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Blue Foods for Indonesia: A Human & Planetary Health Action Lab

Blue Carbon Ecosystems – Blue Foods Nexus:

Lessons Learned from Global Examples of Blue Carbon Ecosystems

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Executive Summary

As Indonesia develops its National Blue Food Assessment, it is critical to understand and facilitate synergies between the Blue Carbon Ecosystems (BCEs) and blue food nexus in policymaking. Targeting policy efforts towards improving the blue food / blue carbon nexus not only encourages the preservation of blue carbon ecosystems, which are critical to Indonesia's climate mitigation goals, yet also supports the livelihoods of coastal communities who depend on local blue food production. In this report, we highlight the critical intersections between BCEs and blue food production, emphasizing four key themes for maximizing the benefits of this nexus in a sustainable and equitable manner: community ownership, education, gender recognition and inclusion, and financing mechanisms. Through an analysis of global case studies and local initiatives from Vietnam, the Philippines, Ghana, The Gambia, Kenya, and Mauritius, this policy memo offers insights into a variety of strategies that can be used to reap the benefits from the BCE / blue foods nexus to drive sustainable development.

I. Introduction

In this critical time period as Indonesia is developing its Long-Term National Development Plan (National RPJPN) for 2025–2045 towards its vision of *Indonesia Emas*, or "Golden Indonesia," maintaining the sustainability of Indonesia's natural resources in the development towards that vision becomes increasingly important. Indonesia's commitments to international and national climate mitigation goals through the preservation of its BCEs while empowering coastal communities in sustainable blue food production present a key challenge and opportunity in working towards Indonesia's wide range of development goals.

In Indonesia, there already exists synergies and tradeoffs between BCEs, such as mangroves and seagrasses, and blue food production, such as fish or shrimp farming through integrated aquaculture projects.[1] By preserving mangrove ecosystems, these farms are able to support the community through increased productivity fish, shrimp, and crab farming while preserving mangrove ecosystems, thus assisting in achieving Indonesia's climate change mitigation goals while supporting coastal communities in accessing affordable sources of

[1] Basyuni et al. (2018). "Evaluation of mangrove management through community-based silvofishery in North Sumatra, Indonesia"

nutrition. In this policy memo, the BCE / Blue Food Nexus team outlines and draws connections from a wide variety of country-level, NGO, and community initiatives that promotes synergies between blue food production and BCE protection.

In this report, we outline four interconnected pillars that allow communities to capture the benefits of the BCE / blue foods nexus: community ownership, education, gender recognition and inclusion, and financing mechanisms. First, local communities are best positioned to drive blue carbon & blue foods projects as they have the greatest stake in their own local ecosystems and are uniquely placed to affect change. Without policies or initiative designs upholding community ownership, not only are those dependent on the BCE left behind, but valuable traditional ecological knowledge (TEK) remains underutilized. Second, education across all levels from local communities to policymakers can raise awareness, build capacity, and create an environment that facilitates genuine community ownership. Today, there are still gaps in knowledge and awareness at the government level, undermining creation of educational initiatives, and the community level, increasing the likelihood of BCE overexploitation. Third, through careful design of financing mechanisms that strengthen the BCE / blue foods nexus, these efforts can provide economically sustainable livelihoods for communities. Many previous efforts fail to consider the economic pressures that explain the local community use of the BCEs today, as well as focus on outside financing schemes like blue carbon projects that do not provide sufficient or sustainable sources of income. The government has a key role to play in ensuring future efforts integrate blue foods production systems rather than conflict with them, and in filling any financial gaps that remain. Fourth, the continued advancement of gender recognition and inclusion is critical for creating a fair and just system in the fisheries sector as well as promoting a healthier ecosystem. Despite their significant involvement, women are severely underrepresented in local governance and lack access to crucial benefits, such as health insurance and access to fishing licenses. Increasing women's representation and ensuring they receive benefits is not only a matter of equity but also enhances the effectiveness and sustainability of BCE / blue foods projects. When women are empowered and included in decision-making processes, their unique perspectives and experiences contribute to more comprehensive and resilient solutions. These gaps in community ownership, education, financing mechanisms, and gender inclusion, limit the effectiveness and sustainability of BCE / blue foods nexus. Protecting the BCE / blue foods nexus requires systematic integration within these four

pillars in management and policy making. By drawing on case studies from around the world regarding this area, effective strategies can be identified and utilized to address the persistent gaps in the status quo.

II. The Importance of the Blue Carbon / Blue Foods Nexus

Environmental degradation has historically accompanied economic development. Mangrove forests, seagrass meadows, and salt marshes—the three traditional BCEs—are no exception. All three ecosystems face significant pressure not only from climate change but also from anthropogenic threats. Coastal development, upstream pollution, aquaculture development, and overexploitation contribute to widespread loss of these three coastal ecosystems.[2] However, case study research reveals that economic development and social well-being must not always come at the cost of BCEs. In fact, the case studies demonstrate that the opposite may be possible: at the intersection of blue carbon and blue foods, the protection of BCEs and development of local livelihoods can strengthen and reinforce each other.

Since the development of the carbon market, BCEs have gained attention for their carbon sequestration services, as they serve as carbon sinks by fixing carbon into organic biomass. In addition to combating climate change by capturing carbon from the atmosphere, BCEs provide many other ecosystem services with both ecological and social benefits. In particular, the case studies highlighted in this report have revealed the potential of healthy BCEs—particularly mangroves—to support sustainable blue food production.

From a broad perspective, mangroves mitigate climate change and the impacts that come with it, such as rising temperatures and ocean acidification that detrimentally impact blue foods productivity.[3] Mangroves also serve as critical nursery habitats for many marine species, such as fish, crustaceans, and shellfish.[4] Mangroves offer shelter and breeding grounds where young organisms can grow safe from competitors, increasing their survival and reproductive rates.[5]

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[2] Reef Resilience Network, "Ecosystem Loss," *The Nature Conservancy*, 2024, https://reefresilience.org/management-strategies/blue-carbon/blue-carbon-introduction/ecosystem-loss/.
[3] Elizabeth Mcleod et al., "A Blueprint for Blue Carbon: Toward an Improved Understanding of the Role of Vegetated Coastal Habitats in Sequestering CO2," *Frontiers in Ecology and the Environment* 9, no. 10 (2011): 552-560, https://doi.org/10.1890/110004.
[4] Ivan Nagelkerken et al., "The Habitat Function of Mangroves for Terrestrial and Marine Fauna: A Review," Aquatic Botany 89, no. 2 (2008): 155-185.
[5] Peter J. Mumby et al., "Mangroves Enhance the Biomass of Coral Reef Fish Communities in the Caribbean," *Nature* 427, no. 6974 (2004): 533-536, https://doi.org/10.1038/nature02286.

Moreover, the root systems of mangroves filter heavy metals, toxins, and sediments from the water, improving water quality.[6] A healthy mangrove ecosystem additionally supports general biodiversity.[7] These attributes not only increase the resilience of the mangrove forest itself, but also fortify the health of the entire coastal landscape, including seagrasses and coral reefs—other key sources of blue foods.[8] Through these ecosystem services, mangroves support healthy populations of fish and shellfish populations that are critical to blue foods production.[9] Indeed, recognizing the synergy between mangrove health and increased blue foods productivity, some communities practice silvofishery and plant mangroves alongside their fish ponds.[10]

In this way, the success of blue foods systems—and through that community well-being—cannot be separated from BCE health. Increased productivity of mangroves and blue foods also has cascading social benefits for communities. Blue foods are highly nutritious, and encouraging the consumption of blue foods could reduce stunting, a key issue present in Indonesia. Moreover, empowering blue foods producers presents an opportunity for improved gender recognition and inclusion, as women play important roles in fisheries, often through gleaning, pre-production, processing, and selling. Mangrove forests also provide other material benefits besides blue foods, including shoreline protection from storms, a site for honey making, resins for leather making, a source of fuel for cooking and heating, and construction material for homes.[11]

The blue carbon / blue foods nexus thus represents an opportunity to achieve these many goals—environmental, economic, and social—synergistically and sustainably. As our case studies show, through an ecosystem-based and community-centered approach, it is possible to capture the synergies of the blue carbon / blue foods nexus while mitigating potential tradeoffs.

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[6] Daniel M. Alongi, "Present State and Future of the World's Mangrove Forests," *Environmental Conservation* 29, no. 3 (2002): 331-349, https://www.cambridge.org/core/journals/environmental-conservation/article/present-state-and-future-of-the-worlds-mangrove-forests/0E3D6B0DF6EE2E9DBD48582964AD492A.

[7] Norman C. Duke et al., "A World Without Mangroves?" *Science* 317, no. 5834 (2007): 41-42, https://www.science.org/doi/10.1126/science.317.5834.41b.

[8] Richard K. Unsworth et al., "Tropical Seagrass Meadows Modify Seawater Carbon Chemistry: Implications for Coral Reefs Impacted by Ocean Acidification," Environmental Research Letters 7, no. 2 (2012): 024026.

[9] Jurgenne H. Primavera, "Mangroves as Nurseries: Shrimp Populations in Mangrove and Non-Mangrove Habitats," Estuarine, Coastal and Shelf Science 46, no. 3 (1998): 457-464

[10] Roel H. Bosma et al., "Challenges of a Transition to a Sustainably Managed Shrimp Culture Agro-Ecosystem in the Mahakam Delta, East Kalimantan, Indonesia," Wetlands Ecology and Management 20, no. 2 (2012): 89-99.

[11] WWF Australia, "The Coral Triangle and Climate Change: Ecosystems, People and Societies at Risk," *WWF Australia*, 2009, https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/climate_change___coral_triangle___full_report.pdf.

In particular, we have identified four key themes across our case studies: community ownership, education, gender recognition & inclusion, and financing mechanisms. The next section of this policy memo discusses these themes, each of which is foundational to harness the blue carbon-blue foods nexus.

The following diagram is an illustration of how shrimp cultivation, mangrove restoration, and blue carbon sequestration are inextricably linked and provide a wide range of ecosystem services (Figure 1).[12]

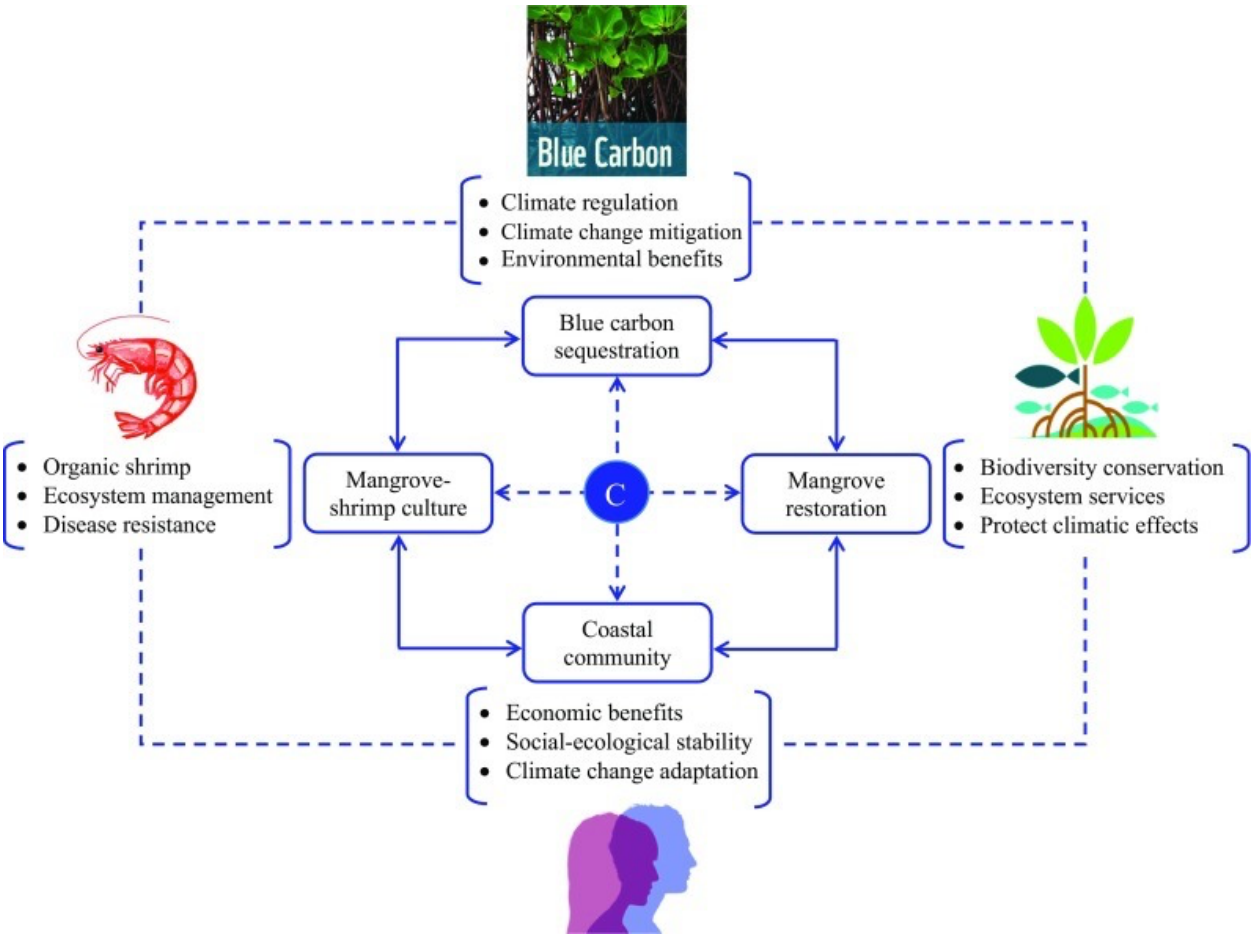

Figure 1. Integrated mangrove-shrimp cultivation: Potential for blue carbon sequestration. Source: Ahmed et. al., 2018.

[12] Nesar Ahmed, Shirley Thompson, and Marion Glaser, "Integrated mangrove-shrimp cultivation: Potential for blue carbon sequestration."

III. Methodology

This report includes findings from a wide variety of expert interviews, scientific journal articles, government reports, and NGO reports. Although we began by researching more broadly on the different BCEs of Indonesia, this report focuses on mangrove ecosystems as the primary BCE in question as it is the most prominent BCE in the country. Specifically, we focused on the blue food benefits from mangrove conservation and the compelling implications for blue food production and local livelihoods. For example, mangrove loss in Southeast Asia accounts for the greatest reduction in any blue carbon system in the world, and Indonesia is uniquely positioned to combat this trend.[13] Mangroves not only span 4.1 million hectares in Indonesia[14] with an estimated potential valuation at $532 million (approximately 8.5 trillion IDR), but they also sequester approximately 11 million tons of carbon dioxide a year as well as provides flood mitigation.[15] As such, mangrove conservation presents a key factor in Indonesian BCEs, especially as there are around 120 million Indonesians living near mangrove ecosystems, many of whom depend on mangroves for their livelihoods,[16] whether through ecosystem services or directly through the harvesting of mangrove-derived products.

This report includes case studies that span a wide range of ecosystem services that mangroves offer–ranging from providing a habitat for local fish, crab, and shrimp species, water quality improvement, and cultural services—and presents the range of benefits that arise from supporting coastal community livelihoods through mangrove preservation.

Following our literature review on initiatives to support mangrove conservation and blue food industries in coastal communities and expert interviews from a wide range of countries engaged in blue carbon / blue food efforts, we examined trends across initiatives and have synthesized our findings into four key themes: *Community Ownership, Education, Gender*

[13] A. Thorhaug, et al., "Coastal and estuarine blue carbon stocks in the greater Southeast Asia region: Seagrasses and mangroves per nation and sum of total," *Marine Pollution Bulletin*, 2020, https://doi.org/10.1016/j.marpolbul.2020.111168.
[14] Reuters, "Indonesia pushes tourism to boost mangrove restoration," *Reuters*, June 2, 2023, https://www.reuters.com/world/asia-pacific/indonesia-pushes-tourism-boost-mangrove-restoration-2023-06-02/#:~:text=JAKARTA%2C%20June%202%20(Reuters),been%20decimated%20by%20human%20activity.
[15] World Bank Group, "Planting Mangrove Forests Is Paying Off in Indonesia," *World Bank Group*, November 30, 2023, https://www.worldbank.org/en/news/feature/2023/11/30/planting-mangrove-forests-is-paying-off-in-indonesia.
[16] World Bank Group, "Indonesia Sustainable Landscapes Management Program (SLMP)," *World Bank Group*, 2024, https://www.worldbank.org/en/programs/indonesia-sustainable-landscapes-management-program/practice.

Recognition & Inclusion, and Financing Mechanisms through an analysis of initiatives from six primary countries: Vietnam, the Philippines, Ghana, The Gambia, Kenya, and Mauritius (Figure 2). We have chosen these countries as they all have the presence of coastal communities, blue food production, and have undertaken initiatives pertaining to the synergies. As a whole, they provide a wide range of approaches used in tackling blue carbon and blue food related challenges, all of which are relevant to Indonesia's development.

Throughout the report, we include insights from 21 expert interviews, ranging from researchers at universities around the world, NGOs, blue carbon project experts, and more. These interviews elucidate key trends, challenges and opportunities in existing blue carbon-blue food programs and point towards areas of opportunity surrounding community empowerment, financing initiatives, and community education. Additional resources and outputs, including a conceptual framework for evaluating competing blue foods futures, will be in the appendix for reference.

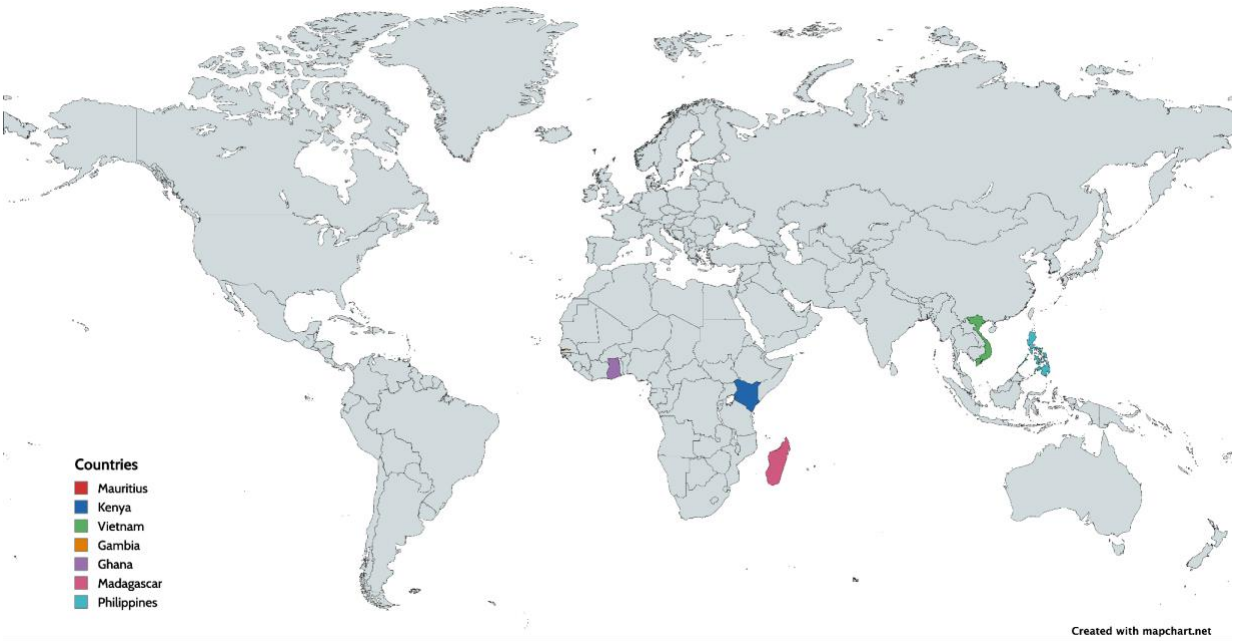

Figure 2. Case study countries.

The Gambia: In the Tanbi Wetland National Park, the Gambia-Senegal Fisheries Program formed in 2009 through the collaboration of the TRY Oyster Women's Association and the University of Rhode Island Center for Coastal Resources. The project focused on local oyster gleaning and was community-driven and women-led, uniting various landing sites in the Tanbi Wetland National Park to agree on regulations to protect the mangrove ecosystems while improving their financial profit from the oyster gleaning. Regulations included limiting harvest to a four-month open season that was strategically timed with Ramadan, prohibiting machete cutting, and creating a size minimum for the oysters that can be gleaned.

Kenya: The Mikoko Pamoja project is a community-led mangrove conservation and restoration project in the Gazi Bay, and the world's first blue carbon project. Since 2010, it has engaged 1,081 households, with 117 hectares under management and has received USD $143,976 in Payment for Ecosystem Services (PES) payments. The project is managed by the Mikoko Pamoja Community Organization (MPCO) – representatives from Gazi Gay, The Mikoko Pamoja Steering Group (MPSG) – technical support, and the Association for Coastal Ecosystem Services (ACES) – the project coordinator. Funds come through the sale of certified carbon credits to Plan Vivo, representing the reduction or avoidance of carbon emissions, verified through community-led activities.

Madagascar: In the Bay of Assassins, Madagascar, the Tahiry Honko Project, initiated by Blue Ventures, began its mangrove management efforts by integrating local governance and TEK in their zoning system design plan. Over multiple rounds of village consultations, the plan outlined conservation zones to protect fishery nurseries, gaining widespread community support. The project, the country's first carbon sequestration initiative, has successfully conserved and restored 1,200 hectares of mangroves, avoiding emissions of 1,300 tons of CO_2 annually, and diversified income through activities like seaweed harvesting and beekeeping, effectively doubling average village income. Despite a $20,000 sale of blue carbon credits, the community faces a significant challenge due to the lack of financial infrastructure to receive payments, highlighting the critical need for proper financial systems to fully realize the project's benefits.

Mauritius: Mauritius is a small island country off the coast of Southeast Africa that has had significant mangrove conservation efforts since 1995 with strong coastal community dependence on mangrove related resources, ranging from blue foods living amongst mangrove ecosystems to a dependence on mangroves as erosion control. Our primary examples and analysis from Mauritius highlight the importance of monitoring and data collection in mangrove conservation efforts and policy cohesion in mitigating the impact of coastal development on mangrove populations. In relation to blue foods, Mauritian studies have indicated that while local communities recognize the economic value of mangroves, their awareness of the full range of benefits is limited. As such, educational campaigns and community engagement on the importance and connection between blue foods and blue carbon ecosystems is critical.

The Philippines: In Infanta, Philippines, the Alitas Farmers Association (AFA) has led a project since 2009 to restore abandoned fishponds back to mangroves. In Alitas, there is high community buy-in, as the mangrove forests are both culturally and economically embedded into their way of life. The AFA has received payments from the Philippine government for their restoration efforts and has implemented a monitoring program. Other efforts in the Philippines have similarly emerged as a result of strong community engagement, including one effort that empowered local communities to create nurseries for crabs and fish through the planting of over 40,000 mangrove seedlings.

Vietnam: In Vietnam, the Payment for Forest Environmental Services (PFES) system, initiated in 2008 with USAID support, mandates that users of forest environmental services compensate suppliers, covering services like watershed protection and carbon sequestration. To facilitate payments, the Vietnam Forests and Deltas program, in collaboration with ViettelPay and the Vietnam Forest Protection and Development Fund, introduced mobile e-payments in 2018, expanding services to 3,600 rural communities and approximately 500,000 households. Despite generating over $1 billion since 2011 for forest conservation, PFES faces challenges, such as low financial incentives for households, who receive only 200,000–400,000 Dong per hectare annually, insufficient to compete with alternative land uses. Nonetheless, it is estimated the program successfully sequesters around 20 million tons of CO_2e annually and supports nearly 500,000 rural households in protecting forests, demonstrating significant environmental impact and economic support.

IV. Case Study Findings

A. Community Ownership

Key Takeaways for Community Ownership:

- Successful community engagement went beyond just involvement—communities were not just included in but rather enjoyed active ownership over blue carbon / blue foods projects.
- Genuine community ownership emerged as a result of three key actions:
    - *Leveraging local knowledge* (achieved through embedding traditional ecological knowledge and cultural values);
    - *Embracing local stewardship* (achieved through participatory co-management led by local resource users);
    - *Local monitoring and enforcing* (achieved through incentivizing local communities to monitor their local ecosystems)
    - *Acknowledging local limitations* (achieved through the recognition of the diversity within communities and the need for support from government policy).

Leveraging Local Knowledge

TEK is defined as the "evolving knowledge, practices, and beliefs regarding the relationship between humans and their environment, which has been accumulated over generations of people who intimately interact and depend on land."[17] Many coastal communities, which have traditionally relied on BCEs for their way of life, have gained this deep knowledge over time. TEK captures a specific understanding of local ecosystems, often in ways that Western science fails to capture. For example, the gradual accumulation of TEK over centuries provides the historical ecological context necessary to notice gradual long-term shifts in specific ecosystems. Western science, in contrast, may lack data on specific locality or lack records stretching back thousands of years.

[17] Kevin Arrigo and Richard Nevle. "Introduction to Earth Systems" (lecture, Stanford University, Stanford, California, 2023).

The case study with successful outcomes did so in part because they leveraged this TEK. Although the blue carbon / blue foods nexus may be relatively new within national policies or investment schemes, the relationship between BCEs and their communities stretches back thousands of years. As a result, many locals—especially those still involved in mangrove-related industries—represent a significant source of local knowledge and already hold a deep understanding of the blue carbon / blue foods relationship. Indeed, one survey of community members in the Tanbi Wetland National Park (TWNP) in The Gambia found that 55.30% of respondents perceived mangrove degradation as a reason for the decline in fish stocks.[18] The survey also noted that the oyster gleaners were particularly articulate in assessing the impact of climate change on their mangrove forests.

Harnessing this knowledge can translate beyond conceptual understanding to concrete policy and action. In The Gambia, for instance, traditional oyster gleaning practices do not damage mangrove forests.[19] Gleaners canoe or wade in during low tide to collect adult oysters.[20] However, in the 1990s, migration inflow and rising consumer demand increased pressure on the oyster population.[21] As a consequence, gleaners began using machetes to cut off entire oyster bearing roots, damaging the mangroves and therefore also the habitats that the oysters depended on.[22] Since the establishment of the Gambia-Senegal Sustainable Fisheries Program (BaNafaa), which seeks to promote mangrove forests and oyster gleaning in TWNP, oysters gleaners have since agreed to abandon machete cutting and return to the traditional collection methods.[23] As not all oyster gleaners may have generational roots in the Tanbi, capacity building also plays a role here. As part of their efforts both to conserve mangroves and support oyster production, the gleaners have led an education campaign on the traditional, sustainable methods of cutting for oyster collection.[24] This case demonstrates that returning to local knowledge and traditional practices may hold the needed solutions.

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[18] Adam Ceesay, et al. "Adapting to the Inevitable: The Case of Tanbi Wetland National Park, The Gambia," *Climate Change Management*, (2016): 257-274, https://link.springer.com/chapter/10.1007/978-3-319-39880-8_16.
[19] Britt Crow and Judith Carney, "Commercializing Nature: Mangrove Conservation and Female Oyster Collectors in The Gambia," *Antipode* 45, no. 2 (2012): https://doi.org/10.1111/j.1467-8330.2012.01015.x.
[20] Ibid.
[21] Jacqueline D. Lau and Ivan R. Scales, "Identity, subjectivity and natural resource use: How ethnicity, gender and class intersect to influence mangrove oyster harvesting in The Gambia," *Geoforum* 69 (2016): 136-146, https://doi.org/10.1016/j.geoforum.2016.01.002.
[22] Ibid.
[23] Karen Kent (Team Leader from the University of Rhode Island Coastal Resources Center for the Gambia-Senegal Sustainable Fisheries Project) in discussion with the authors, April 24, 2024.
[24] Ibid.

Similarly, efforts in the Philippines also found success due to integration of local knowledge systems. In one community, there was already pre-existing expertise in blue food production.[25] Although there was less understanding of mangrove conservation, when given the tools to integrate mangrove conservation into their work, the communities were quickly able to integrate the conservation efforts into their blue food production. They created nurseries for fish and crabs, and planted over 40,000 mangrove seedlings.[26] This project underscores the potential for levering local knowledge and integrating both blue food and mangrove conservation projects.

In addition to TEK, BCEs have also become entwined as a cultural foundation for many communities. Acknowledging this cultural connection and employing it as a motivating factor for mangrove conservation can also help blue carbon / blue foods projects gain traction and support from local communities. Besides the benefit of more robust and productive blue food systems resulting from local conservation efforts, a community may feel more empowered to take ownership of such conservation initiatives when their social and cultural dependence on mangrove ecosystems is accounted for in policy. A recent publication found that while the ecosystem services and local food production benefits of mangroves are well documented, in some communities in Mauritius—and around the world—the main contribution of mangroves to coastal communities was that it was a socially and culturally important community gathering and socializing spot.[27,28] When the cultural significance of mangroves is acknowledged and incorporated into community awareness training, there may be an additional sense of ownership for the communities to design and lead mangrove conservation efforts in tandem with local blue food industries, often shrimp, crab or fish. As such, acknowledging the diverse range of community perspectives is critical in developing targeted programs for coastal communities to develop their local blue food industry through mangrove preservation and restoration.

Indeed, the AFA has succeeded in their efforts to revert abandoned fishponds back to mangroves in Infanta, Philippines, largely due to high community buy-in.[29] In many countries,

[25] Anonymous (Founder of a mangrove conservation organization in the Philippines), in discussion with the authors, May 22, 2024.
[26] Ibid.
[27] Raphael Merven, et al., "Dependency on Mangroves Ecosystem Services is Modulated by Socioeconomic Drivers and Socio-Ecological Changes – Insights From a Small Oceanic island," *Human Ecology* 51 (2021): 1141-1156, https://doi.org/10.1007/s10745-023-00464-3.
[28] Raphael Merven (Indian Ocean Islands Foundation) and Francois Baguette (PhD Candidate at the University of Mauritius) in discussion with the authors, April 30, 2024.
[29] Gevaña, Dixon T., "Climate Change Resiliency Through Mangrove Conservation: The Case of Alitas Farmers of Infanta Philippines," in *Fostering Transformative Change for Sustainability in the Context of Socio-Ecological*

including Indonesia, mangrove conservation faces an enforcement problem, as BCEs are too vast to patrol effectively. However, local policies in Infanta, such as prohibitions on the cutting of mangroves and destructive fishing practices, are strictly enforced.[30] This strict enforcement is only possible due to cultural traditions that value the BCEs.[31] Every year, Infanta holds the *Tulingan* Festival, bringing the town together to celebrate the blessings from the mangroves and ocean.[32] Such traditions emphasize the importance of BCE health and create social pressure to respect local policies that protect the environment. While it may be impossible to create a cultural value without traditional roots, leveraging any preexisting local reverence for BCEs can serve as a powerful tool for BCE management.

Embracing Local Stewardship

Local stewardship positions communities to leverage TEK and cultural traditions by ceding management authority to local communities. Many case studies employed participatory approaches, co-management, or resource-user management—all ways of indicating that the projects were community-driven. These management styles ensured that local communities could give their free, prior, and informed consent. Free, prior, and informed consent is given with full understanding of the terms of agreement before the agreed upon activity starts. In the context of BCEs, this consent is important to ensure that communities truly agree to projects and understand what those projects entail. The case studies that leveraged local stewardship, though, went beyond just free, prior, and informed consent by allowing communities to play the driving role throughout the project from decision-making to implementation to monitoring and enforcement.

The MPCO in Gazi Bay, Kenya, which has conserved 117 hectares of mangroves, has set the standard in this regard.[33] Illegal loggers have long targeted mangrove forests in Gazi Bay, reducing fishery productivity.[34] In 2013, local communities responded, organizing into the

Production Landscapes and Seascapes (SEPLS), ed. Maiko Nishi, et al. (Singapore: Springer Nature, 2021): 195-214.
[30] Ibid.
[31] Ibid.
[32] Ibid.
[33] WWF, "Kenyan coastal community earning economic livelihood through conservation of mangrove trees," *WWF*, 2017, https://wwf.panda.org/wwf_news/?311014/Kenyan-coastal-community-earning-economic-livelihood-through-conservation-of-mangrove-trees.
[34] Ibid.

MPCO. The initial process of founding the MPCO involved community consultations and *barazas* (open-village meetings).[35] During these sessions, participatory appraisal exercises sought the input of local people, asking them to rank priorities and evaluate risks.[36] As a result of this input, MPCO planted community woodlets to provide an alternative source of timer to offset restrictions on mangrove cutting.[37] As mangroves often serve as important sources for fuel and timber, this alternative source was critical to mitigating any negative ramifications of the cutting restrictions.[38] Furthermore, MPCO also placed emphasis on transparency to gain community trust. Recruitment exercises sought to find local leaders who could best represent the needs of their communities, eventually selecting and training a Project Coordinator (PC) on day-to-day operations and public communications.[39] The PC not only coordinates activities, but also manages the funding from carbon credits and relates this financial information to the community.[40] In terms of blue foods, a voluntary Marine Protected Area was established to control destructive fishing by banning the use of fishing gear known to damage seagrass.[41] The development of this area is being led by the MPCO after conducting a full stakeholder consultation of the local fishing community.[42]

Today, this collaborative approach continues. MPCO is now a government-registered community organization that coordinates community engagement, routine project activities, and benefit sharing. Governed by volunteer office members who are village representatives, MPCO continues to employ a participatory approach to engage the entire community—including women and youth—in every step of project design and planning. For example, in an effort to involve the broader community and youth in particular, MPCO has sponsored murals, exhibitions, art contests, essay-writing competitions, and waste recycling projects.

Similarly, the Tahiry Honko Project in Madagascar facilitated strong local governance in the development of their mangrove management plan in the Bay of Assassins. The design plan developed a zoning system, which leveraged local knowledge. Considering communities' TEK

[35] Mikoko Pamoja, "Plan Vivo Project Design Document (PDD)," *Plan Vivo*, 2020, https://www.planvivo.org/Handlers/Download.ashx?IDMF=3faf7087-dec2-41ca-8a67-42a98e21c59d.
[36] Ibid.
[37] Ibid.
[38] Ibid.
[39] Ibid.
[40] Ibid.
[41] Ibid.
[42] Ibid.

and traditional uses, the design plan outlined strict conservation zones in areas known to be fishery nurseries. Throughout the planning process, frequent consultations at the village level confirmed that communities truly supported the management plans. All sectors and social groups from fishers to lime producers to farmers to elders were invited to participate. This widespread engagement ensured that all interested parties could contribute their perspective, thereby providing a more holistic view of the entire coastal system. Following consultations at the village level, the chiefs of village and the elders from the ten villages that shared the mangrove forest regrouped to cross-check and pre-validate the zoning to ensure that each village agreed on the zoning. The pre-validated map was then presented once again at each village for endorsement. Once endorsed, the zoning demarcation was conducted by local communities in each village with the support of technicians from the NGO Blue Ventures. These multiple rounds of engagement with broad swaths of the community provided ample opportunity for genuine discussion and through that raised widespread public support.

Today, the Tahiry Honko Project continues to seek input from communities regularly. Each village elects representatives to serve on management committees for one of three *vondrona*[43] groups within the Velondriake Marine Area.[44,45] As part of their duties, the representatives conduct regular community gatherings to survey community opinions and concerns. Representatives then report this input at bi-monthly meetings of the *vondrona* and quarterly meetings of the entire project region. Through these regular meetings and representatives, the Tahiry Honko Project thus grants local individuals the power to continue shaping the project not only during its initial formation but also throughout its entire lifespan. This approach has paid off: the communities in partnership with the project have replanted 42,148 mangrove seedlings.[46]

Local Monitoring and Enforcement

Monitoring and enforcement are a critical components to ensuring the legitimate protection and restoration of BCEs—in addition to monitoring local blue food populations.

[43] Vondrona: The name for each of the three subregions of the Velondriake marine area.
[44] Velondriake Marine Area: Marine protected region in southwest Madagascar.
[45] Blue Ventures. *2019 Plan Vivo Annual Report - Tahiry Honko*. September 2019 https://www.planvivo.org/Handlers/Download.ashx?IDMF=bf4cd544-38cd-43cb-942d-5a3918410664
[46] Blue Ventures. *2021 Annual Report - Tahiry Honko*. April 2023 https://www.planvivo.org/Handlers/Download.ashx?IDMF=6bb70c97-bab0-463e-83cb-4da50f5a052f.

However, governments often lack the capacity to conduct robust monitoring and enforcement activities, which gives communities the opportunity to share this responsibility. Monitoring can empower coastal communities both through giving them the agency to monitor local blue food populations and enact more sustainable harvest strategies. Further, monitoring efforts can be leveraged to manage local BCEs, allowing them to reap a greater of the value that comes from BCE projects. When communities are empowered to monitor and enforce their own ecosystems and land, they will be equipped to facilitate a strong blue carbon-blue food link that allows them to conserve BCE (with the potential to help them generate income through both carbon credit projects) as well as support local livelihoods with blue food production. The following section provides a discussion on strategies that empower communities to do such monitoring and enforcement.

For instance, community organizations—namely the TRY Women Oyster's Association—plays the primary role in resource management in the TWNP in The Gambia. In this case, the women do not have to wait for political decisions or government regulations, but rather have the power themselves to make decisions in oyster and mangrove management.[47] This power increases local flexibility, allowing the community to respond to pressures in real-time.[48] These decisions, reached at meetings through consensus, have included curtailing the open season, setting market prices, and setting gear restrictions. As oyster populations and mangrove health improves due to these conservation measures, income from oyster gleaning has increased, and TRY has begun investing this profit back into the mangroves through planting efforts.[49] Over time, the women—largely hailing from the marginalized ethnic group—have come to see themselves as stewards of the mangroves. Their agency and influence has also been recognized internationally. On several occasions, TRY has been invited to international functions as a steward for the Tanbi Wetlands, which in turns amplifies their voice and influence.[50]

Furthermore, the TRY Oyster Women's association has been critical in fostering a sense of unity among previously isolated groups of oyster gleaners through creating a community center, organizing group meetings, and hosting an annual oyster festival. Since becoming members, many have expressed a greater sense of community, stating that "since TRY we've

[47] Kent (in discussion with the authors).
[48] Ibid.
[49] Ibid.
[50] Ibid.

become like one big family."[51] More specifically, the annual oyster festival, first held in 2007, has become a significant event where oyster harvesters from all communities cook, eat, and celebrate together, further strengthening community bonds.[52] These efforts, supported by ongoing engagement and collaboration, once again highlight the importance of culture in community ownership of BCE and local blue food production.

Similarly, in Kenya, the recruitment of community scouts and more broadly, community members who received training to assist in nursery establishment and monitoring efforts, have been key in surveilling against illegal harvesting activities. These initiatives were supported by the long-term involvement of the Kenya Marine and Fisheries Research Institute (KMFRI), which had a regional office in Gazi and dedicated support staff.[53] Other key actors included community liaison and engagement groups, such as the Earthwatch-Gazi Community Committee, the Mangrove Women's Boardwalk Committee, and the Youth Group, all of which played a crucial role in setting fundraising priorities and directing development efforts toward collectively agreed projects, for instance, school buildings and well pumps.[54] Such monitoring activities were initially arranged and recorded by the MPCO, with supervision transitioning to verification checks after the first three years.[55] To assess the success of the project, KMFRI forestry technicians were tasked with independently assessing two indicators per year. For context, the Kenyan government owns the mangrove forests, restricting legal extraction to individuals and groups with a Kenya Forest Service license, although illegal extraction remains common.[56] The project was able to ensure local tenureship through a Community Forest Association agreement and established a close working relationship with the Kenya Forest Service.[57] The engagement of community scouts and collaboration with the Kenya Forest Service is an applicable insight for Indonesia, as the Indonesian government already has an amicable relationship with NGOs, which can serve as a starting point for a community collaboration similar to the initiative in Kenya.[58]

[51] Lau and Scales, "Identity, subjectivity and natural resource use."
[52] Ibid.
[53] Mikoko Pamoja, "Plan Vivo Project Design Document (PDD)."
[54] Ibid.
[55] Ibid.
[56] Ibid.
[57] Ibid.
[58] Ibid.

Acknowledging Local Limitations

Although community ownership—through leveraging local knowledge and embracing local stewardship—is critical to the success of blue carbon / blue foods projects, there are also limitations. For instance, communities are not monolithic, and competing interests within communities can sometimes create conflict.

In Mauritius, a tension between coastal communities and the local tourism industry is evident in mangrove management, as it is in the best interest of communities to preserve mangroves for a variety of social, cultural, and economic reasons, while larger organizations seeking to develop Mauritius' tourism industry look to build hotels and other infrastructure on mangrove areas.[59] This challenge is exacerbated by a seemingly well-intentioned law, the Fisheries and Marine Resources Act of 1998, which stipulates that no person shall cut, remove, damage or exploit a mangrove plant or part of a mangrove plant except with the written approval of the Permanent Secretary.[60] In practice, this law often ends up hurting coastal communities who sometimes may need to harvest mangrove-related resources such as using mangrove branches as artisanal fishing gear or using branches and roots of mangroves to treat diabetes in traditional medicinal practices, while turning a blind eye to larger companies who may be developing the coastal region of Mauritius for tourism activities.[61] Mangroves in Mauritius have been in vast decline with only around 10% of the original mangrove area left, in part, due to this development of tourism and coastal development projects for tourist activities.[62] It is important to not harm coastal communities by prohibiting small-scale sustainable resource use through a well-intentioned law to preserve mangrove ecosystems while simultaneously allowing coastal development—which often requires the destruction and clearing of mangrove forests—to occur.[63]

This example also demonstrates the complicated challenge of land tenure rights. Commercializing mangroves for their carbon or blue foods could create a messy political landscape as various groups jockey for power or ownership over a BCE. After all, who owns a BCE, and what does that ownership mean? While policies can give communities the agency over

[59] Merven and Baguette (personal communication).
[60] Ibid.
[61] Ibid.
[62] Ibid.
[63] Ibid.

blue carbon-blue foods projects, it is also clear that national policy can seek to protect and support communities in this endeavor. As blue carbon / blue foods projects become increasingly popular, policies can provide a safety net for communities by respecting land rights, guaranteeing fair compensation for conservation work, facilitating coordination between various communities, and providing funding to kickstart initiatives.

For instance, the TRY Oyster Women's association in The Gambia has implemented various entrepreneurial projects, including skills training for members' daughters and a savings scheme to help manage income from oyster harvesting. When building alternative livelihoods dependent on local blue food industries, governmental policy can play a significant role in supporting these endeavors through providing canopies, sanitation facilities, oyster smoking pens, and other resources to support alternative livelihoods for these communities. Such measures could help provide the space and opportunity for local communities to take charge—which, as these case studies demonstrate, can allow the full utilization of the blue carbon / blue foods nexus.

Another limitation that several case studies acknowledged was that there are often challenges to self-monitoring and enforcing, although social enforcement from within the community may still be the most promising. One avenue to increase a community's capacity for monitoring and enforcement is through providing technical assistance and technologies to communities, which is a strategy employed by Distant Imagery, a UAE-based organization specializing in aerial and underwater solutions for environmental analysis, monitoring, and habitat restoration.[64] Distant Imagery has worked with communities in Brazil, Kenya, Madagascar, and more, and in an interview with one of the co-founders of Distant Imagery, Jane Glavan, we learned that they equip and train community members in the field to use drone, kite, balloon, and remotely operated vehicle (ROV) technology so communities are able to monitor and enforce environmental activities in their region.[65] They also work with communities to find materials and resources accessible to them in their local environment, and they innovate with the communities in adjusting the technology to be made from local resources, such as local wood for drones.[66]

[64] Jane Glavan (Distant Imagery) in discussion with the authors, April 26, 2024.
[65] Ibid.
[66] Ibid.

This technology can increase coastal communities' capacity in various ways, for instance by using technologically equipped kites and balloons to help fishers see where the crab and fish areas are for harvesting or by mapping seagrass areas over time for monitoring and enforcement of carbon projects. These technologies can allow fishers to upscale their livelihoods and enhance their existing distribution through fishing cooperatives. In other instances, these communities are able to make their voices heard as these technologies allow them to collect data and concrete evidence on environmental change that they can use to advocate for themselves. With regards to carbon projects, Glavan claims that with the Distant Imagery system, the community is able to take advantage of the capture 95% of a carbon project's revenue and make partaking in monitoring and enforcement beneficial to their livelihoods, whereas traditional carbon projects have the majority of project revenue taken by external companies and organizations.[67] This approach is highly applicable to Indonesia, where Indonesia has the potential to accumulate $1.39 billion (> 22.5 billion IDR) annually from blue carbon trading alone—thus, if coastal communities were to benefit from this market and develop with the blue economy, it is critical that communities have the technological capacity and training to be able to conduct their own monitoring and enforcement and reap more of the value from these blue carbon projects.[68]

B. Education

Key takeaways for Education:

- Hands-on education models are critical to effectively engaging with and helping a community understand the synergies between BCEs and blue food production, such as study tours to neighboring communities and regions to NGO and local researcher and university student-led workshops.
- Education and capacity building on the importance of and how to monitor and collect data at the nexus should be continuous and robust to accurately assess the efficacy of restoration projects and blue food production.
- Policy cohesion and government awareness of the importance of old-growth mangrove forests, which are better for blue food production, is critical to preventing their destruction to plant new mangrove ecosystems.
- Engaging local youth throughout all educational processes is also critical for the long-term success of blue food / BCE projects.

[67] Ibid.
[68] The Jakarta Post. 2014. "Indonesia's Blue Carbon." The Jakarta Post.

Community based awareness and capacity strengthening programmes on how local marine life interacts with BCEs, is the first step to ensuring that local communities are able to effectively and sustainably manage and harvest local blue foods. By educating communities about the importance of BCEs, they are then able to make more informed decisions on how to best harvest blue foods sustainably within the context of their local communities, local ecosystems, social dynamics, and the resources they have access to. For communities that are not taking action to protect local mangrove populations—perhaps due to lack of full awareness of the suite of services mangrove forests provide—these capacity strengthening programs can provide valuable motivation to more effectively manage these systems for local blue food production.

Education Through Village Study Tours

For the TRY Oyster Women's association in The Gambia, education played a key role in supporting the development of women's oyster harvesting livelihoods through the leadership of a particular woman in the village named Fatou, who led women from different villages on a study tour in Senegal, where they learned about oyster growth and farming, cockleranching, oyster transportation, monthly monitoring, and more.[69] This initiative not only helped the Gambian women get a more tangible and hands-on understanding of oyster farming, but it also forced them to create cross-village bonds and build connections and community beyond their own village. By building these connections, Fatou was able to mitigate the amount of landing site related conflicts between these women in different villages as these women now saw each other as peers who could solve issues and learn about oyster farming together, rather than competitors.[70] While this case study exemplified the potential for study tours to help coastal communities share knowledge on sustainable blue food harvesting practices with each other and build community bonds through a small and highly localized example, Indonesia's vast network of coastal communities make this a highly relevant strategy to support hands-on education between communities while fostering connections and creating more permanent routes to share information.

[69] Kent (personal communication).
[70] Ibid.

Educational Tools

In Kenya, education was a key priority for Mikoko Pamoja, a community-led mangrove conservation and restoration project, where key indicators of success included the number and vitality of mangrove-related businesses, as well as faunal diversity, thus suggesting the interconnectedness between BCE health and blue food production.[71] In this initiative, Kenyan university students brought scientific and research skills to the communities and improved ties with the local universities through these research collaborations and opportunities.[72] Furthermore, local primary and secondary schools were actively engaged in environmental education, which encouraged the education and awareness of the interconnectedness of ecological issues for students beginning at a young age.[73] This early education primes students to more easily understand and adapt more sustainable blue food production and harvesting strategies, as they will understand the importance of preserving BCEs in maintaining healthy blue food populations.

More specifically, the Kenya Marine and Fisheries Research Institute (KMFRI) conducted courses on ecology, the benefits and threats to mangroves, payment for ecosystem services (PES), climate change, and carbon trading, and participating communities received training on establishing nurseries, planting fast-growing tree species, and using energy-saving stoves.[74] The permanent presence of KMFRI staff at the sites ensured that technical support was readily available, with visiting scientists offering assistance with novel developments.[75] The constant support of KMFRI staff as well as the infrastructure put in place for these projects have resulted in substantial success and international recognition.[76,77]

Youth Involvement

As mentioned earlier, involving and educating youth on the importance of ecological concepts surrounding conservation is critical to creating lasting community change that

[71] Mikoko Pamoja, "Plan Vivo Project Design Document (PDD)."
[72] Ibid.
[73] Ibid.
[74] Ibid.
[75] Ibid.
[76] United Nations Information Service Nairobi, "Kenyan Coastal Villagers earning a living from selling Carbon Credits," *United Nations*, 2023, https://www.un.org/zh/Nairobi-unic/story3.
[77] Thelma Mwadzaya, "With mangrove conservation, Kenya's coastal communities plant seeds for sustainable 'blue growth,'" *United Nations New*, June 30, 2022, https://news.un.org/en/story/2022/06/1121792.

effectively benefits from the BCE / blue food nexus. Broadly speaking, the youth are a critical component to strengthening capacity within coastal communities, as educated and empowered youth are able to sustain community development projects and become leaders in the community, ensuring lasting change. In the interview with Jane Glavan from Distant Imagery, the remote sensing NGO that equips communities with technology needed for community-operated monitoring and enforcement initiatives, in a community capacity building project they led in Ecuador, the community sent thousands of local youth, ranging from high schoolers to university students, to conduct site selection for a carbon project with the team at Distant Imagery.[78] The local youth collected the seeds, germinated them through loaded drones, and returned to monitor the seedlings periodically.[79] While this specific example touches more on ecosystem conservation and restoration than blue food production, it highlights the importance of youth involvement and education in government, community, and NGO-led initiatives. Glavan stated that this process allows youth to be engaged in these community projects and enables them to think critically about ways to solve community issues, utilizing the enthusiasm and creativity of youth while ensuring that community projects will be sustained transgenerationally.[80]

Education in Policy Making and Ensuring Policy Cohesion

Education programs about BCEs and the blue foods nexus in policy making are also critical components to ensuring truly comprehensive policy that supports both systems. An example that demonstrates the importance of this distinction is in Mauritius, where in 1995, a wave of mangrove conservation and restoration projects was initiated, and a study found that two-thirds of respondents in their survey of Mauritian coastal communities depend on mangroves for food security and income generation.[81]

However, it is important to note the value differential between old-growth mangrove and newly planted mangrove forests. Old-growth mangrove forests are more important and effective at protecting local marine habitats for local blue food production than newly restored

[78] Galvan (personal communication).
[79] Ibid.
[80] Ibid.
[81] Merven, "Dependency on Mangroves Ecosystems Services is Modulated by Socioeconomic Drivers and Socio-Ecological Changes."

mangroves.[82] However, current policies often lead to the destruction of old-growth mangroves for coastal development—primarily for tourism—while younger mangroves are replanted. Although this can maintain the overall area of mangrove forests, the ecological value declines due to the decrease in effectiveness of newly planted mangrove forests.[83] To address this impact, policymakers can recognize the greater value of old-growth mangroves and include environmental impact assessments that account for mangrove age in development projects. Ensuring policy cohesion, in this case, between coastal development policy and mangrove restoration policy, can prevent the simultaneous destruction and restoration of mangrove forests, thus maintaining the quality of ecosystems necessary for blue food production.

C. Gender Recognition & Inclusion

Key takeaways for Gender Recognition & Inclusion:

- Women account for approximately 90% of worldwide land-based fisheries jobs, ranging from marketing to collection and cleaning.
- In countries such as the Gambia and Mauritius, women play a vital role in supporting their household and children while also participating in the fisheries sector for an income.
- Despite their major role in the trade, women severely lack representation in local governance and access to benefits.
- Some steps have been taken to increase this representation and access to benefits such as health insurance, but major change must be sought out if a more fair and just system in fisheries is created.

Supporting the development of blue carbon / blue food ecosystems is critical to empowering and recognizing a marginalized yet incredibly important population: women. Globally, women are more dependent on mangroves as many of their livelihoods depend on gleaning, or the harvesting of blue foods (e.g., shellfish, crabs, oysters) which live in mangrove ecosystems. In the case of Indonesia, fisherwomen play a pivotal role in supporting their

[82] Iris Uijttewaal, "World Mangrove Day: The Value of Mangroves for Marine Life, Coastal Communities and Climate Change," *Bazaruto Center for Scientific Studies*, July 27, 2021, https://bcssmz.org/the-value-of-mangroves/.
[83] Merven and Baguette (in discussion with the authors).

household via the participation in the processing and marketing side of the fishing industry, accounting for approximately 48% of the household income.[84] On top of this role, Indonesian women are expected to take care of children and maintain the home, creating a system unfavorable to the well-being of women. Despite this important position, women in Indonesia severely lack legal protection and support, specifically regarding the access to insurance provided to fishermen and male fish farmers.[85] However, this issue is not unique to Indonesia and is strongly intertwined into other cultures where fishing is a major income source such as Mauritius, The Gambia, and Ghana.

Unequal Access to Benefits

A critical example that demonstrates the need to acknowledge women's critical and unique role in blue food ecosystems comes from Mauritius. In 2020, in addition to the COVID-19 pandemic, Mauritius experienced a major oil spill which polluted 27 square kilometers of their Southeastern coastline, home to artisanal fishing villages and multiple nature reserves.[86] The compounded impacts of the oil spill in addition to COVID-19 were significant, as it affected coastal livelihoods. However, this issue disproportionately impacted the women whose livelihoods depended on gleaning close to mangrove ecosystems as they were unregistered with the government and were ineligible for automatic government compensation provided to registered fishers in disaster scenarios, thus exacerbating existing gender inequities.[87] Furthermore, many of these women often rely solely on gleaning as income and as a result, many were forced to use their savings to feed their families, buy canned food from stores instead of fishing, and sometimes even prevent their children from attending school because of the loss in income and not being able to provide them with meals. Coupled with the economic slowdown from COVID-19, families suffered from the compounding shocks including women gleaners'

[84] Retnowulandari Wahyuni, "The Inevitability of Double Burden Fisherwomen on the North Coast of Jakarta," *European Union Digital Library* (2022): http://dx.doi.org/10.4108/eai.3-8-2021.2315072.
[85] Ibid.
[86] Lebrasse, Cindy. "Women Gleaners in Mauritius: How Covid-19 and an Oil Spill Amplified Gender Inequalities in Fisheries." *Oceanbites*, 1 Dec. 2022, oceanbites.org/women-gleaners-in-mauritius-how-covid-19-and-an-oil-spill-amplified-gender-inequalities-in-fisheries/.
[87] Josheena Naggea, Emilie Wiehe, and Sandy Monrose, "Inequity in unregistered women's fisheries in Mauritius following an oil spill," *SPC Women in Fisheries Information Bulletin* 33 (2021): 50-55.

inability to access healthy and productive mangrove forests and in turn the limited access to blue foods.[88]

Gaining Access

In Mauritius, efforts to empower women in ocean-based activities, particularly oyster farming, are underway, as highlighted in the March 2023 report on *Women in ocean-based activities in Mauritius and the Seychelles* by the United Nations Development Programme (UNDP). Through initiatives such as the Oyster Farming Programme, around 20 women have enrolled in an 18-month-long course aimed at enhancing their knowledge and skills in oyster farming.[89] The programme, funded by the UNDP GEF Small Grants Programme, sought to strengthen the capacity of coastal communities, enabling women to contribute effectively to the aquaculture sector and enhance food security. The participants aspire to establish cooperatives and are advocating for recognition as fisher people, emphasizing the importance of obtaining registered fisher person cards.

Amidst challenges exacerbated by the COVID-19 pandemic, including dependence on government allowances, women oyster farmers expressed their commitment to their livelihoods and the preservation of traditional artisanal practices.[90] They view these initiatives as essential for securing the future of marine activities for themselves and future generations, particularly young women. Recognizing the historical omission of women's contributions to marine development, they commend the UNDP for targeting women and express optimism that such projects will enable women to find their rightful place in the blue economy and beyond. These initiatives supporting women's livelihoods in blue food production, particularly in the fisheries sector, underscore a vital link between women and the health of local BCEs. Maintaining the health of BCEs in Mauritius is not only essential for biodiversity conservation and climate regulation but also crucial for increasing fisheries catch.

[88] Cindy Lebrasse, "Women gleaners in Mauritius: How COVID-19 and an oil spill amplified gender inequalities in fisheries." *Oceanbites*, October 22, 2021, https://oceanbites.org/women-gleaners-in-mauritius-how-covid-19-and-an-oil-spill-amplified-gender-inequalities-in-fisheries/.
[89] United Nations Development Programme, "Gendered Voices: Women in ocean-based activities in Mauritius and the Seychelles," *United Nations Development Programme*, 2023, https://www.undp.org/mauritius-seychelles/publications/gendered-voices-vol-3-issue-6-women-ocean-based-activities-mauritius-and-seychelles.
[90] Ibid.

Similarly, in The Gambia, women comprise about 80% of all fish processors and 50% of all traders involved in the fishing industry.[91] Despite this dramatic role within the small-scale fisheries of The Gambia, fisherwomen lacked adequate governmental representation as well as a voice in the development of management strategies affecting the BCE systems and the subsequent blue food production.[92]

In this region the shellfishing industry is predominantly led by women, many of whom are single heads of households.[93] These women rely on harvesting oysters from the Tanbi Estuary not only for sustenance but also to support their families financially, particularly in cases where husbands are absent or deceased.[94] While men may contribute financially, it's often the mothers who take on the responsibility of managing child health and education expenses. Interestingly, women view shellfish harvesting not just as a livelihood but also as a means to secure a better future for their children. Despite their socio-economic challenges and lower educational status, women in these roles are seen as exemplars of best practices in resource management. During an interview with Dr. Brian Crawford, the project manager overlooking the Ghana Sustainable Fisheries Management Project (GSFMP), noted that women's involvement in shellfisheries provides an entry point for mangrove management, as they have a vested interest in protecting the habitats vital to their livelihoods. Additionally**,** our team was told about the remarkable resilience and determination of these women, who despite facing significant socio-economic barriers, actively engage in co-management processes, resolve conflicts, advocate with government actors, and demonstrate confidence in public forums during our interview with Dr. Karen Kent, a team leader for the GSFMP. These insights underscore the critical role of women in sustainable resource management and the importance of empowering them to contribute effectively to community development initiatives.

[91] United Nations Conference on Trade and Development, "The fisheries sector in the Gambia: trade, value addition and social inclusiveness, with a focus on women," *United Nations Conference on Trade and Development*, 2014, https://unctad.org/publication/fisheries-sector-gambia-trade-value-addition-and-social-inclusiveness-focus-women.
[92] Colette C.C. Wabnitz, Alison Cutting, and Sarah J.M. Harper, "Gender and Fisheries – The Republic of The Gambia Country Fact Sheet," *Ocean Risk and Resilience Action Alliance*, 2023, https://oceanrisk.earth/wp-content/uploads/2023/05/Gambia_factsheet_fin.pdf.
[93] Lau and Scales, "Identity, subjectivity and natural resource use."
[94] United Nations Development Programme, "TRY Oyster Women's Association, The Gambia," *Equator Initiative Case Study Series*, 2013, https://www.equatorinitiative.org/wp-content/uploads/2017/05/case_1370356657.pdf.

Effective Measures

Further work in Mauritius, particularly on the autonomous outer island of Rodrigues, women's participation in fisheries is notably higher. The larger lagoon areas around Rodrigues facilitate greater engagement in gleaning activities, supported historically by initiatives from the Mauritian government's Ministry of Gender Equality, Child Development, and Family Welfare.[95] In the 1980s, the ministry provided support by issuing boats, lifejackets, and engines to women, enhancing their financial independence and has resulted in around 32% of registered fishers in lagoon areas being women, granting them increased legitimacy to participate in discussions about fisheries management and receive rightful compensation.[96] The heightened dependence of the population on fisheries, particularly women's involvement as octopus fishers, has translated into greater female participation in management compared to Mauritius island itself.

In 2011, the Mauritian government passed the New Local Government Act, an act declaring a minimum of one-third of all municipalities and village councils to be each gender. This act successfully boosted the number of women involved with governance at the local level and created a system that better represents the population.[97] The increased representation of women in local government and awareness towards their participation in fisheries has dramatically grown the movement towards a more inclusive system. To be more specific, in 2022 the **Mauritian** government celebrated the first International Day of Women Working in Maritime Industry. The Minister of Blue Economy, Marine Resources, Fisheries and Shipping, Sudheer Maudhoo, publicly released that 200 fishing licenses for oyster collection and shrimp net fishing will soon be released with women given priority to those.[98]

These initiatives not only empower women economically but also recognize their crucial role in sustainable fisheries management, contributing to more inclusive decision-making processes in the fishing industry. These steps aided in creating a more representative governance structure that truly accounts for the perspective and voice of fisherwomen.

Another example from The Gambia and Ghana that illustrates the intricate relationship between BCEs, blue foods, and the fisherwomen who depend on them comes from work done by

[95] Wabnitz, et al., "Gender and Fisheries." 2023.
[96] Ibid.
[97] Ibid.
[98] Government of Mauritius, "Mauritius marks first ever International Day of Women working in maritime industry," *Republic of Mauritius*, May 19, 2022, https://govmu.org/EN/Pages/NewsDetails.aspx?n=Mauritius-marks-first-ever-International-Day-of-Women-working-in-maritime-industry.aspx.

the TRY Oyster Women's Association.[99] By encouraging cooperation among oyster harvesters and establishing new contact zones through a community center and oyster festival, the association aimed to reduce pressure on mangroves but also shape the identities and social dynamics among the fishing communities. Through regular interactions in these spaces, women oyster harvesters gained a sense of shared experience and fostered a collective identity. Importantly, the health of BCEs, such as mangroves, directly impact the availability and health of blue carbon foods, like oysters, which are essential for the livelihoods of these Gambian fisherwomen. Thus, initiatives aimed at preserving and restoring BCEs are not only crucial for biodiversity conservation and climate regulation but also for fostering social cohesion and sustainable resource management within fishing communities.

D. Financing Mechanisms

Key takeaways:

- Successful efforts identify and alleviate the economic pressures that drive exploitation and overexploitation of BCEs as well as adoption of blue foods practices
    - Incentives can drive behavior change, but may produce unintended consequences
- Consider developing sustainable income streams beyond outside blue carbon project financing, which may be insufficient or only temporary, such as those directly or indirectly promoting blue foods production
- The community equipped with coordination mechanisms and financial infrastructure can quantify ecosystem benefits, receive financial payment, and facilitate democratic allocation. The government can provide workarounds if these structures are not fully in place

BCEs and blue food systems are inextricably linked economically, as the former provides the underlying resource from which the latter is derived. The tension lies in the short-term vs. long-term economic considerations, as common causes of BCE degradation and destruction such as construction, deforestation, and conversion to aquaculture ponds, are intertwined with coastal

[99] Lau and Scales, "Identity, subjectivity and natural resource use."

community subsistence and development.[100] Therefore, efforts must consider financial viability and sustainability trade-offs across all time horizons.

Domestic governments, foreign and international development banks, and foreign governments and development agencies have been the primary funders of mangrove conservation and restoration projects.[101] According to Gatt et al.'s analysis of 123 mangrove restoration studies, the primary aims of these projects were "Coastal defense," "Biodiversity Enhancement," and "Climate Change Resilience."[102] Fewer than ten case studies cited "Employment and Income Generation," suggesting that typically these projects maintain separation of mangroves and livelihoods, and at best provide communities with alternative resources such as charcoal stoves and income streams like beekeeping, in exchange for no longer extracting BCE resources. Given that five or fewer studies cited "Fisheries Enhancement," objectives tied explicitly or directly to blue foods were commonly left out. Therefore, while these projects may have targeted pressure points on the BCE / blue foods nexus, they did not directly reinforce it.[103]

In the 2010s, the advent of blue carbon projects placed an economic value on the carbon stored in BCEs through quantification and selling of credits for buyers to offset emissions.[104] The approach thus far in these projects has been to restore and conserve mangrove areas and provide native communities a share of carbon credit revenue, though recent efforts such as the World Economic Forum's High-Quality Blue Carbon Principles and Guidance outline further objectives beyond mitigating climate change through reduced or avoided carbon emissions.[105] However, large uncertainties around the quantification of ecosystem services beyond carbon mean these

[100] Reef Resilience Network, "Ecosystem Loss," *The Nature Conservancy*, 2024, https://reefresilience.org/management-strategies/blue-carbon/blue-carbon-introduction/ecosystem-loss/.
[101] Yasmine Gatt, et al., "Quantifying the Reporting, Coverage and Consistency of Key Indicators of Mangrove Restoration Projects." *Frontiers for Global Change* 5 (2022), https://doi.org/10.3389/ffgc.2022.720394.
[102] Ibid.
[103] Ibid.
[104] Lindsay Wylie, Ariana E. Sutton-Grier, and Amber Moore, "Keys to successful blue carbon projects: Lessons learned from global case studies," *Marine Policy* 65 (2016): 76-84, https://doi.org/10.1016/j.marpol.2015.12.020.
[105] Conservation International, "High-Quality Blue Carbon Principles and Guidance: A Triple-Benefit Investment for People, Nature, and Climate." *Conservation International*, 2022, https://climatechampions.unfccc.int/wp-content/uploads/2022/11/HQBC-PG_FINAL_11.8.2022.pdf.

projects may decouple the economic value between BCEs and blue foods, as ultimately the main determinant of income is the carbon benefits.[106]

Payment for Ecosystem Services (PES) is a financial instrument that aims to capture broader ecosystem benefits, in which beneficiaries of ecosystem services (provisioning, regulating, supporting, and cultural) pay those who manage the ecosystems. For example, fisheries and aquaculture businesses may pay for the upkeep of mangrove forests to protect coastal waters and serve as nurseries for fish populations, ensuring the long-term viability of their harvests. While PES schemes can create a self-reinforcing flywheel, sufficient infrastructure and institutional support must kickstart and maintain the system.

Financial mechanisms can be a powerful tool to provide primary and supplementary sources of income to support the viability of BCE / blue foods efforts, and amplify the economic relationship of the nexus. Case studies across countries demonstrate the importance of capturing these opportunities.

Alleviating economic pressures

Economic pressures are the underlying drivers of mangrove exploitation and overexploitation.[107] For example, in the 1990s, the regional economy in Senegal was weak, driving women to migrate to the Tanbi area.[108] There, they began oyster gleaning, which emerged as an important source of revenue to pay for children's school fees and food, but strained the local oyster population and mangrove system.[109] As oyster gleaning became more difficult, women began using machetes to cut off oyster-bearing roots rather than collecting individual adults, resulting in permanent damage to the mangroves.[110] In addition to unsustainable cutting practices, the women cut down mangroves to use as firewood for their stoves to steam and preserve the oysters.[111] Although there were attempts to encourage the use of fuel efficient stoves, the appliances proved too expensive to be widely adopted.[112]

This situation demonstrates that economic pressures can leave local communities no

[106] Daniel M. Alongi, "Carbon payments for mangrove conservation: ecosystem constraints and uncertainties of sequestration potential," *Environmental Science and Policy* 14, no. 4 (2011): 462-470, https://doi.org/10.1016/j.envsci.2011.02.004.
[107] Lau and Scales, "Identity, subjectivity and natural resource use."
[108] Ibid.
[109] Ibid.
[110] Ibid.
[111] Crow and Carney, "Commercializing Nature."
[112] Ibid.

other choice than to exploit the mangroves for resources. The most effective BCE / blue foods efforts have thus sought to address these financial pressures and develop economic incentives to employ sustainable practices and maintain sustainable levels of blue food production.[113] For example, recognizing that they needed to limit exploitation to increase Catch Per Unit Effort (CPUE), these women collectively agreed on a closed season and strategically timed the four-month open season with Ramadan when demand was highest.[114] As a result, they could sell lower volumes at higher prices while extracting fewer mangrove resources, allowing the ecosystem to regenerate.[115] Other efforts in The Gambia have similarly aimed to create financial incentives that align both production and conservation objectives.[116] The Gambian National Shellfish Sanitation Program (GNSSP), for example, set out to develop a high-value, low-volume market segment for raw shucked shellfish for hotels by boosting customer confidence of consistent supply in exchange for market access.[117]

Although such financial incentives can increase the economic viability of BCE / blue foods projects, the efforts in The Gambia also demonstrate unintended consequences of increased production must be considered. For example, the oyster commercialization component of the BaNafaa in TWNP, discussed in the "Community Ownership" section, failed to account for how oysters were typically prepared for the market.[118] As a result, many shifted to boiling and steaming the oysters, resulting in more demand for mangrove wood for fuel.[119] Furthermore, while selling shellfish to the tourist market generated revenue, the women rarely consumed blue foods themselves, opting to have cheaper sources of food and less nutritionally rich diets overall due to lack of nutritional knowledge and the economic trade-off.[120] These outcomes show that while financial structures can facilitate both production and conservation simultaneously, their design must also be considered in a holistic context to support community wellbeing.

[113] Kent (personal communication).
[114] Ibid.
[115] Ibid.
[116] MA Rice, "Establishing a National Shellfish Sanitation Program in The Gambia, West Africa," *West African Journal of Applied Ecology* 23, no. 1 (2015): https://www.ajol.info/index.php/wajae/article/view/121900.
[117] Ibid.
[118] Crow and Carney, "Commercializing Nature."
[119] Ibid.
[120] Kent (personal communication).

Developing sustainable income streams

One pathway toward generating economic incentives is blue carbon projects and PES schemes, which can offer an influx of income to communities. While there are projects with notable outcomes, the applicability to all communities and extent of income generation are less certain. All ecosystems offer different project potential, and so consideration of local contexts is critical. These projects alone may not be sufficient income sources, and instead self-sustaining income streams such as those from blue foods are ideally folded into the design.

The Mikoko Pamoja project generates USD $24,000 per year from sale of carbon certificates protecting 117 hectares, 60–70% of which is spent on community development projects, including education, sanitation, and water.[121] Dr. Michie of the University of Portsmouth stated that for blue carbon projects to be economically feasible for communities, 50–60% of the proceeds must go back to the community.[122] In the first year, the income was used to install water systems for the entire village and fund school needs.[123] Dr. Michie pointed out that a large enough area or combination of areas is a prerequisite for a blue carbon project to be investible.[124] "We've seen lots of areas where people are trying to get restoration off the ground, but when you plant the trees they don't survive" she stated, adding, "for projects to be successful, you need scale."[125] This observation partially explains the prevalence of financing a blue carbon project by carbon credits sold on the voluntary carbon market, such as Plan Vivo in Mikoko Pamoja and Tahiry Honko's case. These methodologies are easier to implement due to the diversity and flexibility of different voluntary standards, and lower costs of required carbon accounting, verification, and certification.[126] As a result, there is a lower threshold for how much carbon needs to be sequestered for a blue carbon project to justify the transaction costs.

While the sale of carbon certificates provided material revenue to those in the Gazi Bay, the project also aspired to promote sustainable mangrove-related "Income Generating Activities (IGA)," as outlined in its objectives.[127] This includes beekeeping, ecotourism, as well as planting woodlots to provide fuelwood and timber and a "sustainable source of income for the community

[121] Plan Vivo, "Mikoko Pamoja – Kenya," *Plan Vivo*, 2024, https://www.planvivo.org/mikoko-pamoja.
[122] Laura Michie (University of Portsmouth), in discussion with the authors, May 13, 2024.
[123] Plan Vivo, "Mikoko Pamoja."
[124] Michie (personal communication).
[125] Ibid.
[126] Wylie, et al., "Keys to successful blue carbon projects."
[127] Mikoko Pamoja, "Plan Vivo Project Design Document (PDD)."

fund.[128] As for blue foods production, the project recognizes fisheries provision as a mangrove ecosystem service, as the locals depend on fishing and seine netting finfish, as well as harvesting crustaceans and molluscs.[129] Yet there was little additional programming outside of habitat revitalization to support production, as primarily the key indicators centered on mangrove restoration. As of its 2023 impact report, the Mikoko Pamoja project discussed the sustainable income streams of beekeeping and seaweed farming, but reported no other mangrove-related businesses.[130] The project's progress captures that to elevate the role of blue foods in the local economy alongside environmental objectives takes intentional creation of incentives, as well as the surrounding infrastructure such as offtake agreements and processing facilities, as was created for honey and seaweed.

While Mikoko Pamoja is well-regarded as a successful example of a blue carbon project, the report noted that development of new carbon projects and expansions to existing projects "have been halted in Kenya for political reasons" as the government makes a policy decision on what percentage of project income it can claim.[131] This latest update reflects the vulnerability of communities to policy decisions if the primary income stream from these projects stems from blue carbon credits. In some cases, outside funding requirements may be prohibitive to projects even getting off the ground. Oceanus Conservation, for example, operates under the timelines of its donors, meaning areas that require lengthy negotiations with communities and jurisdictions may be disqualified.[132] Because donor timelines typically range 1–3 years, the organization aims to account for the community livelihood in its work, though Managing Director Camille Rivera emphasized that there still needs to be stronger development programs in place to successfully do so.[133]

Vietnam's Payment for Forest Environmental Services (PFES) system provides an example where funding from sale of certificates is inadequate to sustain the communities it depends on. Designed and launched in 2008 with USAID support, the PFES system has generated $1B+ (> 16.2 billion IDR) since 2011 to finance the conservation of ~40% of

[128] Ibid.
[129] Ibid.
[130] Ibid.
[131] Ibid.
[132] Frances Camille Rivera (Oceanus Conservation), in discussion with the authors, May 23, 2024.
[133] Ibid.

Vietnam's forest area.[134] As of 2020, the system incentivizes ~500,000 rural households in mountainous watershed areas to protect surrounding forests through payments from companies that benefit from the ecosystem services provided, such as clean and sufficient river water. As a result, Vietnam reported sequestration amounts of ~20M tons of CO_2e annually.[135]

Despite the large headline figures, one frequent issue encountered are the tensions around financial incentive for households to engage in these programs. Currently, households are paid 200,000–400,000 Dong (IDR 126,000–252,000 IDR) per hectare per year through management contracts for mangrove conservation, about 5-6% of the annual household income.[136] This amount cannot compete with the value of alternative use of the mangrove areas, and may not even cover monitoring and enforcement costs.[137,138] However, conservation efforts in Vietnam have been successful due to the integration with blue foods production through integrated mangrove-shrimp farming. Integrated mangrove-shrimp culture requires low investment and provides livelihood diversification by serving as a consistent income stream for coastal communities.[139] In particular, the Markets and Mangroves initiative project in the Mekong Delta focused on the development of sustainable shrimp farming models to both restore and protect mangrove forests while enhancing smallholder livelihoods.[140] SNV and the International Union for Conservation of Nature (IUCN) trained over 5,600 farmer households on the mangrove ecosystem and organic shrimp farming practices and helped 3,200 households receive organic certification in order to receive price premiums.[141] A total of VND 5.3B (IDR 3.34B) was also paid out in Payments for Forest Ecosystem Services for adherence to sustainable practices, including maintaining 50%+ mangrove coverage.[142] These outcomes underscore the opportunity that integration of blue foods into BCE efforts creates for building sustainable local livelihoods.

[134] USAID, "USAID Sustainable Forest Management," *USAID*, https://www.usaid.gov/vietnam/fact-sheets/usaid-sustainable-forest-management.
[135] Ibid.
[136] Matt Sommerville, "Mangrove Payment for Environmental Services in Vietnam: Opportunities and Challenges: Tenure," *USAID*, 2016, https://www.land-links.org/wp-content/uploads/2018/02/USAID_LAND_TENURE_TGCC_MANGROVE_PAYMENT_VIETNAM.pdf.
[137] Ibid.
[138] Van Thi Hai Nguyen, et al., "The challenges of collective PES: Insights from three community-based models in Vietnam," *Ecosystem Services* 56 (2022), https://doi.org/10.1016/j.ecoser.2022.101438.
[139] Nesar Ahmed, Shirley Thompson, and Marion Glaser, "Integrated mangrove-shrimp cultivation: Potential for blue carbon sequestration."
[140] SNV, "Mam-II: Scaling up Ecosystem-Based Adaptation in the Mekong Delta."
[141] Ibid.
[142] Ibid.

Community capacity building

Even with a clear economic model in place, the right coordination mechanisms and infrastructure must be in place for communities to design and effectively implement projects.

For instance, financing Mikoko Pamoja required identifying and gathering input from 100+ stakeholders in the area, with the community being incorporated from the outset, and outside expertise provided by the government, academic institutions, and NGOs.[143] The ultimate structure was that buyers purchased carbon credits through the ACES once certified by Plan Vivo.[144] Mikoko Pamoja also set-up a dedicated organizational body that oversaw the democratic allocation of funds, with processes that enabled full transparency.[145]

The project's approach to seagrasses similarly incorporates community feedback while designing a creative financing mechanism. Seine netting, typically used to catch larger fish, can damage seagrasses, and so the project plans to set-up a voluntary seagrass management area, informed by a full stakeholder consultation including the local fishing community.[146] While the protected seagrass will not qualify for Plan Vivo Certificates due to the technical and financial challenges in monitoring and a low anticipated income from seagrass carbon, the income to fund its management is planned to come from a "carbon plus" model.[147] In this model, buyers of certificates will have the option to pay an additional donation to fund these management measures, based on an assumed 1.38tC/ha per year burial.[148] Wider ecosystem services like coastal protection, fisheries enhancement and biodiversity will also be emphasized.[149] This plan highlights the increasing recognition of the value of BCEs beyond just carbon sequestration and points to the possibility of internalizing other sources of value.

While there was successful collection and distribution of income for Mikoko Pamoja, there are other projects in the country hampered by lack of financial infrastructure.[150] Galvan noted from her experience at Distant Imagery that in some cases funding could not be given to certain communities when they were not registered under an official body.[151] This concern is

[143] Michie (in discussion with the authors).
[144] Plan Vivo, "Mikoko Pamoja"
[145] Mikoko Pamoja, "Plan Vivo Project Design Document (PDD)."
[146] Ibid.
[147] Ibid.
[148] Ibid.
[149] Ibid.
[150] Galvan (in discussion with the authors).
[151] Ibid.

particularly salient for women, who may find it difficult to form a formal group.[152] Thus, initiatives that support communities, and in particular women, to self-organize, could alleviate this challenge.

In Madagascar, while the Tahiry Honko Project was set up to sell blue carbon credits under the Plan Vivo standard, the community does not have the infrastructure to receive payments.[153] At this time, Blue Ventures has secured a $20,000 sale of blue carbon credits that has been put in a trust as they wait for the infrastructure to develop.[154] Mangroves are included under the national REDD+ program in Madagascar, so any carbon project on public land must also be incorporated under the project and receive financing through a dedicated fund in the treasury.[155] As the fund is not set-up, a considerably larger source of income remains inaccessible at this time, even as there are auxiliary income resources from the restoration and conservation of the area.[156] The criticality of ensuring proper financial infrastructure is in place cannot be understated.

Vietnam has ensured compensation through various approaches, to uphold government policy. The PFES policy in Vietnam requires users of forest environmental services to make payments to suppliers of these services.[157] As outlined in Decree 99, services include "watershed protection; natural landscape beauty protection and biodiversity conservation for tourism; forest carbon sequestration and reduction of greenhouse gas emissions…, and the provision of the forest hydrological services for spawning in coastal fisheries and aquaculture."[158] Since 2018, compensation has been made easier through USAID's Vietnam Forests and Deltas (VFD) program working with ViettelPay and Vietnam's Forest Protection and Development Fund to introduce e-payments via mobile phones.[159] The ViettelPay system in Vietnam has expanded e-payment services to 3600 rural communities and ~500,000 households across Vietnam, a similar

[152] Ibid.
[153] Leah Glass (Blue Ventures), in discussion with the authors, May 14, 2024.
[154] Ibid.
[155] Ibid.
[156] Ibid.
[157] Open Development Vietnam, "Decree No. 99/2010/ND-CP on the policy on payment for forest environment services," *Open Development Vietnam*, https://data.vietnam.opendevelopmentmekong.net/laws_record/decree-no-99-2010-nd-cp-on-the-policy-on-payment-for-forest-environment-services.
[158] Center for International Forestry Research and World Agroforestry, "Payments for forest environmental services (PFES) in Vietnam," *Center for International Forestry Research and World Agroforestry*, 2014, https://doi.org/10.17528/cifor/005066.
[159] Ibid.

e-payment system being implemented in Madagascar's REDD+ program.[160]

The REDD+ Community Carbon Pools program, run by Fauna and Flora International (FFI), is another initiative that aims to transfer forest tenure rights from state agencies to local villagers, with the goal of generating carbon credits. Due to the slow process of receiving a tenure certificate, by the end of the project in 2014, only one village had received a land tenure certificate. Until the carbon certificates could be obtained, FFI created an enforcement program consisting of forest patrol teams in 11 villages paid to enforce the conservation and protection of the mangroves.[161] This way, as the communities waited for the certificates, there would still be a financial incentive to protect the mangroves. These PES revenues were pooled into community funds with benefit-sharing mechanisms. To receive funds and comply with regulations, villages had to sign forest protection agreements. Afterward, professional forest teams were established and paid monthly salaries. FFI was able to overcome bureaucratic barriers to equip the community with the infrastructure and coordinating mechanisms to be financially sustainable.

V. Conclusion

As home to the highest density of mangroves in the world and the second largest fishing nation, Indonesia is at the forefront of capturing synergies at the BCE and Blue Food Nexus. It can do so by implementing initiatives and policies that support the conservation and management of BCEs in a way that fosters a sustainable and inclusive blue food system.

Indonesia can leverage best practices from these case studies, while tailoring solutions to its unique environmental and socio-economic landscape. Collaborative efforts, both domestically and internationally, will be essential in advancing this agenda, fostering knowledge exchange, capacity building, and policy alignment. Ultimately, Indonesia's success in navigating the intricate interplay between conservation, productivity, and community welfare holds the promise of not only securing its own sustainable future but also inspiring and guiding global efforts in harnessing the potential of the BCE and Blue Food Nexus.

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[160] USAID, "USAID Promotes Electronic Payments to Increase Efficiency and Reduce the Risk of COVID-19," *USAID*, August 7, 2020, https://www.usaid.gov/vietnam/news/aug-07-2020-usaid-promotes-electronic-payments-increase-efficiency-and-reduce-risk-covid-19.

[161] Samantha Citroen, "Fauna and Flora International REDD+ Policy Brief," *Fauna and Flora International*, https://www.fauna-flora.org/wp-content/uploads/2023/05/FFI_201501_005_REDD-Policy-Briefing-Carbon-accounting-Measuring-forest-cover-and-change.pdf.

As highlighted by efforts in these countries, it is critical to have communities own and drive efforts, incorporate effective education at the government and community-level, recognize and include women, and implement sustainable and sufficient financing mechanisms. Beyond the takeaways under each pillar, it's critical to design policies that recognize and amplify the interconnectedness of these themes to drive systems-level change. For instance, supporting community-based education on the importance of BCEs and sustainable methods to harvest blue foods in sustainable ways can increase a community's sense of ownership of the land. In turn, the community is better equipped to inform the design of a financing mechanism that provides sufficient and sustainable sources of income, and to democratically control allocation of outside funding. Financing mechanisms must also consider the role of women in the community, with higher rates of adherence if their inclusion is into laws and regulations. And lastly, women have a critical role to play in the continued education of the youth to ensure longevity of initiatives and can do so with the right support. Indonesia similarly can zoom out to create policies aimed at leveraging the underlying drivers of the dynamics at the nexus.

Overall, the nexus between BCEs and blue foods reflects the power of systems thinking and holistic solutions for social, environmental, and economic challenges. Our policy memo has highlighted the importance of mangroves within the nexus, and future research should continue to explore how the lessons learned from these case studies may be informative for Indonesia's coastal communities.

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VII. Appendices

Appendix 1. Acronyms

ACES – Association for Coastal Ecosystem Services

AFA – Alitas Farmers Association

BaNafaa – Gambia-Senegal Sustainable Fisheries Program

BCEs – Blue Carbon Ecosystems

CEPF – Critical Ecosystem Partnership Facility

CPUE – Catch Per Unit Effort

FCPF – Forest Carbon Partnership Facility

FEE – Foundation for Environmental Education

FFI – Fauna and Flora International

IGA – Income Generating Activities

MPCO – Mikoko Pamoja Community Organization

NGO – Non-Governmental Organization

PES – Payment for Ecosystem Services

PFES – Payment for Forest Environmental Services

ROV – Remotely Operated Vehicle

REDD+ – Reducing Emissions from Deforestation and forest degradation in Developing countries; + is for additional forest-related activities that protect the climate

TEK – Traditional Ecological Knowledge

TWNP – Tanbi Wetland National Park

UNDP – United Nations Development Programme

VFD – Vietnam Forests and Deltas

Appendix 2. Interview Protocol

This report features a variety of findings from 16 expert interviews with a range of actors in the blue foods / blue carbon nexus ranging from NGOs, such as Wetlands International, to universities, such as the University of Mauritius. These interviews have elucidated key trends, challenges, and opportunities in the blue carbon / blue food nexus that demonstrate to BAPPENAS the importance of policy focused on exploiting the synergies of this nexus. For each semi-structured interview, we began by understanding the specific aspect of the blue carbon blue food nexus they focused on and followed with questions such as “How has government policy helped or hindered local blue carbon / blue food ecosystems?” and “How have communities been involved in managing blue carbon / blue food ecosystems, and what benefits do the community receive from these efforts?” Depending on the interviewee’s response, we could continue to inquire about their particular area of expertise within the blue carbon / blue food nexus. We chose a semi-structured interview process due to the vast range in backgrounds and expertise of our interviewees. By adapting our open-ended questions to the expertise of the interviewees, we were able to collect more robust insights that allowed us to understand the benefits and challenges of the blue carbon-blue food nexus clearly.