Climate change, fisheries and aquaculture in the Pacific:
Adaptations for food security, livelihoods & economic growth*

Johann Bell

* Based on presentation made at ICES/PICES/FAO Symposium of the ‘Climate change effects on fish and fisheries’, Sendai, Japan, April 2010
Outline

• Role of fisheries and aquaculture in the lives of the people of the Pacific Community
• Plans to maintain the benefits of fisheries in the face of key drivers
• Vulnerability of these plans to climate change
• How best to adapt
Vulnerability of Fisheries and Aquaculture in the Pacific to Climate Change

Our approach

1. Projected changes to atmospheric and oceanic conditions
2. Ecosystems supporting fish
3. Fish stocks
4. Implications for food security, livelihoods and economic growth
5. Adaptations needed to maintain productivity - management and policies
Multi-model mean from 13 ‘Coupled Model Intercomparison Project III’ models used for IPCC AR-4

Our approach

- Projected changes to atmospheric and oceanic conditions
- Ecosystems supporting fish
- Fish stocks
- Implications for food security, livelihoods and economic growth
- Adaptations needed to maintain productivity - management and policies
70 contributors from 30 institutions

- Alfred-Wegener-Institute, Germany
- Australian Institute of Marine Science
- CSIRO
- CLS, Satellite Oceanography Division, France
- C20 Consulting, Australia
- Danish Meteorological Institute
- Forum Fisheries Agency
- Great Barrier Reef Marine Park Authority
- IFREMER
- Institut de Recherche pour le Developpement
- James Cook University
- LSCE, IPSL, Paris, France
- Network of Aquaculture Centres for Asia-Pacific
- NOAA
- Papua New Guinea National Fisheries Department
- Secretariat of the Pacific Community
- Service de la Peche French Polynesia
- Snowy Mountains Engineering Corporation
- SOPAC
- Solomon Islands Ministry of Fisheries
- SPREP
- The WorldFish Center
- University of Hawaii
- University of Auckland
- University of New South Wales
- University of Queensland
- University of Singapore
- University of Tasmania
- Vanuatu Fisheries Department
- Virginia Institute of Marine Science, USA
- Western Australia Department of Fisheries

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Editors: Johann Bell, Johanna Johnson, Alistair Hobday
1. Roles of fisheries and aquaculture

- Food security
- Livelihoods
- Economic growth and government revenue
Food security

- Per capita fish consumption - rural (kg)

Source: Bell et al. (2009); Gillett (2009)
Food security

- Per capita fish consumption - rural (kg)

<table>
<thead>
<tr>
<th>Country</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palau</td>
<td>43</td>
</tr>
<tr>
<td>Marshall Islands</td>
<td>62</td>
</tr>
<tr>
<td>Nauru</td>
<td>115</td>
</tr>
<tr>
<td>Kiribati</td>
<td>147</td>
</tr>
<tr>
<td>Tokelau</td>
<td>200</td>
</tr>
<tr>
<td>Samoa</td>
<td>75</td>
</tr>
<tr>
<td>Tonga</td>
<td>61</td>
</tr>
<tr>
<td>Fiji</td>
<td>25</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>55</td>
</tr>
</tbody>
</table>

Animal protein: 50-94%
Subsistence fishing: 47-91%

Source: Bell et al. (2009); Gillett (2009)
Livelihoods

- Coastal households selling fish (%)
Economic contributions

- Government revenue
- GDP
- Polynesia

Examples only: Range x-y%

11%, 22%, 20%, 11%, 42%, 20%, 11%, 11%, 22%

Source: Gillett (2009)
2. Plans to maintain benefits

How much fish will be needed for future food security?

How many livelihoods can fish resources and aquaculture sustain?

How can tuna best contribute to economic growth and government revenue?
Food security

- Provide access to 35 kg of fish per capita for food security by 2030.

Source: SPC (2008)
Livelihoods

• Domesticate tuna operations - every 100,000 tonnes landed in the region creates 10,000 jobs

Tuna catch from the Western and Central Pacific Ocean (2007)

1,727,000 mt
432,000 mt
143,000 mt
95,000 mt
Livelihoods

- Restore fisheries for export commodities

![Graph showing density of Sea cucumber (Holothuria whitmaei) across the Pacific.]
Government revenue

- PNA members have 25% of world’s tuna resources and plan to bargain collectively for higher fees

Average 7% of ‘destination’ value of fish
3. Vulnerability of Pacific Community to changes in fisheries resources
Vulnerability of Pacific Community to changes in fisheries resources
Key drivers of change
(Future of Pacific Fisheries Study - 2010)

- Population growth and urbanisation
- Governance and political stability
- Global economic conditions
- Status of fisheries in other oceans
- Climate change
- Markets and trade
- Fuel costs
- Technology and innovation
- Foreign aid
### Population growth and urbanisation

<table>
<thead>
<tr>
<th>Population</th>
<th>2010</th>
<th>2035</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>7,447,753</td>
<td>9,998,975</td>
<td>34 %</td>
</tr>
<tr>
<td>Urban</td>
<td>2,413,735</td>
<td>5,007,625</td>
<td>107 %</td>
</tr>
<tr>
<td>Total</td>
<td>9,861,488</td>
<td>15,006,600</td>
<td>52 %</td>
</tr>
</tbody>
</table>
Vulnerability of plans for food security

- Fish available from coastal fisheries

Based on 3 tonnes of fish per square km of reef (Newton et al. 2007)

<table>
<thead>
<tr>
<th>Sustainable production EXPECTED to meet future needs</th>
<th>Sustainable production NOT EXPECTED to meet future needs</th>
<th>Sustainable production ADEQUATE but distribution difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Checkmark" /></td>
<td><img src="image" alt="X" /></td>
<td><img src="image" alt="Question Mark" /></td>
</tr>
<tr>
<td>Cook Islands</td>
<td>American Samoa</td>
<td>Kiribati</td>
</tr>
<tr>
<td>Marshall Islands</td>
<td>CNMI</td>
<td>FSM</td>
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</tr>
<tr>
<td></td>
<td>Samoa</td>
<td>Wallis and Futuna</td>
</tr>
<tr>
<td></td>
<td>Solomon Islands</td>
<td></td>
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</table>
Vulnerability of plans for food security

- **Group** with availability of fish per capita:
  - 390 kg in 2035
  - 390 kg in 2050

- **Group** with availability of fish per capita:
  - 260 kg in 2035
  - 243 kg in 2050

Availability of fish per capita (kg)

- 35 kg

2035  2050
Vulnerability of plans for food security

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<tr>
<td>[✓]</td>
<td>[✗]</td>
<td>[?]</td>
</tr>
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Marshall Islands  
New Caledonia  
Palau  
Pitcairn Islands  
Tokelau

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CNMI  
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Tonga  
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Wallis and Futuna

Solomon Islands  
Vanuatu
**Effects of population growth**

**Solomon Islands**

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<td>1,245,800</td>
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- **Recent per capita consumption**
- **Availability of reef fish per capita**

- **35 kg**
Solomon Islands

Gap to be filled

Availability of reef fish per capita

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Recent per capita consumption

- 2010: 9 kg
- 2035: 14 kg
- 2050: ? kg
- 2100: 35 kg
Projections for coastal fisheries under climate change

Today

2035 A2 (-2 to -5%)

2050 A2 (-20%)

2100 A2 (-20 to -50%)
Added effects of climate change

Solomon Islands

Recent per capita consumption

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Availability of reef fish per capita

- 2010: 35 kg
- 2035: 14 kg
- 2050: 9 kg

Future consumption projection:
- 2010: 9 kg
- 2035: 17 kg
- 2100: ? kg
4. How should the Pacific Community adapt?
Adaptation decision framework

Addresses Climate Change

Long-term Loss vs. Long-term Gain

- Lose-Lose
  - X
  - X
- Lose-Win
  - ✓
- Win-Lose
  - ✓
- Win-Win
  - ✓

After Grafton (2010)
Adaptations

Restore and sustain coastal and freshwater fisheries

- FAO Code of Conduct for Responsible Fisheries
- Ecosystem Approach Fisheries Management
Adaptations

Increase access to tuna for subsistence fishers with low-cost, inshore Fish Aggregating Devices (FADs)
Adaptations

Store and distribute tuna and by-catch from industrial fleets to urban areas
Adaptations

Develop pond aquaculture
Tuna – the main win-win adaptation

Recent per capita consumption

- 2010: 35 kg
- 2035: 20 kg
- 2050: 10 kg
- 2100: ?

Only resource capable of filling most of the rapidly emerging gap

1,727,000 mt (2010)
432,000 mt (2035)

Pond aquaculture expected to provide only 2 kg per person per year by 2035
Tuna – the main win-win adaptation

• Abundances projected to increase under climate change

Today

2035 A2 (+37%)

2050 A2 (+43%)

2100 A2 (+27%)

Based on output of SEAPODYM modelling for skipjack tuna by P. Lehodey et al., relative to 1980-2000, in the eastern Pacific area 15°N to 15°S and 170°E to 150°W
Projections for tuna (Solomon Islands)

NOW

2035 A2 (+3.2 %)

2050 A2 (-5.5%)

2100 A2 (-15.4 %)

X

X

X

X
Governments of PNG and Solomon Islands will need to allocate a greater proportion of tuna resources for food security.
Other adaptations

Moratoriums to rebuild sea cucumber fisheries
Other adaptations

‘Vessel Day Scheme’ to manage effort of industrial tuna fleets

La Niña

El Niño

Source: P. Lehodey
Other adaptations

‘Vessel Day Scheme’ to manage effort of industrial tuna fleets

La Niña
Vessel owners fishing in PNA waters purchase and trade fishing days depending on the location of the tuna

El Niño

Source: P. Lehodey

Skipjack tuna

2050 A2

2100 A2
Summary

- Population growth is a stronger driver than climate change for food security
- Lose-Win adaptations needed to restore and sustain production potential of coastal fisheries
- Win-Win adaptations are needed to respond to both drivers (by diversifying access to fish for food security)
Acknowledgements

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- SOPAC
- SPREP