

Pacific Climate Change Science

Overview of the (PACCSAP) Pacific Climate Change Science Program

First Meeting of the Steering Committee for the INDARE Initiative, WMO Geneva
29 Sep-01 Oct 2014

Geoff Gooley

.....on behalf of PACCSAP Science Program (CSIRO & Bureau of Meteorology), incl. collaborative partners in Australia & the Pacific

Pacific-Australia Climate Change Science and Adaptation Planning Program



Australian Government

Presentation Outline

- Overview - PACCSAP Science Program
- Overview - new science, tools, communication & capacity development
- Decision-centred approach to adaptation
- Delivering climate science-based evidence
- Data and information management
- The future



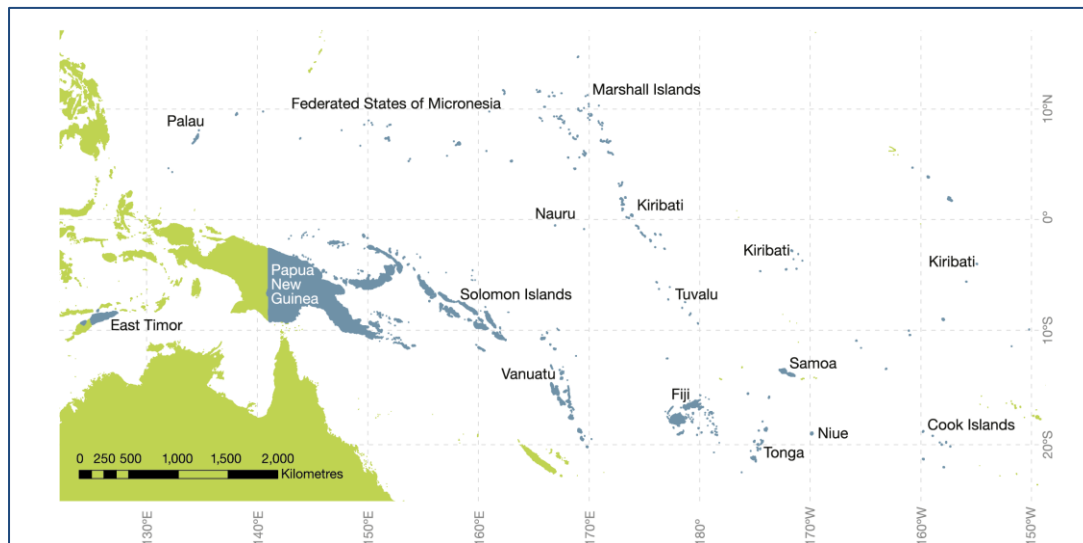
PCCSP/PACCSAP Science

- Pacific Climate Change Science Program (PCCSP)
 - ~\$20m over ~ 3 yrs (2008/09-2010/11)
- Pacific – Australia Climate Change Science & Adaptation Planning (PACCSAP) Science Program
 - ~\$20m over ~ 3 yrs (2011/12-2013/14)
- Funded & administered by Australian Government (DFAT & DotE)
- Delivered by Centre for Australian Weather & Climate Research (CAWCR):
 - partnership between CSIRO and Bureau of Meteorology
- 15 diverse partner countries & numerous regional organisations and universities incl. SPREP, SPC, USP, Red Cross and GIZ
- Other Australian agencies: Geoscience Australia, ARC Centre of Excellence for Climate System Science



PCCSP/PACCSAP Science

- Regional focus on 14 Pacific Island Countries (PICs) + E. Timor
 - key stakeholders - National Met Services
- Response to considerable PIC needs (demand driven, next/end user focus)
- Data/information (knowledge), tools and capacity to facilitate decision-making & associated pathways to adaptation



PACCSAP Science – strategic drivers

- PACCSAP – two components:
 - Adaptation Component (Dept of the Environment)
 - **Science Component (CSIRO & BOM)**
- PACCSAP goal & objective:
 - PICs developed capacity to monitor & adapt to changing natural environment, & enhanced resilience to impacts of CC
 - Emphasis on PIC scientists, decision-makers & planners to apply info/tools & develop in-country responses
- **PACCSAP Science component objective:**
 - Primary: Improve scientific understanding of climate change in the Pacific
 - Together with DotE:
 - Increased awareness of climate science, impacts and adaptation options
 - Better adaptation planning to build resilience to climate change impacts



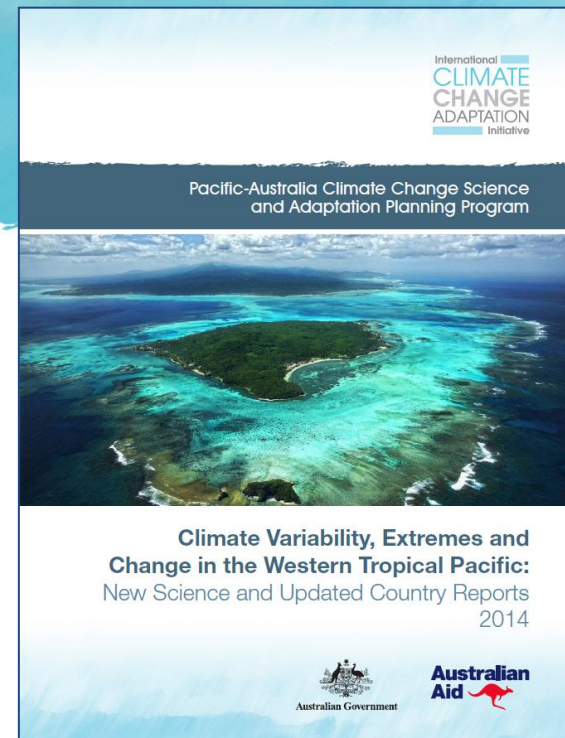
PACCSAP Science Program - Scope

- New science
 - Seasonal predictions & **climate data (n.b. data rescue, digitisation & CliDE)**
 - Large-scale climate features & variability
 - Regionally specific projections & extreme events
 - Ocean processes
- Tools development & technical support
 - Pacific Climate Futures
 - **CliDE**
 - **Data portals**
- Capacity development
 - Mentoring & attachments
 - **Technical training**
 - Workshops, conferences, symposia
 - Networking & relationship management
- Communication products
 - Technical Report
 - Synthesis Report
 - **Journal papers**, animations, fact sheets, **training resources**



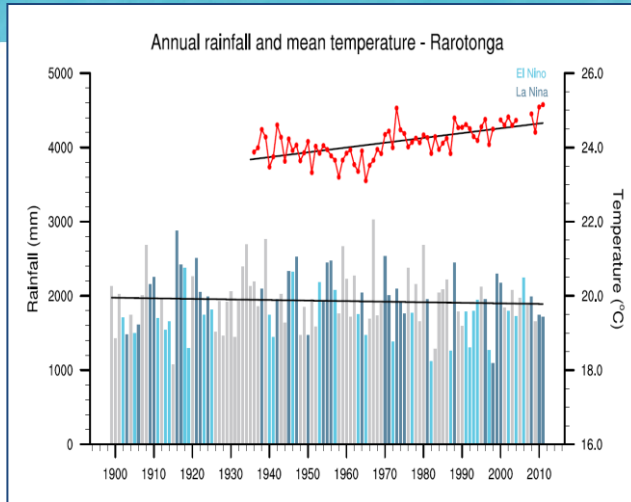
New science/new products

- Climate variability, extremes and change in the western tropical Pacific: new science and updated country reports.....(BOM & CSIRO, 2014)
- Technical report, country specific chapters:
 - Climate summary
 - Data availability
 - Seasonal cycles
 - Observed trends
 - Climate projections (CMIP5)
- On-line publication
<http://www.pacificclimatechangescience.org>

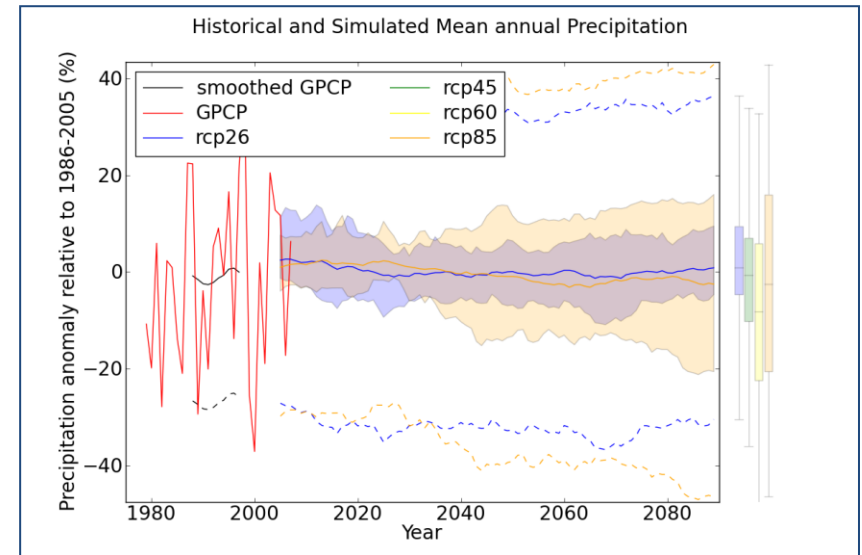
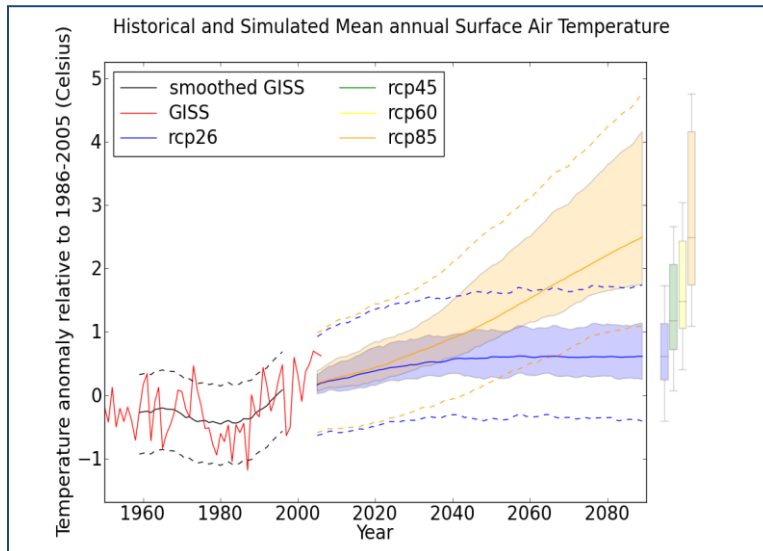


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Technical Report – temperature & rainfall observations & projections

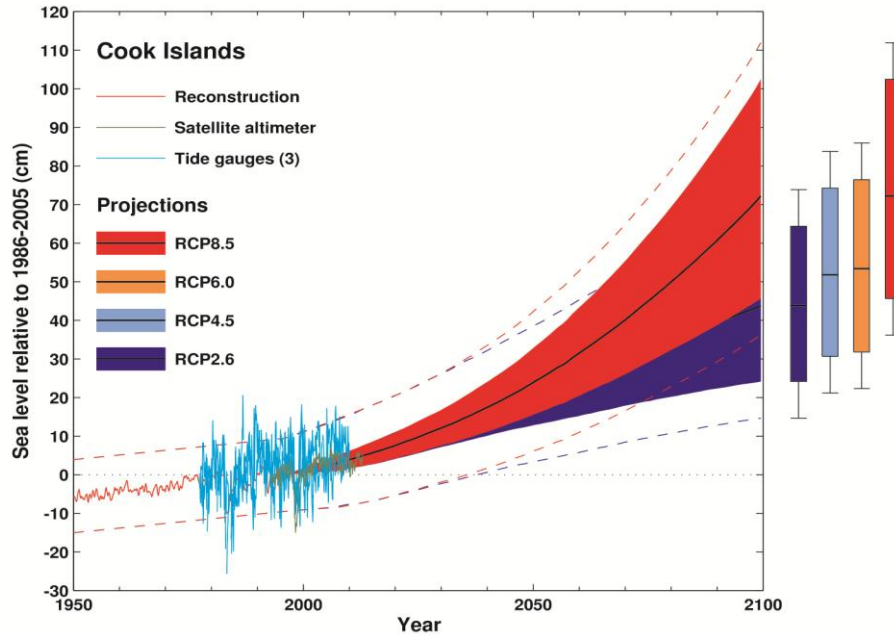


Annual mean air temperature (red line) and annual total rainfall (bars) at Rarotonga. Light blue, dark blue and grey bars denote El Niño, La Niña and neutral years respectively.

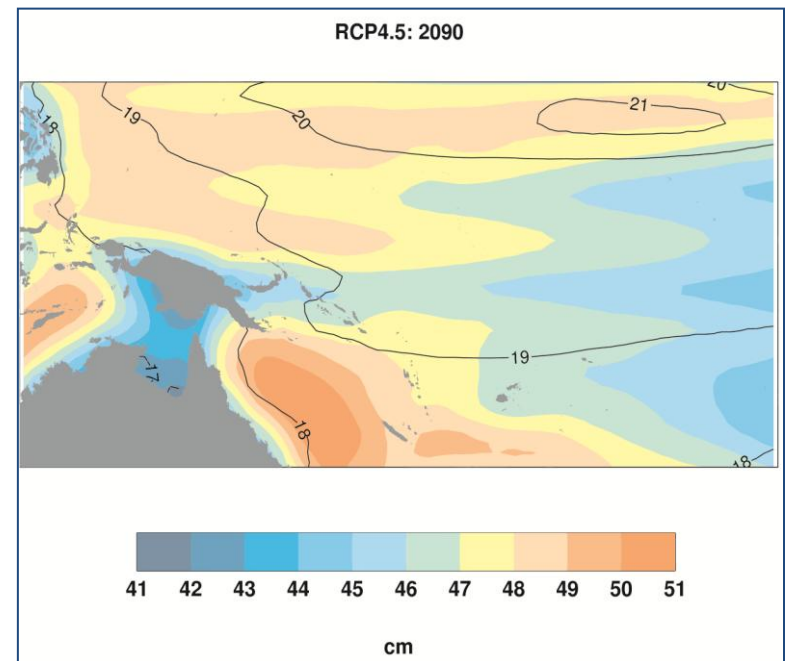


Historical and simulated annual average temperature and rainfall time series for the region surrounding Northern Cook Islands for the CMIP5 models under the very high emission (RCP8.5 very high emissions) and very low emission (RCP2.6) scenarios.

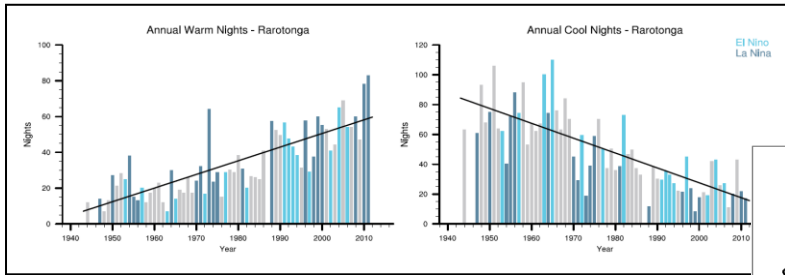
Technical Report – sea level rise observations & projections



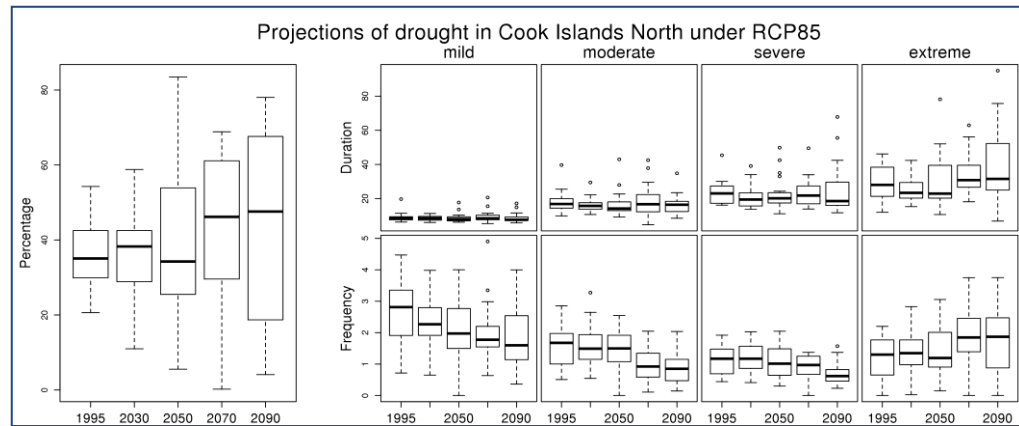
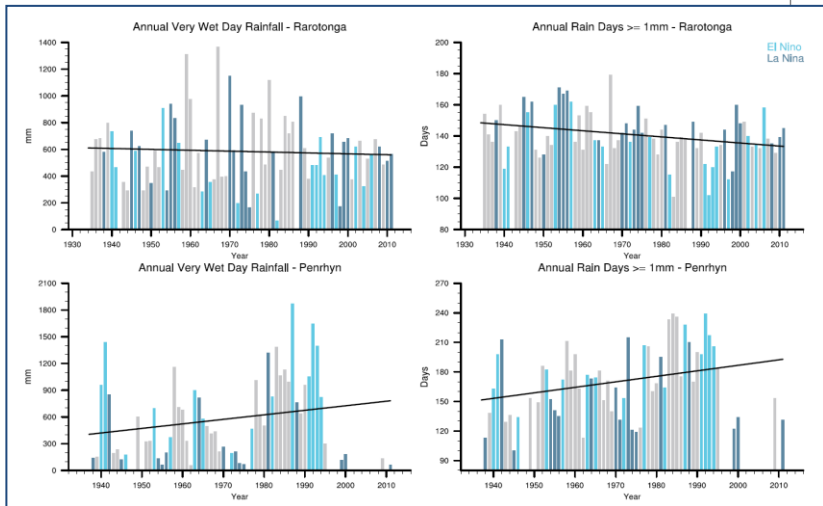
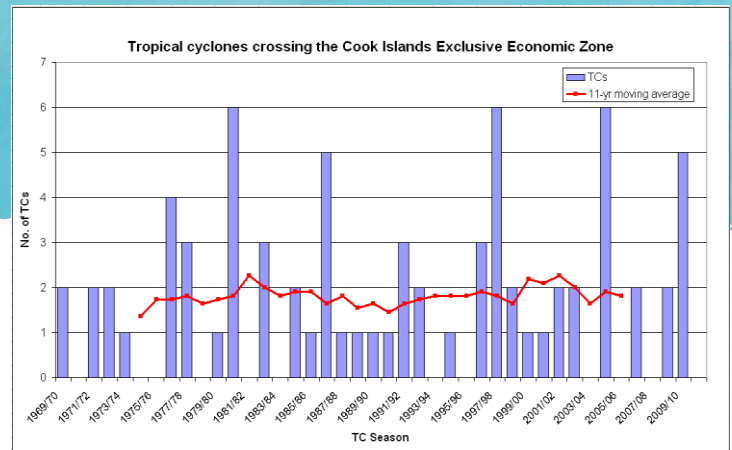
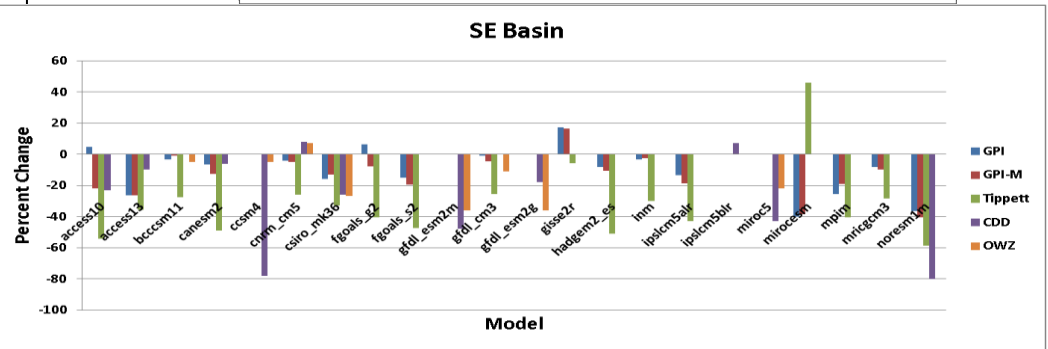
Observed and projected relative sea-level change near the Cook Islands



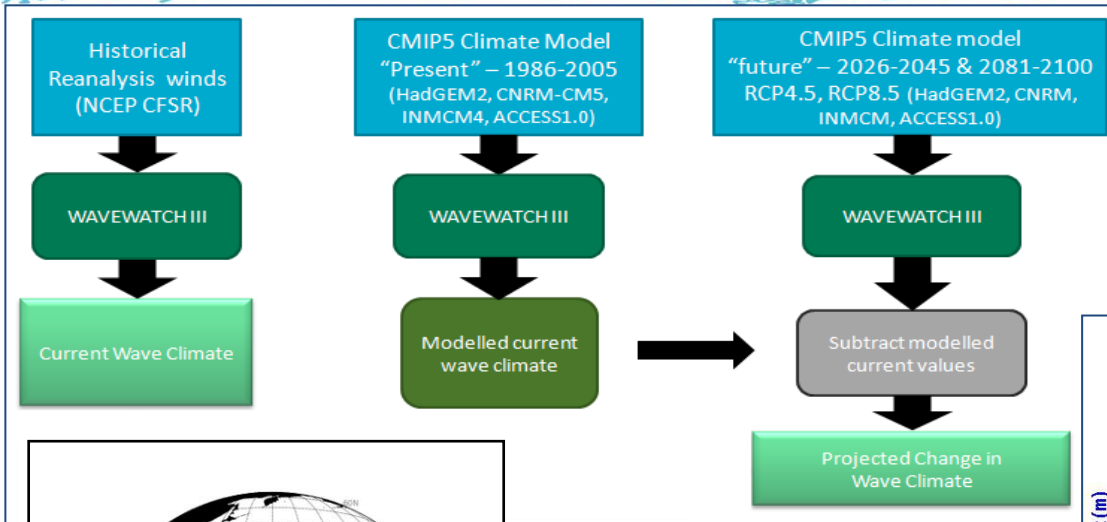
Technical Report – observed & projected extremes



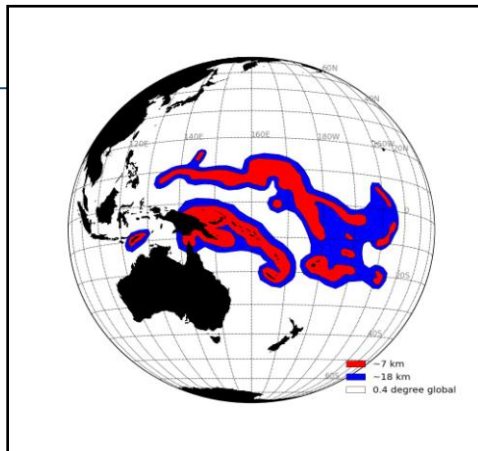
Projected percentage change in cyclone frequency in the south-east basin for 22 CMIP5 climate models, based on five methods, for 2080–2099 relative to 1980–1999 for RCP8.5



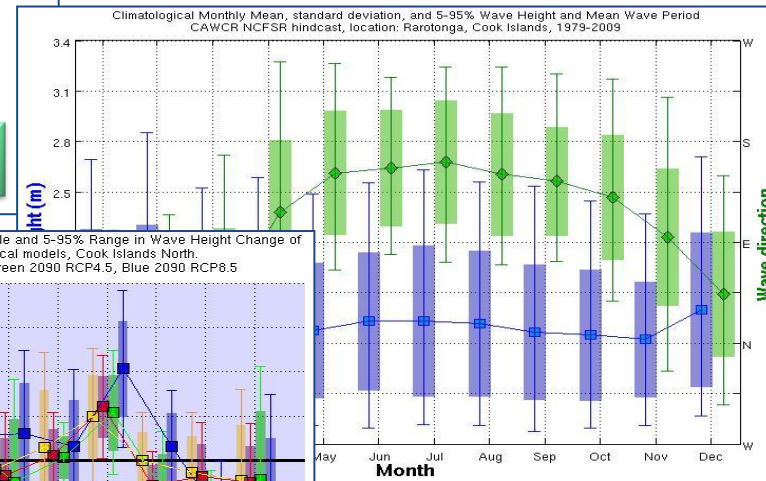
Technical Report – observed & projected wave climate



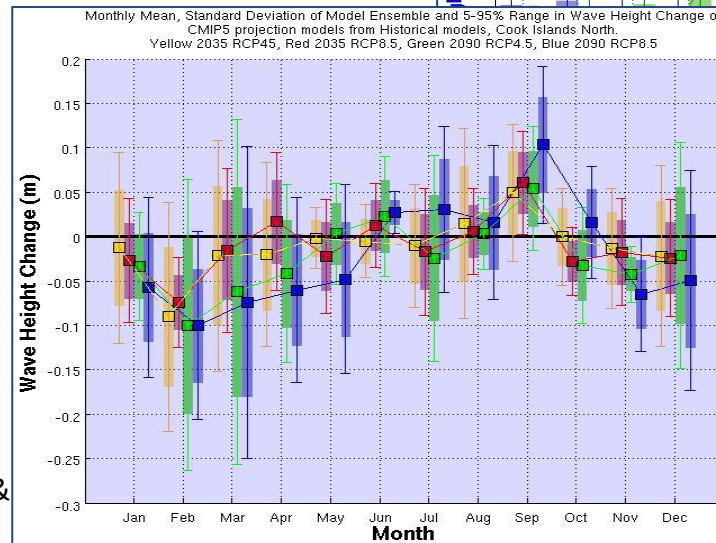
Wave climate description in the historical-current context is developed from a hindcast made by forcing a wave model with reanalysis winds (left), while projected changes are made by forcing the wave model with CMIP5 model winds and looking at the change in wave properties between historical and future time slices (right).



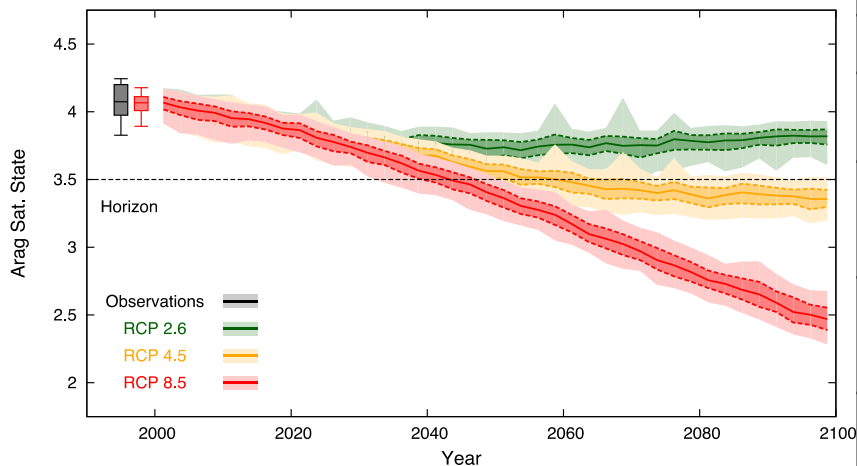
Region of validated high-resolution 30-year wave hindcast, showing a global 0.4 degree grid, with a series of nested grids of 10 and 4 arcminutes (~18 & 7 km respectively) in the western tropical Pacific.



Mean annual cycle of wave height (blue) and mean wave direction (green) at Rarotonga in hindcast data.



Technical Report – Ocean acidification & coral bleaching



Projected decreases in aragonite saturation state in the Cook Islands from CMIP5 models under RCP2.6 (very low emissions), 4.5 and 8.5.

Temperature change ¹	Recurrence interval ²	Duration of the risk event ³
No change - Observations	-	-
+0.25°C	30 years	4 weeks
+0.5 °C	28.2 years (27.4 years – 29.9 years)	4.7 weeks (4.5 weeks – 4.9 months)
+0.75 °C	6.6 years (1.6 years – 14.4 years)	6.7 weeks (3.3 weeks – 9.8 months)
+1 °C	2.7 years (5.2 months – 7.5 years)	10.6 weeks (2.5 weeks – 3.8 months)
+1.5 °C	10.9 months (2.1months – 2.7 years)	3.6 months (2.9 weeks – 6.3 months)
+2 °C	6.5 months(1.8 months – 1.4 years)	6.0 months (6.1 weeks - 8.2 months)

Projected changes in severe coral bleaching risk for the Northern Cook Islands EEZ for increases in SST relative to 1982–1999.

New science/new products

- Climate Change in the Pacific: A Regional Summary of New Science and Management Tools (CSIRO, BoM & SPREP, in prep)
 - Plain language report:... “telling the story of the science”...
 - Targeted at non-technical audience in the Pacific, incl:
 - Sectoral policy makers, planners & associated decision-makers
 - National/sub-national to community level
 - Regional context but with PIC perspectives:
 - Understanding changing climate in the Pacific
 - About the science – climate data, modelling, projections & RCPs, uncertainty, confidence, downscaling
 - Large-scale climate features
 - Temperature, rainfall, oceans, tropical cyclones
 - Climate science tools
 - On-line publication (<http://www.pacificclimatechangescience.org>)

Tools, Communication and Outreach Products

- Existing:

- Enhanced development of CliDE and data portals
- >35 peer reviewed journal papers incl. partner country co-authorships (+ PCCSP!!), IPCC AR5 (WG 1 & 2) reporting + misc. other reports and databases
- Animations:
 - *Climate Crab - regional*
 - *Cloud Nasara - Vanuatu*

- New:

- Pacific Climate Futures V2.0 (n.b. PVUDP)
- Technical Report:
 - New Science & updated Country Reports

- Pending:

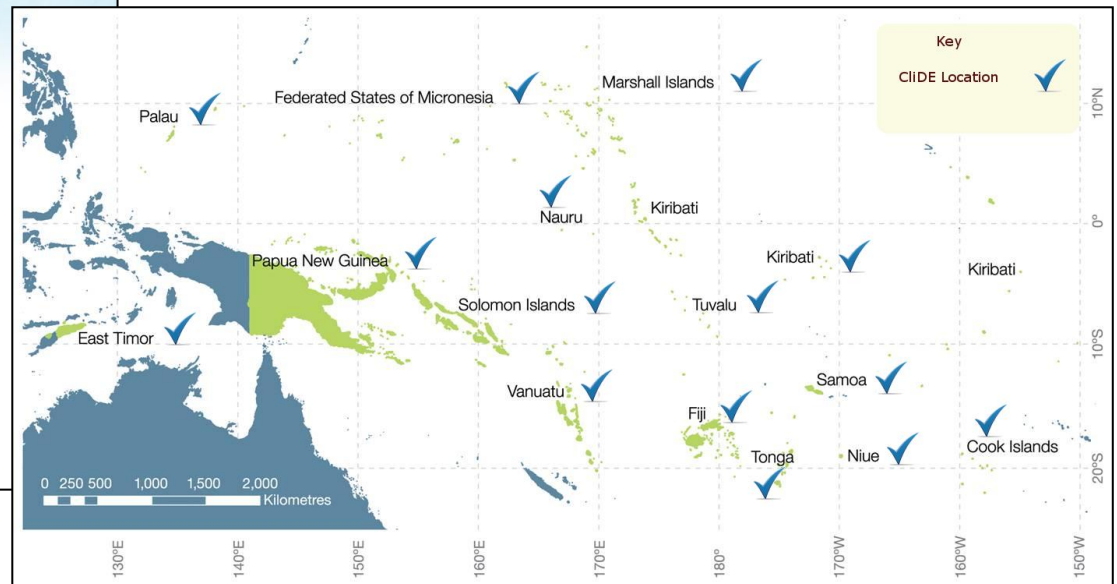
- Summary Report (for policy makers; non-Technical)
- Training materials, Fact Sheets & new country brochures (non-Technical)



CLiDE: Climate Data for the Environment



Martin et al (2014) *Meteorol. Appl.*
DOI: 10.1002/met.1461



- CLiDE is now installed and training provided to met services in 14 Pacific Island Countries plus East Timor
 - now used operationally for data storage and management
 - Visualisation/applications (CLEWS) through CLiDEsc (NIWA).

Data rescue & digitisation

Table 1 - Number of daily records key-entered during this project (to 31 May 2013)

Type	Country	Stations	Work Estimate	Work Done	% Done
daily	Cook Islands	6	27466	7574	28
daily	Kiribati	5	57518	19898	35
daily	Niue	7	19710	4982	25
daily	PNG	158	400040	287454	72
daily	Solomon Islands	7	39777	31503	79
daily	Timor-Leste	15	342370	82711	24
daily	Tonga	6	30052	9720	32
daily	Vanuatu	8	25915	25915	100
daily	Samoa	64	294555	389961	132
subdaily	Niue	3	19710	6218	32
subdaily	PNG	5	400040	25490	6
subdaily	Solomon Islands	7	30660	41353	135
subdaily	Timor-Leste	6	342370	26026	8
subdaily	Tonga	5	11862	11862	100
subdaily	Vanuatu	8	25915	25915	100
subdaily	Samoa	52	294555	142954	49

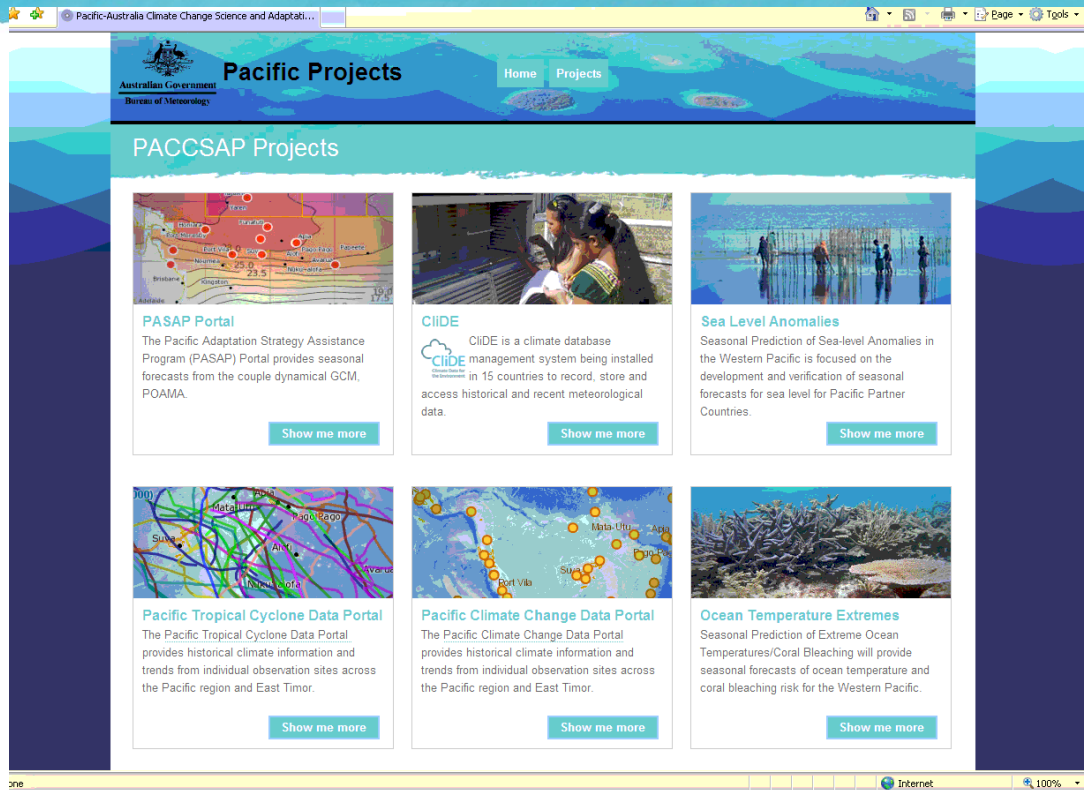


Table 2 - Partner PIC trainees in digitising data into CiIDE in this project

Country	Male	Female	Total
Cook Islands	1	3	4
East Timor	2	4	6
Kiribati	2	4	6
Niue	1	4	5
PNG	2	4	6
Samoa	1	3	4
Solomon Islands	4	3	7
Tonga	2	4	6
Vanuatu	3	3	6
Total	18	32	50



Climate data, tropical cyclone data and seasonal prediction of climate extremes portals



- Climate Data
- Seasonal prediction Portals
- Tropical cyclones

<http://www.bom.gov.au/climate/pacific/projects.shtml>

- Important scientific and technological results have been obtained, particularly in the development of web-based information tools to provide climate data and climatic extremes forecasts in the Pacific and the Australian regions.

Pacific Climate Futures V2.0



Australian

Causes of climate change

The Earth's climate has changed over the centuries and millennia due to a number of different factors (see Figure 9).

These include:

- Natural changes in the Earth's orbit which may occur over time scales of thousands of years
- Natural changes in the sun which affect the amount of incoming solar radiation
- Natural, large-scale volcanic eruptions which eject large amounts of ash into the atmosphere. The ash may remain in the atmosphere for several months or years reflecting sunlight back into space and resulting in a drop of mean global surface temperature
- Changes in atmospheric chemistry (such as the quantity of greenhouse gases) – both natural and caused by human activities. It is almost certain that most of the changes seen in the past century have been caused by human activities such as burning fossil fuels. We will now concentrate on these changes.

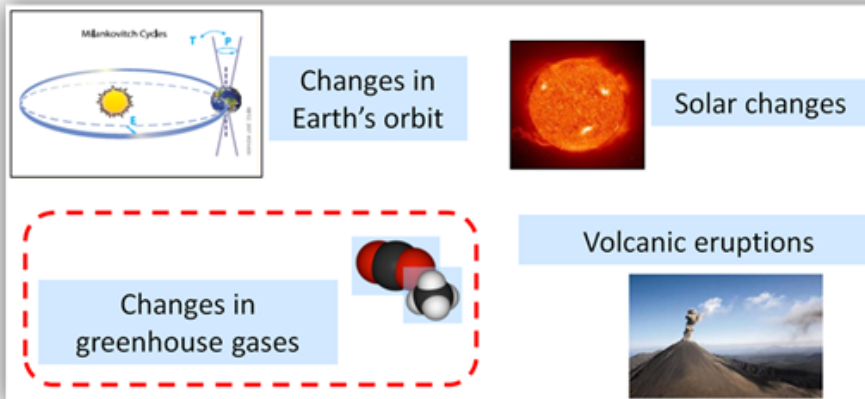


Figure 9: Factors that lead to changes in the Earth's climate.

Projections Builder: Results

These results were produced using the Pacific Climate Futures Projections Builder, based on the settings selected by the user. It is important to retain a record of those settings.

Representative Models

To identify the representative models, all models were ranked using a multivariate statistical technique (Kokic et al., 2002) to identify the model that is the best fit to the settings selected by the user for the Best and Worst cases.

In addition, where possible, the tool identifies the maximum consensus climate future (i.e. the climate future projected by at least 33% of the models and which comprises at least 10% more models than any other).

Case	Representative Model	Consensus
Best Case	CMIP3 - miroc3_2_hires	Very Low
Worst Case	CMIP3 - gfdl_cm2_1	Low
Maximum Consensus	CMIP3 - gfdl_cm2_0	Moderate

Table 1: Climate Futures description, consensus rating and representative model for each of the three cases: Best, Worst and Maximum Consensus.

	SURFACE TEMPERATURE	RAINFALL
	ANNUAL	ANNUAL
Best Case	3.23° C	-5.7%
Worst Case	2.46° C	31.3%
Maximum Consensus	2.46° C	2.1%

Table 2: Projected changes for each of the selected variables and seasons for the three cases described in Table 1.

USING THESE PROJECTIONS

In applying these projections to an impact assessment, the results for each case should be used separately, resulting in separate statements of impact for each case.

Important: The projected changes shown in Table 2 are the results from the corresponding climate model as described in Tables 1 and 2. They represent the projected 20-year average change, calculated over the region selected and are calculated relative to the historic reference period 1986 to 2005. The projected changes are influenced concurrently by the long-term climate trend and the decade variability as simulated by the relevant climate model.

Use of these results is subject to the Pacific Climate Futures Terms of Use, as updated from time-to-time, which can be viewed at the website <http://pacificclimatefutures.net>.

A detailed description of the Climate Futures method can be found in Whetton et al. 2012. The use of the method in an impact assessment is described in detail in Clarke et al. 2011.

REFERENCES

Clarke JM, Whetton PH, Hennessy KJ (2011) 'Providing Application-specific Climate Projections Datasets: CSIRO's Climate Futures Framework.' Peer-reviewed conference paper. In F Chan, D Marinova and RS Anderssen (eds.) MODSIM2011, 19th International Congress on Modelling and Simulation. Perth, Western Australia. December 2011 pp. 2683-2690. ISBN: 2978-2680-9872143-9872141-9872147. (Modelling and Simulation Society of Australia and New Zealand). <http://www.mssanz.org.au/modsim2011/F5/clarke.pdf>.

Kokic P, Breckling J, Lübke O (2002) 'A new definition of multivariate M-quantiles.' In Statistical Data Analysis Based on the L1-Norm and Related Methods. (Y Dodge ed.) pp. 15-24. (Birkhäuser Verlag: Basel).

Whetton P, Hennessy K, Clarke J, McInnes K, Kent D (2012) 'Use of Representative Climate Futures in impact and adaptation assessment.' Climatic Change 115, 433-442. 10.1007/s10584-012-0471-z.

Project

This section is studying. 1

For example increases

4. Best

Based on best (or le

Small Inc

Decrease

5. Worst

Based on worst case

Large Inc

Increase

3.

To



Pacific Climate Futures V2.0

Palau Climate Futures

EXPERIMENT

A1B - medium emissions

A1B - medium emissions

A1B - medium emissions

[add another](#)

TIME PERIOD

2030

2055

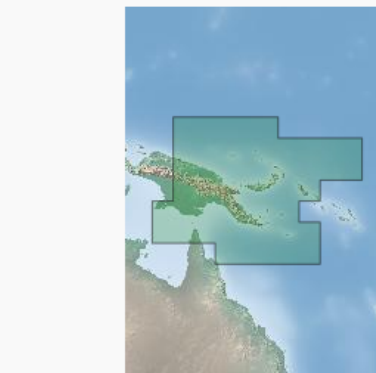
2090

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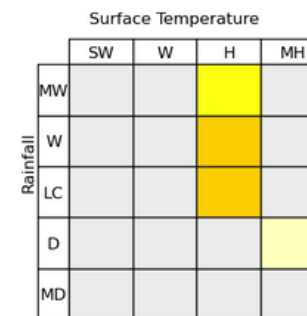
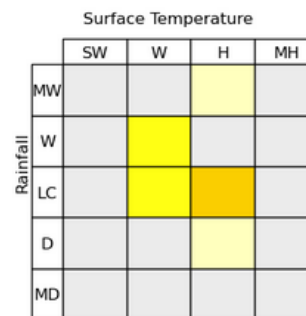
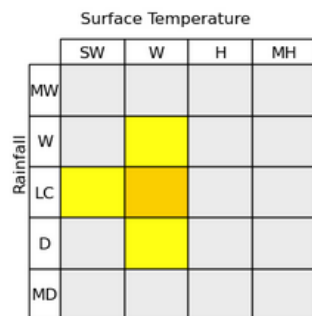
Refresh



2030 A1B - medium emissions

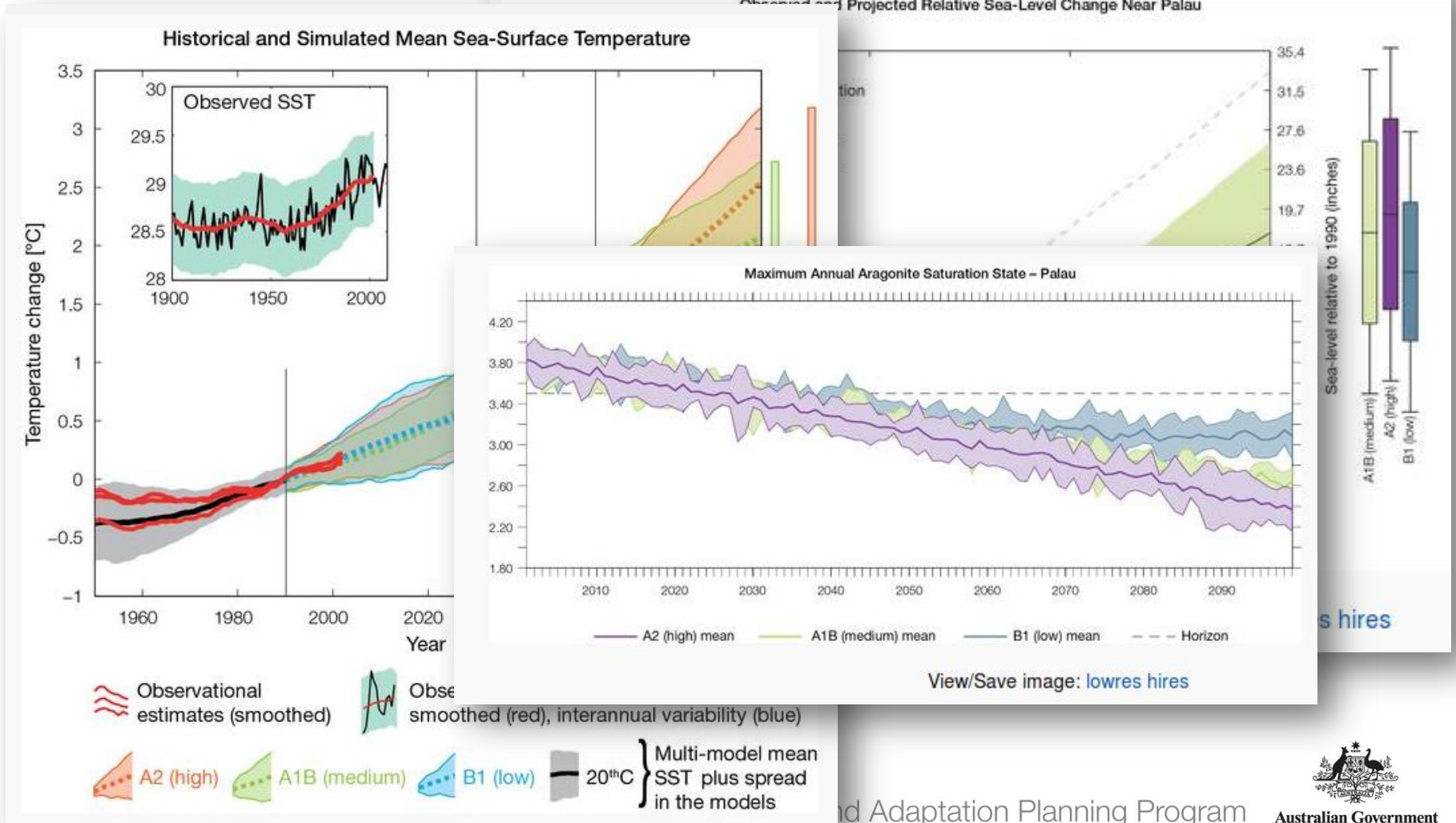
2055 A1B - medium emissions

2090 A1B - medium emissions



Pacific Climate Futures V2.0

- Marine Projections



New products – Pacific Climate Futures V2.0

What's new:

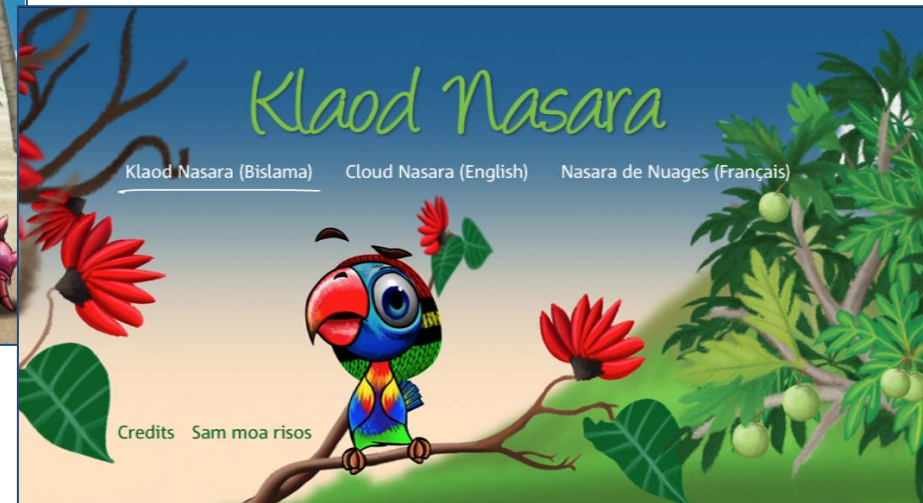
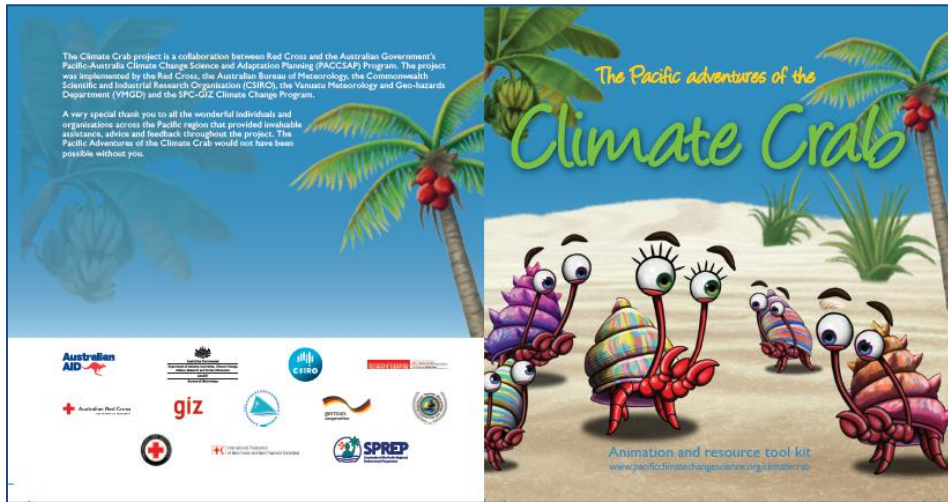
- CMIP5 Data
- Downscaled data for all countries (50km resolution)
- Online training: access to Projections Builder (Intermediate capability)
- Projections Builder: guided generation of internally consistent projections data (Best, Worst and Max. Consensus cases) tailored to suit non-complex impact assessments
- Compare Projection module: contextualise results from multiple sources (e.g. Downscaling, CMIP3, CMIP5); display changes over time
- Online access to pre-calculated, high quality sea level, SST and ocean acidification data
- Outputs applied to observed data sets (CliDE/portal) to generate application-ready climate change data (Advanced capability)



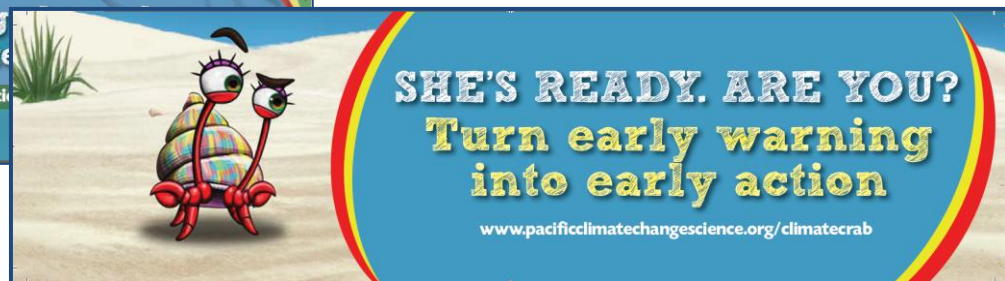
www.pacificclimatechangescience.org
www.pacificclimatefutures.net

Climate animations

- Climate Crab (regional) & Klaod Nasara

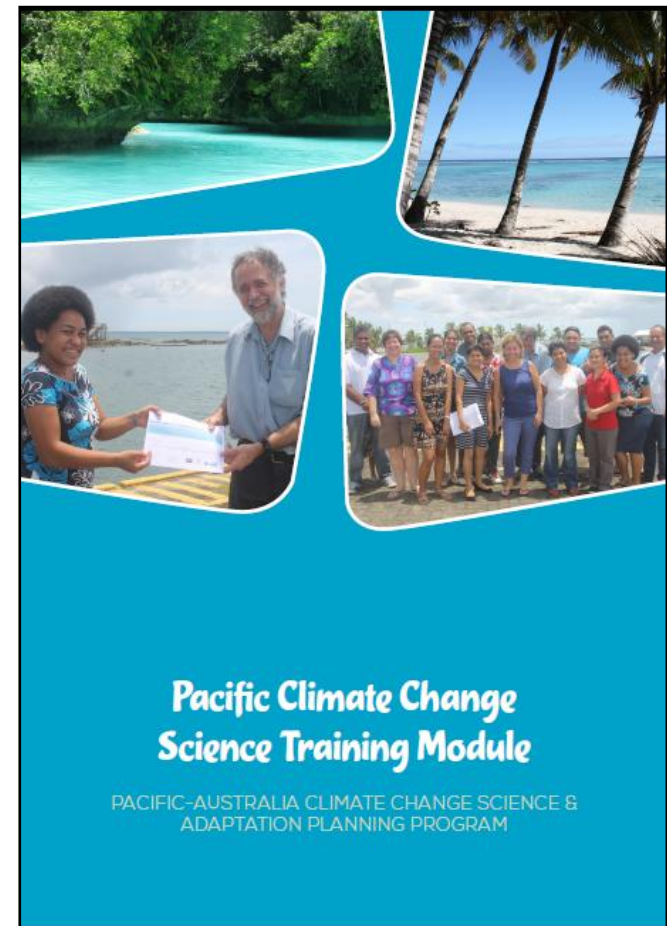


- Resource kits



New science/new products

- Climate science-based training module & associated materials, including documented 'manual' & ppt presentations:
 - Country specific presentations (14 x PICs + Timor-Leste)
 - Tailored for NMSs
 - Regional Pacific current/future climate
 - Understanding climate projections
 - Understanding climate variability and change
 - Tailored for more general use
 - ppt presentation templates to facilitate 'small group' discussions
 - Tailored for more general use



Fact Sheets

Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP)

Climate variability and climate change in the western tropical Pacific

Each region of the world has its own unique climate, which is the typical weather the region experiences. Natural cycles cause variations in the climate on timescales of months, seasons and years. Climate change occurs over much longer timescales as a result of natural processes and human activities.

What is the difference between weather and climate?

Weather refers to atmospheric conditions such as temperature and rainfall over a short period of time (a few hours or a few days).

Climate is the average pattern of weather for a particular place over a long period of time, usually at least 30 years. The natural variation in climate that typically occurs from month to month, season to season, year to year and decade to decade is referred to as **climate variability**.

Climate change refers to the long-term changes in the climate that occur over decades, centuries or longer. Climate change is both a natural and a man-made phenomenon. This can mean a long-term change in average climate conditions (such as rainfall and temperature) and/or a change in extreme weather events (such as tropical cyclones and droughts). On a global scale, temperatures are rising, and long-term weather patterns are changing.

Anthropogenic (man-made) climate change is caused by rising greenhouse gas levels in the Earth's atmosphere due mostly to burning fossil fuels (such as coal, oil and natural gas). Natural climate change is usually much slower and driven by changes in the sun or volcanic eruptions.

How do climate variability and climate change relate?

The annual cycle of wet and dry seasons is one example of natural climate variability experienced by every region in the western tropical Pacific. This cycle varies in timing and intensity between years. Much of year-to-year climate variability is caused by natural variations in the conditions of the atmosphere and ocean.

The most dramatic cause of climate variability in the western tropical Pacific is the El Niño Southern Oscillation (ENSO).

The two extremes of ENSO are El Niño and La Niña. El Niño tends to bring weaker trade winds and warmer ocean conditions near the equator across much of the Pacific, whereas La Niña tends to bring stronger trade winds and cooler ocean conditions. Pacific island countries can experience very wet or very dry conditions depending on their location in years when El Niño and La Niña occur, as well as cooler or warmer than normal temperatures. ENSO also affects climate variability in the Pacific through its influence on one large-scale climate process, including the South Pacific Convergence Zone and the Western Pacific Monsoon.

Over a long period of time (decades or even centuries) the climate changes, however human activities are causing much faster climate change than the slower natural causes. Temperatures are increasing in the Pacific, resulting in more hot temperature extremes, more droughts, and less snow. There is some evidence that extreme natural events are occurring more frequently.

Natural climate variability such as ENSO continues to occur as climate change slowly increases. This means that droughts and floods due to El Niño and La Niña still occur due to natural climate variability.

Extreme El Niño rainfall and associated flooding events in Vanuatu in May 2008 (left) and Meteorological Observatory Heard and Hull, FIJ, in January 2012 (bottom, right)



Extreme El Niño rainfall and associated flooding events in Vanuatu in May 2008 (left) and Meteorological Observatory Heard and Hull, FIJ, in January 2012 (bottom, right)

variability, but some naturally due to climate

Building resilience means making more sustainable

Managing climate change is a significant local commitment in the western tropical Pacific. Adaptation to enhance the resilience of vulnerable communities or potential climate

The timely provision of understanding and ocean mapping will and assist adopt essential

essential equipment sustainable development

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Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP)

Climate extremes in the western tropical Pacific

Countries in the western tropical Pacific are particularly vulnerable to impacts from extremes in temperature, rainfall and sea-level rise, as well as tropical cyclones.

What are climate extremes?

Climate extremes are short-term weather or long-term climate events that are rare or uncommon in occurrence, and often exceptionally severe in impact. Extreme events resulting from natural variability in large-scale climate processes, from season to season and year to year, can include massive fires and damage to infrastructure, industry and environmental assets, and can impact on the health, safety and overall wellbeing of local communities.

These large-scale processes include the El Niño Southern Oscillation (ENSO), the South Pacific Convergence Zone (SPCZ), the West Pacific Monsoon (WPM) and the Interdecadal Convergence Zone (ITCZ).

Long-term variability and climate change compound these impacts, particularly in terms of increased vulnerability to natural, climate-related disasters.

What has happened in the past?

Temperature: There have been more frequent hot days and warm nights, and fewer cool days and cool nights, as average temperatures have increased significantly over the last 50 years.

Rainfall: Rainfall extremes are primarily influenced by year-to-year and decade-to-decade variability associated with ENSO and the intensity/location of other major climate features such as the SPCZ, ITCZ, and WPM. As an example, La Niña events in recent years have been associated with severe drought in Tuvalu and floods in Fiji.

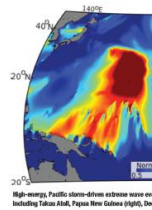
Tropical cyclones: On average, nine tropical cyclones occur in the western Pacific region between November and April each year, mostly between January and March. The greatest numbers of cyclones occur in the Vanuatu-New Caledonia region. The frequency and intensity of cyclones varies significantly from year to year, largely due to ENSO.

Sea level: Natural sea level changes due to tides, weather and climate variability can be quite large at any one time compared to sea-level rise as a result of climate change alone. Climate change causes changes in sea level at a global scale, primarily due to thermal expansion of water as the oceans warm, and melting of glaciers, ice caps and ice sheets on land with increased run-off to the sea.

What might happen in the future?

Temperature: Scientists are very confident that the intensity and frequency of extreme heat will continue to increase for the rest of the 21st century. Events that are considered a heat wave in the current climate are projected to become longer, but the exact range of extreme heat temperatures is still uncertain.

Rainfall: Almost all Pacific island countries are projected to get more rainfall and fewer droughts, with some showing little change, with some showing the intensity of extreme rainfall days after for each



High-intensity, Pacific storm-driven extreme waves event (left) of including Tokelau Atoll, Papua New Guinea (right), December 2007

Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP)

Ocean acidification in the western tropical Pacific

The changing seawater chemistry of the Pacific in response to increasing carbon dioxide in the atmosphere entering the ocean poses a significant threat to long-term viability of coral reefs and associated marine ecosystems, and to coastal communities that rely on them for their livelihood and wellbeing.

What is ocean acidification?

Ocean acidification is a change in ocean chemistry that occurs when atmospheric carbon dioxide is taken up by the ocean, thereby increasing pH. Carbon dioxide is a weak acid, so when it enters the ocean it reacts with seawater, increasing acidity. Oceans absorb about 20% of the carbon dioxide that is emitted into the atmosphere annually. As more carbon dioxide enters the atmosphere, more carbon dioxide is dissolved in the ocean. This process plays a key role in reducing the rate of global warming and therefore climate change, but it also changes the chemistry of the oceans. Carbonic acid is one form in which carbon is stored in the ocean, and is a critical requirement for coral growth.

Increased acidity will result in less carbonate ion availability in the ocean to support coral growth. This poses a significant threat to the diversity, productivity and overall health of vulnerable, high-value aquatic ecosystems, including coral reef structures and associated fisheries, aquatic resources and marine biodiversity.



Divers and diversions fish and coral reef communities in Tuvalu

Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP)

Large-scale climate features in the western tropical Pacific

The Pacific Ocean covers almost precisely one-third of the Earth's surface and is home to many small island nations dotted throughout its vast expanse.

What are the large-scale climate features that drive the climate of the western tropical Pacific?

- **Carbon cycle:** Carbon dioxide (CO₂) is a greenhouse gas that traps heat in the atmosphere, contributing to global warming and climate change. The major large-scale climate features of the western tropical Pacific are the El Niño Southern Oscillation (ENSO), the South Pacific Convergence Zone (SPCZ), the Interdecadal Convergence Zone (ITCZ), and the West Pacific Monsoon (WPM) (Fig. 1). These features affect the region's pattern and seasonal cycle in rainfall, tropical cyclone activity, ocean currents, tides, and many other aspects of the climate and the environment in general.

El Niño Southern Oscillation

The El Niño Southern Oscillation is the major influence on climate variability in the western tropical Pacific. It particularly affects the year-to-year risk of droughts, extreme rainfall and floods, tropical cyclone events sea levels, and coral bleaching. During normal conditions, when ENSO is in its "neutral" phase, the equatorial trade winds push warm water mostly occur at

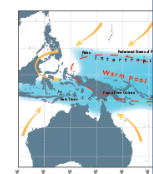


Figure 1: Average positions of the SPCZ features in the western tropical Pacific, winds; blue shading, bands of rainfall; red H, typical position of moving high

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Sea-level rise in the western tropical Pacific

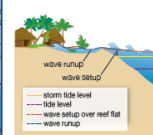
Sea level is affected by tides, weather and natural climate variability as well as climate change. A small amount of overall, long-term sea-level rise due to climate change will compound the effects of natural variability and cause extreme sea levels to happen more often.

What factors affect sea level?

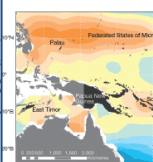
Sea levels change daily, monthly and annually due to a combination of tides, weather and climate variability. The most familiar change in sea level is from daily tidal fluctuations caused by the gravitational pull of the sun and

the moon on the Earth. Over the course of any year, unusually large (king) tides can occur, but all tides are natural and generally periodic and predictable events.

Weather and climate variability also affect sea level, particularly under extreme conditions. For example, storm surge caused by tropical cyclones



Sea levels can change due to tides, winds, storms and climate features such as the El Niño Southern Oscillation (ENSO)



The regional distribution of sea-level rise for the period from January 1993 to December 2009. (Australian Bureau of Meteorology and CSIRO, 2011) Climate Change in the Pacific: Scientific Assessment and New Research

As oceans warm, the water expands causing an increase in sea levels. This thermal expansion is very small but the average depth of most oceans is 3600 m, meaning that even a little expansion has an important influence on sea-level rise.

Over the past century, warmer atmospheric temperatures have caused most glaciers, ice caps and ice sheets on land to melt at an accelerating rate. This increased run-off to the sea has contributed to sea-level rise (note that melting of sea-ice does not cause sea-level rise).

In many locations, including the Pacific, natural sea-level changes due to tides, weather and climate variability can be quite large at any one time compared to sea-level rise through climate change alone. A small amount of overall, long-



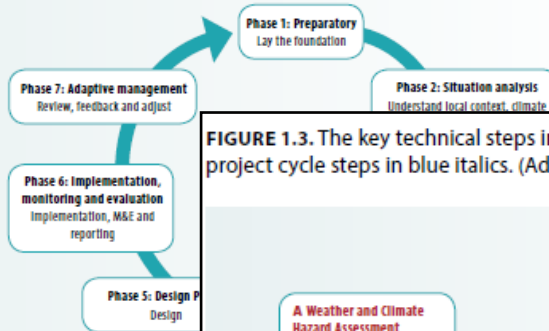
Australian Government

Fact Sheets (<http://www.pacificclimatechangescience.org>):

- Climate variability & change
- Large-scale climate processes
- Climate extremes
- Sea-level rise
- Ocean acidification

Climate Science-based Evidence informing Decision-Making

FIGURE 1.2. The standard seven-phase policy/project decision-making cycle.



Mainstreaming Climate Change Adaptation in the Pacific: a Practical Guide.....PACC (2014)

FIGURE 1.3. The key technical steps in climate risk management in red, with corresponding policy/project cycle steps in blue italics. (Adapted from Mechler (2005).)

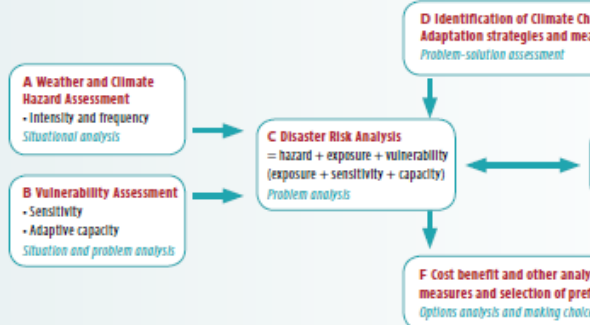
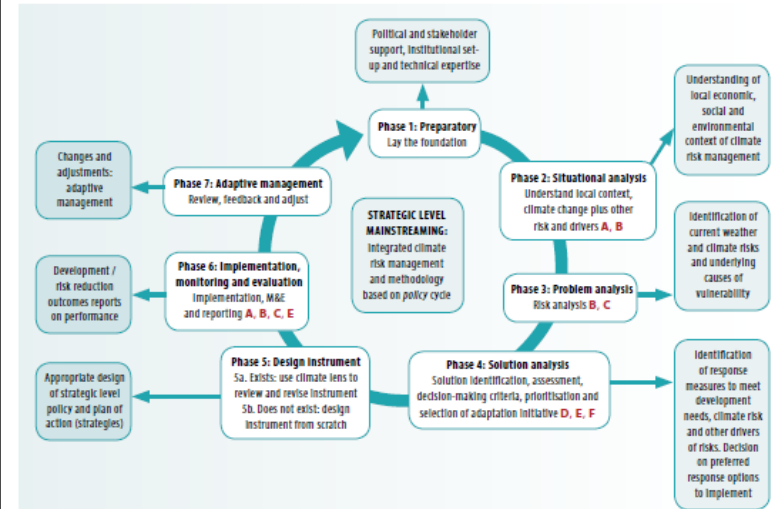


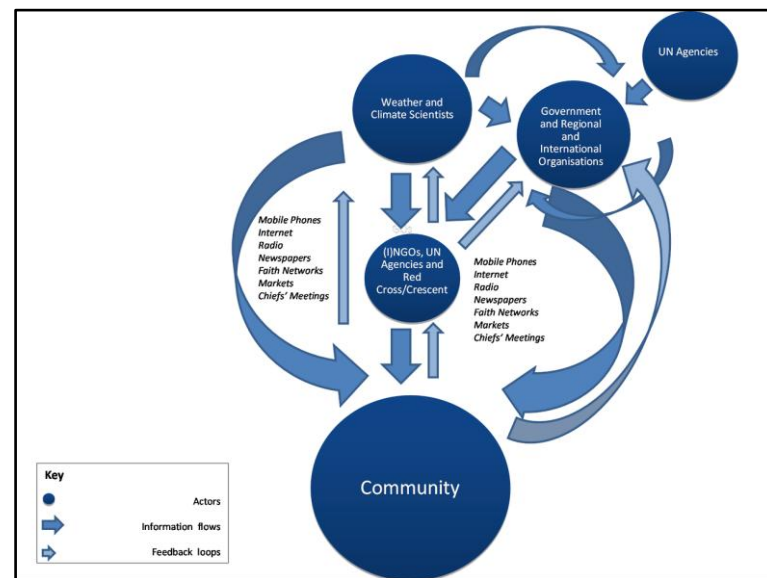
FIGURE 1.4. Strategic level climate risk mainstreaming methodology based on a combined CRM and policy cycle: key phases, and respective decisions and outputs.



Understanding past and current climate observations and trends, and future climate change scenarios is central to analysing climate risks, including hazard identification and vulnerability/impact assessment for CCA and DRM purposes

PACCSAP Climate Data & Information Management

- Obstacles to use of science-based evidence for CCA and DRM decision-making by end-users (modified from draft HFP 'Science Humanitarian Dialogue 2014'):
 - Discoverability
 - Access & opportunity
 - Understanding
 - Relevance and Useability
 - Credibility and legitimacy
 - Resource limitations
 - Decision Support Systems ???
- PACCSAP Climate Data & Information Strategy
 - Climate data/metadata & info: inventory, curation & archiving (incl. fit-for-purpose QAQC standards, cataloguing, repositories & accessibility controls)
 - PACCSAP legacy and sustainability of outcomes
- Pacific iCLIM
 - Regional approach to Pacific climate data and information management
 - Griffith U and SPREP (Australian Govt funded)
 - Pacific Climate Change Portal – secure/stable regional climate data & information hub



The future



- PACCSAP Science Program finishes in 2014
 - New strategic benchmark in fundamental climate science for the western tropical Pacific (n.b. alignment with IPCC AR5)
 - Evaluation & final reporting: leverage off new knowledge, capacity & key learnings
- Strategic considerations:
 - Manage/action existing knowledge: turning outputs into outcomes = impact = compelling case for reinvestment!!
 - Plan for sustainable resilient development: mainstreaming climate adaptation & DRM:
 - Role of climate science/outreach to inform/facilitate evidence-based decision-making?
 - *GFCS innovation pathway: Today's climate science is tomorrow's climate service!*
 - Support in-country capacity development
 - *Coordination, collaboration, partnerships – manage relationships*
 - What are the new and emerging regional/inter-regional needs:
 - tailored/application-ready, multiple sectors, multiple risks, multiple time-frame, finer spatial scale, seamlessly interfaced to DSS!?!??

Thank you

For further information

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Australian Government

Department of the Environment



Australian Government

Bureau of Meteorology



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