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COMMITTEE ON FISHERIES

SUB-COMMITTEE ON FISH TRADE

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THE IMPACT OF CLIMATE CHANGE ON FUTURE FISH SUPPLY TRADE AND CONSUMPTION

Executive Summary

Following a request by the Sub-Committee on Fish Trade (COFI:FT), this paper provides an overview of the expected climate change impacts on production systems, consumption systems and international trade of fish products with possible policy responses.

Suggested action by the Sub-Committee

- Provide guidance on how to proceed with work on climate change as related to fish trade and the post-harvest fisheries and aquaculture sector;
- Share good practices in adaptation to climate change and related national policies to the Sub-Committee, as examples;
- Support the Secretariat to address data/information gaps at regional and country levels related to climate induced resource changes;
- Provide guidance on capacity building to assist those affected by climate change in terms of fish trade, livelihoods and food security, especially the most vulnerable coastal communities, least developing countries (LDCs) and the Small Island Developing States (SIDS).

INTRODUCTION

1. The report of the fifteenth session of COFI:FT[1] highlighted the key role played by the fisheries and aquaculture sector in world food security, as a source of food and as a contributor to economic growth and development, livelihoods and income (para. 9). COFI:FT emphasized the importance of increasing the resilience of vulnerable coastal communities and their livelihoods to threats and crises, especially in a future potentially dominated by climate change and other natural and man-made disasters (para. 29).

2. To complement actions geared towards building resilient fishing communities, COFI:FT suggested developing fisheries and aquaculture management frameworks that jointly integrate climate change and disaster management and recommended continued efforts to gather accurate fisheries and climate data (para. 31).

3. In this context, the Secretariat has prepared this document to highlight the state of evidence in the area of climate change impacts on fish production systems, consumption systems, trade flows and market access relevant for the sector, and identified possible policy responses.

PRODUCTION SYSTEMS AND CLIMATE CHANGE IMPACTS

Drivers and patterns of marine and inland fisheries production change as impacted by climate change

4. Climate change and extreme weather events are compounding threats to the sustainability of marine and inland fisheries. While the knowledge base still needs to be strengthened, especially at regional and local scales, impacts are already being observed as a result of the physical, chemical and biological changes in aquatic ecosystems associated with gradual global warming. Fisheries-dependent communities and economies along the entire value chain are already experiencing or expected to experience the effects of climate change in a variety of ways.

5. Evidence indicates that climate change is affecting the distribution of marine species. Some habitat-free species are already expanding or shifting their distributions towards the poles, and also to deeper waters, to follow thermal preferences or avoid low oxygen zones.[2] These migratory shifts cause changes in the composition of ecosystems, and thus the dynamics of predators and prey. Where distribution shifts are not possible, many species may experience changes in their population size, reproductive cycles and/or survival rates. The impacts, both positive and negative, will depend on the region and latitude, as well as on the life history of the species concerned, genetic plasticity and populations' capacity to adapt to new conditions. Where particular species move away from traditional fishing grounds, new species are likely to enter the vacuum or benefit from reduced competition. In addition to warming impacts, altered riverine flows and freshwater runoffs, and changing coastal and freshwater quality, will also affect ecosystem productivity and species dominance.

6. Overall, the expected impact in most tropical and subtropical marine environments, seas and lakes is of reduced productivity, principally because surface ocean warming will reduce the influx of nutrients from the deep, necessary for ocean production. Conversely, high-latitude systems are predicted to experience increased productivity of capture fisheries, as viable thermal habitats will expand as will

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[1] www.fao.org/3/a-i5580t.pdf.

[2] Pörtner, H.-O., *et al*. 2014: Ocean systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 411–484.

productive seasons. Freshwater systems are vulnerable to seasonal or long term temperature changes and altered precipitation, with limited prospects for adaptation or shifting ranges for the species involved. Coastal systems are specifically vulnerable to multiple stressors from temperature increases, hypoxic zones, acidification, and extreme (weather) events such as sea level rise and storms.

Aquaculture drivers and patterns of aquaculture production change as impacted by climate change

7. Aquaculture has consistently been one of the fastest growing food sectors in recent decades, driven more by opportunity (increasing wealth, urbanization and population growth) than by need[3], but sustained growth is now required to meet demand for fish and to compensate for lack of growth in capture fisheries. However, the rate of growth has recently begun to slow down for a variety of expected reasons, including a growing shortage of production sites, chiefly in coastal areas, and saturation of markets (including a lack of species and product diversification), especially in developed countries, such as member states of the European Union (Member Organization).[4]

8. Climate change and variability can be expected to act as yet a further source of specific challenges impacting on aquaculture production trends. Aquaculture production will be affected in many ways, such as gradual warming and acidification of seawater, sea level rise and resultant salt water intrusion, and extreme events such as changes in the frequency, intensity and location of storms.[5] Such changes will determine where and what species can be farmed, as well as their productivity and yield. Adaptation measures to climate change include diversification of species,[6] modifications to aquaculture systems (e.g. higher pond dykes, more robust cages) and management (e.g. harvesting farmed aquatic produce before high risk seasonal periods).[7]

9. In addition, as water temperatures increase, a number of diseases endemic to both wild and farmed fish populations are expected to become more prevalent, and threats associated with exotic pathogens may rise, especially when species' thermal optima are exceeded.[8] With the expected increases in acidification of coastal marine environments, global mollusc production may decline between 2020

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[3] Troell, M, Naylor, R, Metian, M, Beveridge, M, Tyedmers, P, Folke, C, Österblom, H, de Zeeuw, A, Scheffer, M, Nyborg, K, Barrett, S, Crépin, A-S, Ehrlich, P, Lewin, S, Xepapadeas, T, Polasky, S, Arrow, K, Gren, Å, Kautsky, N, Mäler, K-G, Taylor, S & Walker, B. 2014. Does aquaculture add resilience to the global food system? Proceedings of the National Academy of Sciences 111, 13,257-13,263. doi:10.1073/pnas.1404067111; Little, D C, Newton, R W & Beveridge, M C M. 2016. Aquaculture: a rapidly growing and significant source of sustainable food? Status, transitions and potential. Proceedings of the Nutrition Society 75, 274-286.

[4] see EC Aquaspace project, for example: https://ec.europa.eu/research/bioeconomy/pdf/20141121_09_ ecosystem_approach_to_making_space_for_aquaculture_aquaspace_en.pdf

[5] De Silva, S.S. and Soto, D. 2009. Climate change and aquaculture: potential impacts, adaptation and mitigation. In K. Cochrane, C. De Young, D. Soto and T. Bahri (eds). Climate change implications for fisheries and aquaculture: overview of current scientific knowledge. FAO Fisheries and Aquaculture Technical Paper. No. 530. Rome, FAO. pp. 151–212.

[6] Harvey, B., Soto, D., Carolsfeld, J., Beveridge, M. & Bartley, D.M. eds. 2017. Planning for aquaculture diversification: the importance of climate change and other drivers. FAO Technical Workshop, 23–25 June 2016, FAO Rome. FAO Fisheries and Aquaculture Proceedings No. 47. Rome, FAO. 154 pp.

[7] De Silva and Soto reference; De Silva, S.S. and Soto, D. 2009. Climate change and aquaculture: potential impacts, adaptation and mitigation. In K. Cochrane, C. De Young, D. Soto and T. Bahri (eds). Climate change implications for fisheries and aquaculture: overview of current scientific knowledge. FAO Fisheries and Aquaculture Technical Paper. No. 530. Rome, FAO. pp. 151-212; FAO. 2017. Adaptation Strategies of the Aquaculture Sector to the Impacts of Climate Change by Pedro B Bueno and Doris Soto. FAO Fisheries and Aquaculture Circular No. 1142. Rome, Italy (in press)

[8] De Silva, S.S. and Soto, D. 2009. Climate change and aquaculture: potential impacts, adaptation and mitigation. In K. Cochrane, C. De Young, D. Soto and T. Bahri (eds). Climate change implications for fisheries and aquaculture: overview of current scientific knowledge. FAO Fisheries and Aquaculture Technical Paper. No. 530. Rome, FAO. pp. 151-212; Gubbins, M, Bricknell, I & Service, M. 2013. Impacts of climate change on aquaculture. MCCIP Science Review 2013, 318-327. doi 10.14465/2013.

and 2060, especially in areas where the dissolution level of calcium carbonate is closer to the surface near the coast.[9] The continued - albeit decreasing - dependence of aquaculture on capture fisheries for fishmeal and fish oil from fisheries susceptible to the El Niño Southern Oscillation climate phenomenon[10] further adds to the vulnerability of aquatic farming systems to climate change.

10. Climate change will affect not only production but the entire aquaculture value chain, especially in relation to essential infrastructure (e.g. processing plants, roads), required to facilitate access of producers to essential inputs such as seed and feed and to markets.

CONSUMPTION SYSTEMS, FOOD SECURITY, AND PROJECTED GROWTH IN UTILIZATION

11. Over the last five decades, growth in the global supply of fish for human consumption has outpaced population growth (3.1 percent vs 1.6 percent in 1961–2015), resulting in increased average per capita availability (over 20 kg per capita in 2015 vs 9 kg in 1961) and enhancement of people's diets around the world through diversified and nutritious food.

12. Future prospects point to a further growth of fish consumption, also stimulated by growing urbanization and changes in distribution systems. In the next decade, per capita levels should rise in all continents, except in Africa, where population growth will outstrip its increasing food fish supply. A growing share of fish consumption is expected to originate from aquaculture production, which is projected to represent 58 percent of the total food fish consumed in 2026 and to further grow in the next few decades.

13. These projections do not take into account climate change and extreme weather impacts on fish supply. As noted, the expected impacts of climate change on fish supply, and potentially consumption, are complex to determine given their geographical differences. Impacts are expected to be more evident at country and regional level, rather than globally, and also to have an effect on availability and circulation of fish goods. The repercussions on consumption are expected to be more relevant for the fishing-dependent communities which rely on fish for food and livelihoods[11] and in particular for those living near climate-sensitive environments, like low-lying coastal areas and water-stressed regions. The consequences can be even exacerbated in case of dependency on some specific species, in particular in the case of lack of support in the development of specific policies of adaptation to climate variability.

14. Many commercially important species are predicted to redistribute as a result of changing conditions. These shifts may also affect fishing techniques and practices and as a consequence the nutritional habits of local communities, as well as the patterns and livelihood of producers and exporters. The change in species can affect consumption either in a positive or negative way, by making available on domestic markets species more or less favoured by local consumers.

15. Fish consumption can also be influenced by changes in fish prices, which could be indirectly altered by climate change, either via changes in global and regional fish supply, or via the cost of goods, infrastructures and services required to fish and for aquaculture farming. It has been estimated that the projected changes in temperature and precipitation on food production will contribute to an increase in

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[9] Richards *et al.* reference; Richards, R G, Davidson, A T, Meynecke, J-O, Beattie, K, Hernaman, V, Lynam, T & van Putten, I E. 2015. Effects and mitigations of ocean acidification on wild and aquaculture scallop and prawn fisheries in Queensland, Australia. Fisheries Research 161, 42-56; Clements and Chopin reference…Clements, & Chopin, T. 2016. Ocean acidification and marine aquaculture in North America: potential impacts and mitigation strategies. Reviews in Aquaculture. doi:10.1111/raq.12140.

[10] El Niño Southern Oscillation (ENSO) is a periodic variation in winds and sea surface temperature occurring every 2 to 7 years over the tropical eastern Pacific Ocean and affecting the climate of the tropical and subtropical areas. The warming phase is referred to as El Niño and the cooling phase as La Niña.

[11] Barange, M., *et al.* 2014. Impacts of climate change on marine ecosystem production in fisheries-dependent societies. Nature Climate Change 4:211–216.

global food prices by 2050.[12] This could be applicable to fish prices as well, especially in the case of lower availability in domestic markets or as a consequence of shocks caused by unexpected extreme events. Higher fish prices can weaken fish demand and consumption, which can have a major impact on food security and malnutrition, particularly among the most vulnerable households. In the case of countries dependent on imports for their consumption, higher prices can discourage demand, in particular among the less affluent consumers.

TRADE AND MARKET ACCESS

16. The social and economic contributions of the fisheries and aquaculture sectors, including seafood processing and trade, are important, complex, and growing. Around 36 percent of fish production enters international markets, and the majority of fish and seafood trade originates from developing countries. Changes in fisheries and aquaculture resource productivity can have a large impact on fish trade, and potentially on the food security of countries dependent on trade of fish and seafood products. Thus, climate-induced changes can impact national economies over and above the specific impact on fishers and fish farming communities.

17. Potential, climate change-driven, changes in total fish catch and species composition, especially within Exclusive Economic Zones (EEZs) in tropical regions, could particularly impact small-scale fishers using traditional methods close to shore. If these changes affect revenues of commercial species they would affect employment in the sector and put indirect pressure on other sectors to provide alternative employment for displaced fishers. Extreme weather events and sea level rise are anticipated to damage fisheries-related infrastructure such as ports and fleets, further raising the costs of fishing, processing, and distribution activities and affecting long-term employment in the sector.

18. Climate change therefore has the potential to change the competitiveness of exports from the fisheries sector, the distribution of fisheries production, and ultimately world trade patterns. While some regions may gain from expected resource shifts, others will face major adjustments, which could threaten the sustainability of their livelihoods and food security.[13] Climate-induced changes will require adaptation at all stages of the seafood value chain, from producers, processors, marketers, exporters, and importers as they search for supplies to meet the world's growing demand for seafood.

19. It remains to be seen whether global and regional fish trade can continue to support food and nutrition security and economic growth in fish exporting countries, in the face of multiple challenges. These include not just climate-induced resource shifts, but also market-based measures such as eco-labels, and trade-tightening policies, although these could be important to prevent Illegal Unreported and Unregulated (IUU) fish entering markets.[14] Countries dependent on fish exports for tax revenues and foreign exchange earnings that lead to higher standards of living and diversified domestic diets, may face reduced productivity and thus lower earnings from trade.

20. Developing countries dependent on fish production or imports for domestic consumption may find themselves in a bidding war with wealthier consumers who can pay higher prices in the globalized economy and this may result in fewer imports or less fish on the domestic market at the expense of local nutrition and food security. Challenges remain for many countries, especially LDCs and SIDS, to

[12] Porter, J.R., *et al.* 2014. Food security and food production systems. In C.B. Field, *et al.* eds. Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects, pp. 485–533. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK, and New York, USA, Cambridge University Press.
[13] Merino, G., M. Barange, *et al.* 2012. Can marine fisheries and aquaculture meet fish demand from a growing human population in a changing climate? Global Environmental Change, 22, 795-806.
[14] Chomo, V. and C. DeYoung. 2015. Towards Sustainable Fish Food and Trade in the Face of Climate Change. BIORES Volume 9 - Number 2.

achieve sustainable fish production and trade in face of the possible additional hurdles climate change may present.[15]

21. Lam *et al*. (2016)[16] projected percentage changes in maximum catch potential and maximum revenue potential from fisheries in 2050 under various climate change scenarios. They illustrate that models projecting climate-induced improvements in catches in some regions may not directly equate into changes in revenues to the fisheries sector, due to different market prices of species potentially affected by climate change. For example, there could be an increasing prevalence of low value fish in EEZs that would affect the fisheries net revenue, especially small-scale fishers. Commercial fleets in the high seas may face greater impacts from altered fish migrations under climate change, and thus have more severe revenue impacts for the flag state. The authors highlight the need for more economic analysis of the potential impact of climate change on revenues from global marine fisheries.

EXTREME EVENTS

22. Fishing and aquaculture communities and infrastructures for the landing, storage, processing, and marketing of fish are almost always situated at the interface between land and water where sea level rises, river/lake level changes and where storms (cyclones, hurricanes, typhoons) and floods strike. Not all natural phenomena lead to disasters but when interacting with exposed and vulnerable human and natural systems, natural events can be extremely destructive and cause extensive damage to equipment and infrastructures affecting the production and distribution/supply of fish. After Tropical Cyclone (TC) Winston struck Fiji on 20 February 2016, fisheries was the second most affected agricultural sectors after crops. According to the government-led Post Disaster Needs Assessment (PDNA), fisheries and aquaculture contributed 38 percent of the total damage and loss of the agricultural sector; crops contributed 40 percent. The damage incurred to the fisheries subsector (from boats, engines, fishing gear, fish ponds, farm equipment to farm buildings hatcheries, fish feed, ice plants, nurseries etc.) was valued at over USD19.5 million, representing 51 percent of total damage to the agriculture sector. In addition, the fisheries sector sustained a high value of production losses, at over USD79.6 million.[17] The PDNA also highlighted that the consequences for the fishery sector in particular are expected to last for several years due to continued production losses and associated higher production costs: *"High winds, flooding and storm surges have imposed substantial damage to mangrove forests and coral reefs, which provide a habitat for fish species that have been forced to migrate. This means that those who work in the fisheries sector are unable to capture the same volume as before."*[18]

23. Whereas some argue that extreme events reflect excessive fluctuations in an otherwise stable climate regime, there is increasing evidence that extreme events are made more intense and/or frequent by human-induced climate change. The American Meteorological Society, in its climatic explanation of the 2015 extreme events, found that numerous such events were made more extreme by anthropogenic climate change, including the record high intensity of west North Pacific typhoons, and other temperature-related events, discernible even for those events strongly influenced by the 2015 El Niño.[19] In total, over the past 5 years, of the more than 100 events accepted for publication by the American Meteorological Society on explaining extreme events from a climate perspective, around 65 percent

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[15] Poseidon Aquatic Resource Management Ltd and WorldFish Center. 2009. Climate Change, Fisheries, Trade and Competitiveness: Understanding Impacts and Formulating Responses for Commonwealth Small States.
[16] Lam, V.W., Cheung, G. Reygondeau, U. Sumaila. 2016. Projected Change in Global Fisheries Revenues Under Climate Change. Nature Volume 6.
[17] Government of Fiji. 2016. Post Disaster Needs Assessment Tropical Cyclone Winston, February 20, 2016 www.gfdrr.org/sites/default/files/publication/Post%20Disaster%20Needs%20Assessments%20CYCLONE%20WINSTON%20Fiji%202016%20%28Online%20Version%29.pdf
[18] www.gfdrr.org/sites/default/files/publication/Post%20Disaster%20Needs%20Assessments%20CYCLONE%20WINSTON%20Fiji%202016%20(Online%20Version).pdf, p11.
[19] Herring, S.C., A. Hoell, M.P. Hoerling, J.P. Kossin, C.J. Schreck III, and P.A. Stott, Eds., 2016: Explaining Extreme Events of 2015 from a Climate Perspective. Bull. Amer. Meteor. Soc., 97 (12), S1–S145. www.ametsoc.net/eee/2015/2015_bams_eee_low_res.pdf

were found to be influenced by human-caused climate change.[20] The convergence of risks stemming from climate change, extreme events, water scarcity, resulting migration and conflicts is a potent cocktail and a risk multiplier, especially in the world's more fragile environmental and political contexts.

24. Without increased resilience and better adaptation, the rural populations most at risk from anticipated climate change impacts include those subsisting in semi-arid and arid zones. In the drylands of sub-Saharan Africa, climate change scenarios are predicting increased variability and volatility in the precipitation regimes. Impacts will primarily be felt on fluctuating food supply. Combined with the increased recognition of the nutritional value of fish for food security, the importance of (processed, dried, stored) fish and fish trade for a diversified livelihood strategy in drylands, should be emphasized, promoted and developed, in concert with the development and conduct of other food producing activities.[21]

25. In a study[22] conducted after cyclone Sidr hit Bangladesh in November 2007, aquaculture ponds were found important to provide food and income in the post-disaster period. Seventy-eight percent of households - who practiced a variety of activities for their living including the production of vegetables, livestock, poultry, fish etc. - were found to be willing to re-invest in aquaculture despite the risk of stock losses and damage to infrastructure during recurrent disasters. The study concluded that aquaculture ponds, as part of a diversified livelihood, are likely to provide a mechanism for coping after a disaster, despite the costs involved in repairing them.

POLICY RESPONSES

26. Our understanding of the likely impacts of direct and indirect climate change, including ocean warming and acidification, sea level rise, storminess, rainfall and flooding, and non-linear events, such as El Niño-Southern Oscillation (ENSO), must be understood at global, regional and national level. Countries with a well-developed National Adaptation Plan (NAP) are more likely to have such information than those that do not.

27. Countries are also advised to strive to understand their fishery and aquaculture sector and how it is likely to change over time, in the context of evolving food production systems on land and coastal areas. This is somewhat easier to do if national agriculture, fishery and aquaculture strategies and plans have been developed and are being implemented and if good production statistics are collected. Key stakeholder groups should then be identified. The presence of strong and effective producer organisations, including for hatchery and feed sub-sectors, can help in the effective and cost-effective development and uptake of adaptation measures.

28. In particular, countries should work to determine the likely impacts of both extreme events and more gradual climate change on different types of aquaculture in particular locations, including via flooding and sea level rises and changes in salinity and temperature, on the frequency and severity of Harmful Algal Blooms as well as on prices of fishmeal and fish oil from fisheries whose productivity is vulnerable to ENSO events.

29. Through comprehensive stakeholder workshops, involving all key public sector bodies and representatives of the various fishery and aquaculture sub-sectors, likely climate change impacts on the sector can be identified and stakeholders cost these likely impacts. Adaptation measures, such as re-zoning, species diversification, re-engineering of ponds and cages, national, public sector supported

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[20] In www.ncdc.noaa.gov/news/explaining-extreme-events-2015
[21] FAO. 2016. Fisheries in the drylands of sub-Saharan Africa – "Fish come with the rains". Building resilience for fisheries-dependent livelihoods to enhance food security and nutrition in the drylands, by Jeppe Kolding, Paul van Zwieten, Felix Marttin and Florence Poulain. FAO Fisheries and Aquaculture Circular No. 1118. Rome, Italy.
[22] Karim, M., Castine, S., Brooks, A., Beare, D., Beveridge, M.C.M. & Phillips, M.J. 2014. Asset or liability? Aquaculture in a natural disaster prone area. Ocean and Coastal Management 96, 188–197.

insurance schemes and management interventions (e.g. stocking and harvesting at times to avoid high risk times of the year when losses are likely to be greatest) can then be explored, costed and prioritized. Global impacts, especially those of ENSO on fishmeal and fish oil production and prices, should also be factored into viability of aquaculture enterprises and alternative feedstuffs identified and sourced.

30. Adaptive capacity may have to be built in order to help implement or tailor solutions to specific types of fisheries and aquaculture in specific locations.

31. Climate change could exacerbate ongoing efforts to reduce fisheries market distortions, promote sustainable fish trade, and ensure long-term food security. Appropriately designed multilateral and bilateral trade rules can discourage economically unviable and environmentally damaging fishing practices. The international community could also utilize market access and trade policies to foster resilience to climate change in the fish industry including for the most vulnerable communities.

32. Some essential aspects of trade policy in supporting fisheries and aquaculture adaptation to climate change can be summarized as follows: eliminate tariff escalation in processed fishery products that discourage value-added production in developing countries; remove non-tariff barriers that are not aligned to science-based technical standards; eliminate capacity-distorting fisheries subsidies; encourage product and export diversification through appropriate economic development and trade policies; market goods produced following sustainable and legal practices to better inform consumers about their choices and the impact of their consumption on the environment.

33. At the border, improved trade facilitation rules would promote sustainable fish trade by ensuring that these perishable food products reach international markets more quickly and thus arrive in high quality to meet market requirements. Improved national trade facilitation rules and intra-regional transport systems based on international standards could develop into better South-South trade links, contributing to long-term livelihood resilience for small-scale fishers and aquaculture farmers.

34. The recent gains made in improving regional and domestic food security and reduced dependence on international food aid through trade of high value fish products and consumption and/or importation of low value fish, could be exacerbated by climate impacts on global supplies. As supplies fluctuate, this can result in opportunities as well as risks. Shortages and resulting price rises could cause consumers in the major import markets to demand more exports from developing countries to meet their needs, putting domestic and regional food supplies of fish-exporting developing countries at risk. This requires reflection on national policies related to food security/nutrition, especially protein-rich fish, versus trade promotion to create jobs in processing and export sectors.

35. Increased intra-regional trade would also reduce the carbon footprint of fish trade. Income support programmes would need to be investigated in situations where it is anticipated that shifts in production systems or trade patterns may put vulnerable populations at risk to food insecurity.

36. Trade policy responses to Climate Change must be considered in a context of broader adaptation tool boxes that address three interconnected elements: institutional and governance adaptations; livelihood adaptations; and resilience and risk management. Cohesive responses across and between marine and aquatic sectors are necessary to ensure effectiveness and avoid measures that address specific impacts but exacerbate others.

37. Provision of safe havens/harbours for fishing vessels and equipment and the building of 'climate proofed' infrastructures for fisheries and aquaculture are increasingly important to maintain fish production and trade competitiveness in those areas vulnerable to climate change and extreme events, including rising sea levels and changes in lake levels. Aquaculture development can also contribute to resilience and risk management through investment in technologies that reduce loss of stocks during

floods[23] These technological innovations can be supported in policy through grant and finance schemes for climate proofing and by provision of technical advice through extension services.[24] Income diversification, storage and selection of stress resistant varieties can also be effective ways to cope with disasters while ensuring continuity in food supply.[25]

38. Guidance for responding to fisheries and aquaculture emergencies have been developed by FAO in cooperation with its partners to improve the quality and the design of fisheries and aquaculture interventions, implementation and assessment in the wake of disasters.[26] The Guidance emphasizes the importance of structural solutions to reduce future vulnerability to natural disasters. Improved weather information, disaster forecasting and safety at sea to avoid loss of lives and assets at sea and on shore are also important.

[23] Macfadyen, G., Allison, E. 2009. Climate Change, Fisheries, Trade and Competitiveness: Understanding Impacts and Formulating Responses for Commonwealth Small States. www.preventionweb.net/files/12860_ClimateChangeFisheriesTradeandCompe.pdf
[24] Idem.
[25] Savo, V., Morton, C., Lepofsky, D. 2017. Impacts of climate change for coastal fishers and implications for fisheries.
[26] Cattermoul, B., Brown, D. & Poulain, F. (eds). 2014. Fisheries and aquaculture emergency response guidance. Rome, FAO. 167 pp. www.fao.org/3/a-i3432e.pdf