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Review Paper

Assessing Climate Vulnerability and Enhancing Adaptive Capacity in Social-Ecological Fisheries and Aquaculture Systems

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Abstract

The escalating impacts of anthropogenic climate change pose an existential threat to global aquatic ecosystems and the socio-economic stability of fisheries-dependent communities. This comprehensive review synthesizes empirical literature to evaluate the cascading biophysical stressors—including thermal anomalies, ocean acidification, deoxygenation, and shifting current dynamics—on both wild-capture fisheries and managed aquaculture systems. Utilizing the Intergovernmental Panel on Climate Change (IPCC) vulnerability framework, this paper assesses the exposure, sensitivity, and adaptive capacity of small-scale fisheries (SSF) and coastal communities, highlighting their pronounced susceptibility due to localized resource dependency and limited capital mobility. Furthermore, this review critically examines behavioural, technological, and institutional adaptation strategies. For capture fisheries, resilience mechanisms encompass gear modification, target species diversification, and dynamic spatial management. In parallel, the aquaculture sector must prioritize structural and genetic innovations, such as Recirculating Aquaculture Systems (RAS) and Integrated Multi-Trophic Aquaculture (IMTA). By analyzing over twenty foundational and contemporary peer-reviewed studies, this paper demonstrates that proactive, ecosystem-based management and equitable policy interventions are imperative to secure the socio-economic resilience of global fisheries livelihoods in a warming ocean.

Keywords: Climate change adaptation; Small-scale fisheries; Aquaculture resilience; Social-ecological systems; Climate vulnerability; Marine heatwaves.

Introduction

Global aquatic food systems are experiencing rapid and unprecedented changes due to human-induced greenhouse gas emissions. Fisheries and aquaculture play a vital role in global food security, supplying essential protein to more than 3.3 billion people and sustaining the livelihoods of around 600 million individuals, mainly in the Global South (Food and Agriculture Organization 2022). Nevertheless, these sectors are at the forefront of the climate crisis. The tangible effects of climate change, including increasing sea surface temperatures (SST), ocean acidification, and rising sea levels, are fundamentally disrupting the historical environmental baselines that have traditionally supported fisheries management and the livelihoods of coastal communities[1,2].

Climate change leads to increased temperatures, altered precipitation patterns, and a rise in extreme weather events, such as droughts and floods, all of which negatively impact the development of water resources[3]. Climate change poses a serious threat to the food and livelihood security, the large tract of land being located in arid environment, with lowering forest coverage and expanding desertification[4]. Imbalance in supply and demand of water resources is mainly due to lack of knowledge about climatic changes and mismanagement of water resources[5]. Owing to change in climatic conditions in recent decades because of global warming, the hydrological cycle in India has been adversely affected and due to anthropogenic activities, there is an increase in global surface temperature which is clear from various evidence[6].

For many years, fisheries management operated under the belief that environmental conditions were unchanging. However, recent empirical data have disproven this notion, revealing a widespread global impact of climate change on marine ecosystems. This is evident in the movement of species towards the poles and significantly altered timing of biological events[7].

Such ecological transformations lead to profound socio-economic challenges. The degree to which national economies and local communities are affected by these changes varies greatly; those most dependent on fish for nutrition and economic purposes often have the least ability to adapt[8].

In this paper, the focus is on examining the unique biophysical stressors that affect wild catch and managed farm systems. It also details the sustainable adaptation practices that can be implemented to maintain the livelihoods of those dependent on fisheries.

Theoretical Framework

Vulnerability in Social-Ecological Systems: The vulnerability framework established by the Intergovernmental Panel on Climate Change (IPCC)[9] serves as a crucial basis for assessing climate impacts on fisheries. This framework views fisheries as integrated Social-Ecological Systems (SES)[10]. The vulnerability of a fisheries system is defined both mathematically and conceptually as a function of its exposure to climatic threats, its inherent sensitivity, and its capacity to adapt:

$$\boldsymbol{V = f(E, S, AC)}$$

Where: Exposure (E): This refers to the extent and nature of physical climatic threats that the system encounters, including localized sea surface temperature anomalies, rates of ocean acidification, or how often storm surges occur[11]. Sensitivity **(*S*)**: The extent to which ecological factors, such as the physiological thermal limits of target species, and social factors, like a community's dependence on a single fishery, are negatively impacted by exposure[12]. Adaptive Capacity (AC): Communities can adapt to possible harm or take advantage of new opportunities through certain preconditions, available resources such as financial, technological, and social capital, and governance frameworks[8].

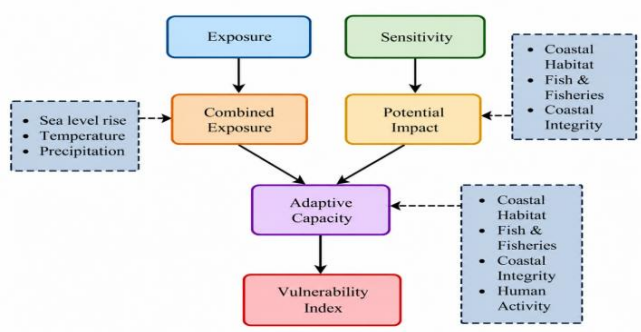


Figure-1: Climate change vulnerability assessment framework.

Sustainable practices mainly function by deliberately reducing system sensitivity, such as altering catch portfolios, and enhancing adaptive capacity, like upgrading to infrastructure that can withstand climate changes.

Biophysical Stressors and Ecological Responses

Identifying the precise biophysical routes by which climate change harms aquatic environments are essential for developing successful adaptation strategies.

Ocean Warming and Marine heat waves: Since the industrial revolution, the global ocean has absorbed about 90% of the surplus heat retained in the climate system. This persistent warming significantly impacts the metabolic rates of marine ectotherms. In addition, there has been a sharp rise in the frequency, duration, and intensity of marine heat waves, which are periods characterized by unusually warm water[13]. When sea surface temperatures surpass the physiological limits of certain species, fish experience slower somatic growth, reduced reproductive success, and increased vulnerability to endemic diseases. The historical warming alone has already led to a 4.1% reduction in the maximum sustainable yield of several crucial marine fish populations globally from 1930 to 2010[14].

Climate Velocities and Species Redistribution: Marine organisms are highly responsive to temperature changes, adjusting their locations to remain within their optimal thermal environments as ocean temperatures rise. This leads to a widespread movement toward the poles and a tendency to inhabit deeper, cooler waters, progressing at an average pace of 72 kilometres per decade[3]. The speed and direction of these shifts in distribution align with local climate change rates. As a result, predictive models suggest a significant global reallocation of maximum catch potential; regions at higher latitudes might see temporary boosts in catch potential, whereas tropical and equatorial areas could experience declines in catch potential by as much as 40% under high-emission scenarios by 2050[15].

Ocean Acidification and Hypoxia: Alongside thermal stress, the ocean has absorbed about 30% of human-made emissions, resulting in a global seawater pH decrease of 0.1 units. This ocean acidification alters the balance of inorganic carbon, significantly reducing carbonate ions, which are essential for the calcification of key organisms such as pteropods, commercially cultivated bivalves, and reef-building corals[16]. Additionally, increased thermal stratification diminishes oceanic ventilation, causing Oxygen Minimum Zones (OMZs) to expand. Hypoxia limits the depth range that many pelagic and demersal species can inhabit, pushing them into narrower surface areas where they are more susceptible to overfishing.

Socio-Economic Impacts on Small-Scale Fisheries

As outlined earlier, the ecological disturbances lead to significant socio-economic challenges, with Small-Scale Fisheries (SSF) bearing the brunt of these impacts. Despite contributing to nearly 50% of the world's fish catches and providing jobs for more than 90% of global capture fishers, SSFs face structural limitations due to restricted capital movement and heavy reliance on resources.

Economic Thresholds and Livelihood Disruption: When traditional and highly prized target species move beyond the reach of local fishing fleets, communities often see a sharp decline in Catch Per Unit Effort (CPUE). Artisanal fishers are hit with a twofold economic burden: reduced income from smaller catches and rising operational expenses, such as fuel, due to the need to pursue fish further offshore[17]. This situation often traps fishers in a poverty cycle, preventing them from investing in new equipment and leaving them without the skills needed to leave the fishing industry.

Linked Sustainability Challenges: The reduction in catch potential poses a direct threat to global nutritional security. In areas such as the tropical Pacific, climate change is expected to significantly harm coral reef ecosystems, leading to a substantial decrease in the availability of reef-associated fish, which coastal communities depend on for vital micronutrients and protein[18]. Additionally, the intricate relationship between diminishing local yields and rising global market demand results in interconnected sustainability challenges that promote localized overfishing, further weakening the resilience of marine biodiversity[19].

Adaptation Strategies in Capture Fisheries

Addressing climate-induced changes in wild-capture fisheries necessitates anticipatory strategies that function concurrently at both the individual fisher level and within broader macroeconomic institutions.

Behavioral and Operational Shifts: At the operational level, survival mandates behavioral flexibility**: Target Species Diversification:** Fishers need to actively separate their income sources from the single species they have traditionally focused on. This adaptation requires them to accept the "tropicalization" of temperate waters by creating markets and employing new equipment for the warm-water species that are now appearing in their usual fishing areas[20]. **Gear Flexibility:** To accommodate changing species groups, it is essential to move away from the use of highly specialized and inflexible fishing tools, such as single-mesh gillnets. Instead, adopting more adaptable gear that can target multiple species and quickly adjust according to stock availability is necessary. **Spatio-Temporal Adjustments:** To align with changes in climate that affect the timing of natural events, spawning activities, and migration routes of marine species, fishers must adjust their navigation paths and shift the timing of their fishing seasons[21].

Institutional and Governance Innovations: Individual fisher adaptation is fundamentally constrained without robust systemic governance support. **Dynamic Ocean Management**: Conventional Marine Protected Areas (MPAs) are based on unchanging, fixed geographic limits. However, as ecosystems shift, these fixed boundaries become less effective for conservation. Fisheries governance needs to shift towards a more flexible spatial management approach, where protected areas, fishing bans, and quotas are regularly updated in real-time using satellite oceanography and predictive species models[22]. **Co-Management Systems**: Governance that is centralized and operates from the top down often overlooks the specific climatic details unique to local areas. By adopting co-management systems that combine traditional ecological insights with local scientific knowledge, coastal communities are empowered. This approach guarantees that adaptation strategies are not only environmentally appropriate but also culturally relevant[11].

Climate Vulnerability and Adaptation in Aquaculture

In policy discussions, aquaculture is often portrayed as a robust solution to the reduction in wild fish stocks. Yet, recent studies reveal that aquaculture operations, whether they involve coastal shrimp farms or open-sea salmon cages, are still significantly vulnerable to climate fluctuations[23].

Environmental Sensitivities and Pathogens: Open-water aquaculture systems are extremely vulnerable to sudden increases in temperature. Higher sea surface temperatures cause ongoing physiological stress in species farmed in cold water, significantly weakening their immune systems and leading to higher mortality rates. At the same time, warmer conditions boost the reproduction rates of aquatic pathogens and widen the range of parasites, causing severe disease outbreaks in densely populated farming operations[24]. Additionally, a major systemic weakness is aquaculture's dependence on wild-caught forage fish, such as anchoveta, for producing fishmeal. Since these wild pelagic fish stocks are very responsive to climate variations like the El Niño-Southern Oscillation, the aquaculture supply chain remains indirectly linked to the unpredictability of wild-capture fisheries[25].

Structural and Ecosystem-Based Adaptation: Ensuring the sustainability of aquaculture requires significant changes in both structure and ecology to separate food production from the uncertainties of environmental factors. **Recirculating Aquaculture Systems (RAS):** Substantial investment is being funneled into closed-loop Recirculating Aquaculture Systems to avoid the impacts of severe coastal weather and rising surface water temperatures. Figure-2 represents recirculating Aquaculture System integrated with Aquaponics[26].

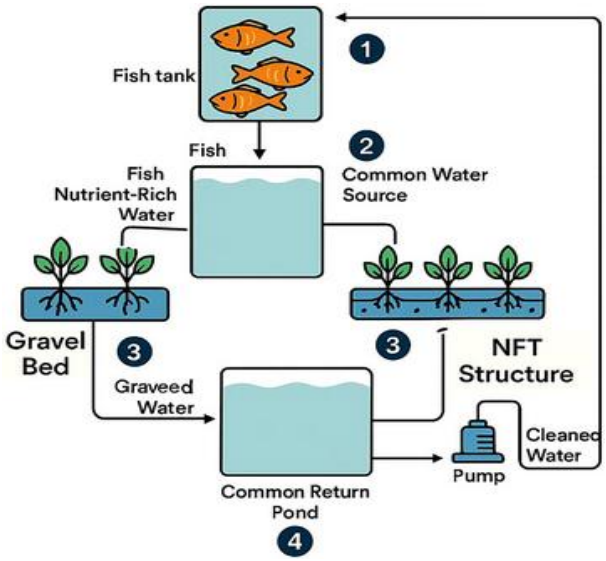


Figure-2: Recirculating Aquaculture System integrated with Aquaponics.

RAS significantly reduces the dangers associated with ocean acidification, harmful algal blooms, and severe storm surges by relocating production inland and mechanically filtering up to 99% of the water. However, this approach requires meticulous oversight due to its high energy demands. **Integrated Multi-Trophic Aquaculture (IMTA):** IMTA is a remarkably sustainable strategy that adapts to nature. It entails cultivating fed species, such as finfish, in conjunction with extractive species like bivalves and macroalgae or seaweed. Figure-3 represents the conceptual diagram of an integrated multitrophic aquaculture (IMTA) operation[27]



Figure-3: Conceptual diagram of an integrated multitrophic aquaculture (IMTA) operation.

Within an IMTA system, macroalgae take in large amounts of dissolved and nitrogenous waste produced by finfish. This swift absorption results in a localized "halo effect," which increases the pH of the nearby water. This creates an essential buffering zone that mitigates ocean acidification, thereby safeguarding the calcification processes of the co-cultured bivalves. This method not only decreases the farm's ecological impact but also boosts climate resilience and broadens the farmer's economic outputs[28,29].

Policy Implications

The future of global aquatic food systems in the face of climate change depends on rapid and fair policy actions. Both international organizations and national governments need to shift their focus from merely responding to disasters to proactively financing adaptation measures. Essential policy priorities are: **Reallocating Subsidies:** Reallocating the billions of dollars currently used for capacity-enhancing subsidies that promote industrial overfishing to support climate resilience efforts, such as financing gear modifications for small-scale fishing fleets and creating early warning systems for marine heat waves. **Livelihood Diversification:** Understanding that solely relying on biological management is inadequate, it is essential for governments to allocate resources to rural economies not dependent on fishing, such as eco-tourism and coastal agriculture, to reduce the inherent vulnerability of coastal communities. **Transboundary Agreements:** With fish populations moving between Exclusive Economic Zones (EEZs), it becomes necessary to renegotiate international agreements to incorporate adaptable, climate-sensitive quota distributions. This approach aims to avert geopolitical disputes over these changing resources.

Conclusions

This review integrates the diverse biophysical and socio-economic impacts of climate change on capture fisheries and aquaculture systems. The data indicates that increasing sea surface temperatures, more frequent marine heat waves, ocean acidification, and growing hypoxic zones have disrupted historical environmental norms, causing species to shift towards the poles and decreasing the productivity of global fisheries. According to the IPCC vulnerability framework, small-scale fisheries (SSFs) are particularly vulnerable due to their limited financial flexibility, significant reliance on resources, and decreasing catch-per-unit-effort (CPUE).

To tackle these challenges, a shift is required from merely responding to disasters as they occur to implementing proactive adaptation strategies that operate on multiple levels:

Capture Fisheries Adaptation: Fishers need to be operationally adaptable by varying their catch portfolios to include "tropicalized" species groups, altering their equipment to prevent reliance on a single species, and adjusting their fishing locations and timing in response to climate-induced changes in species behavior. On an institutional scale, it is essential to implement dynamic ocean management and co-management models to substitute fixed spatial boundaries with adaptable conservation strategies. **Aquaculture Decoupling**: To address the challenges of pathogen spread and feed-supply constraints, it is essential to employ models grounded in engineering and ecosystem principles. Recirculating Aquaculture Systems (RAS) with closed-loop designs offer vital protection against coastal biophysical threats. Meanwhile, Integrated Multi-Trophic Aquaculture (IMTA) helps mitigate localized ocean acidification through the "halo effect" of extractive macroalgae, while also promoting economic diversification. **Institutional Governance and Policy**: Maintaining long-term resilience requires redirecting subsidies that boost capacity to infrastructure that adapts to climate change, encouraging alternative livelihoods outside of fishing in coastal areas at risk, and revising treaties on transboundary allocations to fairly address the redistribution of stocks caused by climate change.

To secure global food supplies and protect coastal communities, it is essential to combine scientific predictions with indigenous ecological insights. Upcoming studies should emphasize detailed hydro-climatic simulations, prioritize risks using multiple criteria, and conduct empirical assessments of the interconnected socio-ecological resilience. This approach is crucial to protect aquatic food systems from the growing unpredictability of the climate.

References

1. Doney, S. C., Ruckelshaus, M., Duffy, J. E., Barry, J. P., Chan, F., English, C. A., Galindo, H. M., Grebmeier, J. M., Hollowed, A. B., Knowlton, N., Polovina, J., Rabalais, N. N., Sydeman, W. J. & Talley, L. D. (2012). Climate change impacts on marine ecosystems. *Annual Review of Marine Science*, 4, 11-37.

2. Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D' Agrosa, C., Bruno, J. F., Casey, K. S., Ebert, C., Fox, H. E., Fujita, R., Heinemann, D., Lenihan, H. S., Madin, E. M. P., Perry, M. T., Selig, E. R., Spalding, M., Steneck, R. & Watson, R. (2008). A global map of human impact on marine ecosystems. *Science*, 319(5865), 948-952.

3. Gupta, S., Tiwari, H. L. & Tiwari, A. (2026). Integrating morphometric analysis and multicriteria decision-making for sustainable watershed prioritization in the Barna River Basin, India. *Journal of Water and Climate Change*, 17(8), 2317-2335.

4. Balvanshi, A. & Tiwari, H. L. (2021). Quantitative estimation of the impact of climate change on crop evapotranspiration and yield in central region of India. *Russian Meteorology and Hydrology*, 46(10), 696-700.

5. Kumar, K. S., Galkate, R. V. & Tiwari, H. L. (2021). River basin modelling for Shipra River using MIKE BASIN. *ISH Journal of Hydraulic Engineering*, 27(2), 188-199.

6. Tiwari, D. K., Tiwari, H. L., & Nateriya, R. (2022). Runoff modeling in Kolar river basin using hybrid approach of wavelet with artificial neural network. *Journal of Water and Climate Change*, 13(2), 963-974.

7. Poloczanska, E. S., Brown, C. J., Sydeman, W. J., Kiessling, W., Schoeman, D. S., Moore, P. J., Brander, K., Bruno, J. F., Buckley, L. B., Burrows, M. T., Duarte, C. M., Halpern, B. S., Holding, J., Kappel, C. V., O'Connor, M. I., Pandolfi, J. M., Parmesan, C., Schwing, F., Thompson, S. A. & Richardson, A. J. (2013). Global imprint of climate change on marine life. *Nature Climate Change*, 3(10), 919–925.

8. Allison, E. H., Perry, A. L., Badjeck, M. C., Adger, W. N., Brown, K., Conway, D., Halls, A. S., Pilling, G. M., Reynolds, J. D., Andrew, N. L. & Dulvy, N. K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries*, 10(2), 173–196.

9. Pörtner, H. O., Karl, D. M., Boyd, P. W., Cheung, W. W. L., Lluch-Cota, S. E., Nojiri, Y., Schmidt, D. N. & Zavialov, P. O. (2014). Ocean systems. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects.* Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 411-484). Cambridge University Press.

10. Kittinger, J. N., Finkbeiner, E. M., Ban, N. C., Broad, K., Chollett, I., Campbell, L. M., Gutierrez, N. L., Hicks, C. C., Koehn, J. Z., McConney, P., O'Garra, T., Scholtens, J., Smith, L. S., Allison, E. H., Sandifer, P. A. & Crowder, L. B. (2013). Emerging frontiers in social-ecological systems research for sustainability of small-scale fisheries. *Current Opinion in Environmental Sustainability*, 5(3-4), 352–357.

11. Daw, T., Adger, W. N., Brown, K., & Badjeck, M.-C. (2009). Climate change and capture fisheries: potential impacts, adaptation and mitigation. In *Climate change implications for fisheries and aquaculture* (pp. 107-150). FAO Fisheries and Aquaculture Technical Paper 530.

12. Cinner, J. E., McClanahan, T. R., Graham, N. A. J., Daw, T. M., Maina, J., Stead, S. M., Wamukota, A., Brown, K. & Bodin, Ö. (2012). Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries. *Global Environmental Change*, 22(1), 12–20.

13. Hobday, A. J., Alexander, L. V., Perkins, S. E., Smale, D. A., Straub, S. C., Oliver, E. C. J., Benthuysen, J. A., Burrows, M. T., Donat, M. G., Feng, M., Holbrook, N. J., Moore, P. J., Scannell, H. A., Sen Gupta, A. & Wernberg, T. (2016). A hierarchical approach to defining marine heatwaves. *Progress in Oceanography*, 141, 227–238.

14. Free, C. M., Thorson, J. T., Pinsky, M. L., Oken, K. L., Wiedenmann, J. & Jensen, O. P. (2019). Impacts of historical warming on marine fisheries production. *Science*, 363(6430), 979–983.

15. Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., Zeller, D. & Pauly, D. (2010). Large-scale redistribution of maximum catch potential in the global ocean under climate change. *Global Change Biology*, 16(1), 24–35.

16. Cochrane, K., De Young, C., Soto, D. & Bahri, T. (2009). Climate change implications for fisheries and aquaculture: Overview of current scientific knowledge. *FAO Fisheries and Aquaculture Technical Paper*, 530. Rome, Italy: Food and Agriculture Organization of the United Nations.

17. Sumaila, U. R., Cheung, W. W. L., Lam, V. W. Y., Pauly, D., & Herrick, S. (2011). Climate change impacts on the biophysics and economics of world fisheries. *Nature Climate Change*, 1(9), 449–456.

18. Bell, J. D., Ganachaud, A., Gehrke, P. C., Griffiths, S. P., Hobday, A. J., Hoegh-Guldberg, O., Johnson, J. E., Le Borgne, R., Lehodey, P., Lough, J. M., Matear, R. J., Pickering, T. D., Pratchett, M. S. & Waycott, M. (2013). Mixed responses of tropical Pacific fisheries and aquaculture to climate change. *Nature Climate Change*, *3*(6), 591–599.

19. Blanchard, J. L., Watson, R. A., Fulton, E. A., Cottrell, R. S., Nash, K. L., Bryndum-Buchholz, A., Büchner, M., Carozza, D. A., Cheung, W. W. L., Elliott, J., Davidson, L. N. K., Dulvy, N. K., Dunne, J. P., Eddy, T. D., Galbraith,

E., Lotze, H. K., Maury, O., Müller, C., Tittensor, D. P., & Jennings, S. (2017). Linked sustainability challenges and impacts of climate change on catch of large marine and freshwater ecosystems. *Nature Ecology & Evolution*, 1(9), 1244–1252.

20. Ojea, E., Lester, S. E. & Salgueiro-Otero, D. (2020). Adaptation of fishing communities to climate-driven shifts in target species. *One Earth*, 2(4), 315–324.

21. Perry, A. L., Low, P. J., Ellis, J. R. & Reynolds, J. D. (2005). Climate change and distribution shifts in marine fishes. *Science*, 308(5730), 1912–1915.

22. Lam, V. W. Y., Cheung, W. W. L., Reygondeau, G., & Sumaila, U. R. (2016). Projected change in global marine fish catches under climate change scenarios. *Ecological Economics*, 128, 64–73.

23. De Silva, S. S. & Soto, D. (2009). Climate change and aquaculture: potential impacts, adaptation and mitigation. In *Climate change implications for fisheries and aquaculture* (pp. 151-212). FAO Fisheries and Aquaculture Technical Paper 530.

24. Soto, D., White, P., Dempster, T., De Silva, S., Flores, A., Karakassis, I., Knapp, G., Martinez, J., Miao, W., Sadovy, Y., Thorstad, E. & Wiefels, R. (2018). Addressing aquaculture-fisheries interactions through the implementation of the ecosystem approach to aquaculture. *FAO Fisheries and Aquaculture Circular No. 1168*. Rome, Italy: FAO.

25. Froehlich, H. E., Gentry, R. R., & Halpern, B. S. (2018). Global change in marine aquaculture production potential under climate change. *Nature Ecology & Evolution*, 2(11), 1745–1750.

26. Abdissa, B., Gete, M. & Muluneh, E. (2025). Evaluation of Nutrient Flow Through and Media-Bed Aquaponic Systems. *Aquaculture, Fish and Fisheries*, 5(5),

27. Chopin, T., Robinson, S. M. C., Troell, M., Neori, A., Buschmann, A. H., & Fang, J. (2008). *Multitrophic integration for sustainable marine aquaculture. Enc. Eco.*, 3, 2463–2475.

28. Galappaththi, E. K., Ford, J. D., & Bennett, E. M. (2020). Climate change and adaptation to global change in aquaculture systems. *Reviews in Aquaculture*, 12(1), 596–613.

29. Chopin, T., Cooper, J. A., Reid, G., Cross, S., & Moore, C. (2012). Open-water integrated multi-trophic aquaculture: environmental biomitigation and economic diversification of fed aquaculture by extractive aquaculture. *Reviews in Aquaculture*, 4(4), 209-220.