacity and Skills

- Our country needs capacity regarding sedimentation
- Equipment to support assessment on the carbon stock
- Below ground carbon data improvement

- Regional workshop on lab analysis especially on sediment analysis with CHNS analyzer
- Long-term training/course work to increase technical personnel in BC (ex. 1-month remote sensing training to fully grasp the methods/practice)
- Training on blue carbon crediting

- Training courses for scholars like INVEST, coding
- Workshop for sediment sampling for locals and university
- More regional hands-on lab techniques for BC
- Increase the budget for hiring people
- Local government unit need training to officer on carbon, data sharing
- Training and capacity building for educational institutions
- Provide funding for learning and skills development
- Partner with other countries or organizations to learn other advanced skills like annual training program
- Technical training
- Establishing an ad hoc national unit/structure as a nationally referenced institution
- Create expert community like Global Mangrove Alliance for seagrasses (Hao)
- (Indonesia) ‘So far so good’
  Clumped
- Regular training on best practice on blue carbon
- Traditional language
- Building the skills and knowledge transferring from generation to another gen by creating the national education research course or programs to build up this skill
- Need more training for local people to help the scientists in the long-term

10.40. The workshop findings highlight several critical areas for advancing blue carbon initiatives in the region:

- **Capacity Development**: There is a need to invest in comprehensive training programs focused on remote sensing, carbon stock assessment, and laboratory analysis techniques, particularly targeting local communities and officials.

- **Technological Infrastructure**: It is essential to address the urgent need for remote sensing equipment and support infrastructure while seeking cost-effective interim solutions through regional sharing programs.

- **Funding Mechanisms**: Establishing dedicated national funding streams for blue carbon initiatives and exploring innovative funding approaches including partnerships with the private sector should be considered.

- **Data Management**: Development of standardized methodologies and centralized, open-access databases to improve data integration, accessibility, and utilization for decision-making are essential.

- **Regional Collaboration**: Existing regional networks should be strengthened to facilitate knowledge exchange, resource sharing, and coordinated blue carbon monitoring efforts.

- **Community Engagement**: Expand involvement of local communities, fishermen, and students in data collection through targeted training and citizen science programs.

11. PEMSEA Regional Blue Carbon Accounting Methodology

11.1. The final session focused on an overview of the draft Regional Framework for Blue Carbon Accounting Methodology presented by Ms. Kristina Di Ticman, a consultant of the PEMSEA Resource Facility. The presentation established the significance of blue carbon ecosystems in climate change mitigation, reviewed existing accounting approaches across the Asia-Pacific region, and proposed a harmonized, tiered methodology to standardize carbon assessment practices. This framework aims to enhance the accuracy, credibility, and comparability of blue carbon measurements to support conservation efforts and facilitate access to carbon markets.

11.2. **Review of Existing Blue Carbon Accounting Approaches**

11.3. Ms. Ticman shared the findings of the comprehensive comparative analysis of blue carbon accounting methodologies currently implemented across the Asia-Pacific region and through international standards. This comparison revealed significant variations in approaches, highlighting the need for harmonization.

11.4. She compared the standards of six EAS countries: China, Indonesia, Japan, Philippines and RO Korea and Thailand alongside the Verified Carbon Standard (VERRA) across several factors: focus, GHG measured, ecosystem types covered, carbon pools, and carbon calculation methods.

11.5. VERRA employs a comprehensive approach covering multiple ecosystem types including tidal wetlands, seagrass meadows, mangrove forests, and herbaceous vegetation in wetlands. Measures all three major greenhouse gases (CH_4, N_2O, CO_2) and assesses five carbon pools (aboveground biomass, belowground biomass, litter, deadwood, and soil).

11.6. In comparison, Japan primarily focuses on carbon crediting for mangroves, tidal flats, seagrass, and seaweed aquaculture. Their standard uniquely includes submarine soil, deep sea organic matter, and seawater as persistent dissolved organic matter from algae measures only CO_2, employing weight per unit area and absorption coefficient methods.

11.7. On the other hand, RO Korea emphasizes reporting and inventory rather than carbon crediting and covers tidal marshes, seagrass meadows, and coastal wetlands. Their

standard measures all three GHGs (CH_4, N_2O, CO_2) and employs both gain-loss and stock-difference methods for carbon assessment.

11.8. China's national standard focuses on monitoring and management of mangroves, seagrass, coastal salt marsh, and aquaculture systems However, Xiamen University has also developed a system specifically for mangroves with carbon crediting as primary focus. Both standards measure all three GHGs and use various calculation methods including profit and loss, treasury difference and burial rate techniques.

11.9. Indonesia on the other hand emphasizes national GHG inventory and reporting for mangroves and seagrasses. Their standard measures CH_4 and CO_2 but not N_2O and employs geometric methods and allometric equations for biomass estimation.

11.10. The Philippines focused on conservation and monitoring of mangrove and seagrass ecosystems. Their standard measures only CO_2, with less emphasis on other greenhouse gases and uses allometric equations and loss-on-ignition methods for carbon assessment.

11.11. Thailand has the T-VER (Thailand Voluntary Emission Reduction), its standard framework for mangrove carbon crediting and the T-VER Premium, an enhanced version that includes both mangroves and seagrasses. These standards use various methods including mean annual increment calculations, stock-difference methods, and root-shoot ratio models

11.12. The study showed key variations in the different countries' approaches. In terms of focus, VERRA, Japan, China and Thailand emphasize marketable carbon credits, national inventory frameworks such as that of Korea and Indonesia focus on reporting and compliance with national commitments. On the other hand, the Philippines prioritizes ecosystem protection over carbon market participation.

11.13. In terms of GHGs measured, comprehensive approaches (VERRA, Korea, China) measure all three major GHGs: CH_4, N_2O, and CO_2 while other countries with simplified approaches (Japan, Philippines, Thailand T-VER) measure only CO_2, potentially underestimating total climate impact.

11.14. Most frameworks include mangroves as the primary blue carbon ecosystem, while more comprehensive approaches (VERRA, Japan, Korea, China-MNR) include additional ecosystems like seagrasses, salt marshes, and tidal flats. Emerging interest in aquaculture systems (Japan, China-MNR) represents an expanding frontier in blue carbon accounting.

11.15. Variations in which carbon pools are included significantly impact overall carbon stock estimates. Most frameworks include aboveground biomass, belowground biomass, and soil organic carbon. More comprehensive approaches (VERRA, Thailand T-VER Premium) also include deadwood and litter. Specialized pools like submarine soil (Japan) reflect unique national priorities and ecosystem characteristics.

11.16. Calculation methods for blue carbon accounting fall into three principal categories. Stock-based approaches include total stock measurements for baseline assessments, stock-difference methods to track temporal changes, and stock loss calculations to quantify carbon released through ecosystem degradation. Process-based approaches examine carbon dynamics through gain-loss methods that track carbon flows and burial rate calculations that measure long-term sediment sequestration. These methodologies are implemented using various technical measurement techniques including loss on ignition for organic content determination, CHN elemental analysis for precise carbon quantification, allometric equations for biomass estimation from tree dimensions, and biomass expansion factors to convert partial measurements to total ecosystem carbon. This methodological diversity reflects both the complexity of blue carbon ecosystems and the need for approaches tailored to specific contexts and resource constraints.

11.17. The comparative analysis showed that several challenges impede standardized blue carbon accounting, including methodological variability, inconsistent data collection practices, lack of cross-regional standardization, poor integration with existing carbon markets, and limited technical capacity in some jurisdictions.

11.18. As such, PEMSEA has developed a draft regional framework to address these challenges in blue carbon accounting through a pragmatic, tiered approach. The purpose of a harmonized regional blue carbon accounting protocol is to be able to facilitate cross-border carbon crediting. To have a common technical foundation for a blue carbon certification system, it has to give a credible or science-based certification across the countrieswherein the methods would have to be comparable.

11.19. The tiered implementation strategy accommodates different capacity levels: Tier 1 (Basic) features minimal field measurements, low-resolution imagery, and simplified error analysis suitable for resource-constrained settings; Tier 2 (Intermediate) introduces expanded measurements, drone-supplemented imagery, and more sophisticated statistical analysis; while Tier 3 (Advanced) employs high-precision site-specific data collection, LiDAR technology, and comprehensive Monte Carlo simulations for uncertainty quantification.

11.20. Carbon stock assessment methodologies are standardized across key carbon pools: Aboveground Biomass (using allometric equations, biomass expansion factors, and selective destructive sampling); Belowground Biomass (through root-to-shoot ratios and direct sampling); Soil Organic Carbon (via soil coring, loss-on-ignition, and CHN analysis); and Deadwood/Litter (using volumetric approaches and decay correction factors).

11.21. Carbon sequestration measurement employs two complementary approaches: the Stock-Difference Method tracking changes over time through repeated measurements,

and the Gain-Loss Method calculating net sequestration by balancing carbon inputs (growth, accumulation) against outputs (harvesting, decomposition).

11.22. Implementation priorities include finalizing standardized protocols, establishing validation pilot projects, building technical capacity, developing supportive policy frameworks, and strengthening international collaboration to scale up blue carbon initiatives.

11.23. The proposed framework for blue carbon accounting offers a pathway to harmonize methodologies while accommodating varying levels of technical capacity and resources. By standardizing assessment approaches, the framework enhances the credibility of carbon estimates, facilitates integration with carbon markets, and supports the protection and sustainable management of vital coastal ecosystems.

11.24. Recommendations for advancing blue carbon integration include

- Finalizing standardized protocols with flexibility for regional adaptation
- Establishing pilot projects to validate methodologies across diverse sites
- Building capacity through training and knowledge transfer
- Developing supportive policy frameworks at national and regional levels
- Strengthening international collaboration for scaling up blue carbon initiatives

11.25. Q&A

Question/Comment	Speaker's Response
What are the specific competencies that the Blue Generation in East Asia should have?	The participants provided suggestions such as education, drone operation, understanding science-policy-program-action, capacity building, standards for capacity, and support for blue carbon capacity development.

12. Role of PNLC in Blue Carbon Program for the Region

12.1. The final workshop focused on identifying the PNLC's role in operationalizing the PEMSEA Blue carbon program. Prof. Dr. Yonvitner, the PNLC President, facilitated the session and emphasized the need to identify specific competencies required for the "Blue Generation" program in the East Asia region.

12.2. Participants were requested to provide inputs on metacards on the state of knowledge, policies, programs and actions related to blue carbon in their respective countries.

12.3. A Summary of the results of the workshop are shown below:

Core Competencies Needed	Participants' Inputs
Technical Knowledge and Skills	● Basic knowledge of blue carbon ecosystems and interdisciplinary skills formation ● Remote sensing methods, mapping and analysis skills ● Estimation modeling of blue carbon using RS-GIS ● Data collection and analysis competencies (field survey, lab work) ● Carbon accounting methodologies ● Scientific and technical expertise in marine science, oceanography, economics and accounting ● GIS and ecosystem service assessment ● Skills for handling large datasets
Policy and Governance Knowledge	● Basic knowledge of local, national, and regional policies ● Legal competency related to blue carbon ● Carbon markets and financial mechanisms understanding ● Policy design and transboundary collaboration expertise
Communication and Leadership	● Ability to communicate carbon data with local communities ● Leadership skills for curriculum design with suitable objectives ● Community empowerment approaches ● Holistic thinking (ecosystem approach) ● Problem-solving capabilities ● Marketing skills to promote projects for potential funding

12.4. Priority areas for development that PNLC can support were also identified.

Core Competencies Needed	Participants' Inputs

Blue Carbon Professional Development	● Develop blue carbon programs for the younger generation ● Foster collaboration between young professionals, experts, and communities ● Create a "Professional Blue Generation" with specializations in: ○ Blue Carbon Mapping ○ Blue Carbon Trading ○ Economic valuation and carbon pricing
Methodological Standardization	● Approved technologies for surveys and sampling ● Standardized methodologies for calculating carbon credits ● Carbon sequestration and biomass methods for seagrass, seaweed, bivalves, and invertebrates
Focus Areas for Conservation	● Mangroves, seagrass beds, and hotspot areas are priorities for conservation ● Areas that previously had mangroves and seagrass ● Need for simultaneous assessment approaches
Research and Education	● Faculty research capacity building ● Creating comprehensive understanding for students ● Addressing urgent gaps in knowledge ● Building blue carbon awareness in communities ● Theoretical research in blue carbon ecosystem science, restoration techniques, and monitoring tools

12.5. Participants also identified the existing resources that learning centers could leverage to support the Blue Carbon Program. Existing curriculum elements that can be enhanced as identified in the metacards include:

- Marine Spatial Planning (MSP) and Integrated Coastal Management (ICM)
- Ecosystem management
- Geospatial analysis
- Environmental economics
- Marine pollution and links to habitat protection and restoration

12.6. Implementation approaches identified in meta cards by participants that the PNLC could also utilize to support the program include:

- Disseminating information about a possible Southeast Asian Blue Generation initiatives
- Engaging the younger generation in learning about blue carbon, coastal resilience and habitat restoration
- Accessing funding for transboundary collaborative research to enhance global understanding of blue carbon
- Innovation in cross-cutting areas (AI, big data, communication)
- Filling gaps in blue carbon ecosystems accounting/measuring/monitoring by leveraging technology
- Understanding holistic connections from local context to global impacts

12.7. Detailed statuses of blue carbon initiatives per country, based on efforts of their respective learning centers may be found in Annex 5 of the document.

13. Poster Presentations

13.1. Several participants presented their respective studies on blue carbon through a poster presentation. Specific posters may be accessed in Annex 4 of this document.

14. Field Visit

14.1. Participants visited the SaenSuk Municipality building, where local representatives presented their initiatives on implementing ICM and protecting blue carbon ecosystems using PEMSEA's ICM framework.

14.2. They shared their local efforts in rehabilitating and conserving mangrove areas in the Bangsaen municipality, as well as policies and frameworks established to mitigate pollution in tourist areas such as Bangsaen beach.

14.3. Afterwards, participants visited a rehabilitated mangrove sanctuary where they were able to see firsthand the local efforts in protecting these ecosystems.

15. Closing of the workshop

15.1. The workshop was formally closed during the closing dinner where Dr. Brian Szuster, Dr. Wansuk Senanan and Dr. Yonvitner expressed their appreciation for the participants' active engagement in the training and thanked the speakers for sharing their time and expertise.

15.2. **Several participants, including Ms. Alin Rahmah Yuliani of CCMRS, IPB University, Ms. Lin Xinying of Zhejian University and Kingsley John De Los Santos of UP Visayas were also asked to share their thoughts on the training, wherein they expressed their appreciation for the knowledge that they gained and the networks that they built with their other colleagues.**

Annex 1. Provisional Program

SCHEDULE OF THE TRAINING PROGRAM

Provisional Program of Activities

Time	Activity	Speakers/Presenters
DAY 1: 25 March 2025		
I. Opening Program		
0900 – 0915	**Welcome Remarks** **Opening Remarks**	**Dr. Wansuk Senanan** Burapha University **Woranop Sukparangsi** Vice Dean, Faculty of Science Burapha University **Dr. Brian Szuster** University of Hawai'i at Manoa **Prof. Dr. Yonvitner** President PEMSEA Network of Learning Centers (PNLC) / IPB University
0915 - 0930	**Introduction to the course** ● Introduction of participants ● Objectives and expected outputs ● Training topics and workshop process ● Group photo	**Ms. Isdahartatie** PNLC Secretariat
II. Understanding Climate Change and the Role of Integrated Coastal Management (ICM)		
0930 – 1030	Climate Issues on Coasts and Oceans and ICM Role in addressing the issues - Climate Issues and its impacts (ecological, economic, and social) on coasts and oceans - ICM Concept, Principles and Framework	**Dr. Brian Szuster** University of Hawai'i at Manoa
1030 - 1045	Coffee break	
1045 - 1200	ICM Implementation in Indonesia	**Prof. Dr. Yonvitner**, IPB University
1200 - 1300	Lunch break	
1300 - 1430	Climate Adaptation and Mitigation through Blue Carbon Ecosystems	**Dr. Keita Furukawa** EAS Partnership Council, PEMSEA

	• Understanding Blue Carbon: Science, Concepts, Principles, Role in Climate Change Adaptation and Mitigation
	• Blue Carbon and ICM as a Management Framework
	  • Policy, Strategies and Plans
	  • Institutional Arrangements
	  • Legislation
	  • Financing
	  • Information and Public Awareness
	  • Capacity Development	

1430 - 1445	Coffee Break	
1445 - 1545	Blue Carbon Financing and Market Opportunities: World Bank Experience on Innovative Blue Financing and Seascape Management	**Ms. Waraporn Hirunwatsiri** Environment and Natural Resources Unit, World Bank
1545 – 1645	Facilitated discussion or workshop on the state of BC efforts in the countries/local areas	Moderator: Dr. Brian Szuster
1645 - 1700	Wrap Up	
1800	Dinner	
DAY 2: 26 March 2025		
III. Legal Framework for Blue Carbon		
0830 – 0840	Recap of previous day's highlights and introduction to Day 1 activities	**PNLC Secretariat**
0840 – 1000	Developing an Enabling Legal and Policy Framework for Blue Carbon in the South East Asian Region for Synergistic Implementation of Multilateral Environmental Agreements (MEA)	**Mr. Yinfeng Guo** National Marine Hazard Mitigation Service (NMHMS)-Ministry of Natural Resources (MNR), China
1000 – 1015	Coffee Break	
IV. Assessment and valuation of Blue Carbon Resources		
1015 – 1115	Blue Carbon Contributions • Ecosystem services (modeling and tradeoffs analyses) • Blue carbon credits, trade, and contribution to national financing • Co-sharing and management mechanisms of blue carbon ecosystem	**Dr. Keita Furukawa** EAS Partnership Council, PEMSEA
1115 – 1200	Facilitated discussion: examples, gaps, needs, how are BCEs valued in countries: status, tools, etc.	Moderator: Mr. Yinfeng Guo
1200 - 1300	Lunch Break	
V. Blue Carbon Financing and Market Opportunities		

1300 - 1400	Blue Carbon Financing Options ● Types of Financing Options for Project Development and BC Conservation, Restoration, and Management ● Carbon Credits and Developing BC Market: Japan Experience	**Dr. Keita Furukawa** EAS PC, PEMSEA
1400 - 1500	Facilitated discussion: What are available financing options in countries/areas? What is the status of carbon trading in countries? Evaluation of blue carbon contribution to NDC and Global Commitment	Moderator: Dr. Keita Furukawa
1500 – 1515	Coffee Break	
1515 – 1545	Stories from the Field	Participants
1545 - 1600	Wrap Up day2	
DAY 3: 27 March 2025		
0830 – 0840	Recap of previous day's highlights and introduction to Day 2 activities	PNLC
0840 - 0940	Overview of the Status of Blue Carbon Science in the Region	**Dr. Milica Stankovic** Prince of Songkla University
0940 -1000	Coffee Break	
VI. PEMSEA Regional Blue Carbon Accounting Methodology		
1000 – 1100	Presentation of Regional Framework for Blue Carbon Accounting Methodology ● PEMSEA Blue Carbon Roadmap ● Presentation of Regional BC Accounting Methodology	**Ms. Kristina di Ticman** PEMSEA Resource Facility
VII. Role of PNLC in Blue Carbon Program for the Region		
1100 – 1200	Workshop: PNLC Role in Blue Carbon Program for the Region ● Gaps and Needs in SEA and Areas for PNLC Work (Capacity development, technical assistance, carbon accounting, information and knowledge sharing, etc.) ● Challenges ● PNLC Needs to provide support to the region ● Action Points	**Prof. Dr. Yonvitner** PNLC President/BC TWG
VIII. Field Visit		
1200 – 1215	Orientation on field visit	**Burapha University**
1215 – 1330	Lunch break	
1330 – 1630	Field Visit to Local Site	Saensuk Municipality and Local Mangrove Area
1630 - 1800	Rest	
1800	Dinner and Closing	
PEMSEA Blue Carbon Technical Working Group Meeting (hybrid)		

March 26: 1615-1700	BC TWG Meeting (hybrid: by invitation)	

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Annex 2. List of Participants

No	Name	Organization
1.	Precioso Catherine	De la Salle Lipa
2.	Aldea Kristian	Catanduanes State University
3.	Shenghui li	Guandong University
4.	Dr. Rongjie Zhao	SKLMP
5.	Oliveira Soares Walter	UNTL
6.	KINGLATTANA Latsamee	NUOL Laos
7.	Ngo Thuy Hao	COMI
8.	De Araujo Elio	UNITAL
9.	Lin Xinying	Zhejiang University
10.	Galera Jesse Jan	Xavier University – Ateneo de Cagayan;
11.	Alin Rahmah Yuliani	CCMRS
12.	Mega Nathasa Indah	CCMRS
13.	Prahandhy Kusuma Novian	UNDIP
14.	Creencia Glenn Bryan	De la Salle University
15.	Kingley John De Los Santos	UPV
16.	Leopardas Venus	Mindanao State University at Naawan,
17.	Dharma Kwarista	UNUD
18.	Dr. Chanh	Danang
19.	Isdahartatie	PNLC Secretariat
20.	Maida Aguinaldo	PRF
21.	Abigail Cruzada	PRF
22.	Kristina Di Ticman	PRF

23	Dr. Cherdsak Virapat	Regional Director for Asia, The International Emergency Management Society (TIEMS)
24	Mrs. Pongsri Virapat	Coordinator for Thailand, Pacific Disaster Center (PDC)
25	Dr. Nutcharin Kaewklah	Faculty of Science, BUU
26	Dr. Anukul Buranaprateprat	Faculty of Science, BUU
27	Dr. Narinratana Kongjandtre	Faculty of Science, BUU
28	Dr. Nittaya Chaiyanate	Faculty of Science, BUU
29	Dr. Janjarus Watanachote	Institute of Marine Science, BUU
30	Ms. Ratima Karuwancharoen	Institute of Marine Science, BUU
31	Ms. Nisakorn Wiwekwin	Saensuk Municipality
32	Ms.Chalatip Junchompoo	Department of Marine and Coastal Resources
33	Mrs. Apaporn Siripornprasarn	Department of Marine and Coastal Resources
34	Mr.Sumet Thongdon-um	Department of Marine and Coastal Resources
35	Mr.Tamanai Pravinvongvuthi	Department of Marine and Coastal Resources
36	Director of the Coordinating Center for Research and Innovation on Blue Economy	
37	Mr. Supajet Muranart	Graduate Student, Faculty of Science, BUU
38	Ms. Thita Nachan	Graduate Student, Faculty of Science, BUU
39	Ms. Sumonrat Chairat	Graduate Student, King Mongkut's University of Technology
40	Ms. Sujata Regmi	Graduate Student, King Mongkut's University of Technology
41	Mr.Uday Simple	Researcher, King Mongkut's University of Technology
42	Ms. Achiraya Lunarit	Graduate Student, Faculty of Science, BUU
43	Ms. Winranwtsiri	
44	Ms. Siayata Regmi	

45	Mr. Udoy Pimple	
46	Mr. Hatim Albasri	
47	Ms. Netchorin	
48	Dr. Noyhacha Changphet	
49	Mr. Amukul Buramapratheprat	
50	Mr. Woranop Sukparangsi	
51	Ms. MitSopharnadee Muangham	
52	Mr. Supattra Muangham	
53	Mr. Supajet Mueanart	
54	Ms. Achiraya Luanrit	

Annex 3. Speakers

Dr. Brian Szuster

Associate Professor, of Geography University of Hawaii

Dr. Brian Szuster Associate Professor, of Geography University of Hawai with expertise in Aquaculture management, shrimp farming, community supported fisheries and aquaculture, marine and coastal tourism, environmental impact assessment roles within Hawai University and has actively participated in national and International working groups and projects related to Climate Change Adaptation for Fisheries and Aquaculture, Management Issues at West Hawai'i Manta Ray Dive Sites, Marine Recreation at the Molokini MLCD, Coastal and Estuarine Land Conservation Plan for Hawai', Small Island Planning in Thailand, Coastal Society of Hawai.

Prof. Dr. Yonvitner

President, PNLC and Director, CCMRS, IPB University, Indonesia

Prof. Dr. Yonvitner is the President of PNLC and the Director of CCMRS at IPB University in Indonesia, with expertise in integrated coastal management, fisheries management, and marine resource management. He has held numerous leadership roles within IPB University and has actively participated in national and subnational working groups and projects related to coastal management, seafood ecolabelling, and maritime investments. With a Ph.D. in coastal resources management and extensive research experience, Dr. Yonvitner contributes to the field through his work on marine pollution, fisheries biology, population dynamics, and coastal resource management.

Dr. Keita Furukawa

Technical Session Chair, PEMSEA

Dr. Keita Furukawa is the president of the NPO in Japan for Shore Environment creation that promotes civil science and stakeholder cooperative actions. He is acting as an environmental scientist and has practitioner with over 30 years of experience in coastal and marine-related research, policy formulation, education, and ecosystem conservation and restoration under his belt. His work focuses on integrated coastal management and blue economy, delving on the enclosed sea, seagrass beds, coral reefs, mangrove forests, tidal flats, and estuaries. He is also working as an Affiliated Research Fellow at one of PEMSEA's Non-Country partners, The Ocean Policy Research Institute of the Sasakawa Peace Foundation; and Affiliate Professor at Tokyo University of Marine Science and Technology and Tokushima University in Japan.

Previously, he was the Technical Session Co-Chair of the East Asian Seas Partnership Council; research coordinator at the National Institute for Land and Infrastructure Management of Japan; and visiting research fellow at the Australian Institute for Marine Science.

Waraporn Hirunwatsiri

Senior Environmental Specialist of the Environment and Natural Resources Unit of the World Bank

Waraporn Hirunwatsiri is a Senior Environmental Specialist of the Environment and Natural

Resources Unit of the World Bank. Waraporn has more than 25 years of experience in environmental management, environmental impact assessment and program monitoring at the national and international levels.

Waraporn joined the World Bank as an Environmental Specialist in August 2004. Based in Bangkok, she has worked and contributed to various projects and reports in Thailand on the environment, climate change, and carbon finance.

Currently, she is the team leader of the Partnership for Market Readiness (PMR) in Thailand project. In addition, Waraporn is an environmental safeguard specialist for various investment and community driven development projects across the East Asia and Pacific region. She has significant regional experience having worked in Thailand, Malaysia, Cambodia, Lao PDR, Myanmar and Vietnam.

Mr. Yinfeng Guo

Chief Expert for International Cooperation at the National Marine Hazard Mitigation Service, Ministry of Natural Resources of China

Mr. Yinfeng Guo currently holds the position of Chief Expert for International Cooperation at the National Marine Hazard Mitigation Service, Ministry of Natural Resources of China. He is the Chinese negotiator in COP 15 and 16 of CBD. In the past 36 years, he has dedicated himself to sustaining the wellbeing and benefits of people, biodiversity and ecosystems of China and East/Southeast Asia at national research institutes, governmental institutions, intergovernmental organizations and UN agencies. He has 14 years of programme management experiences with UN agencies, including services as Chief Technical Adviser and Manager of UNDP/GEF YSLME Phase II Project, Head of Partnership and Planning of the regional intergovernmental organization PEMSEA, and Programme Manager of UNDP China Office. He is recognized of his expertise in knowledge management, development aid evaluation, organizational development and other aspects of sustainable development in the areas of natural resource and coastal governance.

Dr. Milica Stankovic

Lecturer and Research, Prince of Songkla University

Dr. Milica Stankovic is a lecturer and researcher at the Dugong and Seagrass Research Station, Prince of Songkla University, in Hat Yai, Thailand. Her research focuses on understanding and enhancing the role of seagrass ecosystems as carbon sinks, particularly in Thailand and Southeast Asia. With extensive expertise in blue carbon, seagrass ecology, GIS, and coastal ecosystem mapping, she is committed to advancing nature-based solutions for climate change mitigation and promoting sustainable conservation practices.

Her current projects include advancing blue carbon research in the Southeast Asian region, assessing seagrass ecosystems, and developing international conservation frameworks. A key participant in global networks like the IOC Sub-Commission for the Western Pacific and the Global Ocean Decade Program for Blue Carbon, Dr. Stankovic also dedicates her efforts to capacity building, organizing workshops to boost expertise in coastal ecosystem management, and engaging communities in sustainable conservation practices.

Ms. Kristina Di Ticman
Partnerships in Environmental Management for the Seas of East Asia

Kristina Di Ticman is a Blue Carbon Specialist for PEMSEA (Partnerships in Environmental Management for the Seas of East Asia) with over five years of experience in remote sensing and GIS applications for environmental research. She has conducted a comparative analysis of blue carbon accounting methodologies in Japan, China, Korea, the Philippines, Indonesia, and VERRA protocols, identifying key gaps and harmonization opportunities. Currently, she is developing a framework to align these methodologies for a region-specific carbon crediting program in East and Southeast Asia. Kristina has previously worked on blue carbon projects and collaborated with regional scientific institutions to provide training and capacity-building initiatives. She is also connected with SIMSEA (Sustainability Initiative in South and East Asia), dedicated to sustainable management of marginal seas. Kristina holds a Bachelor's degree in Geodetic Engineering from the University of the Philippines and is pursuing her Master's in Geomatics Engineering.

Annex 4. Presentations, Photos and Poster Presentations

A. Presentations - Speakers Presentations
B. Photos - Workshop Photos
C. Posters - LINK

Annex 5. Detailed results of Breakout Session 1 (BCE initiatives status in the EAS Region)

Country	Inventory Status	Assessment Protocols	Progress	Capacity Needs	Knowledge Products
Cambodia	Limited information available Blue Carbon Mapping	N/A	N/A	Community empowerme nt • Local Natural Resource Management (Mangrove, Community Fisheries)	N/A
China	Industry standard of Blue Carbon Ecosystem established in 2023 Covers mangroves, salt marshes, seagrass beds, and carbon storage	Technical guidance in BCEs protection & restoration (2024)	Local initiatives in multiple provinces Shandong Weihai kelp Hebei bivalve Guangdong Mangrove Carbon Trading- Fujian Mangrove Restoration Jiangsu Salt Marshes Carbon Storage First BC trade project in Zhanjiang (2024)	Funding sources for basic research Technical assistance Climate-smart MSP guidance (in development)	CDMI: Research publications, wetlands assessment SKLMP: Research on Carbon Density, MPAs impact OC, ZJU: Papers on Sustainable Development GDOU: BC trade project documentation Bachelor: Sustainable ocean governance

					Master's: China-ASEAN ocean cooperation
Indonesia	Advanced framework for mangroves Developing framework for seagrass Carbon Valuation for BCEs (PP 98, 2021) National Inventory methods exist	Measurement Reporting Protocol Indonesia Carbon Trading Handbook Validation Method for GHG Calculation (SNI 7724, 2019) National KLHK registration system	Advanced for mangroves Limited for seagrass Working with UNDP on second ENDC	Blue carbon market expertise Policy and carbon trading skills PDD and GIS skills Advanced lab analysis (CHRL) Remote sensing technology Funding Regional data integration	Curriculum for BC measuring in mangrove/seagrass PDD for BC Project curriculum Forestry undergraduate programs Focus on seagrass as key knowledge area
Philippines	Internationally funded mangrove projects Limited seagrass projects National mapping initiatives	Published protocols exist but lack national standardization	Intermediate level National centralization/ standardizatio n needed	LGU capacity building Citizen science initiatives More funding and grants More expertise and technical practitioners PNLC support for inter-	Internships & on-the-job training Marine science programs

	No unified protocols			university training	
Thailand	Knowledge on ecology (2018-2026) Fragmented national policy 3,151 km coastline baseline Local-based initiatives Limited mangrove mapping	Various standards used No standardized management References to international conventions Coastal Resources Promotion Acts 2558 BE	Intermediate capacity Draft approaches Implementation in Gulf of Thailand and Phang Nga Limited seagrass research	Practical training for researchers BC methodology workshops Technical training in data collection Regional standardization More technical personnel Better lab facilities Grant writing skills Curriculum integration	Marine Science curricula Research on Gulf of Thailand mangroves Biodiversity, rehabilitation, biomass studies No specific BC degrees
Vietnam	Decision No. 232/QD.TTg for carbon market Two-phase implementation plan (2025+)	National Action plan (2021-2030) for wetlands Decree 66/2019 for wetland management	MANGROVES: AIMVIE Study (2023), UNDP+MARD initiatives • SEAGRASSES: Quang Tri Province	Human resources (Da Nang University) Research & technology capacities	Research publications Educational materials

			(2024) evaluation	International collaboration Community outreach	