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**OUTCOMES OF THE WORKSHOP ON PRIORITY ADAPTATIONS TO  
CLIMATE CHANGE FOR PACIFIC FISHERIES AND AQUACULTURE**

[www.spc.int/fame/](http://www.spc.int/fame/)  
[www.fao.org/fishery/en](http://www.fao.org/fishery/en)

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## MEETING OUTCOMES

A special workshop for the SPC Heads of Fisheries (HoF) on 'Priority adaptations to climate change for Pacific fisheries and aquaculture' was jointly organised by SPC and FAO (with the generous support of AusAID, and the Governments of New Caledonia, Japan and Sweden) at SPC Headquarters in Noumea from 5<sup>th</sup> to 8<sup>th</sup> June 2012. The objectives of the workshop were to help HoF and national climate change and disaster risk management focal points use the information from the recent comprehensive assessment of the vulnerability of fisheries and aquaculture to climate change ([www.spc.int/climate-change/fisheries/assessment/](http://www.spc.int/climate-change/fisheries/assessment/)) to identify priority adaptation actions by government, enterprises, communities and other stakeholders to reduce the risks and capitalise on opportunities. The ultimate aim of the workshop was to assist countries and territories understand how climate change may affect the plans outlined in the 'Future of Pacific Island Fisheries' study commissioned by the Forum Fisheries Agency (FFA) and SPC on behalf of their members to maintain or improve the benefits they derive from fisheries and aquaculture.

The heads of fisheries and other delegates also heard FAO's perspective on the importance of fisheries and aquaculture globally, the multiple drivers already affecting the resilience of the sector and the compounding effects that climate change will have, both directly and indirectly, on the aquatic systems and Pacific communities that depend on these resources for food, livelihoods and economic development. While not limited to negative impacts, vulnerability to change may include the lack of capacity by the sector to benefit from potential opportunities. Climate change underlines the urgent need to build ecological, social and economic resilience by implementing the FAO's Code of Conduct for Responsible Fisheries, the ecosystem approach to fisheries and aquaculture, and the holistic, participatory, adaptive and integrated policies and management frameworks they support. FAO's five year climate change strategy for fisheries and aquaculture places emphasis on linking science to policy, and assisting countries to define and implement climate change adaptation strategies, supporting the sector's contributions to greenhouse gas mitigation and strengthening partnerships for more effective action. FAO also informed delegates that this workshop was one of a series of workshops being held around the globe to increase understanding of the sector's vulnerability to climate variability and change and to develop priority adaptations.

The key messages that delegates heard at the workshop, and the main outcomes identified by the participants, are summarised below.

### **Understanding the projected changes to surface climate and the Pacific Ocean**

Through presentations by Dr Janice Lough, Dr Sen Gupta and Dr Alexandre Ganachaud, participants learned about projected changes to surface climate in the tropical Pacific, including warmer temperatures, increased rainfall in tropical areas, more extreme weather events, the possibility of more severe but less frequent cyclones, and continued ENSO variability. It is also apparent that the rates of all these changes are likely to accelerate. Delegates also learned about observed changes to the tropical Pacific Ocean. In particular, the ocean has warmed, sea level has risen, ocean pH has declined and low oxygen areas have expanded. The continued changes projected to occur this century include: further ocean warming, greater stratification of the water column, changes to major currents, decreased nutrient supply, reduced O<sub>2</sub> below the mixed layer, and the decline of aragonite concentration below critical thresholds. The presenters emphasised that climatic variability would continue to occur over and above projected climate change and that this variation would be noticed as the extreme events became more extreme

The breakout groups following these presentations helped delegates strengthen their existing knowledge of climate change issues and reinforced the key messages with robust examples. These groups discussed the important issues of how to use the model projections at the local/country level (downscaling) and how to mainstream climate change into national and regional initiatives (e.g. the Micronesian Challenge). Participants acknowledged that they need to be prepared for the effects of

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climate change on fisheries and aquaculture because they are such important industries in the region. They also encouraged the meeting to realise that these messages need to incorporate traditional knowledge and be communicated appropriately at the grass-roots level using simple messages to raise awareness of vulnerability and the steps that can taken to adapt.

## **Understanding projected changes to tuna**

Building on the knowledge of the projected changes to the ocean, delegates heard a presentation from Dr Valerie Allain about the five provinces of the Pacific Ocean, how they support different food webs for tuna, and the changes likely to occur to these provinces that are expected to alter these food webs. The projected changes to the provinces include contraction of the nutrient-rich equatorial upwelling and expansion of the Warm Pool to the east, together with greater stratification of the water column and corresponding decreases in food resources for tuna.

Dr Patrick Lehodey then explained the use of the SEAPODYM model to project how tuna catches are expected to be affected by climate change. Participants learned how tuna are likely to be impacted by ocean warming, reduced O<sub>2</sub> and the reduced primary production in the ocean. The distribution of skipjack tuna is projected to extend further eastward over time, with catches eventually decreasing in the west. The situation for bigeye tuna is expected to be different, with stocks eventually decreasing across the region. The meeting also heard new preliminary analyses for albacore, which is expected to contract in range and decline in biomass as oxygen levels are affected by climate change. Dr Lehodey concluded by outlining the steps needed to improve the models used to forecast the effects of climate change on tuna: better global climate models for the physical, chemical and biological process in the tropical Pacific Ocean and reporting of tuna catches from the high seas on much finer spatial scales. It was recognised that a better understanding of biological processes would depend on more observations (long-term monitoring) on the responses of food webs for tuna to climate change.

Within the breakout groups, participants found the description of stratification useful and how it affects the nutrients needed to support tuna food webs. They also identified the need for more information on implications of declines in primary productivity for coastal fisheries. There was also great interest in the projected changes to tuna catches, particularly in the reliability of the modelling given the potential strong implications for changes in tuna distribution and abundance for the many locally-based and foreign industrial fishing operations in the region, and national economies.

## **Understanding changes to coastal fisheries**

To inform the workshop about the projected effects of climate change on coastal fisheries, Dr Janice Lough and Johanna Johnson began by making presentations on how the habitats supporting coastal fisheries (coral reefs, mangroves, seagrasses and intertidal flats) were likely to be affected. Delegates heard how coral reefs are vulnerable to climate change due primarily to rising sea surface temperatures, ocean acidification, and more intense cyclones. Impacts have already been observed due to increases in sea surface temperature (e.g. mass coral bleaching, decreased coral diversity and reduced reef complexity). Although the combination of the projected impacts is not expected to cause reefs to disappear, the reefs of the future will be less complex systems that provide less structural habitat for fish and shellfish.

Participants also heard how seagrass, mangroves and intertidal flats are vulnerable to sea-level rise, rising sea surface temperatures, more intense cyclones and changing rainfall patterns. As a result, these habitats are projected to decline in area, although landward migration should be possible if there are no barriers. The speakers emphasised that good management of catchments, to ensure that all coastal habitats are not subject to increased runoff of sediments, nutrients and pollution, will help build their resilience to climate change.

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Dr Pratchett then informed the workshop about the direct and indirect effects of climate change on the three main groups of coastal fisheries: demersal (bottom-dwelling) fish, nearshore pelagic fish and invertebrates. Demersal fish are most vulnerable to the indirect effects of habitat degradation, although changes in water temperature and ocean acidification are also expected to have direct effects on the growth and reproduction of these fish, and ocean acidification may affect the survival of larvae settling on reefs. The effects on nearshore pelagic fish are expected to be similar to those projected for tuna, although other nearshore pelagic species are likely to be influenced by local changes in coastal productivity related to nutrient supply. Many of the invertebrates are expected to be vulnerable mainly to ocean acidification and habitat degradation.

Fisheries productivity of demersal fish and invertebrates is expected to decline, with decreases of ~20% by 2050 and 20-50% by 2100 under the A2 emissions scenario<sup>1</sup>. On the other hand, it will be difficult to separate the effects of climate change from the effects of other stresses on habitats and stocks over the next 2-3 decades. Priority adaptations include protecting coastal fish habitats to build their resilience to climate change, diversifying coastal fisheries activities and including climate change implications into fisheries management. Because demersal fish, nearshore pelagic fish and invertebrates have different vulnerabilities to climate change, HoF heard how it will be important to collect separate catch information for these three groups of coastal fisheries resources in the future to help monitor the effects of climate change.

The breakout groups were concerned about the vulnerability of coral reefs, mangroves and sea grasses and how this will affect fish and shellfish that are an important source of food for coastal communities. Delegates identified the need to raise political awareness about the importance of these habitats to fisheries, and to promote investments and supporting policies to protect these habitats to build resilience to climate change. Mangrove replanting was discussed as one viable adaptation strategy, and participants suggested better exchange of knowledge on replanting species among countries and territories.

## **Understanding changes to aquaculture**

Dr Pickering informed the workshop about the value of mariculture (coastal aquaculture) and the projected changes due to climate change. Overall, this part of the sector is vulnerable to climate change in a number of ways: ocean acidification is expected to affect the efficiency of collecting the spat of pearl oysters and the quality of the nacre that forms pearls. Ocean acidification is also likely to affect the appearance and value of cultured shrimp, whereas higher water temperatures will exacerbate stratification with ponds and increase the loss of crops due to deoxygenation of the water. Higher rainfall will reduce the number of sites suitable for growing seaweed and the incidence of seaweed diseases. Participants learned that the location of mariculture facilities affects the vulnerability of some farming operations to higher temperatures, inundation and/or storm damage. Adaptations include moving pearl farms into deeper cooler waters, appropriate site selection (or relocation of sites) for seaweed farms and raising the wall and floor height of shrimp ponds so that they continue to drain as sea level rises.

During a second presentation by Dr Pickering, the workshop learned that whereas climate change was likely to decrease the efficiency of mariculture, the productivity of freshwater aquaculture is expected to be enhanced by higher water temperatures and greater rainfall. Such changes will allow tilapia and milkfish to grow faster in ponds and for ponds to be built in more areas, including at higher elevations in the case of tilapia farming. *Macrobrachium* aquaculture is also likely to benefit in the short-term but increasing temperatures will impact on them in the longer-term.

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<sup>1</sup> The A2 scenario is one of the representative scenarios for high emissions of carbon dioxide and other greenhouse gases used in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

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The breakout group discussions were interested in the range of potential impacts to mariculture and the implications for their future plans and opportunities for diversifying livelihoods away from coastal fisheries and into mariculture. Participants discussed the great potential benefit of enhanced freshwater aquaculture for inland communities in PNG, Solomon Islands and Fiji, but also the opportunities it provides for low-lying countries expected to receive more rainfall. In this regard, participants thought that milkfish has real expansion potential (and is amenable to low-cost, capture-culture aquaculture methods). For higher islands, tilapia is the only viable option for efficient expansion of freshwater aquaculture but the meeting agreed that care was needed to reconcile the production of these fish for food security with biodiversity conservation. Participants were encouraged to follow the policies related to this issue set out in the background publications for the workshop.

## **Understanding changes to freshwater fisheries**

The implications of climate change for freshwater habitats and fisheries were addressed by Dr Peter Gehrke. His presentation highlighted the importance of freshwater fisheries to inland communities in the Pacific, particularly PNG, Fiji and Solomon Islands. Increased rainfall is very likely to increase freshwater habitat availability, and therefore fisheries productivity. However, Dr Gehrke warned that in catchments that have been disturbed by unregulated mining, forestry and agriculture these benefits will be restricted. He stressed that good management of catchments and freshwater fish stocks, and prevention of unwanted invasive fish species, are important strategies to capitalise on the future potential for increased production from freshwater fisheries. Capitalising on the potential benefits will also eventually require more efficient methods for catching freshwater fish from the expanded flood plain habitats.

Although not all countries and territories have freshwater fisheries, the breakout groups recognised their value to several members and the discussion focused on the joint benefits to both freshwater and coastal fisheries of maintaining good vegetation in catchments to protect the habitats on which these fisheries depend.

## **Implications, adaptations and suggested policies**

Armed with the best estimates of projected changes in oceanic, coastal and freshwaters fisheries and aquaculture production, the workshop was able to consider the implications for economic development, food security and livelihoods. Mike Batty noted that tuna is a very important sector in the Pacific for government revenue and gross domestic product (GDP), with many economies having a high dependence on tuna (e.g. canneries in American Samoa, Fiji, PNG and Solomon Islands, and the contributions of license fees in Kiribati, Nauru and Tuvalu). The projected changes in the distribution of tuna are expected to have proportional effects on government revenues and GDP, with the smaller nations with a high dependence on tuna in the east having the potential for increased benefits. In the west, where tuna catches are eventually expected to decline, the negative effects are expected to have relatively low impacts on national economies due to the modest contribution of tuna fishing and processing to GDP. There is concern, however, that unless steps are taken to maintain the supply of fish to canneries as tuna are redistributed east, jobs could be lost in canneries.

Mike Batty then outlined adaptations and policies needed to reduce the risks and capitalise on the opportunities for national economies, stressing that no future benefits would be available unless tuna stocks are managed responsibly to maintain their capacity for replenishment. Wherever possible, these adaptations should be 'win-win', ie., they should address important drivers facing the sector now, and build resilience to climate change in the future. The key adaptations and supporting policies were explained and participants were encouraged to use the summary volume for the vulnerability assessment ([www.spc.int/climate-change/fisheries/assessment/](http://www.spc.int/climate-change/fisheries/assessment/)) to study a range of possible recommended actions in detail to decide which ones were national priorities.

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The workshop then heard presentations from Dr Johann Bell on the implications for food security and livelihoods, and the appropriate adaptations and policies to maintain the vital roles of fish in the diets of Pacific Island people. This message stressed that it was not only the effects of reduced coastal fisheries production that threatened the availability of fish for food security – rapid population growth was also reducing the supply of fish per person in many countries. In fact, population growth is expected to have a greater effect than climate change for several of the larger countries in the region, especially Fiji, PNG, Solomon Islands and Vanuatu. By 2035, a substantial gap is expected to emerge between the fish needed to supply the 35 kg of fish per person per year recommended for good nutrition and the fish available from coastal fisheries associated with coral reefs for many of these countries (PNG is the exception because providing access to this quantity of fish will not be possible for the large inland populations there). Filling this gap will require diversifying coastal fisheries to make larger catches of nearshore pelagic fish (mainly tuna but also small pelagic species) and developing freshwater pond aquaculture. However, the workshop heard that the majority of the gap would need to be filled with tuna and countries would need to progressively allocate more of their tuna resources for this purpose.

Key adaptations and supporting policies for maintaining the important role of fish for food security were also presented and participants were once again encouraged to use the summary volume for the vulnerability assessment to study possible recommended actions in detail to decide which ones were national priorities. Participants were encouraged to think of the adaptations and policies in two ways: (1) those needed to reduce the size of the emerging gap between the fish available and the fish needed for food security through good management of coastal habitats and fish stocks, and (2) those required to increase alternative supplies of fish to fill the gap.

The breakout group discussions focused on the vital role of the vessel day scheme in distributing the benefits from tuna to members of the Parties to the Nauru Agreement (PNA) during ENSO events and the features of the scheme that will enable it to continue to be a practical adaptation to climate change. Participants also stressed the need for immediate reduction in fishing effort on bigeye tuna and considered the benefits of operating other fishing effort schemes and other ways of continuing the supply of fish to canneries in the future. Advantages were seen in implementing energy audits of fishing vessels, both to mitigate emissions but also to assist the marketing of tuna from the region.

Key adaptations for minimising the size of the gap to be filled centred on improved management of vegetation in catchments to maintain fish habitats and ‘primary fisheries management’ based on an ecosystem approach to keep coastal fish stocks within sustainable bounds. Both adaptations depend on effective cross sectoral management. To fill the gap, participants agreed that redistributing low value tuna landed by industrial fleets at major ports to urban communities at low cost would be of great assistance to food security of the urban poor. Inshore FADs were also seen as the main way that coastal communities can have better access to the tuna they will need for food security in the future.

## **Climate-related disasters**

The workshop recognised the great similarities in adaptations to climate change required in the fisheries sector and the adaptations needed to reduce the risk of disasters resulting from events such as cyclones and floods. Tagaloa Cooper and Florence Poulain presented regional and global perspectives and initiatives in this important area. Participants heard how FAO is working towards strengthening policy coherence to ensure explicit and adequate consideration of fisheries and aquaculture activities in disaster risk management and climate change adaptation strategies, taking into account the characteristics and special needs of fishers, fish farmers and their communities. FAO emphasised that disasters are a significant threat to fisheries and aquaculture, with developing countries and vulnerable groups being the most affected and the slowest to recover. Building resilience to disaster risks is more cost-effective than responding after a disaster has occurred and therefore necessitates investment. Within the region, the workshop noted that SPC and SPREP are working towards mainstreaming DRM and climate change adaptation. The Pacific Islands Framework on Climate Change (PIFCC)

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and the Pacific DRR and Disaster Management Framework for Action 2005–2015 (RFA) provide useful overarching regional frameworks. In 2011, a process to formulate an integrated regional strategy for DRR/M and climate change was endorsed to replace the RFA and PIFACC by 2015.

The processes underpinning the development of national DRM plans and the similarities and crossover with climate change adaptation processes provides a strong justification for combining the climate change adaptation and disaster risk planning processes to formulate Joint National Action Plans (JNAPs). Several countries have already developed JNAPs and several more are in the pipeline. The importance of supporting the integration of fisheries and aquaculture into national plans on climate change and disaster risk management was reiterated.

## **National and Sectoral Climate Change Strategies**

The workshop participants were provided with an overview of the different mechanisms and processes in place to formulate national climate change and disaster risk management strategies. In relation to climate change, Pepetua Latasi and Brian Dawson introduced the meeting to the processes of developing National Adaptation Programmes of Action (NAPAs) within the Least Developed Countries (LDC). NAPA have been developed within the five LDC Pacific Island countries, under support from the UNFCCC Least Developed Countries Fund. These documents describe the vulnerable sectors and defined short-term adaptation priorities for the country as a whole. The participants were informed of up-coming National Adaptation Programs (NAPs) that will define medium- to long-term adaptation priorities and strategies for all developing countries, although dedicated funding is available only for the LDC. Guidelines for NAP development are being drafted by the UNFCCC LDC Expert Group, which includes members from the Solomon Islands and Tuvalu (current Chair), representing SIDS.

Brian Dawson highlighted that many of the national plans lacked sufficient detail on the actual priorities and actions that could be implemented at the sector level and the workshop participants were encouraged to develop more specific sector adaptation and disaster risk management plans that could feed upwards into the national strategy documents and discussions.

## **Climate Change Finance**

The workshop was provided with a brief overview of the international climate change finance situation and the modalities through which climate change finance could be delivered by Brian Dawson. Information was provided on the international commitments that were in place to ensure a continued increase in the amount of finance that would be made available to developing countries to support adaptation and mitigation actions. By 2020, up to \$100 billion per year could be provided to support climate change response measures. The main modalities included support to project-based activities through the UNFCCC (Green Climate Fund, Adaptation Fund, GEF and others), multilateral processes (via ADB, World Bank, GIZ, EU and UN Agencies), and bilateral and NGO sources. Apart from the well-established mechanisms for supporting project-based approaches, a range of new financing mechanisms were emerging. These include: regional climate funds, national trust funds, direct budget support and sector-wide approaches. Many of these mechanisms are at an early stage of development and it is likely to be some years before they will be fully operational in the region.

The workshop participants were also informed about the complexities and constraints in accessing funds through these different modalities and were urged to be well aware of the need to have in place appropriate documentation and due diligence procedures to actually access climate change funds. The meeting participants were also encouraged to adopt a systematic and well-structured approach to developing fishery sector plans and project proposals that could be submitted to development partners for funding. SPC and other agencies in the region were available to support country efforts in developing these sector-based plans and funding proposals.

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## **Assistance from partners**

Presentations from IUCN, LLMA, TNC, USP and CI provided participants with a broad understanding of the array of initiatives underway by non government organisations and regional organisations that can provide support for countries and communities to build the resilience of fish habitats (coral reefs, mangroves and seagrasses) and fish stocks to climate change. The long history that many of these organisations have in working with national governments and communities provides a strong framework for cascading the results of SPC's vulnerability assessment and FAO's code of conduct for responsible fisheries and their recommended approaches for the ecosystem approach to fisheries management and the use of marine protected areas, to communities. Partnerships between communities and NGOs will be particularly important in developing the effective 'on-the-ground' adaptations needed to make a difference in the lives of Pacific Island people by minimising the risks of climate change and maximising opportunities.

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