POLICY BRIEF
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Secretariat of the Pacific Community

Aquaculture and climate change

Photo: Ben Ponia

Purpose

The aim of this policy brief is to:

- alert Pacific Island countries and territories (PICTs) to the projected effects of climate change on the contributions of aquaculture to food security and livelihoods; and
- identify the adaptations and policies needed to capitalise on the opportunities and reduce the threats.

Key messages

Projected increases in air temperatures and rainfall in the tropics are expected to improve the conditions for freshwater aquaculture. Conversely, projected increases in sea surface temperature, rainfall, sea-level, ocean acidification and the intensity of cyclones are likely to cause problems for coastal aquaculture (mariculture).

Significance of aquaculture

Freshwater pond aquaculture is helping to supply nutritious food for the rapidly growing rural and urban populations of the region. The number of households farming freshwater fish is increasing quickly – the latest estimates indicate that there are more than 10,000 farms (with 50,000 ponds) in Papua New Guinea.

Coastal aquaculture commodities, particularly pearls, shrimp and seaweed, make substantial contributions to livelihoods in some PICTs. More than 7000 people are employed full-time or part-time in coastal aquaculture, including 5000 jobs in French Polynesia and 200–600 jobs in each of Cook Islands, Fiji, New Caledonia and Solomon Islands (Table 1).

Projected effects of climate change on conditions for aquaculture

The higher rainfall and warmer air temperatures expected to occur in the tropics (Table 2) should improve the conditions for freshwater pond aquaculture in Melanesia.

On the other hand, projected increases in sea surface temperature (SST), rainfall, sea level, ocean acidification and the intensity of cyclones (Table 2) are likely to reduce the suitability of coastal habitats for the range of commodities presently grown there.

Projected effects of climate change on freshwater aquaculture production

Warmer air temperatures and higher rainfall are expected to lead to progressively greater production of tilapia, carp and milkfish in freshwater ponds in Melanesia due to increases in the quality and quantity of sites for this type of aquaculture, and faster rates of fish growth (Table 3).

Projected effects of climate change on coastal aquaculture production

The expected changes in surface climate and the ocean (Table 2) are likely to make the production of all commodities presently grown in coastal habitats (Figure 1) more difficult. The problems that are likely to occur for the major commodities in the future are given below.

Pearls: Increases in SST are likely to affect the way pearl oysters deposit nacre, and therefore pearl quality. Ocean acidification is also expected to reduce the growth and survival of young pearl oysters, and affect pearl quality. Sea-level rise and more intense cyclones may increase the risk of damage to pearl farms.

Shrimp: Higher and more variable water temperatures, and reductions in rainfall in the subtropics (Table 2), would increase the risk of temperature-related shrimp diseases in New Caledonia. Sea-level rise is also expected to make it more difficult to drain ponds between production cycles, resulting in anoxic sediments that reduce the growth and survival of shrimp.

Seaweed: Increased SST and reduced salinity are expected to stress *Eucheuma* seaweed, inhibit growth and promote outbreaks of epiphytic filamentous algae and tissue necrosis. Lower salinities caused by increased rainfall are likely to reduce the number of sites in the tropics where seaweed can be grown. More intense cyclones would increase the risks of damage to seaweed farms.

Implications for food security and livelihoods

Freshwater pond aquaculture is one of the few ways to increase the availability of dietary animal protein for inland populations in Melanesia, particularly in Papua New Guinea. More favourable conditions for freshwater pond aquaculture should enhance the plans to increase the supply of fish in this way. Provided ponds are constructed where they are not subject to flooding, freshwater aquaculture should be at low risk from climate change.

On the other hand, production of coastal aquaculture commodities for livelihoods is likely to be increasingly vulnerable to climate change. This does not necessarily mean a total reduction in productivity compared to present levels (there is considerable scope for increased harvests of some commodities in the shorter term). However, the efficiency of enterprises is likely to be affected in the longer term (Table 3).

Table 1 Estimated number of people involved in aquaculture on a fulltime, part-time or self-employed basis, producing commodities for food security (F) and livelihoods (L) in Pacific Island countries and territories (PICTs). Source: Pickering et al. (2011) Chapter 11 PDF: http://www.spc.int/climate-change/fisheries/assessment/main-book.html

PICT	People employed		
	F	L	Total
Melanesia			
Fiji	300	250	550
New Caledonia		560	560
PNG	>10,000	>60	>10,000
Solomon Islands	10	600	610
Vanuatu		30	30
Micronesia			
FSM		20	20
Guam		20	20
Kiribati	5	5	10
Marshall Islands		5	5
CNMI		12	12
Palau		5	5
Polynesia			
American Samoa		15	15
Cook Islands		450	450
French Polynesia		5000	5000
Samoa		16	16
Tonga	10	10	20
Total	**13,325**	**7058**	**17,323**

Table 2 Projected changes to the main features of surface climate and the tropical Pacific Ocean expected to affect aquaculture in the tropical Pacific under a high (IPCC A2) emissions scenario in 2035, 2050 and 2100, relative to 1980–1999. Source: Lough et al. (2011) Chapter 2 PDF: http://www.spc.int/climate-change/fisheries/assessment/main-book.html; Ganachaud et al. (2011) Chapter 3 PDF: http://www.spc.int/climate-change/fisheries/assessment/main-book.html

Climate feature	2035	2050	2100
Air temperature	+0.5 to 1.0°C	+1.5°C	+2.5 to 3.0°C
Rainfall			
- tropical	+5 to 20%	+10 to 20%	+10 to 20%
- subtropical	-5 to 20%	-5 to 20%	-5 to 20%
Cyclones	Number of cyclones may decrease but they may be more intense		
Sea surface temperature	+0.7 to 0.8°C	+1.2 to 1.6°C	+2.2 to 2.7°C
Sea-level rise			
- IPCC	+8 cm	+18 to 38 cm	+23 to 51 cm
- Other models	+20 to 30 cm	+70 to 110 cm	+90 to 140 cm
Aragonite saturation (Ω)*	Ω ~ 3.3	Ω ~ 3.0	Ω ~ 2.4

*A measure of ocean acidification

Adaptations

The following management measures should help capitalise on the opportunities for increased freshwater pond aquaculture and reduce the threats to coastal aquaculture.

Manage and restore vegetation in catchments: Increasing the vegetation in catchments will help reduce the transfer of sediments and nutrients to rivers and coasts and maintain water quality for both freshwater and coastal aquaculture.

Develop appropriate models for expansion of freshwater pond aquaculture: Identifying the hatchery systems and networks that allow (1) high-quality juvenile fish to be produced and distributed to both small-scale and large-scale farmers, and (2) securing the supplies of cost-effective feeds required for semi-intensive and intensive farming systems, will help freshwater pond aquaculture fulfil its potential.

Select sites for freshwater ponds carefully: Locating ponds where they will not be affected by stronger floods or saltwater intrusion will help safeguard investments.

Figure 1 The main aquaculture commodities grown in Pacific Island countries and territories and the habitats that support them.

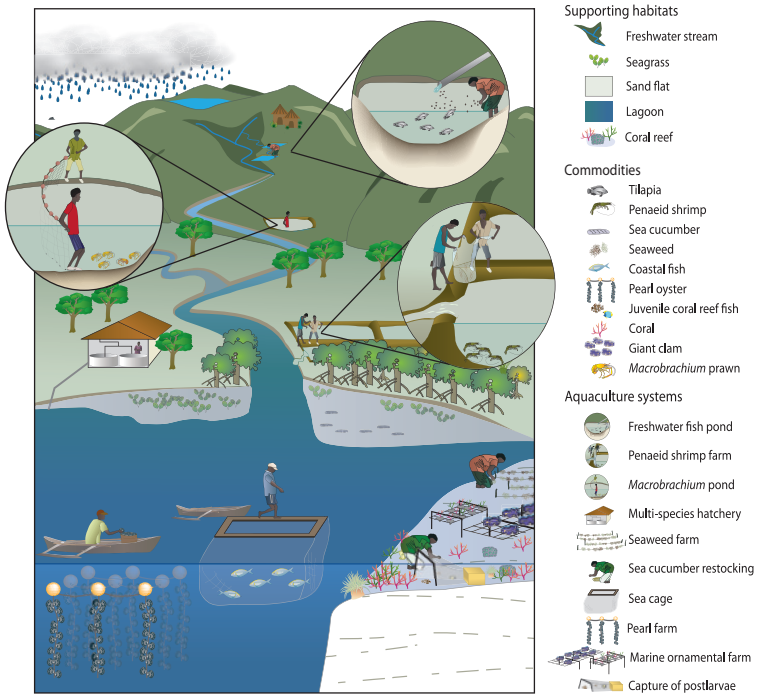
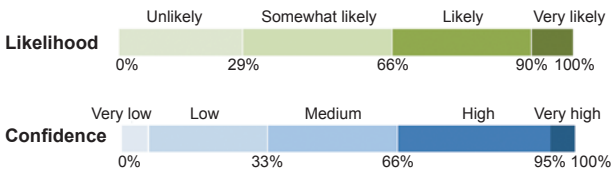


Table 3 Projected changes in production of aquaculture commodities under a high (IPCC A2) emissions scenario in 2035, 2050 and 2100, relative to 1980–1999. Source: Bell et al. (2011) http://www.spc.int/climate-change/fisheries/assessment/summary.html

Commodity	Production efficiency		
	B1/A2 2035	B1 2100*	A2 2100
Food security			
Tilapia and carp	↑	↑	↑
Milkfish	↑	↑	↑
Livelihoods			
Pearls	↓	↓	↓
Seaweed	↓	↓	↓
Shrimp	↑	↓	↓
Marine ornamentals**	↓	↓	↓
Freshwater prawn	↑	↓	↓
Marine fish	↓	↓	↓
Sea cucumbers	↓	↓	↓
Trochus	↓	↓	↓

* Approximates A2 in 2050; ** includes coral fragments, live rock and giant clams.



Improve technical and business skills: Providing training in farm management, and in the business skills needed to operate enterprises profitably, will assist farmers to capitalise on the more favourable opportunities for freshwater pond aquaculture.

Diversify production of coastal aquaculture commodities: Assessing the potential to grow 'new' commodities likely to be favoured by prevailing and projected environmental, economic and social conditions would help increase the number of jobs based on coastal aquaculture.

Map the location of all coastal aquaculture operations: Pinpointing the risks to aquaculture activities and infrastructure posed by expected changes in rainfall, sea-level rise and increased storm surge will help identify which operations need to be relocated.

Modify locations and infrastructure for coastal aquaculture: Reducing the expected negative effects of ocean acidification, higher water temperatures and sea-level rise on coastal aquaculture activities by:

- Relocating pearl farming operations to deeper water, and to sites closer to coral reefs and seagrass/algal areas, where water temperatures and aragonite saturation levels are likely to be more suitable for good growth and survival of pearl oysters, and formation of high-quality pearls.
- Raising the walls and floor of shrimp ponds so that they drain adequately as sea level rises.
- Identifying which shrimp ponds may need to be used more intensively or dedicated to producing other commodities.

Suggested supporting policy actions

- Strengthen governance of agriculture, forestry and mining practices to prevent soil loss and pollution, and maintain the water quality needed for freshwater and coastal aquaculture.
- Capitalise on opportunities for freshwater pond aquaculture to supply fish for growing inland communities and urban populations with poor access to other sources of animal protein.
- Limit farming of Nile tilapia to catchments where there is a chronic shortage of fish and where Mozambique and/or Nile tilapia are already established.
- Facilitate the training needed to operate aquaculture enterprises successfully.
- Develop partnerships with regional technical agencies to provide the necessary technical support for development of aquaculture.
- Strengthen national and regional capacity to adopt and implement aquatic animal health and biosecurity measures, including development of a regional aquatic biosecurity framework and international protocols for monitoring, detecting and reporting aquatic animal diseases.
- Inform prospective investors in coastal aquaculture enterprises about the projected horizons for economically viable operations under climate change.
- Provide incentives for aquaculture enterprises to assess risks to infrastructure so that farming operations and facilities can be 'climate-proofed' and relocated if necessary.
- Strengthen environmental impact assessment procedures for aquaculture developments to include the additional benefits or risks posed by climate change.
- Improve systems for collecting, storing and analysing the statistics needed to monitor and forecast aquaculture production.
- Revise primary school curricula to teach children about fish and food security, focusing on the importance of fish for their health; and the options for increasing future supplies of fish through freshwater pond aquaculture

Further reading

Bell JD, Johnson JE and Hobday AJ (eds) (2011) Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change. Secretariat of the Pacific Community, Noumea, New Caledonia (Chapters 11, 12 and 13).

Gillett R (2009) Fisheries in the Economies of Pacific Island Countries and Territories. Asian Development Bank, Manila, Philippines.

Gillett R and Cartwright I (2010) The Future of Pacific Island Fisheries. Secretariat of the Pacific Community, Noumea, New Caledonia.

SPC (2008) Fish and Food Security. SPC Policy Brief 1/2008. Secretariat of the Pacific Community, Noumea, New Caledonia.

SPC (2012) Opportunities for the Development of the Pacific Islands Mariculture Sector. SPC Policy Brief 20/2012. Secretariat of the Pacific Community, Noumea, New Caledonia.

Technical assistance

For advice on the development and management of aquaculture in the tropical Pacific, contact SPC's Fisheries, Aquaculture and Marine Ecosystems Division (cfpinfo@spc.int).

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