



Climate Change and Climate-Resilient Fisheries Management

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Climate change is increasingly transforming aquatic ecosystems and creating new challenges for sustainable fisheries management. Rising water temperatures, ocean acidification, altered rainfall, changing fish distributions and extreme weather events can affect fish stocks, fishing activities and the livelihoods of fishing communities. These changes highlight the limitations of conventional management approaches based mainly on historical environmental conditions. Climate-resilient fisheries management provides a more flexible approach by integrating climate information, ecosystem-based management, adaptive strategies and community participation into fisheries planning. Technologies such as GIS, remote sensing, artificial intelligence and forecasting systems can further strengthen monitoring and decision-making. Protecting critical habitats, diversifying livelihoods and developing resilient fisheries infrastructure can improve the adaptive capacity of fishing communities. A coordinated approach combining scientific knowledge, local experience, technology and effective governance is essential for achieving sustainable and climate-resilient fisheries in a changing ocean.

Keywords: Adaptive management; Climate change; Climate resilience; Fisheries management; Sustainable fisheries

Introduction

Fisheries are fundamental to global food and nutritional security, employment generation and the livelihoods of millions of people, especially those living in coastal and fisheries-dependent communities. However, climate change is increasingly affecting aquatic ecosystems by modifying ocean and freshwater temperatures, ecosystem functioning, fish distribution, biological productivity and the availability of fishery resources. Such environmental changes can influence fish catches, fishing grounds, fishing activities, income and the safety of fishing communities, thereby creating significant challenges for sustainable fisheries management (FAO, 2024a; Barange et al., 2018). Climate projections also suggest considerable changes in the distribution, productivity and biomass of marine species, emphasizing the importance of integrating climate-related factors into fisheries assessment, planning and management (Blanchard & Novaglio, 2024). Under these rapidly changing environmental conditions, conventional management approaches based mainly on historical patterns and relatively stable ecosystem conditions may become increasingly inadequate. Therefore, fisheries management must evolve towards flexible, adaptive and climate-resilient strategies that can accommodate changing ecosystem conditions while supporting healthy fish stocks, sustainable fisheries and resilient fishing-dependent communities (FAO, 2022; FAO, 2025).

How Climate Change is Changing Fisheries

Rising temperatures are major threats to aquatic ecosystems, affecting fish metabolism, growth, reproduction, survival and distribution. Warming waters can also reduce dissolved oxygen and alter food-web interactions, causing changes in fish abundance, community structure and fishing grounds. At the same time, increasing atmospheric CO₂ is driving ocean acidification,

which can negatively affect corals, molluscs and other calcifying organisms and influence fisheries productivity (FAO, 2018; IPCC, 2022). Changes in rainfall, freshwater flow and salinity can affect fish migration, recruitment, habitat quality and productivity in inland and coastal fisheries. Climate change also increases the risk of cyclones, floods, droughts and marine heatwaves, which can damage fishing infrastructure, disrupt fishing activities and increase safety risks for fishing communities (FAO, 2011; FAO, 2018).

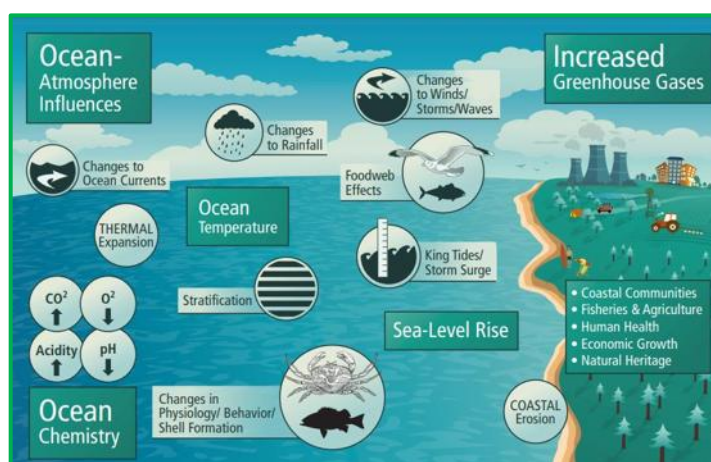


Fig. 1 Climate change can affect many parts of the ocean ecosystem including which species live in ocean, foodwebs and storms; which factors affecting to aquatic ecosystem
Source: <https://www.cooldavis.org/wp-content/uploads/2018/09/Climate-Change-Assessment-2018-image.jpg>

Impacts on Fish Stocks and Fisheries

Climate change can alter fish distribution, abundance, productivity, reproduction, migration and seasonal occurrence. Changes in temperature may shift species towards higher latitudes or deeper waters, affecting fishing grounds, fishing seasons and catch composition. Warm-water species may expand their ranges, while cold-water species may lose suitable habitats. These changes can increase uncertainty in fish biomass and catches and create management challenges when fish populations cross geographical or national boundaries. Climate vulnerability assessments can therefore help identify potential risks and guide effective fisheries management (FAO, 2018; IPCC, 2022; NOAA Fisheries, 2026).

Impacts on Fishing Communities

The consequences of climate change are not limited to aquatic organisms but also extend to the communities whose livelihoods depend on fisheries. Variations in fish abundance, distribution and seasonal availability can make catches less predictable and negatively affect household income, employment and livelihood stability. When fish become less abundant in traditional fishing areas, fishers may have to travel greater distances or spend longer periods at sea, increasing fuel, labour and operating expenses. Climate-related extreme events and changing marine conditions can also increase risks to fisher safety, particularly among small-scale fishing communities that have limited access to financial resources and modern technologies. Declining access to fish resources may further affect food and nutritional security, encouraging communities to seek alternative livelihoods, diversify fishing activities, undertake aquaculture or increase value addition. The severity of these impacts varies according to socioeconomic conditions and adaptive capacity, making small-scale and vulnerable fishing communities particularly susceptible to climate-related changes (FAO, 2018; NOAA Fisheries, 2026).

What Is Climate-Resilient Fisheries Management?

Climate-resilient fisheries management is an approach designed to help fisheries, aquatic ecosystems and dependent communities prepare for, respond to and recover from climate-related changes while maintaining sustainable fish populations and ecosystem health. Unlike conventional approaches that may depend heavily on historical environmental conditions, climate-resilient management recognizes that future ecosystems may differ considerably from the past and therefore incorporates climate information and uncertainty into management decisions. It brings together ecological resilience through healthy fish stocks and habitats, economic resilience through sustainable and diversified livelihoods, social resilience through community involvement and equitable resource access, and institutional resilience through flexible policies and adaptive governance. Together, these elements can reduce vulnerability

and improve the long-term sustainability of fisheries under changing climatic conditions (NOAA Fisheries, 2023; NOAA Fisheries, 2024).

Adaptive Fisheries Management

Adaptive fisheries management provides flexibility to modify management measures as fish populations and environmental conditions change. Under climate change, managers can periodically reassess scientific information and revise catch limits, fishing seasons, fishing effort, gear restrictions and spatial management measures when necessary. Rather than maintaining regulations unchanged for long periods, adaptive management follows a cycle of monitoring, evaluation, decision-making and adjustment. This approach enables fisheries managers to respond to unexpected changes in fish distribution, abundance and productivity while maintaining sustainable exploitation and addressing uncertainty associated with future environmental conditions (NOAA Fisheries, 2023; NOAA Fisheries, 2024).

Climate-Smart Stock Assessment

Climate-smart stock assessment incorporates environmental variability and climate information into the evaluation of fish stocks and their future productivity. Along with conventional fisheries information such as catch, fishing effort, age structure and population abundance, assessments can include environmental factors such as temperature, salinity, ocean currents, dissolved oxygen and habitat suitability. Climate vulnerability assessments can help identify stocks that are particularly sensitive to projected environmental changes, while scenario-based approaches can be used to examine possible future conditions and management options. Incorporating these factors can improve estimates of stock distribution and productivity and provide a stronger scientific basis for determining sustainable catches and management measures (NOAA Fisheries, 2026).

Ecosystem-Based Fisheries Management

Ecosystem-based fisheries management (EBFM) considers fisheries within the wider context of aquatic ecosystems rather than treating individual fish stocks independently. It takes into account relationships among fish populations, habitats, food webs, environmental conditions and human activities. This approach is particularly relevant under climate change because warming, acidification, habitat degradation and fishing pressure can interact and influence fisheries simultaneously. EBFM therefore emphasizes the protection of important spawning and nursery habitats, consideration of predator-prey relationships and management of interactions among different fisheries and ocean users. Maintaining healthy and functioning ecosystems can improve the ability of fish populations and fisheries to withstand environmental disturbances and recover from climate-related impacts (NOAA Fisheries, 2024).

Marine Protected Areas and Climate Refugia

Marine protected areas and other spatial conservation measures can support climate resilience by conserving habitats that are essential for feeding, spawning, recruitment and shelter. Climate refugia are areas where environmental conditions remain relatively suitable for organisms during periods of climatic stress and may therefore become increasingly important as ocean conditions change. Conservation of coral reefs, mangroves, seagrass ecosystems, estuaries and other productive habitats can help maintain biodiversity and provide important areas for fish populations to survive and recover. Spatial protection can complement conventional fisheries regulations by reducing additional human pressures on ecosystems already affected by climate change and conserving habitats that contribute to long-term fisheries productivity (NOAA Fisheries, 2024).

Diversification of Fishing Activities

Diversifying fishing and livelihood activities can increase the economic resilience of communities that depend heavily on fisheries. Changes in fish distribution, abundance and fishing seasons may make dependence on a single species or fishing ground increasingly risky. Fishers can therefore adapt by targeting suitable alternative species, adopting appropriate

fishing gears and improving post-harvest handling, processing, storage and value addition. Where feasible, complementary activities such as sustainable aquaculture, seafood processing, tourism and other alternative livelihoods can provide additional sources of income. Such diversification can reduce the economic consequences of unpredictable catches and improve the ability of households to cope with climate-related disturbances (FAO, 2018; NOAA Fisheries, 2026).

Climate-Resilient Fishing Infrastructure

Strengthening fisheries infrastructure is essential for reducing the damage caused by climate-related hazards such as cyclones, storms, flooding and sea-level rise. Fishing harbours, landing centres, processing facilities, cold-storage units and transportation systems can be designed or upgraded according to local climate risks to reduce damage and operational interruptions. Improvements in vessel safety, harbour protection, cold-chain facilities and emergency communication can help protect fishers and reduce economic losses during extreme events. When combined with disaster preparedness and effective early-warning systems, resilient infrastructure can also improve the ability of fishing communities to recover following climate-related disasters (FAO, 2018; FAO, 2011).

Technology and Digital Fisheries Management: Digital technologies provide important opportunities for improving fisheries management under changing climatic conditions. GIS, remote sensing and satellite observations can help monitor changes in oceanographic conditions, habitats and fish distribution, while IoT-based sensors and electronic monitoring systems can generate timely information about fishing operations and environmental conditions. Artificial intelligence and machine-learning methods can analyse large and complex datasets to identify patterns, predict fish distribution and support fisheries decision-making. Vessel Monitoring Systems (VMS) and electronic catch-monitoring technologies can further improve information on fishing activities and support compliance with regulations. Combining these technologies with climate and ecosystem data can make fisheries management more timely, predictive and evidence-based (NOAA Fisheries, 2024).

Community-Based and Participatory Management

Active participation of fishing communities is essential for developing effective and socially appropriate climate-resilient fisheries management. Fishers possess valuable local and traditional knowledge regarding changes in fish distribution, seasonal fishing patterns, weather conditions and ecosystem behaviour, which can complement scientific observations. Building the capacity of fisher organizations and local institutions through climate-awareness programmes, training and access to relevant information can further enhance their ability to anticipate and respond to climate-related risks. Thus, participatory fisheries governance can strengthen social resilience while improving the effectiveness and sustainability of fisheries management (NOAA Fisheries, 2024; NOAA Fisheries, 2025).

Climate-Resilient Fisheries in India

Indian fisheries are increasingly affected by rising sea-surface temperatures, changing monsoon patterns, cyclones and other coastal hazards, which can alter fish distribution, abundance, productivity and fishing activities. These changes particularly affect small-scale fishing communities whose livelihoods depend heavily on marine resources. ICAR-CMFRI plays an important role in monitoring climate-related changes in Indian marine fisheries and assessing their vulnerability. Strengthening adaptive management, early-warning systems, fisher awareness and climate-resilient policies can help sustain Indian fisheries under changing climatic conditions.

Role of Blue Economy in Climate-Resilient Fisheries

A sustainable blue economy can strengthen fisheries resilience by promoting responsible fishing, ecosystem restoration, sustainable aquaculture, coastal tourism, seafood value addition and alternative livelihoods. Protecting mangroves, coral reefs and seagrass habitats can

increase ecosystem resilience, while improve seafood value chains and reduce environmental impacts can support both economic development and marine conservation.

Future of Fisheries Management Under Climate Change

Future fisheries management should move from conventional approaches towards climate-informed and adaptive management. Integrating climate and fisheries data with AI, GIS, remote sensing, satellite technology and forecasting can improve prediction and decision-making. Combining these technologies with ecosystem conservation and community participation can help build sustainable and climate-resilient fisheries.

Key Challenges

Major challenges include inadequate long-term climate and fisheries data, uncertainty in climate projections, limited financial and technological resources, low adaptive capacity among small-scale fishers and weak institutional coordination. Changes in fish distribution across management and national boundaries also create additional challenges. Addressing these issues will require better data, flexible policies, technological support, stronger institutions and regional cooperation.

Conclusion

Climate change is becoming a major challenge for fisheries by altering ocean temperature, species distribution, ecosystem productivity, extreme weather patterns and the livelihoods of fishing communities. Building climate-resilient fisheries therefore requires a shift from conventional management based mainly on historical conditions towards flexible, adaptive and ecosystem-based approaches. Climate information should be incorporated into stock assessment, harvest strategies, early-warning systems and fisheries planning so that management decisions can respond to changing environmental conditions. Long-term resilience will also depend on reducing overfishing, protecting critical habitats, strengthening marine conservation, diversifying fisher livelihoods and improving community participation in decision-making. Combining scientific knowledge with local and traditional knowledge, digital technologies, forecasting tools and effective governance can improve the capacity of fisheries and fishing communities to cope with future climate risks. Ultimately, climate-resilient fisheries management should aim not only to maintain fish stocks and sustainable catches but also to protect food security, livelihoods, biodiversity and the health of aquatic ecosystems for future generations.

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