



Food and Agriculture
Organization of the
United Nations

FAO's work on climate change Fisheries and aquaculture 2020

FAO's work on climate change

Fisheries and aquaculture 2020

Required citation:

FAO. 2021. *FAO's work on climate change – Fisheries and aquaculture 2020*. Rome. <https://doi.org/10.4060/cb3414en>

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ISBN 978-92-5-133989-3

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Introduction

Fisheries and aquaculture and their dependent communities are at the forefront of climate change impacts, calling for concerted efforts in mitigation and adaptation.

Climate change is one of the greatest challenges of our time. The September 2019 Special Report on the Ocean and Cryosphere (SROCC) of the Intergovernmental Panel on Climate Change (IPCC) is a key milestone in the knowledge of climate change impacts on oceans and seas. The report confirms the multi-decadal trend of ocean warming and the rise of global mean sea level at a rate that has tripled over the last century as a result of ice and glacier melting at global scale.

The report also indicates that cryospheric and associated hydrological changes have impacted and will continue to impact terrestrial and freshwater ecosystems in high mountain and polar regions with major shifts in species distributions, as a result of the appearance of land previously covered by ice, changes in snow cover, and thawing permafrost.

The SROCC singles out the fisheries and aquaculture sector as one of the human activities exposed and vulnerable to climate drivers and analyses impacts and responses, echoing the most relevant messages of the FAO Fisheries and Aquaculture Technical Paper 627, *Impacts of climate change on fisheries and aquaculture – synthesis of knowledge, adaptation and mitigation options*. Climate change will lead to significant changes in the availability and trade of fish products, with potentially important geopolitical and economic consequences, especially for those countries most dependent on the sector.

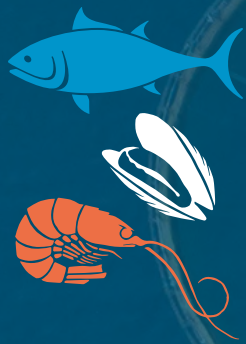
The extent of the impacts of climate change on the fisheries and aquaculture sector, including climate change-induced extreme events, will largely be determined by the sector's ability to develop and implement mitigation and adaptation strategies. Although a relatively small global contributor, fisheries and aquaculture have a responsibility to limit greenhouse gas (GHG) emissions as much as possible through mitigation measures such as reducing energy consumption, better feed and feed management, and low-impact fishing methods and

gears. As far as adaptation is concerned, FAO has provided an adaptation toolbox, which comprises institutional adaptation, measures addressing livelihoods, and measures intended for reduction and management of risk which thereby strengthen resilience.

Efforts to mitigate and adapt to climate change must be human-centred. Millions of people are struggling to maintain reasonable livelihoods through fisheries and aquaculture. These are the people who are the most vulnerable to the impacts of climate change, which adds to the many threats and obstacles that already confront them in their day-to-day lives. While effective mitigation and adaptation will be required across all scales and sectors of fisheries and aquaculture, particular attention needs to be given to the most vulnerable if the sector is to continue to contribute to meeting global goals of poverty reduction and food security.

FAO has implemented and will continue to implement a range of activities aiming at supporting member countries and partners to effectively mitigate and adapt to the impacts of climate change for fisheries, aquaculture and aquatic ecosystems, through knowledge development and exchange, policy development, practical demonstration and capacity-building. Impacts of climate change may be intensifying, but so are FAO's efforts. FAO is stepping up to address the climate challenge in the fisheries and aquaculture sector.

Facts and figures



177.8 MILLION TONNES

Excluding crocodiles, aquatic mammals and plants, global production of fish, crustaceans, molluscs and other aquatic animals continued to grow and reached **177.8 million tonnes** in 2019.



World marine capture fisheries production was **80.4 million tonnes** in 2019.



92.5 MILLION TONNES

Global capture production was **92.5 million tonnes** in 2019.



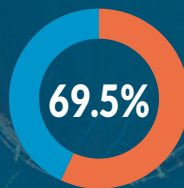
12.1 MILLION TONNES

Global capture fisheries production in inland waters reached **12.1 million tonnes** in 2019, accounting for **13.1 percent** of total capture fisheries production.



59.5 MILLION PEOPLE

In 2018, about **59.5 million people** were engaged in the primary sector of capture fisheries and aquaculture. Of this total, 39 million people were engaged in fisheries and 20.5 million in aquaculture.



Fed aquaculture (**57 million tonnes**) has outpaced non-fed aquaculture (**25 million tonnes**)

and accounted for **69.5 percent** of total aquaculture production in 2018.

85.3 MILLION TONNES

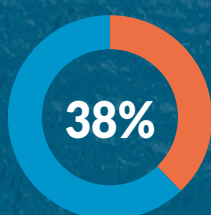
Global aquaculture production (excluding aquatic plants) reached **85.3 million tonnes** in 2019.



50%

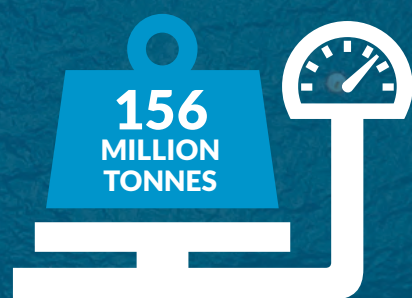
The total engagement of **women across both fisheries and aquaculture was over 50 percent** when including the secondary sector.

USD 165 BILLION



A large share of all fish production enters international marketing channels – about **38 percent** (live weight equivalent) **was exported** in 2018. In the same year, world exports of fish and fish products reached **USD 165 billion**, a new record high.

In 2018, about **88 percent (156 million tonnes)** of world fishery production was used for **direct human consumption**. The remaining 12 percent (22 million tonnes) was destined for non-food products, mainly for the manufacture of fishmeal and fish oil.



Imports of fish and fish products of developing countries represented **31 percent** of the global total **by value** and **49 percent in quantity** (in live weight) in 2018, compared with 12 percent and 21 percent, respectively, in 1976.

The percentage of marine **fish stocks fished within biologically sustainable levels** has exhibited a decreasing trend, **from 90.0 percent in 1974 to 65.8 percent in 2017**. In contrast, the percentage of stocks **fished at biologically unsustainable levels** increased **from 10 percent in 1974 to 34.2 percent in 2017**.



Preliminary estimates for 2018 indicate apparent per capita fish consumption of **20.5 kg**.

5.9%
increase during
2001–2010

4.7%
increase during
2011–2019

World aquaculture production of aquatic animals enjoyed an average annual growth rate of **5.9 percent during 2001–2010**. The annual growth rate reduced to an average of **4.7 percent during 2011–2019**. The contribution of aquaculture to the total production of aquatic animals from capture fisheries and aquaculture combined has risen steadily from **26 percent in 2000 to 48 percent in 2018**.




USD 401 BILLION

In 2018, the total first sale value of total production was estimated at **USD 401 billion**, of which USD 250 billion was from aquaculture.

Impacts of climate change on fisheries and aquaculture

Climate change is poised to transform marine and freshwater ecosystems. The livelihoods of millions of fishery-dependent people are at risk.



Impact pathways of climate change

Climate change is having profound impacts on fishery and aquaculture-reliant communities and the ecosystems they depend on, especially in tropical regions. Climate change drivers are causing and are expected to continue to cause potentially significant changes in ocean currents, sea level rise, acidification, rainfall, river flows, lake levels and thermal structure, as well as changes in the severity and frequency of storms (Figure 1).

In turn, these changes are affecting the production ecology and biodiversity of aquatic systems, resulting in changes in species composition in catches, reduced production and yield (especially in the tropics), increased yield variability, diseases, coral bleaching, calcification and distribution.

Moreover, these changes are also impacting the socioeconomic status of the fisheries and aquaculture sector in many parts of the world and the poverty and food insecurity of areas dependent on fish and fishery products, as well as the governance and management of the sector and wider society.

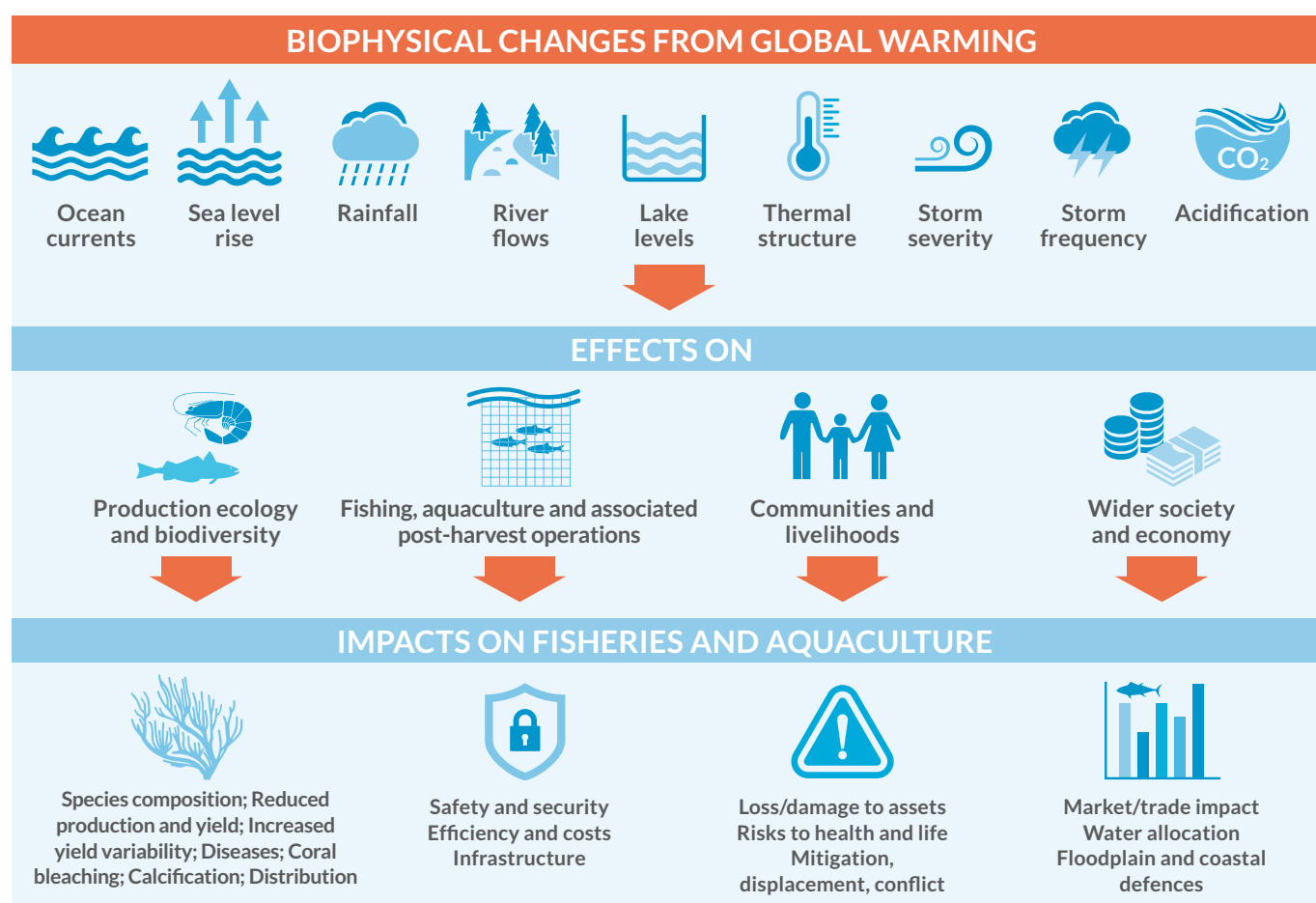


Figure 1: Climate variability and change impact pathways in fisheries and aquaculture
Source: adapted from Badjeck *et al.*, 2010.

Catch potential in fisheries

Climate change could substantially alter the provision of the goods and services obtained from freshwater and marine ecosystems. The largest impacts to inland fisheries are likely to be driven by competition for scarce water resources with other more valued economic sectors. As an additional stressor, climate change impacts, such as increasing water temperature and altered discharge, are threatening approximately 50 percent of inland fish species, (Reid *et al.*, 2019) with decreased abundance in coldwater and coolwater fish as the most common directional response. (Myers *et al.*, 2017)



The regions and the countries supporting inland fisheries will undergo considerable changes induced by climate change. It is projected that China and India, major inland fishery producers, are likely to face considerable stressors affecting their inland fisheries in the future. In contrast, large groups of countries responsible for around 60 percent of global inland fisheries production are projected to face medium or relatively low future stress, and will not be subject to the most extreme impacts of climate change. (FAO, 2018a) However, even those countries with low future climate-related stress will be exposed to an array of other anthropogenic drivers of change, which can impact the capacity of fisheries to maintain food supply as much as, or even more than, climate change itself. These include overfishing, over-extraction of water, introductions of non-native fishes and other taxa, and the modification, degradation and loss of key habitats.

In marine ecosystems climate change is producing shifts in the distribution of aquatic species, and this trend is set to continue. Marine species have been expanding the leading edges of their distributions, generally poleward, by 72 km per decade on average; while the arrival of spring conditions in marine habitats has been advancing by 4.4 days per decade. (FAO, 2018b) Recent evidence indicates that poleward expansion will result in a net local increase in species richness (i.e. the number of different species represented in an ecological community, landscape or region) in most places, except in tropical regions, where strong decreases in species richness are expected. In the absence of fishing, mean global marine animal biomass is expected to decrease by 5-17 percent by 2100, depending on the emission scenario considered, driven primarily by increasing temperatures and decreasing primary production. (Lotze *et al.*, 2019) By 2050, biomass changes will result in decreases in maximum fish catch potential – which denotes ecosystem productivity – in the world's exclusive economic zones (EEZs) of 2.8-5.3 percent under a strong mitigation scenario, and 7.0-12.1 percent under a business-as-usual scenario. (FAO, 2018a) (Figure 2).

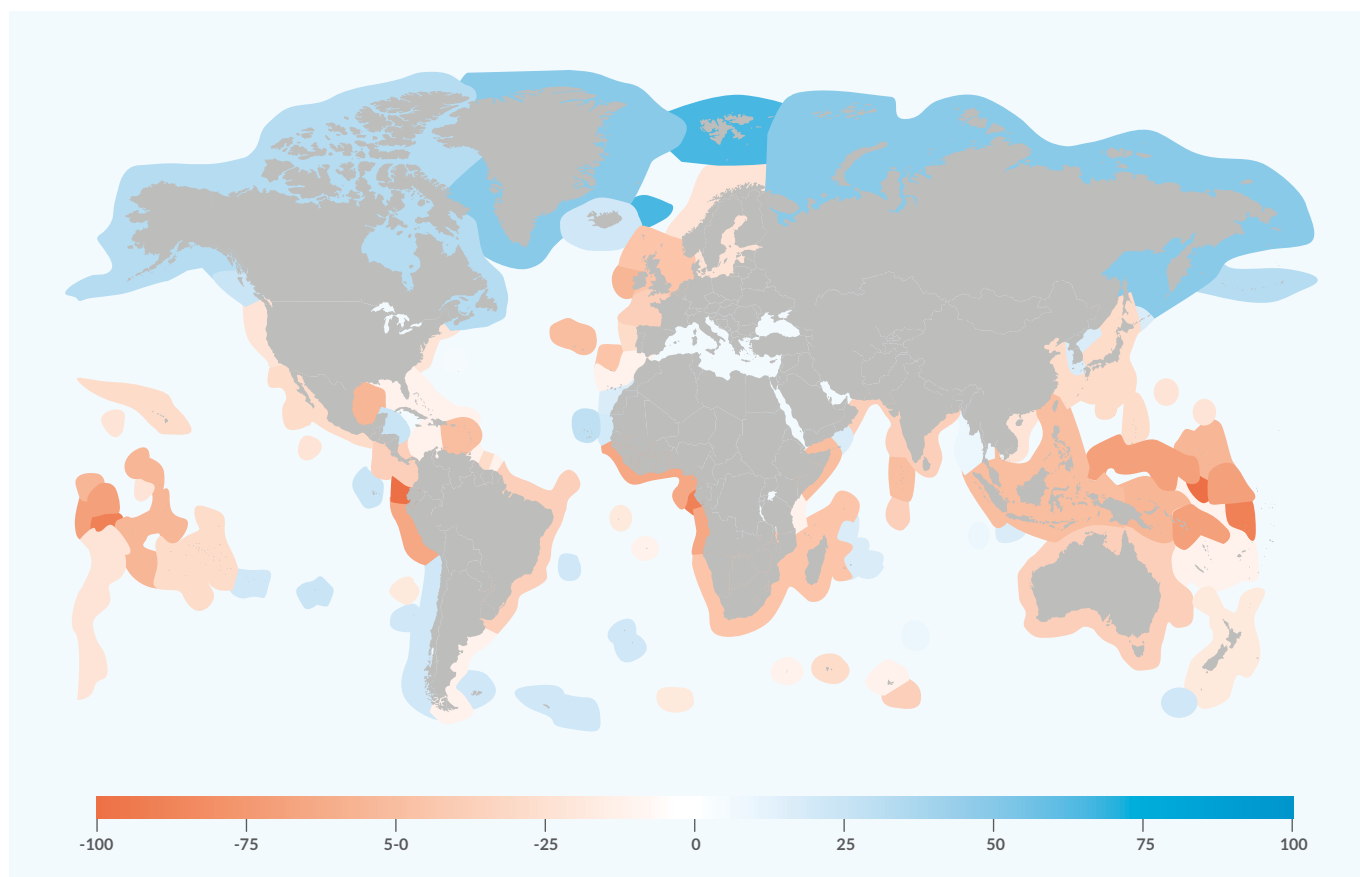


Figure 2: Projected changes in maximum catch potential (percent) under a business as usual scenario (RCP8.5) by 2050 (2046 to 2055) for the Dynamic Bioclimate Envelope Model (DBEM) projections

Source: adapted from FAO, 2018a.

Maximum catch potential versus realized fish catch

The realized catch (i.e. the amount of fish actually taken) is a combination of maximum fish catch potential (i.e. the maximum catch that can be sustained given the productive capacity of the marine ecosystem), fisher activity, market demand, and particularly fisheries management actions. Thus, changes in realized catch in the future do not necessarily mirror changes in maximum fish catch potential, as they heavily depend on how management systems respond to climate impacts. The maximum fish catch potential should rather be seen as the upper limit of sustainable future catches.

This is particularly relevant when considering the projected global changes in maximum fish catch potential by 2050, estimated to decrease by 2.8-12.1 percent dependent on emission scenarios. Currently, because of ineffective fisheries management practices, the

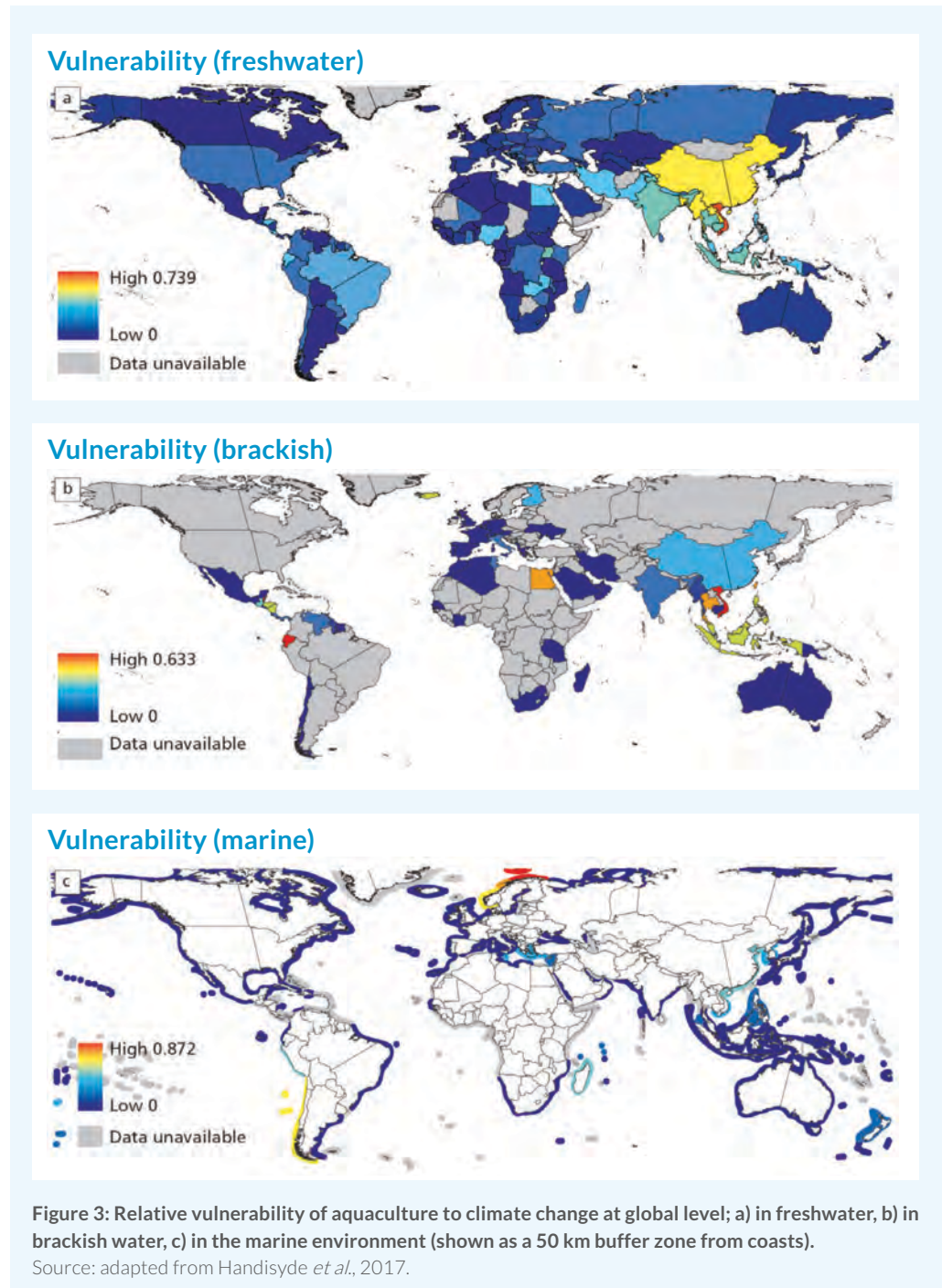
ocean's maximum catch potential is not fully achieved; realized catches are estimated to be 20 percent below the maximum catch potential. Improvements or deteriorations in fisheries sustainability in the future will thus condition future realized catch trends: even if maximum fish catch potential is projected to decrease, the realized catch can increase or decrease by virtue of the management response to productivity changes.

For this reason, it is crucial to recognize the importance of adaptive and effective fisheries management in addressing the current level of overexploitation as well as the anticipated impacts of climate change on fish species productivity. In this sense, climate change provides one of the most powerful arguments to improve fisheries management, and thus fisheries sustainability globally. (Barange, 2019)

Aquaculture

Climate-driven changes in temperature, precipitation, ocean acidification, incidence and extent of hypoxia and sea level rise, among others, will potentially have both favourable and unfavourable impacts on aquaculture. However, the available information indicates that unfavourable changes are likely to outweigh favourable ones, particularly in developing countries where adaptive capacity is typically weakest. (FAO, 2018a)

Aquaculture's vulnerability to climate change can have significant geographical variability (Figure 3). For freshwater aquaculture, Asia is the most vulnerable area. In the case of brackish water production, Viet Nam, Egypt and Thailand emerge as having the highest vulnerabilities. For marine aquaculture, Norway and Chile have been identified as the most vulnerable. (Handisyde *et al.*, 2017).



Impacts of climate change on food security

Climate change will have potentially significant impacts on the four dimensions of food security, namely food availability, food stability, food access and food utilization (Figure 4).



Availability of aquatic foods will vary, positively and negatively, through changes in habitats, stocks and species distribution.



Stability of supply will be impacted by changes in seasonality, increased variance of ecosystem productivity, increased supply risks and reduced supply predictability – issues that may also have large impacts on supply chain costs and retail prices.



Access to aquatic foods will be affected by changes in livelihoods and catching or culture opportunities combined with transferred impacts from other sectors (e.g. increased prices of substitute foods), competition for supply, information asymmetries, and rigid management measures that control temporal and spatial access to resources.



Utilization of aquatic products and the nutritional benefits produced will be impacted by changes in range and quality of supply, market chain disruptions, greater food safety issues, and reduced opportunities to consume preferred products.

Figure 4: Climate change impacts on food security

Exacerbating these climate-driven impacts on food security, human population growth is likely to increase demand, and potentially increase prices, in the coming decades. While price increases may lead to a decrease in fish consumption globally, higher prices should provide an incentive for those engaged in fisheries and aquaculture to increase their production and efficiency.

Food security will also be positively affected by increasing the percentage of fish used for direct human consumption (versus fish used for feed) and reducing post-harvest losses through spoilage and waste. Climate change will add to the complexity of addressing these issues, and climate events may have a direct negative impact on the control of spoilage and waste.

Regional variability of climate change impacts on fisheries and aquaculture

The impacts of climate change on fisheries and aquaculture are expected to have very significant geographical variability.

While these impacts will be predominantly negative in many fisheries-dependent tropical regions, temperate regions will also see some opportunities (Figure 5).

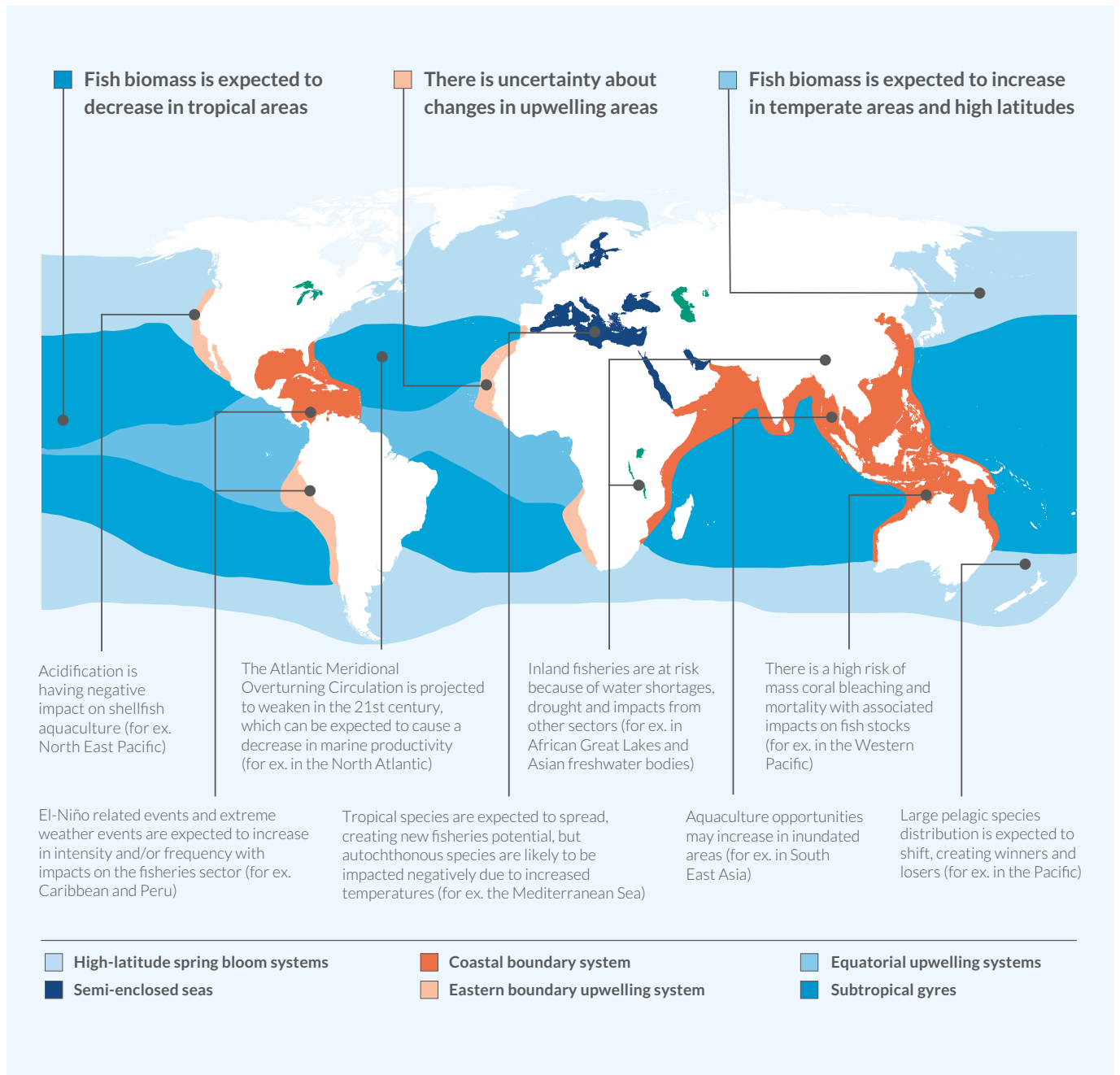


Figure 5: Examples of regional variability of climate change impacts on fisheries and aquaculture
Source: modified from IPCC, 2014.

Impacts of climate-driven extreme events and disasters

Climate-related disasters now account for more than 80 percent of all disaster events, with significant social and economic impacts.

An extreme event is defined as the occurrence of a value of a weather or climate variable above or below a threshold value near the upper or lower ends of the range of observed values of the variable. Even if not extreme in a statistical sense, a weather or climate event – or two or more events occurring simultaneously – can be considered to be extreme if it has high impacts or consequences for people, the environment or infrastructure (Figure 6).

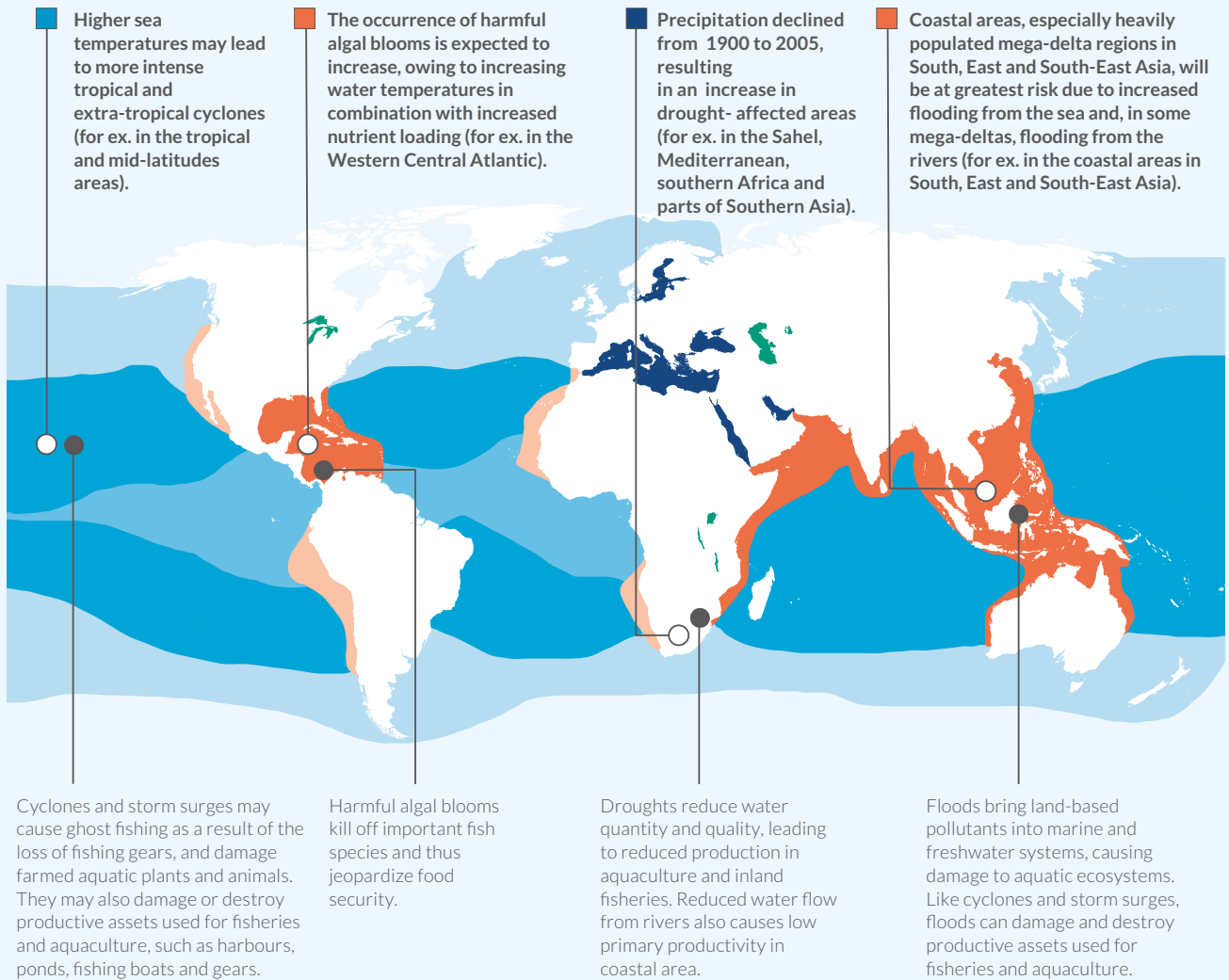
While the attribution of extreme events is frequently difficult, there is growing confidence that extreme weather events in a number of regions are on the increase, and that this increase is related to anthropogenic climate change. Climate-related disasters now account for more than 80 percent of all disaster

events, with significant social and economic impacts, including both short- and long-term displacement of people and populations. Extreme events with significant impacts on fisheries and aquaculture include cyclones and storm surges, coastal and inland flooding, drought, and harmful algal blooms.



Aerial view of flooding and coastal damage in the Sundarbans Region following Cyclone Sidr.

○ OBSERVED AND PROJECTED IMPACTS ASSOCIATED WITH CLIMATE-DRIVEN EXTREME EVENTS



● RISKS TO FISHERIES AND AQUACULTURE FROM OBSERVED AND PROJECTED IMPACTS

- High-latitude spring bloom systems
- Coastal boundary system
- Equatorial upwelling systems
- Semi-enclosed seas
- Eastern boundary upwelling system
- Subtropical gyres

Figure 6: Examples of observed and projected impacts associated with climate-driven extreme events (top), with examples of risks to fisheries and aquaculture from such impacts (bottom)

Source: modified from FAO, 2018a; IPCC, 2007.




©Shutterstock/Richard Whitcombe

Aerial view of an algae bloom on a tropical beach in the Caribbean.

Vulnerability of fisheries and aquaculture to climate change impacts

Vulnerability assessments should give particular attention to individuals and groups with the highest levels of poverty who are almost invariably the most vulnerable to climate change.



Vulnerability is the propensity or predisposition to be adversely affected, and is often described in terms of exposure and sensitivity to negative effects (i.e. susceptibility to harm) mitigated by the capacity to respond, also known as adaptive capacity (Figure 7).

This understanding of vulnerability is commonly used in climate change vulnerability assessments in the fisheries and aquaculture sector to identify practical adaptation options to assist communities, countries and regions in their efforts to reduce vulnerability to climate change and optimize opportunities.

Fisheries and aquaculture activities have specific geographical, environmental and socioeconomic contexts that will each have different and unique vulnerabilities (Figure 8). While climate change will impact fisheries and aquaculture as a whole, the individuals and groups with the highest levels of poverty – especially small-scale fishers and fish farmers in developing countries – are almost invariably the ones who are most vulnerable to climate change. Therefore, vulnerability assessments should give particular attention to those people and groups.

For this reason, it is best to identify and assess the different groups within the system – according to, for example, socioeconomic status, poverty and food security, age and gender – in order to ensure that the most vulnerable are recognized and included in relevant plans and policies.

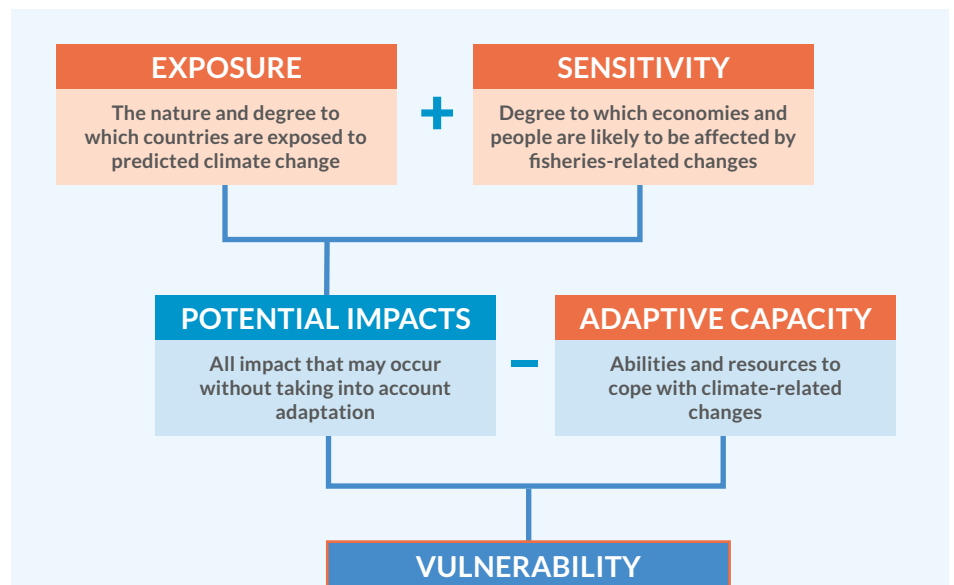


Figure 7: Interpretation and adaptation of the IPCC model of vulnerability to the context of fisheries and aquaculture

Source: adapted from FAO, 2015.

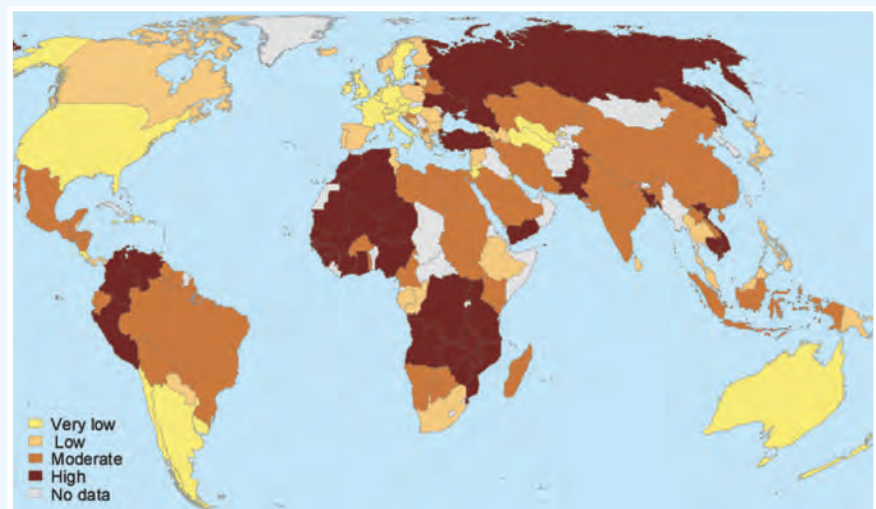


Figure 8: The first global mapping of national economies' vulnerability to climate change impacts through fisheries

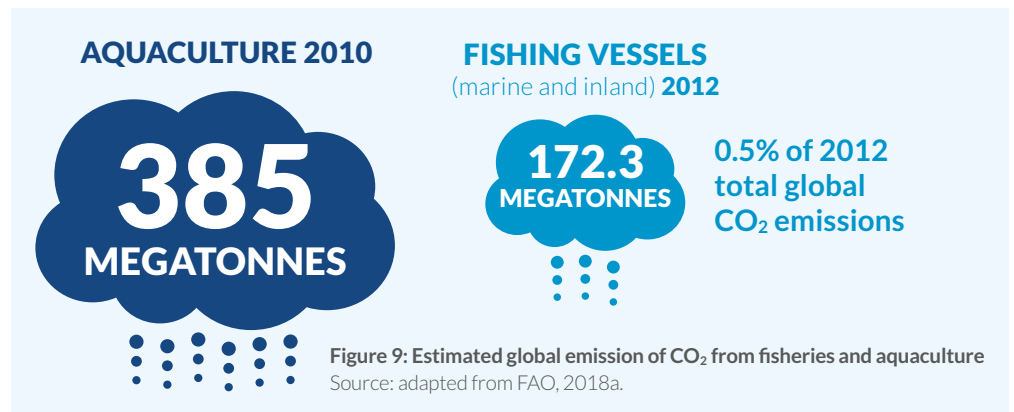
Source: adapted from Allison *et al.*, 2009 and Daw *et al.*, 2009.

Carbon footprints of the fisheries and aquaculture sector

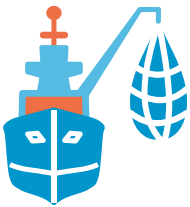
Fisheries and aquaculture have a relatively small overall carbon footprint compared with other land-based food production systems.

In 2012, the estimated global emission of carbon dioxide by fishing vessels, both marine and inland, was 172.3 megatonnes, which was about 0.5 percent of total global emissions that year. The aquaculture industry, including the emissions involved in capturing fish for feed, was estimated to have led to the emission of 385 megatonnes of carbon dioxide in 2010. (FAO, 2018a) (Figure 9).

Overall, the energy use of protein production per unit mass of fish is comparable to chicken, but is much less than that from other land-based systems such as pork and beef. Fisheries and aquaculture are therefore only minor contributors to emissions.

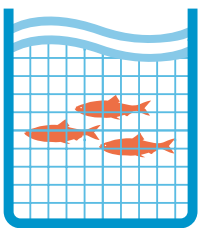


CARBON FOOTPRINTS OF FISHERIES AND AQUACULTURE ACTIVITIES



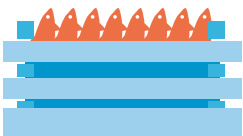
Fisheries operations:

- Industrial fisheries have much greater total CO₂ emissions than small-scale fisheries.
- Fuel use is the sector's major source of emissions, estimated around 3 tonnes of CO₂ for each tonne of fuel used.
- Management measures that encourage a 'race to fish' create incentives to increase engine power.
- Overfished stocks at lower densities and smaller individual sizes require vessels to exert more effort, thereby increasing fuel use per tonne of landings.



Aquaculture production:

- Most aquaculture production only requires small amounts of fertilizer, often organic, and in some cases low-energy supplementary feeds, and therefore has a relatively small overall carbon footprint compared to most other animal husbandry practices.
- The organic feeding materials used in aquaculture ecosystems to accelerate primary production, especially in tropical fishponds, can have significant effects on microbial processes, which in turn affect carbon biogeochemical processes that emit methane (CH₄).
- Some species and systems which are of high quality food value – such as shrimp, salmon and marine carnivores – have high feed energy or system energy demands, and consequently have very high carbon footprints.



Post-harvest practices:

- As in all food production sectors, post-harvest activities entail stocking, packaging and transporting: these create post-consumption waste, all linked with CO₂ emissions.
- Intercontinental airfreight may emit 8.5 kg CO₂ per kg of fish shipped, about 3.5 times the levels from sea freight, and more than 90 times those from the transport of fish consumed within 400 km of its source.

Mitigation

Opportunities exist for reducing fuel use and GHG emissions in capture fisheries and aquaculture.

Although they are a relatively small contributor in global terms, fisheries and aquaculture have a responsibility to mitigate GHG emissions as much as possible.

In the case of capture fisheries, a 10 to 30 percent reduction of vessel emissions is achievable with efficient engines and larger propellers, better vessel shape and hull modifications, and speed reductions. (FAO, 2018a) There are also opportunities to reduce GHG emissions in aquaculture, which include

improving technological efficiency, reducing reliance on fossil fuel, replacing fish-based feed ingredients and improving feed conversion rates. Combining these approaches would result in a reduction of 21 percent in CO₂ emission per tonne of fish produced. (FAO, 2018a)

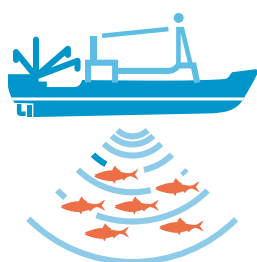
POTENTIAL MEASURES TO REDUCE GHG EMISSIONS FROM FISHERIES AND AQUACULTURE

Potential mitigation measures in fisheries operations:



Fishing vessels

- Improving fuel efficiency in existing vessels through actions such as reducing vessel speed, utilizing waste heat, and improving insulation for heating and cooling
- Improving fuel efficiency in new vessels through actions such as selecting efficient engines and larger propellers, and creating better vessel shapes and hull dimensions
- Undertaking regular maintenance of engines and other machinery
- Lowering fuel consumption by slightly reducing steaming and/or towing speed



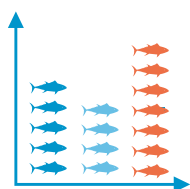
Fishing gear

- Replacing fuel-intensive gears with alternatives that require less fuel
- Modifying designs of towed fishing gears by using high-strength materials, efficient otter boards, larger mesh sizes and thinner twines
- Using electric stimuli for beam trawls and energy-efficient lights to attract fish
- Improving fishing instrumentation by using seabed-discriminating acoustic devices, gear monitoring and catch sensors, and positioning and tracking systems



Fishing port infrastructure

- Improving energy efficiency in cold storage and ice plants
- Using renewable energy systems such as solar and wind for land-based port facilities
- Designing port buildings with a low carbon footprint



Fisheries management

- Adopting and implementing fisheries management measures to reduce fishing effort and increase fish stocks through input control measures, output control measures, and fuel subsidies and incentives

Potential mitigation measures in aquaculture production:



Production of feed materials

- Selecting feedstuffs with lower associated emissions (e.g. locally-sourced oilseeds, which are much lower than fishmeal and fish oil sourced from capture fisheries)



Feed mill energy use

- Improving management efficiency of feed mills
- Substituting high emission intensity fuels with low emission intensity alternatives



Feed conversion rates

- Optimizing the nutritional content of feed and its availability
- Improving feed management
- Increasing dissolved oxygen levels to increase feeding efficiency



Fish health

- Improving water quality management
- Maintaining appropriate fish stocking densities
- Implementing effective biosecurity measures
- Using medicines properly



On-farm N₂O emissions

- Adhering to fertilization guidelines in pond aquaculture
- Improving feed management to reduce uneaten food

Mitigation opportunities also exist in fisheries and aquaculture post-harvest practices. Potential measures include increasing energy use efficiency in fish processing (e.g. more efficient wood use in smoking fish), improving fuel and energy use efficiency in handling and cold / freezer storage, consuming locally to reduce GHGs during transport, and reducing food loss and waste along the value chain.

In addition to measures to reduce the sector's own contribution to GHG emissions, aquatic systems also play a significant role in supporting the natural system's removal of emissions by capturing and sequestering carbon. It is estimated that around 93 percent of global carbon is stored in aquatic systems, and around 30 percent of annual emissions are sequestered in aquatic environments, primarily in mangroves, seaweeds, seagrasses, floodplain forests and coastal sediments. Two measures are essential to improving

the sector's capacity to remove emissions. First, it is of primary importance to halt the disruption of carbon sequestration caused by habitat destruction and improve the often inadequate management of fisheries and aquaculture. Second, there may be valuable opportunities to enhance sequestration by expanding planted areas of mangroves and floodplain forests.

Distinct from usual trade-offs between mitigation and food production in other sectors, mitigation efforts in the fisheries and aquaculture sector can generally lead to a win-win situation that reduces or removes GHG emissions while ensuring sustainable fish production and livelihoods of communities dependent on the sector. This is because mitigating GHG emissions in the sector can result in healthier ecosystems and thus a greater abundance of aquatic species, which would contribute to improving the quantity and quality of local and regional ecosystem services.



©FAO/Ernesto Benavides

FAO technical officers and members of the Peruvian Production Ministry measuring the size of the fishing nets as they carry out inspections aboard of fishing ships in the port of Callao-Pesquera Diamante.

Adaptation

FAO has developed an adaptation toolbox for governments, industries and individual fishers and fish farmers.

Although different types of adaptation tools have been developed over the last two decades, there is minimal guidance available specifically aimed at developing adaptation strategies for the fisheries and aquaculture sector. FAO has filled this gap by providing a portfolio of tools and measures recommended and currently available for capture marine and inland fisheries and for aquaculture, as well as guidance for selecting, implementing and monitoring the effectiveness of adaptation actions while limiting maladaptation (Figure 10).

Adaptation toolbox

The FAO adaptation toolbox comprises institutional adaptation, measures addressing livelihood, and measures intended for risk reduction and management which thereby strengthen resilience.

Category 1: Institutional adaptation. For fisheries and aquaculture, setting out a design for change may require a change in existing public policies and legal frameworks. Moreover, climate change needs to be integrated into fisheries and aquaculture management, and institutional frameworks should be created or revised to ensure effective stakeholder participation and to enhance cooperation mechanisms between countries and other stakeholders.

Category 2: Measures addressing livelihoods. Livelihood adaptation includes a mix of public and private activities within the fisheries and aquaculture sector, as well as non-fish-related sectors. A common strategy is diversification within or outside the sector to reduce the vulnerability to change of fisheries-dependent livelihoods.

Category 3: Measures intended for risk reduction and management for resilience. Tools for risk reduction and resilience building include a mix of public and private activities to pool and transfer risk, promote early warning and information systems, improve risk reduction and preparedness, and enhance response to shocks from climate change impacts.

Using the toolbox

A key step in climate change adaptation is putting adaptation tools into practice. Decisions in relation to climate change are not a once-and-for-all event, but an iterative (or adaptive) process that is likely to continue over decades, where there will be opportunities for learning and mid-course corrections in the light of new information. The iterative process is represented in Figure 11 and explained in the steps below.

Step 1: Scoping and objective setting. To assess the vulnerability of fisheries and aquaculture to climate change, the relevant stakeholders should start with determining objectives and scope, then gather relevant data, information and expertise, and finally assess the components of vulnerability.

Step 2: Analysis of the results of the vulnerability assessment and development of a climate adaptation strategy. The results of the vulnerability assessment exercise can be used to develop an overall climate adaptation strategy or plan for a given context. In this step, adaptation tools are prioritized and selected, using standard methods which include scoping, expert elicitation, stakeholder consultation and economic analysis.

Step 3: Implementation, monitoring and evaluation. It is key to build measurable goals and indicators into implementation in order to continuously monitor and evaluate whether or not the tools are meeting the selected adaptation objectives.

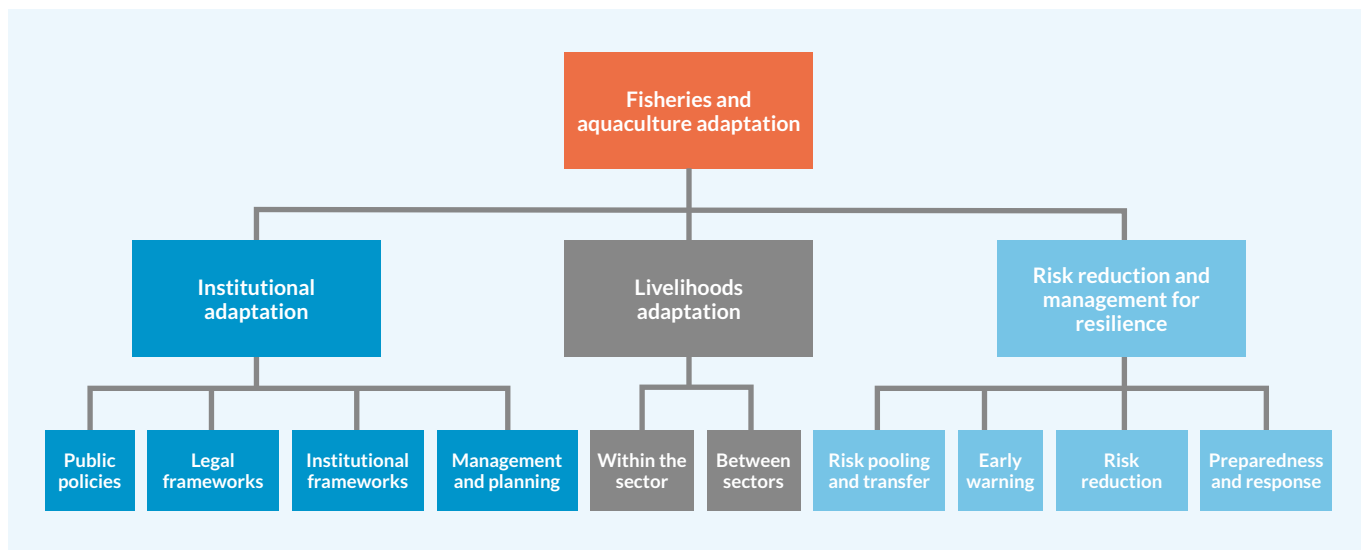


Figure 10: Categories of adaptation activities

Source: adapted from FAO, 2018a.

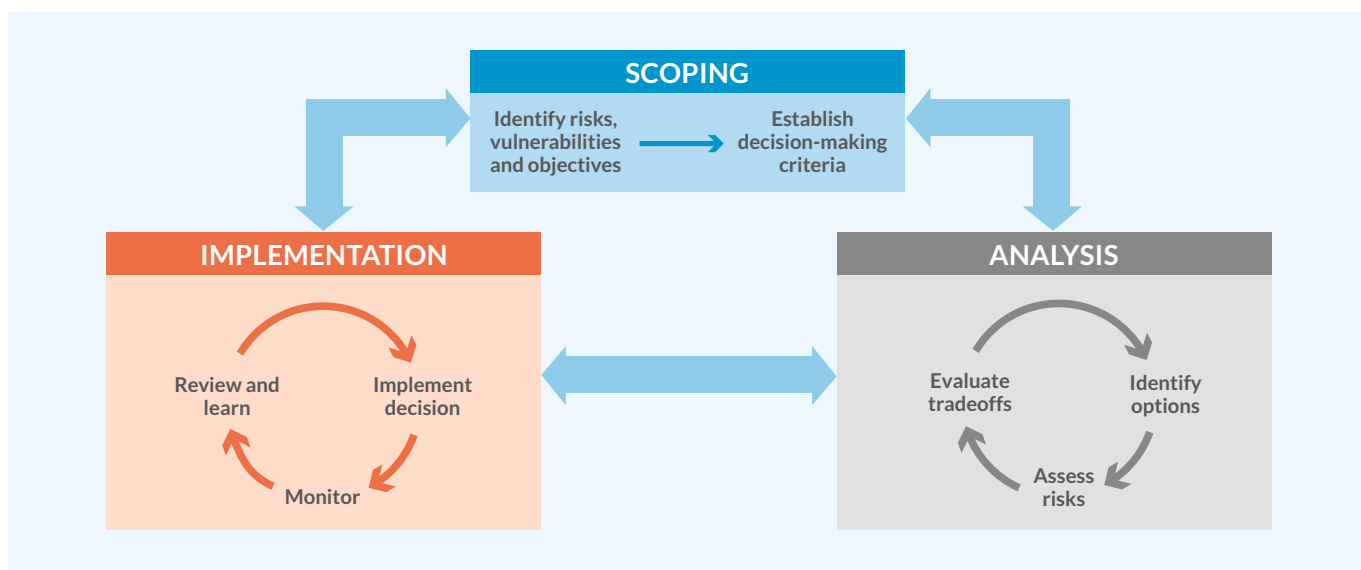


Figure 11: An iterative risk management framework incorporating system feedbacks

Source: adapted from Jones *et al.*, 2014.

National adaptation plans

To advance global adaptation efforts, the Paris Agreement calls on all countries to prepare and implement National Adaptation Plans (NAPs). NAPs enable countries to identify their medium- and long-term adaptation needs and to develop and implement strategies and programmes to address those needs. NAPs are an important element in the identification and prioritization of adaptation priorities for countries, and will inform Nationally Determined Contributions (NDCs).

The mainstreaming of fisheries and aquaculture issues in national adaptation processes is improving, but often remains incomplete and superficial. The downscaling of the formulation and implementation of an adaptation plan that recognizes, integrates and addresses concerns specific to fisheries and aquaculture will lead to greater resilience for the sector and the communities it supports in the face of climate and other environmental threats. In addition to sector-specific adaptation plans, it is also important for the

fisheries and aquaculture sector to take part in a broader adaptation planning process, as there can be synergies and trade-offs across sectors (Figure 12).

In response to a call by the Least Developed Countries Expert Group (LEG) of the UNFCCC, inviting international actors to 'come forward in drafting supplementary materials to the NAP Technical Guidelines', FAO prepared

supplementary guidelines addressing fisheries and aquaculture in NAPs. The supplementary guidelines will support fisheries and aquaculture institutions, enabling adaptation planning within the sector and helping national climate change planners and decision-makers to understand sector-specific vulnerabilities and priorities for adaptation as part of the national development and adaptation system.

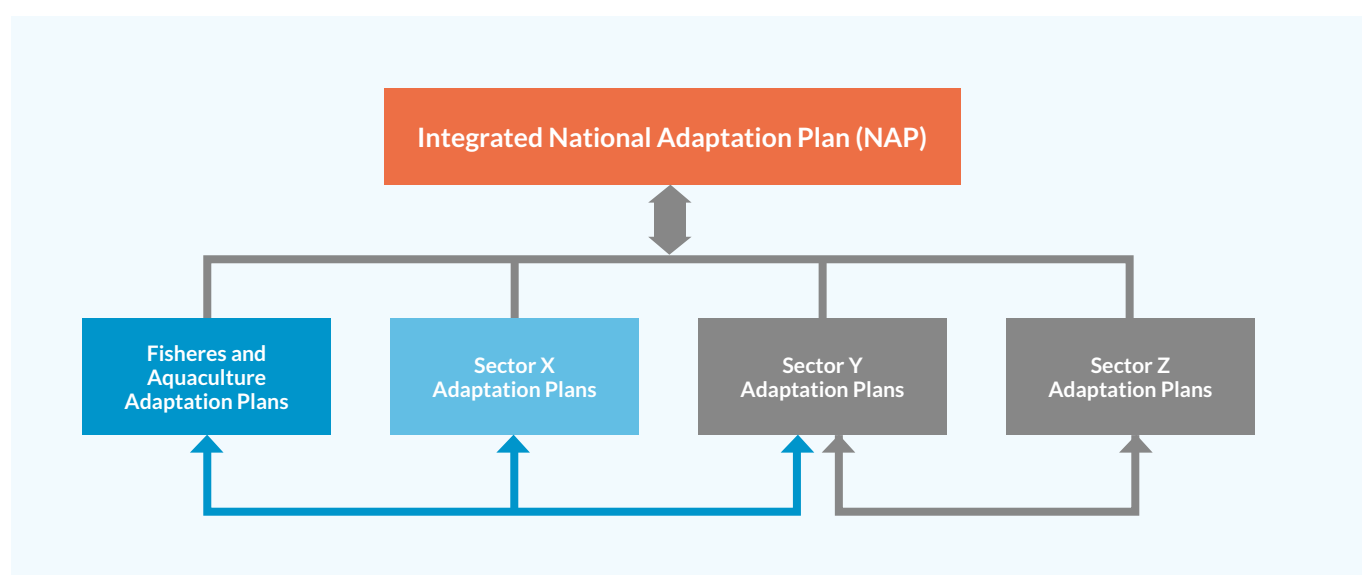


Figure 12: Links among sector-specific and national-level adaptation plans

Source: adapted from FAO, 2020b.

Increasing climate resilience through genetic improvements in aquaculture

FAO has reported on the state of the world's aquatic genetic resources for food and agriculture and reviewed their use both in capture fisheries and in aquaculture, in areas under national jurisdiction. (FAO, 2019) The report suggests that wider, appropriate and long-term application of genetic improvements in aquaculture, with a focus on selective breeding (e.g. species with high temperature tolerance), will help boost food production to meet a projected increase in demand for fish and fish products with increasing climate resilience and relatively little extra feed, land, water and other inputs.

Climate-smart fisheries and aquaculture

Climate-smart approaches in fisheries and aquaculture address three key objectives, namely sustainable food systems, adaptation and mitigation.

Climate-smart agriculture (CSA) is an approach developed by FAO that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. The fisheries and aquaculture sector is likely to experience some of the greatest impacts on productivity and livelihoods as a result of climate change and climate variability and their influence on the distribution of resources. The impacts of climate change and adaptation options vary by region. Local context-specific, climate-smart agriculture solutions will be required to guide the sector toward a sustainable future.

Three objectives

Climate-smart approaches in fisheries and aquaculture address three key objectives, namely sustainable food systems, adaptation and mitigation. In particular, the first objective is connected to the overarching goal of achieving sustainable food systems, which encompasses the environmental, social and economic aspects of fisheries and aquaculture. The second objective focuses on the need for adaptation to climate change, including climate-induced extreme events and disasters, by reducing the sector's vulnerability and increasing its resilience. The third objective is to enable the sector, where possible, to contribute to the mitigation of GHG emissions (Figure 13).

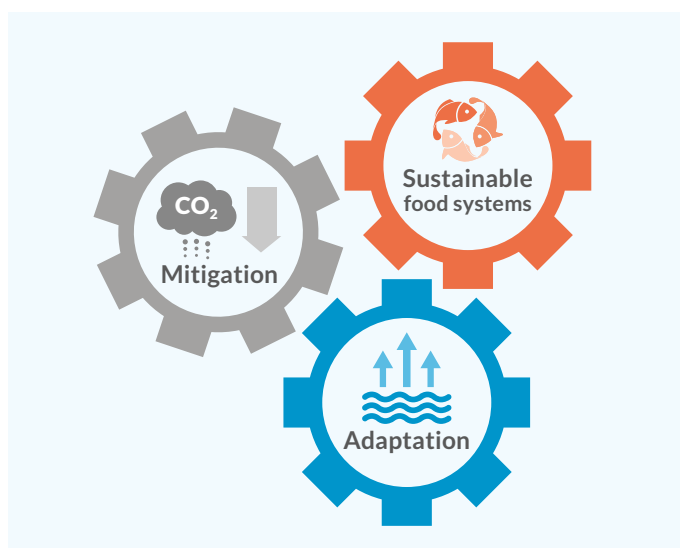
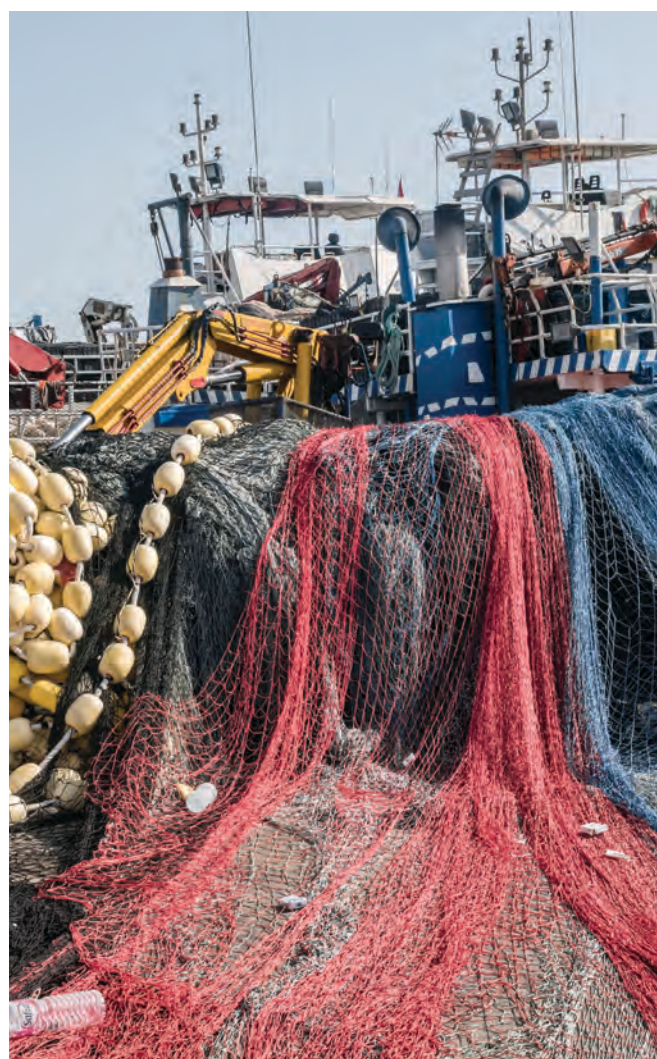


Figure 13: Three objectives of climate-smart approaches in fisheries and aquaculture



Implementation: a four-step process



©FAO/Sia Kambou

Abidjan, Cote d'Ivoire - Fishermen offloading tunas after a fish catch at Abidjan's industrial fish port, an area supporting strengthening the fisheries sector's policy, legal and regulatory frameworks to incorporate environmental, social and economic sustainability considerations.

Climate-smart approaches in fisheries and aquaculture rely on a comprehensive process leading to the identification and dissemination of locally suitable practices and context-specific technologies. It includes four steps (Figure 14).

Step 1: Expand the evidence base. This step requires more detailed knowledge on the regional and sub-regional impacts of climate change, in order to understand the vulnerabilities of individual ecosystems, capture fisheries, aquaculture systems, food processing and trade, and the communities and societies that are directly or indirectly dependent on them.

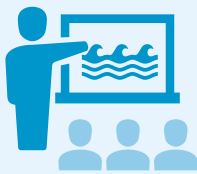
Step 2: Support enabling frameworks. This step requires the development and implementation of well-structured, enabling policy frameworks and investment plans to identify and address specific gaps in capacity, efficiency and system resilience for the sector.

Step 3: Enhance financing options. This step requires innovative mechanisms (e.g. Green Climate Fund) that link and blend climate finance and investments to sector-specific needs.

Step 4: Implement practices in the field. This step calls for the integration of local fishers' and farmers' knowledge, requirements and priorities into climate-smart fisheries and aquaculture approaches. Suitable climate-smart strategies can be identified through the participation of fishers and farmers in local projects. Climate-smart approaches must be recognizable and actionable by policy agents in order to work effectively with practitioners and beneficiaries at all levels.

Four-step process of climate-smart approaches in fisheries and aquaculture

1



Expanding
evidence
base

2



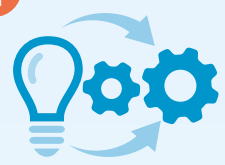
Supporting
enabling policy
frameworks

3



Enhancing
financing
options

4



Implementing
practices at
field level



Figure 14: Four-step process of climate-smart approaches in fisheries and aquaculture

Source: adapted from FAO, 2017.

Supporting countries on mitigation and adaptation

FAO provides guidance and support for member countries and partners to effectively mitigate and adapt to the impacts of climate change in the fisheries and aquaculture sector.

An aerial photograph of three circular fish ponds, each with a central point and radial supports. The ponds are arranged in a triangular pattern. The background is a deep blue color with a subtle texture. There are several small, light-colored circular markers scattered across the blue background.

Strengthening the knowledge base and guidance for policy development

Climate planning can only work when decision-makers have the capabilities to forecast climate-induced changes and trigger alerts in fisheries and aquaculture. To make this possible, FAO and its partners have been working to identify climate change implications, vulnerabilities and context-specific adaptation and disaster risk management strategies to improve the resilience of aquatic systems and their dependent communities.

Important FAO publications include a comprehensive technical paper on the impacts of climate change on fisheries and aquaculture, a revised CSA Sourcebook to better guide policymakers and practitioners to make the sector more sustainable and productive while responding to climate change and food security challenges, and specific guidelines addressing fisheries and aquaculture in National Adaptation Plans.

Reducing vulnerability of fishing and fish-farming communities to climate change and natural disasters

The notable increase in the frequency of climate-related events over the past decades poses a significant challenge to fisheries and aquaculture systems, given their crucial reliance on climate. FAO seeks to continue providing updated and systematic data and analysis, in order to build a holistic information system on the impact of disasters

on agriculture in developing countries. This will also contribute to implementing and monitoring the three main 2015 international agendas (Sustainable Development Goals, the Paris Agreement and the Sendai Framework for Disaster Risk Reduction), which recognize resilience as fundamental to their achievement.

Initiatives and actions undertaken by FAO include the development of a guide on spatial technology for emergency preparedness and response for aquaculture, and studies on insurance programmes for small producers to increase their resilience to climate risks and disasters.

Developing and implementing projects

FAO has developed and is implementing a number of projects to support adaptation, risk reduction and resilience building in marine capture fisheries, inland capture fisheries and aquaculture at global, regional and country levels. For example, Global Environment Facility (GEF)-funded projects through the Special Climate Change Fund (SCCF) and/or the Least Developed Countries Fund (LDCF) are underway in Bangladesh, Benguela Current, Cambodia, Chile, Eastern Caribbean, Pacific Small Island Developing States (SIDS), Malawi, Myanmar and Timor Leste.

FAO also provides direct assistance to countries through Technical Cooperation Programme (TCP) and Regular Programme projects, such as rice-fish and climate-resilient tilapia, covering Bangladesh, Indonesia, the Philippines, Sri Lanka and Viet Nam.

Raising awareness of the emissions and mitigation potential from fisheries and aquaculture

Significant opportunities exist for reducing fuel use and GHG emissions in the fisheries and aquaculture sector, even though the GHG contributions of this sector are considered to be relatively small in overall terms. The first step of emission reduction in capture fisheries is to audit the energy used by fishing vessels to systematically evaluate the potential cost and environmental benefits of fuel-saving practices.

FAO has carried out an energy audit project in Thai trawl fisheries, which successfully identified some effective fuel-saving practices. It is recommended that similar projects be carried out in other developing countries to make the most of simple and cost-effective options for fuel-saving and emission reduction. In support of mitigation efforts in aquaculture, FAO has developed a tool for quantifying sector GHG emissions based on the results of a joint FAO-Global Salmon Initiative workshop.

Increasing visibility of fisheries and aquaculture in cross-sectoral and global climate change discussions

With the increasing recognition that oceans are part of the climate action agenda, discussions in international climate change fora involving the ocean community are now more focused on showcasing concrete actions and initiatives to illustrate potential responses of ocean-related sectors to climate change, rather than on advocacy.

FAO, with the support of partners and member countries, has showcased adaptation solutions through its efforts on the identification of climate vulnerabilities and context-specific strategies to improve the resilience of dependent communities and increase the relevant knowledge base. FAO will continue to work to strengthen international mobilization and cooperation for the conservation and enhancement of ocean resilience under the United Nations Framework Convention on Climate Change (UNFCCC).



©FAO/Roberto Faiaduti

FAO has carried out an energy audit project in Thai trawl fisheries, which successfully identified some effective fuel-saving practices.

FAO action areas

FAO has developed and is implementing a number of projects to support adaptation, risk reduction and resilience building in marine capture fisheries, inland capture fisheries and aquaculture at global, regional and national levels.

Key icons

Subsectors



Marine capture fisheries



Inland capture fisheries



Aquaculture

Thematic areas



Strengthening knowledge on impacts and vulnerability



Building resilience of dependent and vulnerable livelihoods



Supporting adaptation planning and implementation



Ensuring sustainable fish production

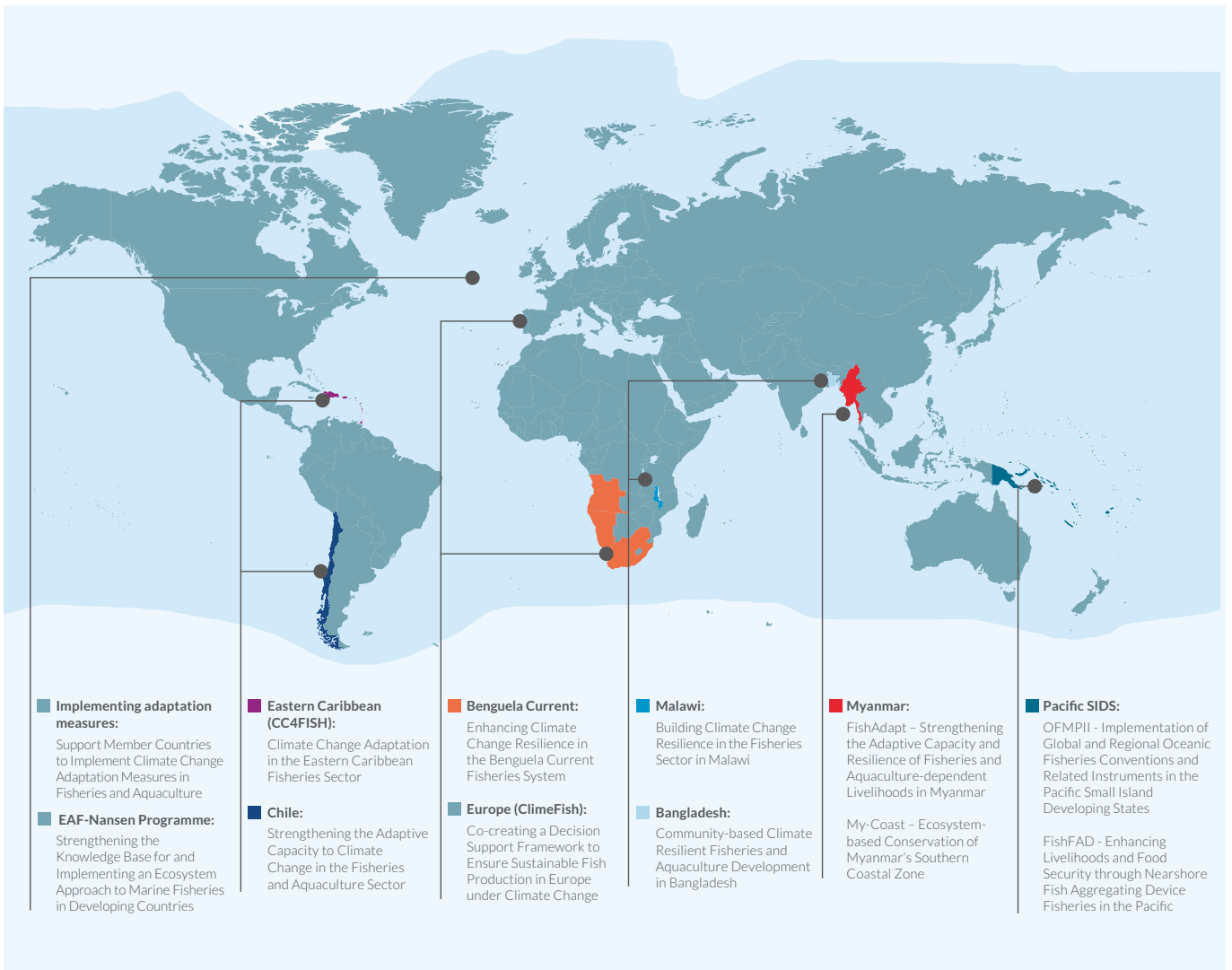
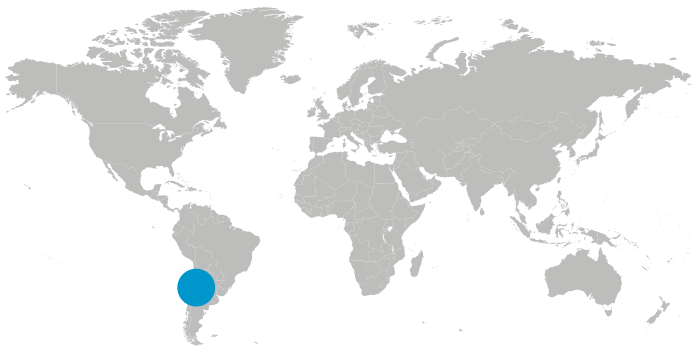


Figure 15: Examples of FAO climate change adaptation projects

Source: adapted from FAO, 2018b.

Caribbean and Latin America

Chile



small-scale fishers. The outputs of this project are expected to increase the overall resilience of artisanal fisheries and small-scale aquaculture sectors in four coves located in different regions of Chile from North to South. The lessons learned could be replicated in many other coves of the country and would also provide guidance to neighboring countries and further afield who face similar threats from the effects of climate change.



DONOR(S)

GEF



IMPLEMENTING PARTNER(S)

Undersecretariat of Fisheries and Aquaculture and Ministry of the Environment, Chile



OVERALL OBJECTIVES

The project ("Strengthening the Adaptive Capacity to Climate Change in the Fisheries and Aquaculture Sector") aims to reduce vulnerability to climate change in fisheries and aquaculture in Chile and increase their adaptive capacities. This project is a response to the threats that climate change is exerting on the fishery resources and on the most vulnerable user group, the



FACTS AND FIGURES

- Chile is one of the largest fish producing countries in the world. In 2018, the volume of the total landings from capture fisheries and aquaculture was about 3.4 million tonnes, with 2.1 million tonnes from capture fisheries and 1.3 million tonnes from aquaculture.
- The fisheries and aquaculture sector generates direct and indirect employment for over 200 000 people in Chile and is the only source of income in some coastal areas.
- Climate change is expected to produce a southward shift of high pressure, increasing the wind blowing along the Chilean coast and causing a greater upwelling of cold waters to offset the surface warming, which will have a significant impact on biological productivity of the ocean.
- Another significant climate change impact is that the decrease in rainfall could lead to increased salinity in coastal areas and southern fjords, with impact on aquaculture related to the incidence of parasites and some other diseases.



IMPACT

The project promotes the strengthening of capacities in: (i) public and private institutions and (ii) coastal communities in 4 pilot sites - Caleta Riquelme (Tarapacá Region), Caleta Tongoy (Coquimbo Region), Caleta Coliumo (Biobío Region), and Caleta El Manzano-Hualaihué (Los Lagos Region).

The project designed and implemented a training program on climate change adaptation in the fisheries and aquaculture sector for public officials, national experts and decision-makers at the national, regional and local levels. Training was also carried out for artisanal fishers and small-scale aquaculturists. The objective of this activity, at both levels, was to raise awareness and expand knowledge on climate change to better prepare institutions to act in a timely manner in the decision-making process, and to implement concrete and effective actions to ensure the sustainability of the fisheries and aquaculture sector under climate change scenarios.

The project provides technical assistance through the implementation of demonstrative experiences of alternative production systems to supplement income and maintain the socio-economic structure of fishing communities that are experiencing the impacts of climate change. The pilot experiences are being carried out in the four fishing and aquaculture coves in the country.

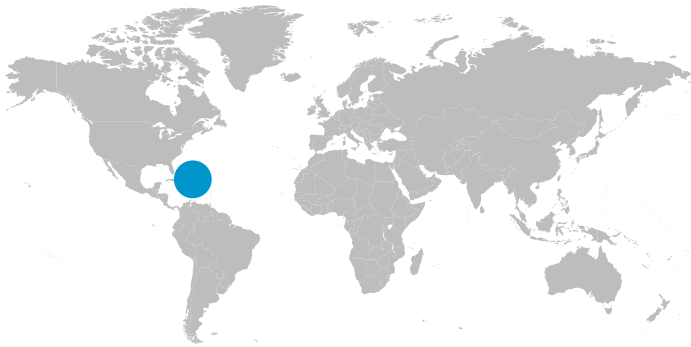
Demonstrative experiences use participatory methods to promote the involvement of artisanal fishers and small-scale aquaculturists to integrate

their local knowledge. These demonstrative experiences include: adaptive exploitation and alternative processing of accompanying fauna; diversifying productive activities (from fishing to aquaculture); incorporation of added value to products from fisheries and aquaculture; and expanding the productivity of the sector by promoting tourism in order to obtain complementary profits from those of the fishing and aquaculture activity.

Given that the project has generated social and cultural changes in the pilot sites, which constitutes an achievement that deserves recognition, an identity mark was developed to differentiate the coves that are adopting adaptation measures. This mark will be promoted in other coastal communities throughout the country and aims to demonstrate to the authorities and sources of financing, the seriousness and level of commitment of the coves to climate change, to enable investment and development of projects and to generate strategic alliances with the public and private sectors for the implementation of adaptation measures.

In addition to the above, the project is implementing a communication strategy at all levels to expand knowledge about the impacts of climate change in the sector and to demonstrate the need and urgency of addressing this issue to identify, prioritize, implement, monitor and evaluate adaptation strategies and measures at the national, regional and local levels.

Eastern Caribbean (CC4FISH)



DONOR(S)

GEF – SCCF



IMPLEMENTING PARTNER(S)

National institutions;¹ Western Central Atlantic Fishery Commission (WECAFC); Caribbean Regional Fisheries Mechanism (CRFM); Caribbean Network of Fisherfolk Organizations (CNFO); University of the West Indies (UWI)

¹ Fisheries Division of the Ministry of Agriculture, Fisheries and Barbuda Affairs, Antigua and Barbuda; Fisheries Division of the Ministry of Blue & Green Economy, Agriculture & Natural Food Security, Dominica; Fisheries Division of the Ministry of Climate Resilience, The Environment, Forestry, Fisheries and Disaster Management, Grenada; Department of Marine Resources of the Ministry of Agriculture, Fisheries and Marine Resources, Saint Kitts And Nevis; Department of Fisheries of the Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Co-operatives, Saint Lucia; Fisheries Division of the Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry and Labour, Saint Vincent and the Grenadines; Fisheries Division of the Ministry of Agriculture, Land and Fisheries, Trinidad and Tobago



OVERALL OBJECTIVES

The CC4FISH project (“Climate Change Adaptation in the Eastern Caribbean Fisheries Sector”) aims to increase resilience and reduce vulnerability to climate change impacts in the Eastern Caribbean fisheries sector, through the introduction of adaptation measures in fisheries management and capacity-building of fishers and aquaculturists.



FACTS AND FIGURES

- The seven countries participating in this project (Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago) are Small Island Developing States.
- Climate change challenges facing the Eastern Caribbean fisheries and aquaculture sector are, *inter alia*, sargassum influxes, storms and hurricanes, coastal erosion, changes in distribution and productivity of fish stocks, and coral reef bleaching.
- Fisheries in the Eastern Caribbean are mostly small-scale. Due to the high dependence on marine resources and the high vulnerability of the fishing sector, plus the increasing intensity of extreme weather events, there is rising concern over the consequences of climate change and climate variability for the fisheries sector in the region.
- Smaller catches can be expected to have significant socio-economic implications for those working in the harvest and post-harvest sectors. This will also have implications for national governments such as reduced domestic productivity in the fishing sector, food security, international trade and foreign currency earnings, especially for those countries with export-oriented fisheries.

- Fish resources in the region are typically shared by multiple nations, and climate-induced changes to their distribution may require changes to multi-lateral or international agreements, whilst changes in genetic connectivity of stocks will impact the effectiveness of marine reserve networks in protecting source populations.
- Climate change stressors such as sea level rise and increased frequency or severity of hurricanes in the region will continue to have significant negative impacts on safety of fishers, fisheries infrastructure, boats and fishing equipment, and coastal fishing communities.
- Climate change needs to be mainstreamed into fisheries plans and policies, alongside the Ecosystem Approach to Fisheries and Disaster Risk Management.



IMPACT

The CC4FISH project has been successful in developing a regional Vulnerability and Capacity Assessment (VCA) framework. This framework is of direct relevance to the FAO's normative work and is currently used to inform other field projects in an attempt to optimize the use of resources and avoid duplications.

This project's scientific outcomes on the recent influxes of sargassum have fed ongoing discussions in the region about this issue, provided a prediction model, and informed stakeholders on the impacts of sargassum on key fish species. As no institution has been able to handle these influxes yet properly and understanding on this topic is still limited, the CC4FISH contribution is timely. Communication materials developed on the sargassum issue have been creative, including management plans, outlook bulletins, and a best-practices guide for fisherfolk in coping with sargassum.

The capacity building activities are the core of the CC4FISH project and have been of high relevance. The activities show a variety of work, for example, on safety-at-sea, including training events and training materials such as manuals, as well as equipment (very-high-frequency (VHF) radios and dual repeater systems), and information and communications technology (ICT) training on cellphones, VHF radios and the Global Positioning System (GPS). Such work is of great importance considering that fishing is rated as the third most dangerous occupation in the world. The project thus provides improved safety of fishers in the face of an increasing number of high-intensity hurricanes in the region as well as an increase in unpredictability in weather events.

Improved value adding in the fisheries sector has also been an activity under the CC4FISH project both nationally and internationally, as well as aquaculture development (seamoss farming and aquaponics) which is still in its infancy in the region. This activity helps improve capacity of farmers and fishers, improve food security and provide business opportunities.

Mainstreaming of climate change adaptation and disaster risk management into fisheries policies, plans and legislation is proving to be of increasing importance to the region, now that it is already facing climate change impacts such as sargassum, coral reef bleaching events, and increasing numbers of high-intensity hurricanes.

A significant challenge with a potential impact on the long-term sustainability of the changes that the project seeks is the unequal level of implementation in seven project countries due to each country's specific situation. Additional challenges, which have occurred as a result of hurricanes and institutional weakness, have delayed some core activities. This has, however, also provided a learning opportunity on lessons learned in fisheries sector adaptation.

Africa

Benguela Current



DONOR(S)

GEF – LDCF & SCCF

IMPLEMENTING PARTNER(S)

Benguela Current Commission (BCC)

OVERALL OBJECTIVES

The Benguela Current project ('Enhancing Climate Change Resilience in the Benguela Current Fisheries System'), put in place by the FAO and the intergovernmental Benguela Current Commission (BCC), aims to build resilience and reduce the vulnerability to climate change of the marine fisheries and mariculture (marine aquaculture) sectors within the Benguela Current Large Marine Ecosystem (BCLME), through adaptation strategies to ensure food and livelihood security.

FACTS AND FIGURES

- The BCLME involves three coastal states, namely Angola, Namibia and South Africa, and is one of the most productive marine areas in the world.
- The abundance and productivity of the marine living resources in the system provide the resource base for important and diverse fisheries, ranging in scale from subsistence to large-scale commercial activities and contributing to local food security and employment for hundreds of thousands of people, many of whom have few or no alternatives.
- The fisheries sectors in the three countries are facing a number of serious challenges to ensuring sustainable use of the productive but vulnerable marine resources that support them. These include over-exploitation of many of the marine resources by fisheries, habitat loss and pollution, and climate variability and change.

IMPACT

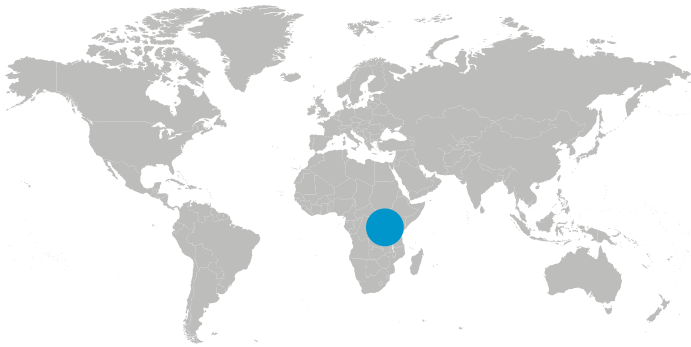
This project is expected to generate four adaptation benefits. First, climate change adaptation actions in fisheries and fishery-dependent communities will be incorporated into key policies and planning in Angola, Namibia and South Africa. Second, five adaptation plans will be promoted and strengthened in fisheries and fishery-dependent communities. Third, proposals to implement early warning systems in the three countries will be submitted to the competent authorities for implementation. Fourth, at least 400 people from small-scale fishery communities, government, universities, non-governmental organizations and the industry will receive targeted training on climate change risks and adaptation.

As indicated in the mid-term evaluation report published in January 2020, this project is starting to lay the foundations for putting adaptation actions into practice in the selected highly vulnerable fisheries and communities. Nevertheless, this project has shown slow progress in supporting the elaboration of community-based adaptation action plans and contributing to putting climate change adaptation actions into practice. One of the major challenging factors that affected the performance of the project is its design which lacked a theory of change showing a clear operational approach for its integration into government structures. To address this challenge, it is recommended to re-examine the logic of the project in order to make explicit its theory of change, with a focus on country-driven integration of the project's activities in their marine fisheries climate change adaptation strategies, and the measures for sustainability. Meanwhile, as a first step of the process, the FAO and BCC conducted a technical working session to redesign the project, and as a result, the log frame consisting of the result matrix, monitoring & evaluation plan, work plan and the project budget was revised. The revised log frame will be submitted to the Project Steering Committee to follow the BCC process of project implementation.



Angola. Fishermen with their catch.

Malawi



DONOR(S)

GEF – LDCF



IMPLEMENTING PARTNER(S)

Department of Fisheries, Ministry of Agriculture, Irrigation and Water Development, Malawi



OVERALL OBJECTIVES

The Malawi project ('Building Climate Change Resilience in the Fisheries Sector in Malawi') aims to build resilience in the beleaguered fisheries sector, especially among the riparian communities of Lake Malombe. The waters of Lake Malombe, connected to Lake Malawi in the north by the Upper Shire River, are heavily overfished. Combined with overfishing, local communities face the added pressures of climate change, making this project a matter of urgency.



FACTS AND FIGURES

- In Malawi, the fisheries and aquaculture sector contributes approximately 4 percent to the national Gross Domestic Product (GDP). Capture fisheries dominate. The fisheries and aquaculture sector is of great importance to Malawi's economy as a source of employment, food, rural income, exports, import substitution and biodiversity.
- The sector directly employs some 59 873 fishers and indirectly it supports more than 500 000 people involved in fish processing, fish marketing, boat building and engine repair. Nearly 1.6 million people in lakeside communities derive their livelihood from the fishing industry.
- Lake Malombe is a heavily overfished ecosystem, and climate change adds more complexity. Numerous aspects of fish life cycles and habitat suitability, as well as species-specific biological and ecological reactions to temperature changes, can significantly impact this sector's biodiversity and economic performance.
- However, the impacts of climate change on the Lake Malawi ecosystem and its dependent communities are not yet fully understood, and are certainly not sufficiently integrated into national approaches to management in the fisheries and aquaculture sector.



IMPACT

One priority of Malawi is to increase knowledge on climate trends, extreme events and resource status as a basis for formulating and implementing effective and timely adaptation measures. For this purpose, this project has conducted Vulnerability and Disaster Risk Assessments (VDRAs) of communities around Lake Malombe and an assessment of rainfall monitoring stations.

Another adaptation priority is to strengthen capacities of fisheries managers and build resilience of local fishing communities to climate change and its impacts. Accordingly, this project has carried out an Ecosystems Approach to Fisheries Management (EAFm) training for inland fisheries, and an assessment of the technical and physical capacity/needs of the National Aquaculture Centre (NAC) to provide a basis for development of a biosecurity plan.

Moreover, to promote diverse and resilient livelihoods, this project has embarked on small-scale cage-based aquaculture along the Upper Shire River for small-scale cages for rearing of local tilapia (*Oreochromis shiranus*), and promotion of deep pond technology for climate proofing of pond-based aquaculture.

The project is also involved in integrated watershed management. Kulungwi micro-watershed was selected following assessment with community representatives. The participatory multi-sectoral restoration plan has been developed for increased adaptation/resilience building of dependent communities.

In terms of challenges, a rapidly increasing population in Malawi is putting ever more pressure on already heavily exploited resources. The limited progress in Malawi's economic development is another major constraint, and coupled with a mostly low education among the target population, this reduces options for alternative employment and/or migration to more prosperous areas. There are also some difficulties in logistical arrangements in organizing meetings/workshops where local stakeholders are involved. For example, there is a need to find ways to organize multi-day meetings where participants can be provided with accommodation.

Europe

ClimeFish



DONOR(S)

European Union



IMPLEMENTING PARTNER(S)

University of Tromsø (Norway), together with 20 partners including FAO²



OVERALL OBJECTIVES

The overall goal of the ClimeFish project ('Co-creating a Decision Support Framework to Ensure Sustainable Fish Production in Europe under Climate Change') is to support climate change adaptation of fisheries and aquaculture through effective forecasting and development of management tools for adapting to climate change.



FACTS AND FIGURES

- ClimeFish is organised into nine different work packages (WPs): case study and knowledge gap analysis; data harmonization and visualization; biological forecasting; identify risks and opportunities and develop early warning methodologies; develop strategies to mitigate risk and utilize opportunities; stakeholder interaction; develop the ClimeFish Decision Support Framework; dissemination and training actions; and project management.
- The highest contribution from FAO is expected on WP6 (stakeholder interaction) and WP8 (dissemination and training actions).

² UiT, The Arctic University of Norway; FAO; Memorial University of Newfoundland, Canada; AVS Chile SA; Biologické Centrum AV ČR, v.v.i., Czech Republic; International Council For The Exploration Of The Sea, Denmark; SP/F Syntesa, Faroe Islands; Federation Européenne des Producteurs Aquacoles, France; Brandenburgische Technische Universität Cottbus-Senftenberg, Germany; Hellenic Centre for Marine Research, Greece; Nemzeti Agrárkutatási Es Innovációs központ, Hungary; Matis OHF, Iceland; Università Ca' Foscari Venezia, Italy; Institute Of Marine Research (IMR), Norway; Nofima, Norway; Centro Tecnológico Del Mar- Fundación Cetmar, Spain; Agencia Estatal Consejo Superior de Investigaciones Científicas, Spain; Stockholm University, Sweden; The University Court of The University of Aberdeen, United Kingdom; The University of Stirling, United Kingdom; Truong Dai Hoc Nha Trang, Viet Nam



IMPACT

The ClimeFish project has developed the General Guidelines to Develop Climate Adaptation Plans (the CAP guidelines) by drawing on fifteen case studies in Europe (ClimeFish, 2020), which provide an accessible and practical framework for the development of climate adaptation plans based on the principles and steps of the ecosystem approach to fisheries and to aquaculture (EAF/EAA). Moreover, a capacity development package built on ClimeFish tools and results was developed to ensure wide dissemination of the project outcomes as well as cross-fertilization with existing initiatives in developing countries.

In agreement with project partners and coordinator, the capacity development package includes three main elements: (i) an e-learning course on adaptation and mitigation made available free of charge on the FAO e-learning Academy website (FAO, 2020c); (ii) a guidance document on adaptation that is based on the CAP guidelines as well as work done beyond the ClimeFish project (including existing FAO tools, publications, and extensive experience based on positive examples of work on the ground); and (iii) the participation of FAO field projects representatives in the 2020 International Forum on the Effects of Climate Change on Fisheries and Aquaculture (Rome, 25-26 February 2020) (FAO, 2020d). These three types of outputs complement each other and are expected to have short- and medium- term impact.

The e-learning course on 'climate adaptation and mitigation in fisheries and aquaculture' provides an overview of climate change impacts on the fisheries and aquaculture sector, as well as adequate responses.

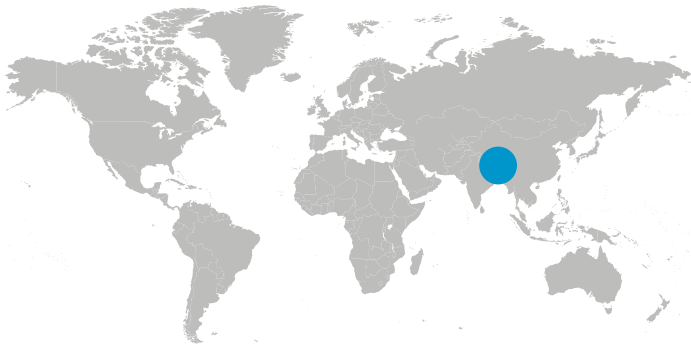
While ClimeFish has focused mainly on adaptation, an additional module was included to cover mitigation and to provide a comprehensive overview of climate responses that are available for the fisheries and aquaculture sector. At the end of the course, the learners are expected to gain insight into impacts of climate change on the sector, suitable adaptation strategies together with their practical application through case studies, development process of adaptation plans, and mitigation measures to reduce the sector's carbon footprint.

The guidance document on adaptation is intended to be a version with extended scope and relevance that is also useful for developing countries. The inclusion of climate change in EAF/EAA management plan will feed the guidance that is progressively building on adaptation and mitigation, providing practical insight as to how to account for climate change impacts and projections in fisheries and aquaculture management and development.

Five FAO field projects (i.e. the CC4FISH, Mediterranean, Chile, FishAdapt, and Malawi projects) representatives were invited to present FAO's work on climate change in their respective regions at the ClimeFish international forum under session 2 'Potential impacts of climate change on seafood production'. Their participation was an outstanding opportunity to connect projects that usually operate in poor-data and low-capacity contexts to advanced bio-climatic and bio-economic modelling and expose them to methodologies and experiences that could potentially be picked up in non-European countries.

Asia

Bangladesh



OVERALL OBJECTIVES

The Bangladesh project ('Community-based Climate Resilient Fisheries and Aquaculture Development in Bangladesh') aims to build and enhance the adaptive capacity and resilience of vulnerable coastal communities and deeply flooded *haor* wetland communities in Bangladesh dependent on fisheries and aquaculture for their livelihoods, so as to reduce their vulnerability and improve their resilience.



DONOR(S)

GEF – LDCF



IMPLEMENTING PARTNER(S)

Department of Fisheries, Bangladesh



FACTS AND FIGURES

- The fisheries and aquaculture sector in Bangladesh provides about 60 percent of national animal protein, with more than 17.5 million people engaged in the sector on a full-time and part-time basis.
- Bangladesh is the most vulnerable country in the world to tropical cyclones and the sixth most vulnerable to floods.
- This project has selected two vulnerable intervention areas: (1) the south-west coastal area, which is increasingly affected by rising sea levels, saltwater intrusion and storm surges; and (2) the north-east *haor* wetland area that is increasingly affected by flash floods, erratic rainfall and drought. Both areas hold some of the largest fisheries, aquaculture production operations and sector-dependent communities.



IMPACT

This project is expected to remove key barriers to effective adaptation to climate change in the fishery and aquaculture sector and build the resilience of the fishery sector through capacity development and policy reform. It will strengthen the awareness and knowledge of local communities, and enhance local adaptive capacity through transfer and adoption of appropriate site-specific climate resilient fisheries and aquaculture intervention technologies and approaches. These interventions will be underpinned by effective knowledge management (e.g. use of ICT-based climate and disaster information services) to ensure wider dissemination of best practices and lessons learned.

The project results will be delivered through four components: (1) climate resilient fisheries sector through relevant national capacity development; (2) strengthening knowledge and awareness of fisheries/aquaculture dependent communities facing the adverse impacts of climate change; (3) enhancing local adaptive capacity to support climate resilient fisheries and aquaculture management and alternative livelihoods in the face of climate change; and (4) dissemination of best practices and lessons learned, monitoring and evaluation.

The expected overall impact of this project will be that the poor and smallholders in the project areas will benefit from project interventions both socially and financially, including capacity development to adapt to the adverse impacts of climate change and variability. The coastal and inland aquatic ecosystems of this project (covering an area of about 4 790 km²) will be under climate resilient plans and management practices. About 400 000 people will have reduced vulnerability to climate change, of which at least 40 percent are women.

Myanmar



other project is the My-Coast project ('Ecosystem-Based Conservation of Myanmar's Southern Coastal Zone'), which seeks to improve coastal zone management to benefit marine biodiversity, climate-change mitigation, and food security.



FACTS AND FIGURES

- Myanmar, situated in South East Asia, has a population of around 51.4 million. It has one of the lowest GDPs in the world, with the World Bank estimating its poverty rate at 37.5 percent.
- Myanmar enjoys diverse climatic conditions including both subtropical and tropical zones, as well as low to high rainfall regions. As a result, the country produces a wide range of almost all crops, and livestock and fishery products.
- The fisheries and aquaculture sector in Myanmar is critically important to the country's food and nutrition security (61 kg/capita/year) and economy (9 percent of GDP). An estimated 1 million people directly and 3 million people indirectly are involved in this sector.
- For marine and inland capture fisheries, climate change impacts include changes in sea surface temperature, higher inland water temperature, changes in ocean currents, changes in the frequency of El Niño-Southern Oscillation (ENSO) events, sea level rise, and changing levels of rain and water availability.
- The aquaculture sector is also exposed to climate-related hazards such as salt-water intrusion, flooding of ponds, shortages in water supply, invasive species, and ad hoc development planning which alters local ecosystem dynamics and undermines their resilience, integrity and functionality.
- Myanmar is vulnerable to extreme climate events. They have caused significant loss of life and damage to infrastructure, and have also impacted fishers' and fish-farmers' livelihoods.



DONOR(S)

GEF – LDCF (for the FishAdapt project); GEF Trust Fund (for the My-Coast project)



IMPLEMENTING PARTNER(S)

FishAdapt: Department of Fisheries of the Ministry of Agriculture, Livestock, and Irrigation, Myanmar

My-Coast: Ministry of Natural Resources and Environmental Conservation, and Ministry of Agriculture, Livestock, and Irrigation, Myanmar



OVERALL OBJECTIVES

There are two ongoing adaptation projects in Myanmar. One is the FishAdapt project ('Strengthening the Adaptive Capacity and Resilience of Fisheries and Aquaculture dependent Livelihoods in Myanmar'). The FishAdapt project aims to assist the government in enabling inland and coastal fishery and aquaculture stakeholders to adapt to climate change by understanding and reducing their vulnerabilities, piloting new practices and technologies, and sharing information. The



IMPACT

The FishAdapt project is working along the three main levels or categories of intervention as described in the FAO adaptation toolbox: improving institutional adaptation, enhancing livelihoods, and identifying vulnerabilities and minimizing risks and impacts (at all levels). Following this approach, the project is trying to enable inland and coastal fisheries and aquaculture small-scale communities to adapt to climate change by understanding and reducing their vulnerabilities, planning and piloting new and sustainable good practices and critical technologies, as well as by generating and sharing information.

The project's relevance to the country and to the sector is well understood by the concerned stakeholders and implementing partners, specifically by the Department of Fisheries (DOF) and the affected communities, which promotes high ownership, interest and involvement of the beneficiaries (over 90 000 at household level). This enabling environment is allowing the project to implement the activities foreseen at different levels and involving different stakeholders as planned.

The FishAdapt project has adopted adaptation measures in six FAO priority areas on climate change adaptation:

1. Development and application of data and knowledge for impact assessment and adaptation: Vulnerability assessments, village profiling, Community Based Climate Change Adaptation Plans (CBCCP), and Climate Change National Monitoring System.
2. Support and improvement of governance for climate change adaptation: Legal and policy framework review and updating.
3. Building of livelihood resilience to climate change: 120 Community Integrated Management Plans, and specific pilots on Climate-Smart Aquaculture, Mangrove Friendly Aquaculture, and Rice-Fish Culture.
4. Targeted approaches for conservation and sustainable management of biodiversity: the ecosystem approach to fisheries/aquaculture management (EAFM/EAAM) plans.
5. The identification, support and application of innovative technologies: Drones and GIS Mapping.

6. Improved disaster risk management: Early Warning Systems Early Action Plans (EWEA), Disaster Risk Reduction, and Safety at Sea.

In a country prone to disasters and unfortunately, severely often hit by them (e.g. Cyclone Nargis in 2019), the fact that climate is changing and that this change (not an entelechy) may imply impacts on the lives of the people is well understood. Villagers already felt it and talk about it: how the monsoon onset is delayed year after year, how the rain season is more intense and shorter, water scarcity and floods, and so on. Climate change and climate-related disasters are in people's worries, conversations and imaginary; the FishAdapt project is therefore perceived as needed by the beneficiaries.

The main obstacle for project success is the lack of capacity to really obtain all the potential benefits from the project. The capacity to absorb, retain and sustain what the project delivers is very low, and a comprehensive capacity development effort concentrated in a few years is not going to change this. Therefore, additional efforts on top of what the project delivers are needed. This low capacity is reflected as follows: weak governance, non-organizational capacities, poor institutional arrangements, limited technical capacity and knowledge (sustainable resource management and climate change related), limited human and economic resources (no enforcement), and therefore lack of adequate sustainable resources management plans and climate change sectorial adaptation plans.

The My-Coast project comprises two inter-related components. Under component one, national capacities will be built to develop and implement strategic coastal conservation management. Under component two, local capacities will be built, and demonstrations will be implemented. Demonstrations contributing to holistic and integrated coastal zone management will be conducted within a specific geographic area (the southern Tanintharyi Region and Myeik Archipelago) to allow for the measurement of ecosystem-level impacts. The My-Coast project is currently in the project preparation phase. Activities supported during this phase will include the key information-gathering stakeholder consultation tasks. These activities will result in the preparation of the documentation required for submission of the full-size project for endorsement by GEF and approval by FAO.

Pacific

Pacific SIDS - FishFAD



DONOR(S)

Government of Japan



IMPLEMENTING PARTNER(S)

Ministry of Fisheries, Fiji; Ministry of Fisheries and Marine Resources Development, Kiribati; Marine Resources Authority, Marshall Islands; Ministry of Natural Resources, Environment & Tourism, Palau; Ministry of Agriculture and Fisheries, Samoa; Fisheries Department, Tuvalu; Ministry of Agriculture, Livestock, Fisheries, Forestry & Biosecurity, Vanuatu



OVERALL OBJECTIVES

The FishFAD project ('Enhancing Livelihoods and Food Security through Nearshore Fish Aggregating Device Fisheries in the Pacific') aims to support Pacific SIDS to enhance food security, nutrition and livelihoods in nearshore fishing communities in Fiji, Kiribati, Marshall Islands, Palau, Samoa, Tuvalu, and Vanuatu.

This project contributes to this goal through a focus on the safe development of nearshore fish aggregation device (FAD) fisheries supported by co-management approaches and through the development of value adding and alternative livelihoods to diversify income sources.



FACTS AND FIGURES

- The waters of the Pacific Islands region cover an area of around 40 million square kilometres, or around 8 percent of the Earth's surface. This is equivalent to about 30 percent of the area of the Earth's land surfaces.
- The people of the Pacific Islands, on average, consume two to three times the global average of fish per capita per year. Fish also accounts for 50 to 90 percent of animal protein in the diets of coastal populations, and most of it comes from coastal fisheries (e.g. reef fish and small pelagic species).
- Fish and fisheries not only constitute a vital part of income generation in coastal communities but also are of significant cultural value. However, coastal fisheries production has not increased significantly in the 15-year period between 1999 and 2014 despite indications at the national level of increasing fishing pressure.
- The Pacific is projected to experience higher than average impacts from climate change in coastal areas.
- The waters hold the world's largest stocks of tuna and related pelagic species. The waters of the Pacific Islands region provide around a third of the world's catches of tuna and related species, and over half of the world's supplies for canned tuna.



IMPACT

The seven project countries in the Pacific are at different stages of development in their nearshore FAD fisheries. To maintain current levels of consumption of marine resources, Pacific Island nations will need to develop improved fisheries management of nearshore resources as well as to utilize adaptive responses that can assist with 'filling' the gap in marine resources that will emerge in the coming years. Thus, greater efforts are required to promote the contribution of small-scale fisheries to food security and nutrition at the same time as enhancing the socio-ecological resilience of Pacific SIDS fishing communities.

This project will be directly implemented by FAO, but will also utilize triangular implementation working with regional partners and Japanese institutions that have played a key role in development of the fisheries sector in the Pacific and the involved countries. In addition, the project will make use of south-south cooperation arrangements, as some of the partner countries in the project are in a position to be able to contribute to knowledge sharing and technical assistance on topics such as design and deployment of nearshore FAD.

The four main areas of intervention include: (1) strengthening and developing community nearshore FAD programmes to provide improved access to high value species; (2) structuring and strengthening of fishers' associations and cooperatives; (3) developing livelihood opportunities and revenue generating activities and products; and (4) improving safety at sea for fishers of nearshore FADs.



©FAO/FISHFAD

FAO SAP local tuna troll fishers from the Tarawa FAD Committee are being trained to adopt new fishing technologies and build resilience within their livelihoods that enables expansion beyond their present single troll fishing methods. One of the key objectives of the project is to train small-scale tuna fishers in new mid-water fishing technologies targeting high-value larger tuna and in improved on-board handling practices to land higher quality tuna into onshore post-harvest fish processing activities.



©FAO/FISHFAD

FAO SAP tuna processors are being trained in improved food safety and in the introduction of Sanitation Standard Operating Procedures (SSOPs) within the processing environment especially in relation to new novel tuna products. The project is building pilot commercial value-added tuna processing businesses within fisher association communities. Sustainable revenue generating motivates manufacturing safe food products to be marketed at large urban markets and leads to long-term employment and future potential to target export markets.

Pacific SIDS - OFMPII



DONOR(S)

GEF Trust Fund

IMPLEMENTING PARTNER(S)

Co-implementing agency - United Nations Development Programme (UNDP)

Executing partners - Pacific Islands Forum Fisheries Agency (FFA); Secretariat of the Pacific Community (SPC); Parties to the Nauru Agreement (PNA); Pacific Islands Tuna Industry Association (PITIA); World Wildlife Fund – Pacific Programme (WWF)

OVERALL OBJECTIVES

The OFMPII project ('Implementation of Global and Regional Oceanic Fisheries Conventions and Related Instruments in the Pacific Small Island Developing States (SIDS)') aims to support Pacific SIDS in meeting their obligations to implement and effectively enforce global, regional and sub-regional arrangements for the conservation and management of transboundary oceanic fisheries thereby increasing sustainable benefits derived from these fisheries, with the emphasis on implementation.



FACTS AND FIGURES

- In addition to hold the world's largest stocks of tuna, the waters of the region also contain globally important stocks of sharks, billfish and other large pelagic species, whales and other marine mammals, and turtles.
- The conservation of these globally important transboundary fish stocks, and the protection of the associated transboundary nontarget species (especially of sharks, seabirds and sea turtles), while considering climatic variability and change, constitutes the global environmental benefit for this project.
- Climate change concerns include sea level rise, which can be expected to inundate the territories of some Pacific SIDS, and changes in the distribution of species such as tuna stocks in ways that would greatly affect the economic values of Pacific SIDS exclusive economic zones.



IMPACT

The project comprises five components: (1) regional actions for ecosystem-based management; (2) sub-regional actions for ecosystem-based management; (3) national actions for ecosystem-based management; (4) stakeholder participation and knowledge management; and (5) project management. Structured in this way, the project is expected to support Pacific SIDS as the major bloc at the Western and Central Pacific Fisheries Commission (WCPFC) to adopt regional conservation and management measures. It will also support the innovative approaches being developed by Pacific SIDS at sub-regional level as they collaborate in fisheries of common interest and assist SIDS to apply measures nationally in their own waters and to their fleets.

Overall, this project is making satisfactory progress towards expected outcomes. At the regional level, work is well underway in aligning Pacific SIDS' legislation and policy with WCPFC requirements as well as on climate change modelling (e.g. projection of the impact of climate change on bigeye, skipjack, south Pacific albacore and yellowfin tunas, which make up over 95 percent of the commercial catch in SIDS waters). At the sub-regional level, operational cap and trade measures are in place for purse-seine and in process for longline fisheries for the Parties to the Nauru Agreement (PNA, namely Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu), and compliant skipjack products are granted certification to the Marine Stewardship Council (MSC) Standard for Sustainable Fishing. At the national level, work is ongoing to address country-level actions through development/revision of management plans and regulatory requirements, with slow progress due to delays at the start of the project, capacity limitations and competing priorities at country levels. To further facilitate the project progress, it is recommended to identify key or necessary success factors to be recorded as lessons learned from the project about what works best for developing and implementing management arrangements at sub-regional and national levels. It is also recommended to promote active engagement with national fisheries departments highlighting the role and potential for support for eligible national projects.



Solomon Islands. On board a Pole and Line.

©Francisco Blaha

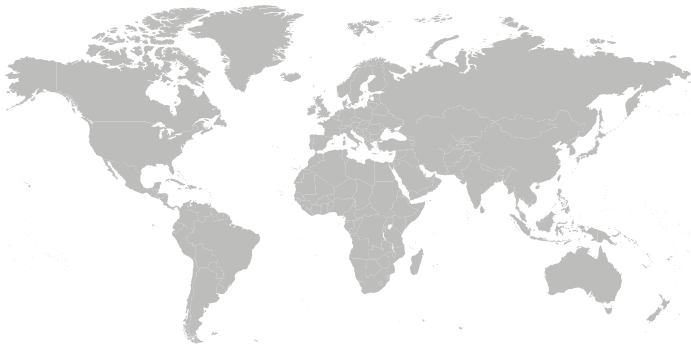


Papua New Guinea. Subsistence fishers.

©Francisco Blaha

Global

Implementing adaptation measures



DONOR(S)

Government of Norway



IMPLEMENTING PARTNER(S)

National institutions responsible for fisheries/aquaculture and for climate change in Saint Lucia, South Africa, and the Philippines



OVERALL OBJECTIVES

The project ('Support Member Countries to Implement Climate Change Adaptation Measures in Fisheries and Aquaculture') aims to assist partner countries and key stakeholders, including trade and industry experts, policy and management experts, fishers and fish workers, to adapt to climate change effectively while ensuring the socio-economic development of the fisheries and aquaculture sector. The ultimate goal of this project is to support partner countries in the development and implementation of their NDCs and NAPs under the Paris Agreement.



FACTS AND FIGURES

- This project is a global project with country-specific activities. Three countries have been selected on the basis of agreed criteria: Saint Lucia, South Africa, and the Philippines.
- NDCs are the formal commitments that member countries will make towards achieving the mitigation and adaptation objectives of the Paris Agreement, and countries were expected to provide their first mandatory submission in 2020.
- NAPs are member countries' medium and long-term adaptation plans submitted to UNFCCC.



IMPACT

Activities supported by this project include: (1) strengthening countries' capacity to move from vulnerability assessment to adaptation planning and implementation in fisheries and aquaculture using the FAO Adaptation Toolbox; (2) market support to develop new value chains and enhance opportunities for value addition to address falling revenues from climate change on current practice; (3) demonstration studies to support the uptake of climate smart aquaculture and resilient coastal livelihood diversification; and (4) safety-at-sea improvement, climate change and disaster preparedness plan.

National project coordinators have been instrumental for the good implementation of the project. Existing FAO projects where the project is working have also helped to kick start activities. The challenge is that this project has a short period of time and limited funding, and thus exit strategies are important.



Worker harvesting shrimps at a shrimp breeding farm.

EAF-Nansen Programme



support from FAO for the implementation of an ecosystem approach to fisheries (EAF) management and to improve their knowledge base for decision making. The aim is to promote sustainable utilization of marine living resources and improved protection of the marine environment. The current phase of EAF-Nansen Programme addresses climate change as one of the main stressors together with overfishing and pollution, with a particular aim of improving knowledge on the actual impacts at the regional and local scales and assessing vulnerability of fisheries-dependent communities in selected areas.

 **DONOR(S)**
Government of Norway

 **IMPLEMENTING PARTNER(S)**
Fisheries research and management institutions; regional fisheries bodies in relation to Africa, including the Fishery Committee for the Eastern Central Atlantic (CECAF), Southwest Indian Ocean Fisheries Commission (SWIOFC), Benguela Current Commission (BCC), and South East Atlantic Fisheries Organisation (SEAFO)

 **OVERALL OBJECTIVES**

The EAF-Nansen Programme ('Supporting the Application of the Ecosystem Approach to Fisheries Management considering Climate and Pollution Impacts') offers an opportunity for coastal partner countries in Africa and the Bay of Bengal to receive

FACTS AND FIGURES

- Unsustainable fisheries, climate change and pollution are undermining livelihoods and food security in many developing countries, especially in Africa, where most coastal communities live primarily on fish as a source of food and livelihoods.
- FAO estimates that fish provides 22 percent of animal protein intake in sub-Saharan Africa, this share exceeding 50 percent in the poorest countries (especially where other sources of animal protein are scarce or expensive).
- In countries with upwelling regions, such as Mauritania or Namibia in northwest and southwest Africa respectively, fisheries represent a high percentage of GDP. However, there is conflicting information as to the consequences of climate change on coastal upwelling, a crucial element in the biological production of many areas of the African coastal zone.



IMPACT

The EAF-Nansen Programme is expected to achieve the long-term objective that people in partner countries are food and nutrition secure. It will work towards the overall outcome that fisheries in partner countries are sustainably managed based on ecological, socio-economic and governance considerations. Three outcomes are expected. First, fishery research institutions will provide relevant and timely scientific advice for management. Second, fisheries management institutions will have appropriate management processes and policies in place according to the EAF principles. Third, partner institutions will have appropriate and adequate human and institutional capacity to manage fisheries sustainably. Furthermore, this project is expected to improve understanding of the impacts of climate change and other anthropogenic impacts on fish stocks and ecosystems. It will also provide technical assistance to support socio-ecological assessments of the vulnerability of coastal communities to climate variability and change.

This Programme has a strong research component - it is the only FAO project with a research vessel operating around Africa and in the Bay of Bengal to collect data. The Programme also has a science plan that addresses climate change questions. Ongoing research activities concern the Angolan and Western Gulf of Guinea coastal upwelling ecosystems, the Canary and Benguela currents eastern boundary upwelling ecosystems, shelf and inner-shelf circulation off the South-Eastern coasts of Africa (South Africa, Mozambique and Tanzania), and the Bay of Bengal. In addition, the Programme is planning to carry out a vulnerability assessment in the Gulf of Guinea.

For this purpose, a review of vulnerability assessment methodologies is under preparation with the purpose of harmonizing approaches through a common standard. The methodology for the Gulf of Guinea will be designed based on the results of the review and the needs in situ.



Djerba Island, Tunisia - Fishermen in the port of Ajim. Blue Hope - Blue Hope Initiative project sites in Zarzis. Supporting Mediterranean small-scale fishing communities in transforming vulnerable coastal zones into engines of stability and hope.

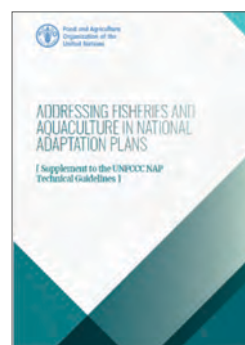
Selected publications



Impact of climate change on fisheries and aquaculture

This publication is a synthesis of current knowledge on climate change implications for marine fisheries, inland fisheries and aquaculture. It provides the fundamentals of observed

and projected changes in the climate system and their consequences for the marine and freshwater systems. The technical paper recognizes the importance of contextualizing the topic of climate change in fisheries and aquaculture in terms of poverty alleviation and the existing policy commitments such as the 2030 Agenda for Sustainable Development and the Paris Climate Agreement, and on our current and expected socioeconomic dependencies on the sector.



Addressing fisheries and aquaculture in national adaptation plans – Supplement to the UNFCCC NAP Technical Guidelines

This document provides technical guidance on

the integration of fisheries and aquaculture in the formulation and implementation of National Adaptation Plans. It aims to draw the attention of policy makers and government officers responsible for National Adaptation Plans planning and processes generally, as well as fisheries and aquaculture officers at country level, specifically. It collates and analyses relevant information from fisheries and aquaculture to support the sector's ability to take part in national climate change adaptation planning processes.



Addressing agriculture, forestry and fisheries in National Adaptation Plans – Supplementary guidelines

The guidelines outline four elements and related steps for preparing the agriculture sectors' contributions to National Adaptation Plans. They are intended to be used by national planners and decision-makers working on climate change issues in developing countries and authorities and experts within the agriculture sectors who are contributing to climate change adaptation and National Adaptation Plans formulation and implementation.



Fisheries and aquaculture in the climate-smart agriculture sourcebook

The purpose of the sourcebook is to further elaborate the concept of

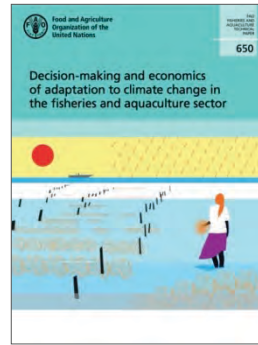
Climate-Smart Agriculture and demonstrate its potential, as well as its limitations. This sourcebook is a reference tool for planners, practitioners and policy makers working in agriculture, forestry and fisheries at national and subnational levels, dealing with the effects of climate change.



Adaptive management of fisheries in response to climate change

The implementation of adaptive fisheries management responsive to climate change impacts and the evaluation of its success in real-world

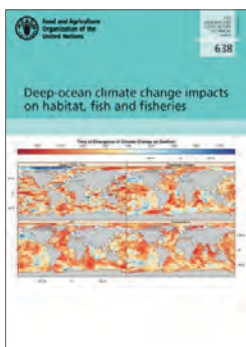
situations are generally lacking. This publication seeks to fill this knowledge gap by analyzing practical experiences of fisheries management adaptation to climate change under a variety of species, environmental and governance contexts and by identifying examples of good practices to increase fisheries resilience. Ultimately, this publication aims to accelerate climate change adaptation implementation in fisheries management throughout the world and to provide a range of options for stakeholders, including the fishing industry, fishery managers, policymakers, and other stakeholders involved in decision making, to select adaptations which are specific and tailored for their individual contexts.



Decision-making and economics of adaptation to climate change in the fisheries and aquaculture sector

This FAO Technical Paper synthesizes current knowledge on the impact of El

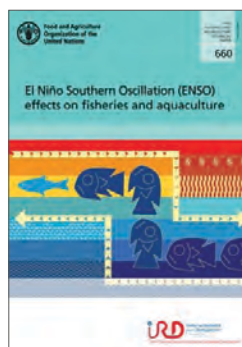
Niño Southern Oscillation (ENSO) events on fisheries and aquaculture in the context of a changing climate. It describes the diversity of ENSO events, ENSO forecasting, and ENSO in the context of climate change. It includes a global overview and regional assessment of ENSO impact and a focus on coral bleaching and damage to reefs and related fisheries. Finally, it synthesizes the lessons learned and the perspectives for ENSO and preparedness in a warmer ocean.



Deep-ocean climate change impacts on habitat, fish and fisheries

This publication presents the outcome of a meeting between the FAO/UNEP ABNJ Deep-seas and Biodiversity project and the Deep Ocean

Stewardship Initiative. It focuses on the impacts of climatic change on demersal fisheries, and the interactions of these fisheries with other species and vulnerable marine ecosystems. Predictions are made to changes in distributions of commercial species, though in practice the processes governing population abundance are poorly understood in the deep-sea environment, and predicted distributional changes are not always as expected and may be manifested as simple disappearance of species or ecosystems. The publication underscores that adaptive monitoring and management mechanisms must be in place to ensure sustainable fisheries and healthy environment.



El Niño Southern Oscillation (ENSO) effects on fisheries and aquaculture

This FAO Technical Paper synthesizes current knowledge on the impact of El Niño Southern Oscillation (ENSO) events on fisheries and

aquaculture in the context of a changing climate. It describes the diversity of ENSO events, ENSO forecasting, and ENSO in the context of climate change. It includes a global overview and regional assessment of ENSO impact and a focus on coral bleaching and damage to reefs and related fisheries. Finally, it synthesizes the lessons learned and the perspectives for ENSO and preparedness in a warmer ocean.



Assessing climate change vulnerability in fisheries and aquaculture

This publication provides an overview of vulnerability assessment concepts and methodologies. It sheds light on the different vulnerability

assessment methodologies that have been developed, and on how these are conditioned by the disciplinary traditions from which they have emerged. It also analyses how these methodologies have been applied in the context of fisheries and aquaculture, with illustrative examples of their application. It also proposes a series of practical steps to assess vulnerability in the fisheries and aquaculture sector.



Guidance on spatial technologies for disaster risk management in aquaculture: a handbook

This document addresses the use of spatial technologies that support those working to

reduce disaster risks and respond to emergencies in the aquaculture sector. It describes the principles for using spatial technologies in disaster risk management and will therefore remain relevant, even in the context of rapid technological innovation and the advancement of these technologies.



Fisheries and aquaculture climate change adaptation examples

This circular contains a selection of current and recent climate change adaptation activities and measures in the fisheries and aquaculture

sector. Descriptions for 26 current or recent activities and programmes focused specifically on or benefiting fisheries and/or aquaculture (and other sectors if relevant), primarily in developing countries, highlight the diversity of potential adaptation actions at the local to regional scales.



Adaptation strategies of the aquaculture sector to the impacts of climate change

This document reviews the numerous options for aquaculture described in literature; it identifies key research areas that would

improve the sector's capacity to adapt to climate change impacts and inform policy on adaptation. The document ends with a set of suggestions for assessing potential adaptation measures and implementing them. These are built around two pillars: a sustainable livelihood framework, and an ecosystem approach to aquaculture management, supported by risk assessment and management along the value chain and a feasibility assessment. The capacity of the main stakeholders to apply these concepts - sustainable livelihoods analysis, risk assessment and management, feasibility assessments (including cost-benefit analysis), and an ecosystem approach to aquaculture management should be developed or strengthened.



Quantifying and mitigating greenhouse gas emissions from global aquaculture

Global aquaculture makes an important contribution to food security directly (by increasing food availability and accessibility)

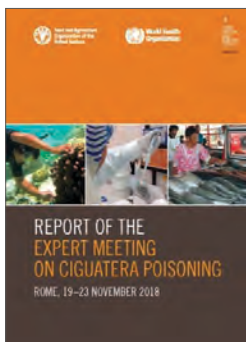
and indirectly (as a driver of economic development). In order to enable sustainable expansion of aquaculture, we need to understand aquaculture's contribution to global greenhouse gas (GHG) emissions and how it can be mitigated. This study quantifies the global GHG emissions from aquaculture (excluding farming of aquatic plants) and explains how cost-effectiveness analysis (CEA) could be used to appraise GHG mitigation measures. Cost-effective mitigation of GHG from aquaculture can make a direct contribution to United Nations Sustainable Development Goals 13 (Climate Action), while supporting food security (Goal 2: Zero Hunger), and economic development (Goal 8: Decent Work and Economic Growth).



Greenhouse gas emissions from aquaculture: a life cycle assessment of three Asian systems

In order to estimate the possible scale of greenhouse gas emissions from aquaculture in Asia, a study was carried out on three

aquaculture systems: Nile tilapia in Bangladesh, Indian major carps in India and striped catfish in Viet Nam. The analysis was intended to improve the understanding of where and how GHG emissions arise in Asian aquaculture, whilst highlighting weaknesses in the currently available data. The results of this study will guide future studies on where to improve the data and on how to develop cost-effective ways of improving aquaculture performance and reducing emissions. This report highlights the variation within each farming system at every stage of the three Asian aquaculture systems. The report makes some suggestions for methods which potentially could reduce emission intensities related to the farming systems, but applying best practices uniformly on farms and thus increasing efficiencies appear to be major factors for improvement.



Report of the Expert Meeting on Ciguatera Poisoning

Climate change and coastal water over enrichment create an enabling environment for harmful algal blooms (HABs), which seem to have become more frequent, more intense and more widespread in the past

decades. Benthic HABs (BHABs) happening at the bottom of coastal waters, especially Gambierdiscus and Fukuyoa species responsible for ciguatera poisoning (CP), are the most common non-bacterial seafood poisoning globally. Small island States in tropical regions are particularly vulnerable to the consequences of ciguatera poisoning, and global changes in climate may exacerbate the incidence rates and impacts on natural and economic resources of endemic populations. For this reason, CP was raised at the Codex Committee on Contaminants in Food at its 11th Session (CCCF11). The Committee requested scientific advice from FAO/WHO for full evaluation of known ciguatoxins (toxicological assessment and exposure assessment), including geographic distribution and rate of illness, congeners and methods of detection; and based on this, guidance for the development of risk management options.



Guidelines for increasing access of small-scale fisheries to insurance services in Asia

These Guidelines for increasing access of small-scale fisheries to insurance services in Asia have been developed to support the implementation of the Voluntary Guidelines for Securing

Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines). The purpose of these Guidelines is fourfold: (1) to increase awareness about the needs of small-scale fishers for better risk management, disaster preparedness and insurance services; (2) to guide policy and decision makers to help introduce insurance services to small-scale fishers, with the ultimate objective to strengthen the sustainability and ecological and economic viability of these fisheries; (3) to build capacity among insurance providers, fisherfolk organizations, NGOs, and concerned government agencies, to design and implement insurance programmes that suit the needs of small-scale fishing communities and enhance social protection; and (4) to promote insurance services that incentivize and reward a responsible and sustainable conduct of fishing operations and a better preparedness for natural disasters including climate change related challenges.



Climate change and fisheries in the Caribbean

Climate change is significantly disrupting fisheries and aquaculture across the globe. Caribbean fisherfolk are on the frontline in the battle against climate change, fighting

to maintain their catches, their income and their livelihoods. At stake is our food security, our fishing heritage, the well-being of coastal communities and an important contribution to the emerging blue economy. This policy brief highlights the climate change impacts affecting the Caribbean fisheries sector, the existing adaptation measures, and presents supporting policy actions for adaptation.



Guía básica - Cambio climático pesca y acuicultura (Simple guide - Climate change fisheries and aquaculture)

This document in Spanish has been published under the FAO-GEF project 'Strengthening the Capacity for Adaptation in the Chilean Fisheries and Aquaculture Sector to Climate Change'.

This Simple Guide on Climate Change, Fisheries and Aquaculture was designed to help understand through a simple and visual booklet the causes and effects of climate change. It is hoped that the guide will raise awareness of the many challenges that lie ahead and motivate communities to take and implement actions to mitigate and adapt to climate change that would improve their livelihoods and quality of life.



Building climate-resilient fisheries and aquaculture in the Asia-Pacific region

The FAO/APFIC Regional Consultative Workshop, Building Climate-Resilient Fisheries and Aquaculture in the Asia-Pacific Region brought together

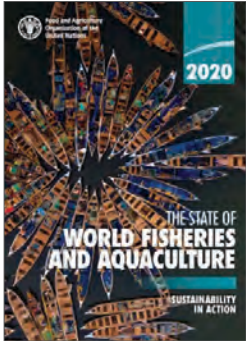
policymakers, managers and practitioners who were engaged in addressing climate change in relation to fisheries and aquaculture in the Asia-Pacific region through the development and implementation of regional and national policies, programmes and projects. Key presentations by FAO set the scene for the workshop including an introduction to the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement and its implications for national actions, and regional overviews on the status of climate change adaptation and mitigation actions in the fisheries and aquaculture sector. Presentations on the efforts and progress made by national governments and international and regional organizations in addressing the effects of climate change in the fisheries and aquaculture sector were delivered, and various issues and gaps, and the support needed to address climate change more effectively in the sector were highlighted.



An ecosystem approach to promote the integration and coexistence of fisheries within irrigation systems

This technical document has been developed in recognition of the increasingly

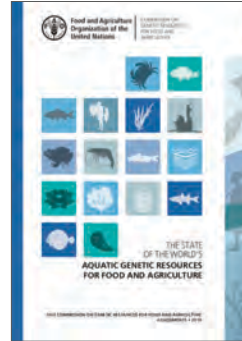
diverse demands for water from irrigation systems and the need to introduce more holistic land uses into conventional irrigation management. Despite historical precedents and efforts in the twentieth and early twenty-first centuries, the potential for the integration of fish production (capture fisheries and aquaculture) and irrigation systems has yet to be fully realized. Capturing these underutilized opportunities for the integration of fisheries and aquaculture could significantly increase local economies, food security, household incomes and livelihood diversity within irrigated agriculture systems.



The state of world fisheries and aquaculture 2020 - Sustainability in action

The 2020 edition of The State of World Fisheries and Aquaculture has a particular focus on sustainability. While

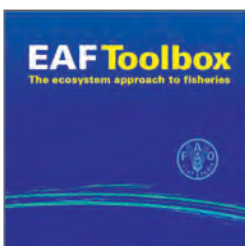
Part 1 retains the format of previous editions, the structure of the rest of the publication has been revised. Part 2 opens with a special section marking the twenty fifth anniversary of the Code of Conduct for Responsible Fisheries. It also focuses on issues coming to the fore, in particular, those related to Sustainable Development Goal 14 and its indicators for which FAO is the 'custodian' agency. In addition, Part 2 covers various aspects of fisheries and aquaculture sustainability. The topics discussed range widely, from data and information systems to ocean pollution, product legality, user rights and climate change adaptation. Part 3 now forms the final part of the publication, covering projections and emerging issues such as new technologies and aquaculture biosecurity. It concludes by outlining steps towards a new vision for capture fisheries.



The state of the world's aquatic genetic resources for food and agriculture 2019

This report reviews our use of aquatic genetic resources both in capture fisheries and

in aquaculture, in areas under national jurisdiction. The first-ever global report of its kind is based on information provided by 92 countries, together representing 96 percent of global aquaculture production and over 80 percent of capture fisheries production.



EAF Toolbox - The ecosystem approach to fisheries

The EAF Toolbox is aimed at national and local fisheries management authorities,

including fishery managers, scientists and stakeholders looking for practical solutions they can apply given their circumstances and resources. It has been designed to guide users through each of the four main EAF management planning steps and activities using simplified text and clear instructions. The toolbox also helps users decide which tool(s) could be most appropriate for each step given the type of fishery, their resources and capacity.



Ecosystem approach to fisheries management training course (Inland fisheries) Volume 1: Handbook for trainees

This Ecosystem Approach to Fisheries management training course (Inland Fisheries) is designed as a complete training course for the sustainable management of inland fisheries using the ecosystem approach. It is targeted at middle-level fishery and environment officers, extension workers, facilitators and other stakeholders engaged in the planning and management of inland fisheries.



Fishermen and artisanal fishing boats in the port of Mindelo, Cabo Verde.



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The Food and Agriculture Organization of the United Nations (FAO) works towards ending hunger and poverty while using precious natural resources sustainably. The fisheries and aquaculture sector makes substantial contributions to food security, livelihoods and global trade. Global production of fish and other aquatic animals was 177.8 million tonnes in 2019, and about 59.5 million people were engaged in the primary sector of capture fisheries and aquaculture in 2018. Fishery net exports generate significantly more revenue for developing countries than other agricultural commodities such as rice, coffee and tea.

Millions of people are struggling to maintain reasonable livelihoods through the fisheries and aquaculture sector. These are the people who are the most vulnerable to the impacts of climate change. Climate change adds to the many threats and obstacles that already confront them in their day-to-day lives. Particular attention must be given to be the most vulnerable if the sector is to continue to contribute to meeting global goals of poverty reduction and food security.

This publication presents FAO's work on climate change and fisheries and aquaculture. It includes examples of FAO's support to countries so that they are better able to adapt to the impact of climate change in the fisheries and aquaculture sector. It also brings together FAO's most up-to-date knowledge on climate change, including a portfolio of adaptation tools and measures used to support countries' climate commitments and action plans.

ISBN 978-92-5-133989-3



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CB3414EN/1/05.21