Vulnerability and adaptation of coastal fisheries to climate change: monitoring indicators and survey design for implementation in the Pacific

19-22 April 2010
Workshop Report

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Note:

This report summarises the outcomes of an expert workshop coordinated by the Secretariat of the Pacific Community to discuss current coastal fisheries and climate change monitoring and research projects, and design a monitoring program. The workshop was held at the Secretariat of the Pacific Community from 19-22 April 2010, and included representatives from many Pacific Island Countries and Territories, as well as scientists working in relevant fields. The workshop was an initiative of the Coastal Fisheries Programme, and was facilitated by Johanna Johnson of C_2O Consulting. This report has been prepared for the Secretariat of the Pacific Community to outline the main objectives and outcomes of the workshop. The Coastal Fisheries Programme is the primary contact for questions about the background of the workshop, workshop outcomes, next steps for the project and longer-term goals. All reasonable efforts have been made to ensure that the content of this report accurately reflects discussions held by participants during the workshop.

Report details:

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1. Introduction

The Coastal Fisheries Programme at the Secretariat of the Pacific Community (SPC) secured funding assistance from the Australian Agency for International Development (AusAID) to launch a project to assist Pacific Island countries and territories (PICTs) to design and field-test monitoring pilot projects to determine whether changes are occurring in the productivity of coastal fisheries and, if changes are found, to identify the extent to which such changes are due to climate change. This project complements an existing SPC project assessing the vulnerability of coastal fisheries to climate change, and the results of the vulnerability assessment will be used to inform the final monitoring design and implementation of pilot projects.

2. Workshop objectives

1. Identify data currently collected in the Pacific, purpose and whether they will allow separation of climate change effects.

2. Identify optimum monitoring design, including practical indicators, survey designs and methods.

The monitoring design needs to include standardized methods that can be feasibly implemented in the Pacific region, and build on existing monitoring programs where possible. In addition, the ability to align the monitoring with the ongoing assessment of the vulnerability of coastal fisheries to climate change, and future adaptation strategies and plans is desirable.

3. Workshop outputs

The workshop participants were provided with an overview of current coastal fisheries and climate change monitoring in the Pacific region and asked to focus on the following monitoring question.

What can be monitored (as part of fisheries management) to detect climate change influences?

Breakout group sessions separated into (i) oceanic environments, (ii) habitats that support coastal fisheries, (iii) fish and invertebrate resources, and (iv) fish and invertebrate fisheries worked to identify:

- indicators for vulnerability of coastal fisheries to climate change,
- indicators for monitoring of coastal fisheries change,
- temporal and spatial design of monitoring,

- monitoring sites and sampling design,
- approaches for separating long-term climate change impacts versus short-term human impacts, and
- approaches for relating observed change to climate.

While identifying possible indicators and methodologies, participants considered a range of feasibility factors to enable the most practical survey method to be designed for the Pacific region. These feasibility factors included: cost, skill requirements, government and community capacity and simplicity. Table 1 summarizes the indicators, provides some prioritization of indicators and outlines the complete survey design to monitor vulnerability and adaptation of coastal fisheries to climate change in the Pacific.

Table 1. Proposed survey design for monitoring climate change influences on coastal fisheries in the Pacific region

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
Oceanic environment			*Regional/ national/ local*	*number/ location/ criteria for selection*		*community/ community with support/ scientists*		*SST+/pH/ rainfall/ circulation/ sea level*			
	SST	SST+	Remote sensing; Argo floats	Regional	All Pacific; Argo 3,000 floating sensors	Weekly data	Scientists	Repositories exist Higher resolution data with receiving station	SST+	Satellite data at 50 km resolution	Decadal data needed because of ENSO
	Ocean colour	Upwelling, algal bloom, productivity	SeaWifs, MODIS	Regional	All Pacific	Weekly data	Scientists	Repositories exist	Upwelling/ circulation	250 m resolution	
High priority	Temp, Tides (pressure sensors)	Upwelling, temperature stress on habitat	*in situ* temp loggers to measure difference in offshore v coastal temp; tide and wave	National	2 per island; leeward, windward, outer reef, depth (10 m)	Hourly data; 2 year replacement cycle	Deployment by community (staged)	Need for exchange of data, network	SST+, ocean circulation	Need for site specific loggers.	Long term data series for outer reef needed (> 20 yrs)
Low priority	pH, pCO_2, alkalinity, carbonate, aragonite, dissolved	Water chemistry		Regional			Scientists	Link with USA/ Australian agencies	Ocean acidification	NOAA Global Ocean Obs. Network/ Aust CC Science	Requires collaboration

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
	carbon etc.									Program	
	Wave/ pressure	Wave height	Wave rider buoy; tide gauge on fore-reefs	National	1 per island; offshore	Hourly data; 2 year replacement cycle	Scientists	Existing repositories	Wind changes, El Nino	Regional models, hindcast	Very few buoys (Guam, Majuro)
Moderate priority	Currents, river flush, salinity	Ocean circulation	Continuous recorder	Local		As needed; 6 -12 mth cycle	Scientists		Ocean circulation		
	Current, temp, depth	Current, temp, depth	CTD casts	Local	Opportunistic	Opportunistic sampling	Scientists		Ocean circulation		
	Plankton abundance and distribution	Primary productivity		Regional			Scientists		Upwelling		Requires further work with experts
Habitats supporting coastal fisheries											
	Change in habitat type	Habitat resource change due to loss of coral or seagrass	Habitat mapping using remote sensing or IR photos (change detection)	National to Local (hierarchical)		Infrequent 4 years (first survey in year 1); event based possible with new images	Scientists	IRD/SPC	SST+, ocean acidification, storms		Ground truthing needed for each new site if you want to classify habitats
	Rugosity metric	Reef structural complexity	Chain (resource intensive),	Local	Depend on complexity and habitat	Event based (pre, during and	Experts for chain and visual	National/ Regional agencies	SST+, ocean acidificatio	LIDAR (limited availability)	LIDAR is not yet available in

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
			photo transect (analyzed later), diver visual assessment against 5-point scale		types. Selection of sites based on satellite imagery; all reef zones	6 mth post); plus infrequent 4 years (first survey in year 1)	assessment ; trained observers for photo transect		n, extreme weather events		the Pacific and is expensive to acquire
	Change in benthic cover	Benthic cover (coral/ seagrass/ soft bottom)	50 m photo-quadrats (photo linked with time synchronized GPS positioning); 5 & 15 m sampling depth	Local	Depend on complexity and habitat types. Selection of sites based on satellite imagery; all reef zones	Event based (pre, during and 6 mth post); plus infrequent 4 years (first survey in year 1)	Fisheries officers/ community members inform alert on bleaching events	National/ Regional agencies	SST, ocean acidification, extreme weather events		
	Juvenile Acropora recruits	Degradation of dominant structural components	quadrats	Local	Depends on complexity and habitat types. Selection of sites based on habitat maps	Event based (pre, during and 6 mth post); plus infrequent 4 years (first survey in year 1)	Fisheries officers	National/ Regional agencies	SST, ocean acidification, changing currents		
Low priority	Corals, Halimeda, forams	Reduced calcification	Coral cores; microscope obs for structure change; settlement	Local	Sample collection at sites of interest	Every 4 years	Fisheries officers	National/ Regional agencies	Ocean acidification		Maybe more specialized research project, not really

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
			plates to count calcifiers								monitoring
Fish and invertebrate resources											
Demersal Finfish 1. High	Species comp – abundance & biomass	Commercial species (incl. reef sharks and carangids)	UVC, SPC; to species or genus where possible (can pool to Family level); random replicates (10)	Local & Regional	MPAs/atoll free of land runoff, fishing, fewer COTS. Complement habitat sites	Inter-annual and intra-annual blocks; (same lunar phase); event based	Scientists, trained observers	Central coordination (standard training, codes, data entry, database)	SST+, ocean circulation	French Polynesia, US Territories	Remote sites may not remain remote or may have unquantified illegal activity
	Functional groups	Family level	UVC, SPC	Local & Regional			Scientists, trained observers		CC resilience	French Polynesia, US Territories	
	Bulbametapon, Chaetodons	Key species	UVC, SPC	Local & Regional			Scientists, trained observers				
	Size/age at maturity	Commercial species	UVC, SPC	Local & Regional			Scientist				
High	Spawning aggregation	Reproductive changes	UVC, SPC	Local		Inter-annual and intra-annual blocks; (same	Scientists, trained observers		SST+, ocean circulation		

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
						lunar phase); event based					
Nearshore pelagic finfish	Species comp – abundance & biomass	Scombrids, Carangids, Barracudas , Fusiliers, Clupeids	UVC, SPC to species or genus where possible (can pool to Family level)	Local & Regional			Scientists, trained observers		SST+, ocean circulation	French Polynesia, US Territories	
	Species distribution	Commercial species – tuna, Spanish Mackerel	UVC, SPC	Local & Regional			Scientists, trained observers		SST+, ocean circulation		
Gleaned invertebrates 2. High	Shell density, growth rate, zooxanthellae	Giant clams	UVC, SPC; possible of future deployment	Local & Regional			Scientists, trained observers		SST+, ocean acidification		
4. Mod-high	Sentinel species - abundance	Whelks, limpets, bivalves, urchins	Monitor natural population or deploy; settlement plates	Local		Event based	Scientists, trained observers		Ocean acidification		
Targeted invertebrates 3. High	Species comp – abundance & biomass	Trochus, pearl oyster, beche de mer, green	UVC, SPC	Local & Regional		Inter-annual and intra-annual blocks; (same	Scientists, trained observers				

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
		snails, urchins				lunar phase); event based					
Fish & invertebrate fisheries											
High	Species composition for food	Catch species composition (to highest possible taxonomic level)	Market and landing and village catch surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	10 days per month- market and landing Quarterly	Fisheries officers (training required)- market and landing; communities collecting log book- analyzed by fisheries/NGO/Research institutions	Country nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERSHIP RIGHTS	SST+, ocean circulation	Market and landing surveys	
High	Catch quantity (amt)- calculate CPUE	Fish abundance	Market and landing and village catch surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	10 days per month- market and landing Quarterly	Fisheries officers (training required)- market and landing; communities collecting log book- analyzed by fisheries/NGO/Research	Country nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERSHIP	SST+, ocean circulation	Market and landing surveys	

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
							institutions	RIGHTS			
High	Fish size-total length		Market and landing and village catch surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	10 days per month-market and landing Quarterly	Fisheries officers (training required)-market and landing; communities collecting log book-analyzed by fisheries/NGO/Research institutions	Country nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERSHIP RIGHTS	SST+, ocean circulation	Market and landing surveys	
High	Season/ time	Fish distribution	Market and landing surveys	Local					SST+, ocean circulation		
High	Maturity status	Reproductive state in indicator species	Market and landing surveys	Local	At minimum at main market	10 days per month-market and landing approx 10 of same species per day-targeted according to size and season	Fisheries/NGO/Researchers (training required)	"	SST+		The feasibility of market gonad surveys in some nations will need to be reviewed (eg Solomons)
High	Harvest	Spatial	Market and	Local	Where data	10 days per	Fisheries	Country			

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
	location	distribution of effort	landing and village catch surveys – commercial and subsistence; household survey		is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	month- market and landing Quarterly	officers (training required)- market and landing; communities collecting log book- analyzed by fisheries/NGO/Research institutions	nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERSHIP RIGHTS			
Med	Geomorphology of where harvested	"	Market and landing and village catch surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	10 days per month- market and landing Quarterly	Fisheries officers (training required)- market and landing; communities collecting log book- analyzed by fisheries/NGO/Research institutions	Country nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERSHIP RIGHTS			
Med	Proximity		Market and landing and village catch surveys – commercial and	Local	Where data is already collected; gap analysis for additional	10 days per month- market and landing	Fisheries officers (training required)- market and landing;	Country nodes with SPC regional database. ALL THIS			

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
			subsistence		sites (range of fishing pressure & env sensitivity)	Quarterly	communities collecting log book- analyzed by fisheries/NGO/Research institutions	NEEDS DATA SHARING AND OWNERSHIP RIGHTS			
Low	Transport		Market and landing and village catch surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	10 days per month- market and landing Quarterly	Fisheries officers (training required)- market and landing; communities collecting log book- analyzed by fisheries/NGO/Research institutions	Country nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERSHIP RIGHTS			
Med	Fishing gear		Market and landing and village catch surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	10 days per month- market and landing Quarterly	Fisheries officers (training required)- market and landing; communities collecting log book- analyzed by fisheries/NG	Country nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERS			

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
							O/Research institutions	HIP RIGHTS			
Med	Fishing method		Market and landing and village catch surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing pressure & env sensitivity)	10 days per month- market and landing Quarterly	Fisheries officers (training required)- market and landing; communities collecting log book- analyzed by fisheries/NGO/Research institutions	Country nodes with SPC regional database. ALL THIS NEEDS DATA SHARING AND OWNERS HIP RIGHTS			
Med	Demographics		Household; census	Local; national & regional	Same as market and landing surveys		NGO/govt (highly coord and complex)				
High	Fisher group composition (age/sex)		Household; fishing survey	Local; national & regional	Same as market and landing surveys		NGO/govt (highly coord and complex)				
High	Purposes (subsistence, cash income, traditional use)		Market and Household surveys – commercial and subsistence	Local	Where data is already collected; gap analysis for additional sites (range of fishing	10 days per month- market and landing Quarterly	Fisheries officers (training required)- market and landing; communities collecting log	Country nodes with SPC regional database. ALL THIS NEEDS DATA			

Priority	Indicator	Measuring	Methodology	Scale	Sites	Sampling frequency	Who monitors (level of expertise)?	Data mgt	Possible climate change influence	Existing monitoring or data	Gaps/ comments
					pressure & env sensitivity)		book-analyzed by fisheries/NGO/Research institutions	SHARING AND OWNERSHIP RIGHTS			
high	Dependency on fishery for food	Rural versus urban dependency	Household; and national census	Local; national & regional	Same as market and landing surveys	3-5 years; census each 10 years	NGO/govt (highly coord and complex)				
high	Dependency on fishery for income generation		Household; and national census	Local; national & regional	Same as market and landing surveys	3-5 years; census each 10 years	NGO/govt (highly coord and complex)				
Med	Non-coastal fishery livelihoods		Household; and national census	Local; national & regional	Same as market and landing surveys	3-5 years; census each 10 years	NGO/govt (highly coord and complex)				
Med	Market accessibility (what it takes to turn fish to cash)		Key informant	Local		3-5 years	NGO/govt				
High	Resource governance	Ability to implement management adaptation and climate hazard mitigation for fisheries	Institutional analysis to identify governance structures, gaps in ability to govern and strengthen	Local and national and regional (community, govt, MDAs)	Locally-same as HH surveys, nationally and regionally	3-5 years	NGO/govt				

N.B.

- Collection of photo data requires consideration of photo analysis up front and identification of analysis technicians/resources to avoid backlogs of unanalyzed data.
- Prioritization of indicators will need to be reviewed against the findings of the Pacific Vulnerability Assessment (SPC) to ensure variables that are most vulnerable, or contribute most to fisheries vulnerability, are included in the final monitoring survey design.
- The oceanic environment indicators tend to be those that measure 'exposure' variables; the habitat and fish/invertebrate resources indicators tend to measure "sensitivity' to and 'potential impacts' of climate change; and the fisheries indicators tend to measure 'adaptive capacity'.

The survey design outlined in Table 1 provides a standardized methodology for monitoring coastal habitats and fisheries, and it is planned will over time detect climate change influences on these fisheries. The project will field-test this monitoring approach in 4-5 pilot project areas, and the criteria for identifying and selecting suitable pilot project locations is outlined in Table 2.

Table 2. Criteria for selecting suitable pilot project locations

Essential criteria	**Important criteria**	**Desirable criteria**
National agreement	Vulnerable location	Locally relevant
Government capacity to support project	Important and vulnerable fishery species to be monitored	Cross sectoral relevance
Census data	Existing fish/invertebrate monitoring data	Household survey data
Community commitment	Existing benthic monitoring capacity	
Management options available	Known fishing/WQ/other pressures: atolls and/or high islands	
	Remote sensing and oceanic instruments in situ	
	Market and landing surveys	

The scale of the proposed high priority indicators varies from regional (1,000s of km) to national (100s of km) to local (10s of km), to the individual site and replicate scale (Figure 1). These spatial differences provide an opportunity to use a hierarchical approach to implementing monitoring, and collect a range of data in a single pilot project location. However, it does therefore require that suitable pilot project locations are selected based on the criteria developed in the workshop (Table 2).

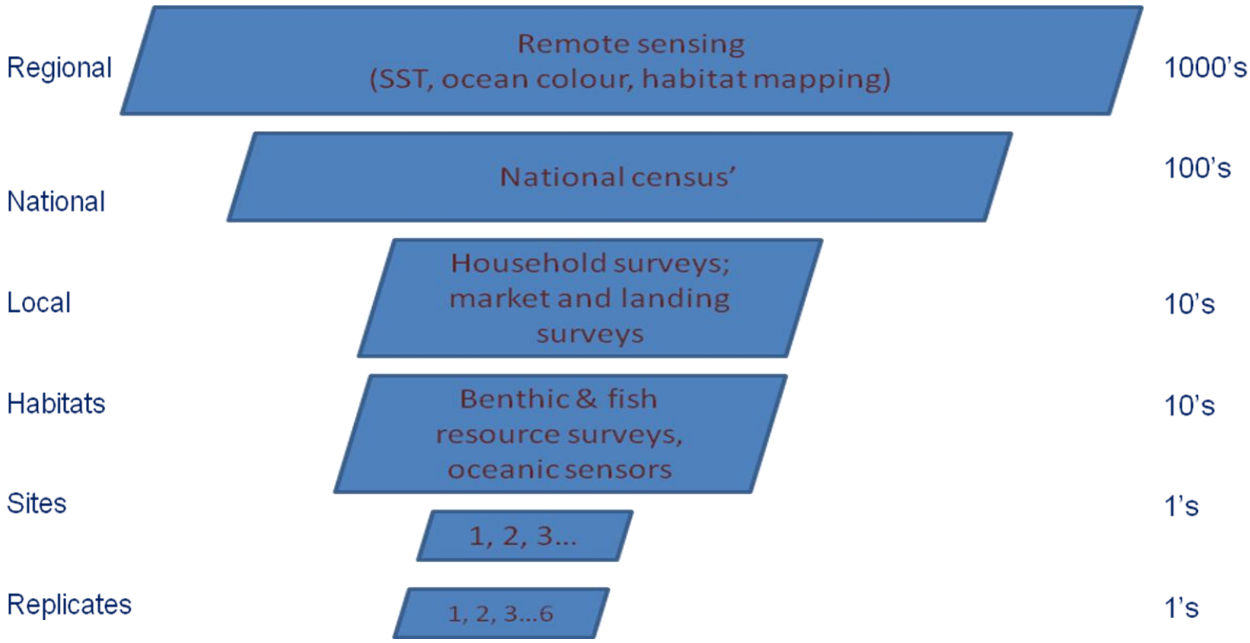

Figure 1. Spatial scale of the different indicators identified to monitor climate change influences on coastal fisheries in the Pacific and the relationship between the indicators.

4. Project next steps

The final monitoring design will be informed by the results of the SPC project assessing the vulnerability of Pacific fisheries and aquaculture to climate change. The vulnerability results will provide information on which fisheries or specific locations are most vulnerable to climate change, and therefore are likely to show change that can be detected by monitoring. The results will also identify factors that contribute to this vulnerability, which will inform the subset of indicators to be field-tested in the pilot projects. In addition, the monitoring program results can help determine whether projections of both climate and climate impacts on Pacific coastal fisheries are actually occurring and whether to adjust monitoring and/or management.

The workshop participants also identified a number of next steps for this project in order to take forward the outputs of the workshop and ensure that the monitoring design is field-tested in a number of pilot projects over the next 12-18 months.

These follow-on activities included:

- Establish and maintain an email network to continue to identify, share and combine existing knowledge and data,
- SPC to maintain a secure website as a data repository to store available data that can be accessed by all project contributors,
- SPC in consultation with key workshop participants to conduct an iterative selection process using the criteria in Table 2 to select 4-5 possible pilot project sites, and based ultimately on project feasibility and costs, select as many pilot projects as possible,
- SPC to secure interest and agreement from relevant PICTs to participate and support the selected pilot projects.

5. Further background reading

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