Proposal for a geospatial framework for climate change adaptation in the coastal zone of Mangaia Island, Cook Islands

07 October 2010

prepared for:

Secretariat of the Pacific Regional Environment Programme

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Contents

1 Introduction

1.1 Outline of this proposal

This proposal has been prepared by the Ocean and Islands Programme (OIP) within the Pacific Islands Applied Geoscience Commission (SOPAC) in collaboration with the National Institute of Water and Atmospheric Research (NIWA). It has been prepared in response to an invitation[1] from the Secretariat of the Pacific Regional Environment Programme (SPREP) to assist the Cook Islands in deriving coastal related information to underpin and inform climate change adaptation decisions for coastal areas of Mangaia Island.

The combination of OIP and NIWA provides a team with unrivalled experience in the technical requirements of all aspects of the project, and extensive experience in conducting similar work in the Cook Islands and other Pacific Islands. Specifically, this team can bring:

- SOPAC's extensive experience in geophysical, geological, hydrographic, oceanographic, environmental and coastal survey work throughout the Pacific region.

- NIWA's wide experience of extreme wave and water level modelling and assessment of climate change impacts on coastal processes, and the development of user-friendly tools for risk and adaptation decisions for Pacific Island decision-makers.

Furthermore, the team can deliver a scalable outcome that provides "climate proofing" information and tools that enable the Cook Island Ministry of Infrastructure and Planning to carry out their own future assessment, not only in Mangaia, but to underpin coastal-related adaptation decisions in all other islands of the Cook Islands.

1.2 An overview of this proposal

This proposal details how SOPAC and NIWA intend to conduct the study to fully meet the needs and requirements specified within the project brief. This proposal presents:

[1] http://www.sprep.org/tender/tender_detail.asp?id=882, accessed 22 September 2010

- Our proposed methodology for fulfilling the requirements of the study (Section 2)
- The Project Team assembled to deliver the project, project timelines and associated schedule of fees (Section 3)
- SOPAC and NIWA's capability and professional expertise relevant to the study, details of our project management systems and procedures to ensure that our services are delivered on time, and to the required standards to each client, and our terms and conditions relating to this proposal (Section 4).

Appendices contain further details of our track record on projects of relevance to this study and detailed CV's for each of the proposed project team.

2 Delivering a geospatial framework to underpin climate change adaptation

2.1 Our understanding of the project requirements

Property and infrastructure located in the coastal margins of the Cook Islands are extremely vulnerable to the effects of climate change and sea-level rise. However, little specific work has been carried out to quantify the changes on hazard occurrence and magnitude and associated risk at island or community levels that may result due to different future climate change scenarios.

The overall purpose of the Cook Island demonstration study of the Pacific Adaptation to Climate Change Project (PACC) is to:

- Develop baseline information necessary to support a risk-based approach to climate change adaptation in the coastal zone of Mangaia Island.
- Assess how climate change and sea-level rise will impact on the frequency, magnitude and extent of coastal-related inundation along the village / harbour and airport shorelines of Mangaia Island.
- Provide a sound, objective and evidence-based framework for developing climate change adaptation strategies for Mangaia.
- Demonstrate an approach that is scalable and can be transferred and applied to other coastal areas in the Cook Islands (or indeed other Pacific Islands).

2.2 Understanding inundation processes on Mangaia to inform field and modelling work

Most coastal-related inundation tends to be episodic. In the Cook Islands, such events tend to occur during either cyclone conditions or during periods with large swell. However, the severity of inundation and damage during such wave events is related to their coincidence with higher sea levels (e.g. whether the largest cyclone waves coincide with high or low tide, Spring or Neap tide, etc.).

Understanding extreme water levels and wave conditions, how likely they are to occur together, and how these two parameters influence wave set-up, wave run-up, overtopping and overwashing pathways is fundamental in understanding and assessing inundation of land areas in the Cook Islands, and how this may change with sea-level rise and other climate change effects (such as changes in intensity and frequency of cyclone conditions).

Extreme water levels experienced at the shoreline on Mangaia (and any other ocean shoreline in the Cook Islands fronted by a fringing reef) comprise of a number of components (Figure 1):

- The ***astronomical tide.***

- The ***mean level of the sea*** (MLOS) – upon which the tide oscillates. MLOS varies due for example to seasonal effects, such as El Niño Southern Oscillation (ENSO), and, in the longer-term, is rising due to climate change induced sea-level rise.

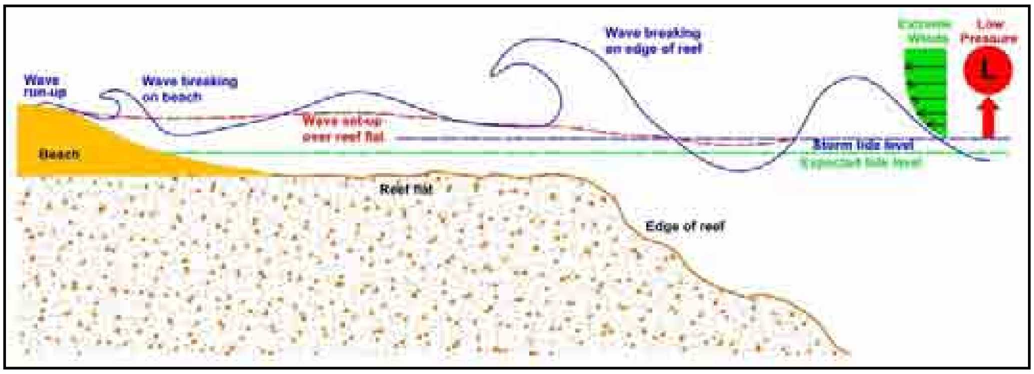

Figure 1: Basic components of water level over a fringing reef.

- ***Storm surge*** - the increase in regional sea level (excluding the effects of waves) due to low barometric pressure (e.g. during cyclone events) and set-up due to winds blowing onshore (in deep water offshore this will be minimal).

- ***Wave set-up***, the increase in sea level over the reef flat due to waves breaking on the seaward edge of the reef. In many cases (e.g. during periods of large swell) this can have a much larger influence on sea levels at the shoreline than storm surge. Wave set-up can vary considerably over short timescales (4-5 minutes) due to the influence of ***wave grouping.***

In terms of extreme wave conditions, inundation events tend to be linked to either:

- ***Cyclones***, particularly cyclone events that track in a south-easterly direction to the west of Mangaia.

- Distantly generated ***swell*** waves. Long-period swell conditions often cause the most significant occurrences of inundation in the Pacific. For example the occurrence of long period swells from storm conditions south of the equator which are known to propagate north, can cause significant damage to south facing coastlines in the southern Pacific Islands, including the Cook Islands.

In developing a risk-based approach to assessing coastal inundation, and how inundation risk may change due to climate change, understanding the interactions between extreme water levels and wave conditions is important:

- In deep water, understanding how often large wave events will occur at the same time as high water levels (storm tides). During cyclone events, high waves and high storm surges are likely to occur together, but a particular event may not coincide with a high spring tide or a period when ENSO has increased mean level of the sea.

- The deep water wave/water level combination determines how much wave set-up occurs over the fringing reef (which is very sensitive to water depth over the reef).

- In turn, the wave set-up level determines the size of the waves that reach the shoreline (and hence, the magnitude of wave run-up, overtopping and inundation).

The shoreline of Mangaia Island is characterised by a raised fossil reef. The old spur and groove zone of the raised reef edge is well defined along the village frontage, less so along the airport coast which is in the form of a low cliff. Inundation pathways along the village frontage will tend to occur through wave run-up through the old grooves in the reef. Along the airport frontage direct wave impact on, and overtopping of, the low vertical raised reef will be the main inundation process.

The interactions between waves and water levels over fringing reef environments and how they interact with the shoreline morphology on Mangaia are too complex for normal hydrodynamic modelling approaches (e.g. use of models such as MIKE 21 for storm surge, SWAN for wave conditions) as they either do not simulate the coastal processes occurring over fringing reef environments or cannot accommodate the water level-wave interactions and feedbacks.

The risk-based approach outlined in the following sections takes account of the complex nature of episodic coastal inundation on fringing reef environments and is based on an approach successfully adopted to provide "climate proofed" design conditions (wave, water-levels, run-up and overtopping) for coastal infrastructure in Kiribati as part of the Kiribati Adaptation Project.

2.3 Baseline data to underpin inundation modelling

How well the modelling approach can represent reality, largely depends on accurate boundary conditions (e.g. tropical cyclone induced waves – discussed in next section), a seamless terrain model referenced to a common datum, and the availability of calibration data.

This proposal therefore emphasises the importance of collecting robust scientific baseline data to underpin the numerical modelling efforts. Considerable resources will be allocated to the acquisition of field data as outlined in Figure 2. SOPAC is well placed to undertake all major components of this Project as it maintains and operates a suite of survey-grade instruments capable of obtaining the necessary data to build a suitable geospatial framework.

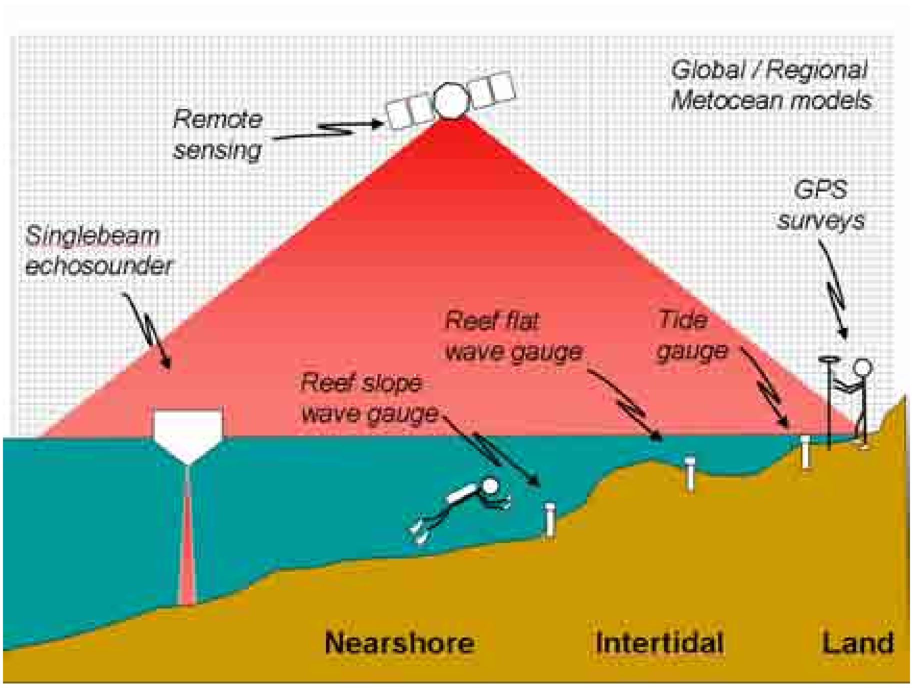

Figure 2: Proposed field data collection scheme. A suite of instruments and techniques will be used to provide baseline data for the nearshore inundation modelling.

The critical outputs required from the field component of the project for use in the modelling component outlined in Section 2.4 and 2.5 are:

- bathymetry of the reef slope down to 20 – 30 m water depth relative to datum

- Topography relative to datum to accurately represent reef crest / flat and beach / shoreline levels and any potential inundation pathways and low-lying areas in the coastal hinterlands of the village/harbour and airport areas.

- Wave and water level measurements on the reef slope seaward of the location of wave breaking and on the reef flat at the village and airport locations. This data is needed for: 1) calibrating the wave set-up and wave propagation model over the fringing reef, 2) deriving the key tidal constituents (needs 33 days of water level measurements) to construct the astronomical tide time series, and 3) relating the mean level of the sea back to the longer period of measurement from the SEAFRAME water level gauge at Rarotonga.

2.3.1 Proposed data collection workplan and description of methods

Bathymetry data will be collected using a shallow water (200 kHz) single beam transducer, which will be operated to International Hydrographic Organisation Order 1 requirements. Order 1 is recommended for coastal areas with depths up to 100 m, and stipulates horizontal and vertical depth-dependent accuracies of minimum 5 m and 0.5 m, respectively. Final accuracies will be determined by actual water depths and environmental conditions such as surface swells at the time of the survey. Survey lines will be run perpendicular to the shore to water depths of 30 m. The line spacing will be 100 m at positions that are seaward extensions of the land transects. The distance between depth points along transects will not exceed 5 m. The survey platform will be a boat of opportunity and will most likely be a local fishing dinghy from Mangaia Island.

Topography will be collected using survey grade GNSS equipment. Vertical and horizontal accuracies will be equal to or better than 0.5 m. Spot heights will be collected along shore perpendicular transects from the reef crest to a distance inland of approximately 300 m. Along-shore spacing of transects will be at intervals of 100 m. Additional spot heights and / or transects will be collected in areas that are identified as particularly vulnerable by the local expert knowledge. Spot heights along a transect will be collected every 10 m, or more frequently in areas of large topographic variation, e.g. uplifted and remnant spur and groove system at the shoreline.

Local expert knowledge and information on the community's experience of tropical cyclone impacts will form an important part of the proposed data collection. Community meetings and selected household surveys will be conducted to match human memory and oral history of the depth and extent of inundation against a historical database of tropical cyclones.[2]

Wave and tide data will be collected using submersible non-directional pressure sensor and digital loggers. In the case of the tide gauge, the logger will be referenced against benchmarks on land and deployed for a minimum of 33 days. This will provide the common datum and allow the stitching together of the nearshore bathymetry and intertidal and land topography. The wave data will be collected following standard oceanographic procedures and set to collect 2048 samples every three hours at 2 Hz. A total of four wave loggers will be deployed for a minimum of 14 days at:

- the reef slope seaward of Oneroa Village and the airport, and
- on the reef flat fronting the village and airport.

This will provide wave and water level calibration data for the shoreline conditions based on the empirical approach described in Section 2.4.4.

2.4 Assessing inundation drivers and the effects of climate change

2.4.1 Offshore wave climate and extremes

The assessment of the offshore wave climate will provide:

- Extreme swell wave conditions (from 2 to 100 year return periods) offshore of every island in the Cook Islands (including off the village and airport shorelines of Mangaia).
- Extreme cyclone wave conditions (from 2 to 100 year return periods) offshore of every island in the Cook Islands (including off the village and airport shorelines of Mangaia).
- Any other standard wave climate statistics that may be required offshore of any island in the Cook Islands.

[2] E.g. de Scally, F.A., Wood, G.V., Maguire, L.K., Fournier-Beck, M.-A., Silcocks, D., 2006. A history of tropical cyclones and their impacts in the Cook Islands.

To derive offshore (deep-water) wave climates off the village and airport coastlines of Mangaia we will make use of:

- A 45 year wave hindcast (1957-2002) simulation that NIWA has developed for the South Pacific as part of a New Zealand project to assess climate change effects on wave and storm surge climate around New Zealand. This will be used to derive the general wave climate and the extreme swell climates.

- A long-term simulation of cyclone tracks and characteristics and corresponding deep water cyclone wave conditions (and deep water storm surge – see next section). This, in conjunction with the modelling above, will be used to derive extreme wave height conditions.

Swell wave climate and extremes

The wave hindcast model is forced by wind and sea-surface pressure outputs from the ERA-40 reanalysed dataset from the European Centre for Medium- Range Weather forecasts at a resolution of 1.125 x 1.125 degree resolution in latitude / longitude. The 45 years of data provide a sufficient length of time to enable extreme swell conditions, as well as the influence of climate variability (such as ENSO) on the wave climate, to be assessed.

The SOPAC wave data collected off the southern coast of Rarotonga in the early 1990s[3] will be used to further calibrate the wave model conditions in the vicinity of the Cook Islands.

Given the coverage of the model, it is relatively straightforward to derive wave conditions from the model offshore of any island in the Cook Islands. In addition to the information for Mangaia, deepwater wave information will be derived for all other islands (e.g. off the North, East, South and West coasts of each). The deepwater wave climate, based on the closest hindcast location to each island, will be filtered to only include wave conditions from within an appropriate directional sector for the corresponding exposure of each section of each island's coastline.

Cyclone wave conditions

Unfortunately, in areas that experience cyclones, extreme wave-height conditions can not be directly calculated from the hindcast dataset due to the relatively coarse spatial

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[3] Barstow, S.F. and Haug, O., 1994a: The Wave Climate of the Cook Islands, SOPAC Tech. Report no. 200.

resolution of the model, and to do so would tend to under-predict extreme wave conditions.

NIWA holds a cyclone track dataset going back to 1940, although it is only since satellite tracking of such events commenced in 1970 that all the basic cyclone parameters are available. However, the duration of this dataset is too short to robustly derive cyclone wave return period conditions out to a 1:100 year return period. Rather this dataset will be used to calibrate a statistic model of cyclone track information linked to an empirical wave and deep-water storm surge model. This will enable a synthetic cyclone track / extreme wave height dataset to be developed which will be of sufficient length to robustly derive extreme wave return periods.

The synthetic cyclone wave conditions, in conjunction with the continuous record from the wave hindcast dataset, will be combined using a technique developed by NIWA to combine episodic and continuous datasets. Extreme offshore wave conditions up to a 1:100 year significant wave height will be determined for each island.

2.4.2 Storm tide levels

This component of the assessment will provide extreme offshore storm-tide water levels (up to 1:100 year return periods) at Mangaia accounting for:

- Astronomical tide based on a harmonic analysis of 33 days of water level measurements at Mangaia.

- Climate variability in mean level of the sea due to ENSO influences based on an analysis of the ~17 years of data from the SEAFRAME sea-level dataset from Rarotonga.

- Storm surge synthesis using inverse barometer effect and derived from the synthetic cyclone dataset discussed in the previous section.

Extreme deepwater storm tide levels off Mangaia will be derived using a new empirical technique[4] developed by NIWA to derive robust probabilistic estimates of extreme sea levels from short data records. The technique essentially involves:

[4] Goring, D. G.; Stephens, S. A.; Bell, R. G. ; Pearson, C. P. in press: Estimation of Extreme Sea Levels in a Tide-Dominated Environment using Short Data Records. Journal of Waterway, Port, Coastal and Ocean Engineering

- Deriving the constituent sea-level components (e.g., tide, mean level of the sea, storm surge) as outlined above.

- Using Monte Carlo simulation techniques, randomly re-combining the components to produce an annual series of sea levels at high tide from which an annual maxima is selected.

- Carrying out the simulation many thousands of times to generate a large dataset of annual maximums from which statistics of extreme sea level values can be robustly derived.

2.4.3 Joint probability of extreme wave and water levels

As damaging wave run-up, overtopping and inundation tend to occur at times when large waves *and* high sea levels coincide, understanding the likelihood of these parameters occurring together is important.

With a time series of both deep water extreme wave conditions and extreme water levels derived at Mangaia, joint probability techniques will be used to assess the correlation between extreme water levels and extreme wave and swell conditions. An example of a joint probability is shown in Figure 3.

This assessment would produce a joint probability table of extreme sea level and extreme wave combinations for return periods between 2 and 100 years offshore at the village and airport locations in Mangaia.

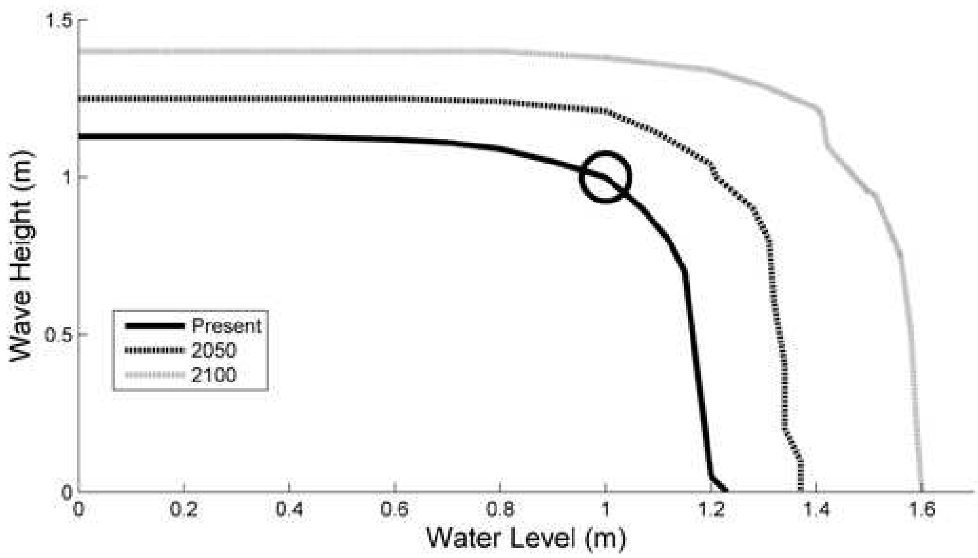


Figure 3: Example of a joint probability contour. Each combination of wave and water level on the contour has the same return period or likelihood of occurring. For this example also shown are the corresponding wave/water level joint probabilities for 2050 and 2100 for a particular climate change scenario.

2.4.4 Shoreline water levels, waves, wave run-up and overtopping

Along both the village and airport shorelines each combination of offshore extreme wave / water levels will be translated into corresponding shoreline conditions (accounting for alongshore variability in reef / shoreline characteristics). This will be based on an empirical approach that has been used successfully by NIWA in recent projects in Kiribati and Tokelau which accounts for:

- Wave breaking at the edge of the reef flat based on reef face slope, reef edge and reef rim elevation.
- Wave set-up, including the effect of wave grouping.
- Wave propagation over the reef flat accounting for different reef flat characteristics.

Both wave set-up and wave heights over the reef will be calibrated against the field data collected (Section 2.3).

This will provide return period conditions for:

- Shoreline wave heights.
- Shoreline water levels.
- Wave run-up levels and overtopping volumes for a range of different sloping or vertical shoreline morphology / coastal defences.

All the offshore wave and water level data will be contained within a spreadsheet database along with the routines to translate these conditions to the shoreline. This tool was developed by NIWA for the Kiribati Adaptation Project and allows site specific calculations to be made, and comparison between present day and potential future (based on defined climate change scenarios and timeframes – see next section) values of:

- Mean and high tide levels.

- Return period conditions for:
  - Storm tide levels.
  - Wave set-up levels over the fringing reef flat
  - Wave heights at the shoreline.
  - Wave run-up levels on beaches (e.g. within the grooves of the uplifted reef that forms the shoreline of Mangaia).
  - Wave overtopping volumes for a range of different sloping or vertical shoreline morphology

This will enable the Cook Islands to make their own assessment of the impacts of climate change and sea-level rise on coastal processes for both Mangaia and for other locations in the Cook Islands. An example of the screenshot of the tool developed for Kiribati is shown in Figure 5.

Figure 5: Example of the calculator tool developed to assess climate change and sea-level rise impacts on coastal inundation drivers as part of the Kiribati Adaptation Project.

2.4.5 Influence of climate change and sea level rise

A pragmatic approach will be adopted to assess the influence of climate change on the drivers of coastal inundation by assessing the impacts on future cyclone characteristics as well as sea-level rise.

There is increasing evidence that climate change will: 1) increase the intensity of the most severe cyclone conditions, and 2) reduce the frequency of occurrence of the less severe cyclones. The statistical cyclone model described in Section 2.4.1 can be "adjusted" to assess the impact that increased cyclone intensity / reduced frequency may have on extreme wave and storm surge conditions experienced offshore at Mangaia. Based on a scenario of current changes in cyclone frequency / intensity from the science literature (specifically guidance from outputs from the Japanese Earth Simulator and Australian Pacific Climate Change Science Program), future extreme wave / water level joint probabilities will be calculated off both the village and airport coastlines of Mangaia.

This will be combined with future projections of sea-level rise (for each decade from the 2020s to 2090s), based on:

- All six IPCC emission scenarios summarised in the IPCC Fourth Assessment Report. NIWA is currently deriving regional variations (from the global mean) in sea-level rise as part of work in New Zealand which covers most of the South Pacific and use will be made of any information on significant departures for the Cook Islands.
- More recent sea-level rise scenarios from the science literature.

The future joint probability data and sea-level rise scenarios will be built in to the calculator tool to enable climate change impacts on the parameters listed in Section 2.4.4 to be assessed based on a user-selected future timeframe and emission scenario.

2.5 Deriving areas at risk from inundation

Translating wave run-up levels and overtopping volumes into areas of potential hinterland inundation (and how this will change due to climate change and sea-level rise) is not straightforward, particularly given the raised "spur and groove" nature of the fossil reef that makes up the shoreline at Mangaia. In part this assessment will be based on experience and judgement (including local community experience and judgement). Based on the outputs of the modelling described above and the topography data collected as part of the field work we will:

- Derive a zone of direct wave run-up / overtopping risk for both the present day and selected future climate change scenarios / timeframes.
- Assess how the frequency of overtopping (e.g. within each groove or directly over the spur) may change for selected future climate change scenarios / timeframes.

- In GIS assess coastal inundation zones based on potential inundation pathways landward from the top of the groove, derived from the topography data, and how the area at risk from potential coastal inundation may change for selected future climate change scenarios / timeframes.

2.6 Outputs from the data collection and modelling assessment

2.6.1 Data collection outputs

The work outlined in Section 2.3 will produce the following outputs:

- A report that documents the equipment and methodologies applied to collect and post-process all bathymetry, topography, wave, and tide data.

- Hydrographic fair sheets and bathymetry maps with contours at scales of 1:5,000 for the nearshore areas of Oneroa village and harbour as well as the airport

- Topographic maps of spot heights and contours at 1:5,000 in the intertidal and low-lying areas of the coastal hinterlands at the village/harbour and airport areas.

- Coastal terrain cross-sections consisting of shore perpendicular transects of nearshore bathymetry and land elevation.

2.6.2 Extreme wave, water level and inundation outputs

The work outlined in Sections 2.4 to 2.5 will produce the following outputs:

- Extreme cyclone and swell wave conditions and extreme wave/water level joint occurrence tables for deep water locations around each island in the Cook Islands (including offshore at Oneroa village and airport on Mangaia).

- A report that documents, in a user-friendly way, extreme wave and water level data derived, shoreline wave and water level conditions, run-up and overtopping and how these inundation-drivers may be impacted under different climate change scenarios. It will outline how this data can be used and applied in different contexts. Appendices will contain in detail the various analysis and methodologies used to derive the datasets.

- Inundation maps, overlain on to high resolution satellite imagery, for Oneroa village / harbour and airport coastlines for different return period events and different future timeframe / climate change scenarios and supplied in paper copy and as GIS layers.

- A spreadsheet tool (Cook Islands Coastal Calculator) that contains all the wave and water level data and will allow site-specific calculations to be made of climate change effects on shoreline wave / water levels, run-up and overtopping on any fringing reef in the Cook Islands based on user-entered information on the reef and shoreline characteristics

- A user-manual for the Cook Islands Coastal Calculator.

2.7 Cook Islands involvement and capacity building

2.7.1 Cook Islands Coastal Calculator training

The spreadsheet tool (Cook Island Coastal Calculator) developed to store and apply the wave / water level data, for this project, provides the opportunity for technical staff within the Cook Islands Ministry of Infrastructure and Planning to use and apply the coastal data and make other assessments of the potential impacts of climate change on shoreline wave and water levels, wave run-up and overtopping.

A hands-on one week training course involving both a workshop and one-on-one training will be conducted in Rarotonga for technical staff to enable them to be fully conversant with, and competent in, the practical use and application of the coastal information (and associated calculator) as an input to a risk assessment and adaptation decision-making process.

The GIS-based information in the form of inundation maps will also be presented during this workshop. Technical staff from SOPAC and NIWA will ensure that the overlays are fully integrated into government GIS for easy retrieval and assessment.

3 Project implementation

3.1 The project team

SOPAC and NIWA have access to over 100 and 600 technical staff respectively. The most appropriate teams are assembled depending on the requirements of each project with all staff used on any project well experienced in conducting coastal-related studies. All teams having sufficient staff resources and back-up to ensure that each project is completed within the agreed timeframes and to the required standards. Key staff members likely to be involved with this proposed study are summarised below, with detailed CV's contained in Appendix 3.

Jens Kruger BSc MSc
Team Leader, Physical Oceanography, Ocean & Islands Programme (SOPAC)

Team leader on multi-country marine mapping and applied research projects. Ten years experience in coastal / marine surveying, mapping and data interpretation / reporting, including planning, mobilisation, data acquisition, processing, report production, client liaison and post-survey applications. PADI Rescue SCUBA Diver.

Herve Damlamian MSc
Numerical Modeller, Ocean & Islands Programme (SOPAC)

Five years experience in the field of hydrodynamic modelling and coastal engineering with significant knowledge in remote sensing and computer programming. Skilled in tsunami, water flow, inundation, particle dispersion, and wave modelling. PADI Open Water SCUBA Diver.

Ashishika Sharma BSc MSc
Technical Specialist, Ocean & Islands Programme (SOPAC)

Senior Technical Officer on multi-country marine mapping projects, with experience in oceanographic data acquisition, post-processing, reporting and delivery. Habitat mapping and aerial photograph analysis skills. Expert at sediment analysis. Additional marine biology and aquaculture background. PADI Rescue SCUBA Diver.

Salesh Kumar BSc PGD
Technical Specialist, Ocean & Islands Programme (SOPAC)

Senior Technical Officer on multi-country marine mapping projects, with experience in oceanographic data acquisition, post-processing, reporting and delivery. Habitat mapping and aerial photograph analysis skills. Additional background in Geology. PADI Rescue SCUBA Diver.

Doug Ramsay BEng MSc MBA CEng MICE MCIWEM FRGS
Manager, Pacific Rim & Coastal Consultant (NIWA)

Doug is a Chartered Civil Engineer with over 19 years professional experience of coastal engineering, strategic shoreline management, the hazard interactions between people and the coast, and the effect of climate change on coastlines. Between 1992 and 1998 and 2000 to 2003 he worked in the UK for HR Wallingford, an international environmental and engineering research and consultancy organisation, and between 1998 and 2000 as Coastal Management Adviser to the Government of Kosrae in the Federated States of Micronesia. In 2003 he moved to the National Institute of Water & Atmospheric Research (NIWA) in New Zealand where he is currently Manager of NIWA's Pacific and Asia activities.

Doug has wide experience of conducting coastal erosion, inundation and climate change impact assessments in the Pacific region, including recent projects in Tuvalu, American Samoa, Tonga and Tokelau. He led the NIWA team carrying out the *Climate Information for Risk Management* component for the Kiribati Adaptation Project. In New Zealand he has recently led the revision of the Ministry for the Environment publication: *Coastal Hazards and Climate Change: A guidance manual for Local Government in New Zealand.*

Dr Scott Stephens BSc PhD
Coastal Scientist (NIWA)

Scott has over ten years experience as a coastal oceanographer/ numerical modeller in environmental research and consulting for private, government and NGO clients. He has undertaken a wide variety of environmental research and commercial consultancies including interdisciplinary water related environmental studies, and projects combining field studies, large-scale instrument deployments and numerical modelling. His expertise covers a broad range of technical disciplines, with particular skills in the areas of wave analysis and modelling, extreme-value techniques, and hydrodynamic and particle-tracking modelling. He has contributed to 50 consultancy reports to commercial clients and first-authored 18 of these, and has appeared as an expert witness in the Environment Court.

Dr Richard Gorman BSc PhD
Senior wave modeller, (NIWA)

Richard has over 20 years experience in coastal and offshore hydrodynamics. In this time, his major research focus has been on surface wave wave processes, with particular emphasis on the role of nonlinear four-wave interactions and bed friction. He has implemented spectral wave models (WAM, Wavewatch III, SWAN) for hindcasting and forecasting applications as well as process studies, and has developed phase-resolving models for applications to harbour wave simulations with associated wave measurement studies. He has also developed directional wavelet techniques for analysing the spatial structure of surface wave fields from remote-sensed data. Other research interests have included wave dynamics on beaches and associated mechanisms for sediment transport and bar formation in the surf zone, including the development of numerical modelling techniques for cross-shore transport, and image analysis methods to provide objective measures of bar movement from video records.

3.2 Proposed work schedule

The total duration of the project will be seven months from the inception visit to Rarotonga and Mangaia by the Team Leader as outlined in Table 1. This is followed by a minimum of 10 weeks to carry out the deep water cyclone and swell assessment and joint probability work. During this time, and starting at about one month into the project, the five week field data collection phase will be completed.

Field data such as bathymetry, topography, and water level information needs to be post-processed prior to the start of the nearshore wave component, as the observed data will underpin the coastal wave hazard mapping.

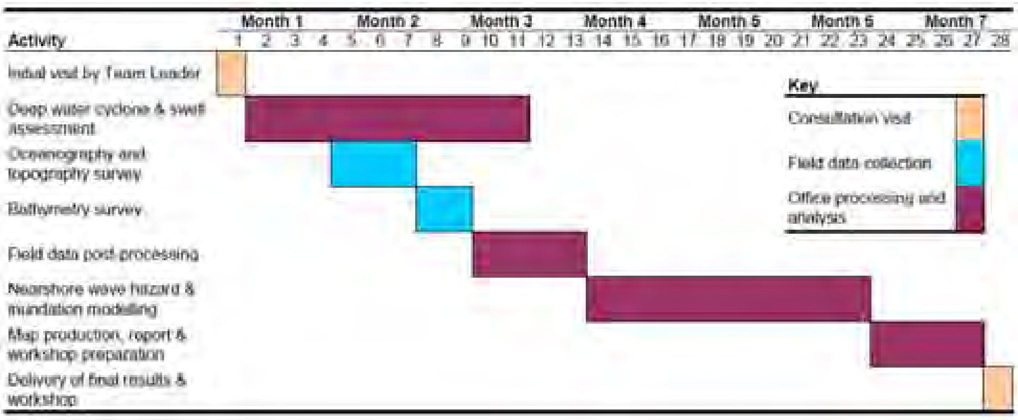


Table 1: Project schedule. It is proposed that the final delivery of results will be in the form of a week long training session in Rarotonga.

3.3 Schedule of fees

	Expenses	Unit	# of units	Unit rate (in FJD)	Cost (in FJD)	Cost (in NZD*)
		Project				
1	**Bathymetry**					
	Salaries field work					
	Technical, surveyor	Per day	12	196	2,352	1,693
	Technical, survey engineering	Per day	12	341	4,092	2,946
	Salaries office					
	Team Leader	Per day	2	685	1,370	986
	Technical, survey engineering	Per day	1	341	341	246
	Technical, electronics	Per day	3	81	243	175
	Technical, data processing & GIS	Per day	8	196	1,568	1,129
	Daily subsistence allowance for missions/travel					
	Technical, surveyor - Raro/Auck transit	Per day	4	306	1,224	881
	Technical, survey engineering - Raro/Auck transit	Per day	4	306	1,224	881
	Technical, surveyor - Magaia	Per day	8	126	1,008	726
	Technical, survey engineering - Mangaia	Per day	8	126	1,008	726
	Travel					
	International travel (From Suva to Mangaia return)	Per flight	2	3,500	7,000	5,040
	Equipment, supplies, and acquisition					
	Survey boat charter, incl. fuel	Per day	5	500	2,500	1,800
	Echosounder system, incl. ancillary system	Per day	5	92	460	331
	Echosounder mobilisation/demobilisation	Per survey	1	500	500	360
	Subtotal Bathymetry				**24,890**	**17,921**
2	**Topography & Oceanography**					
	Salaries field work					
	Team Leader	Per day	23	685	15,755	11,344
	Technical, coastal engineering	Per day	23	341	7,843	5,647
	Technical, survey & GIS	Per day	23	196	4,508	3,246
	Salaries office					
	Team Leader	Per day	5	685	3,425	2,466
	Technical, data processing & GIS	Per day	14	196	2,744	1,976
	Daily subsistence allowance for missions/travel					
	Team Leader - Raro/Auck transit	Per day	4	306	1,224	881
	Technical, coastal engineering - Raro/Auck transit	Per day	4	306	1,224	881
	Technical, survey & GIS - Raro/Auck transit	Per day	4	306	1,224	881
	Team Leader - Mangaia	Per day	18	133	2,394	1,724
	Technical, coastal engineering - Mangaia	Per day	18	133	2,394	1,724
	Technical, survey & GIS - Mangaia	Per day	18	133	2,394	1,724
	Travel					
	International travel (From Suva to Mangaia return)	Per flight	3	3,500	10,500	7,560
	Equipment, supplies, and acquisition					
	Survey boat charter, incl. fuel	Per day	5	500	2,500	1,800
	Survey grade GPS	Per day	19	115	2,185	1,573
	Wave gauge (x4)	Per day	14	23	322	232
	Tide gauge	Per day	33	7	231	166
	Batteries	Per item	5	50	250	180
	Field laptop	Per day	19	5	95	68
	Subtotal Topography & Oceanography				**61,282**	**44,123**
3	**Wave Hazard Analysis**					
	Salaries office					
	Team Leader	Per day	30	685	20,550	14,796
	Technical, coastal engineering	Per day	60	341	20,460	14,731
	Technical, GIS	Per day	20	196	3,920	2,822
	Equipment, supplies, and acquisition					
	Offshore wave climate and extremes	Per study	1	51,000	51,000	36,720
	Nearshore waves and inundation maps	Per study	1	56,000	56,000	40,320
	Subtotal Wave Hazard Analysis				**151,930**	**109,390**
4	**Other Costs, Services**					
	Travel by Team Leader for initial briefing	Per travel	1	6,000	6,000	4,320
	Week long training workshop delivered by NIWA & SOPAC	Per workshop	1	47,000	47,000	33,840
	Car / Bike Hire	Per day	21	200	4,200	3,024
	Air freight	Per item	10	2,000	20,000	14,400
	Insurance rate (1% of shipment value)	Per shipment	2	4,000	8,000	5,760
	Communications	Per day	40	30	1,200	864
	Miscellaneous (consumables and incidentals)	Per day	40	200	8,000	5,760
	Subtotal Other Costs, Services				**94,400**	**67,968**
		Project				
	Expenses	**Unit**	**# of units**	**Unit rate (in FJD)**	**Costs (in FJD)**	**Cost (in NZD*)**
6	**Subtotal direct costs of the Action (1-4)**				**332,502**	**239,401**
7	Provision for contingency, e.g. weather down time during survey (10% of item 1)				2,489	1,792
8	**Total eligible Direct costs of the Action (6+7)**				**334,991**	**241,194**
9	Administrative costs (8% of item 8)				26,799	19,296
10	**Total eligible costs (8 + 9)**				**361,790**	**260,489**
11	**Equivalent U.S. Dollars (1 FJD = USD 0.52, 21/8/2010)**				**188,131**	

*Note: 1 FJD = 0.72 NZD 1 NZD = 1.39 FJD (20/8/2010)

SOPAC is an international organisation and is not registered for VAT (tax)

Table 2: Itemised costs for the proposed project. Total fee for the project is USD188,131.00.

The total fee for the project is USD 188,131, and details of the proposed budget are given in Table 2. The costs are divided into four main components which all require the specialised skills of the respective teams. The components are 1. bathymetry, 2. topography and oceanography, 3. wave hazard analysis, 4. consultation and workshop delivery. The first two components involve fieldwork and data collection which will be conducted by SOPAC. Components three involves modelling, as well as statistical and empirical analysis, and will primarily be carried out by NIWA with minimal input from SOPAC. The final workshop, fourth component, will be a collaborative effort between NIWA and SOPAC and take place in Rarotonga.

4 Capabilities and professional experience

4.1 SOPAC

Since it's inception in 1972, The Pacific Islands Applied Geoscience Commission (SOPAC) has expanded considerably to become a leading regional organisation in the provision of applied science and technical support to Pacific member countries to help them achieve and maintain their economic and social potential.

The Ocean and Islands Programme (OIP) within SOPAC is committed to improving the technical knowledge of ocean and island ecosystems for the sustainable management of natural resources. OIP has extensive experience in geophysical, geological, hydrographic, oceanographic, environmental, and coastal survey work throughout the Pacific Region.

The total approved budget for SOPAC in 2009 was USD 15.7 million. SOPAC currently has some 100 staff of which more than one third are professional with the remainder being technical and support staff. OIP has a total of 18 staff directly involved in marine and coastal technical work and/or applied research. The award of this Project will continue SOPAC's long-term commitment to improving the technical knowledge and capacity of ocean and island geosciences in the Cook Islands and throughout the Pacific Islands.

Further information on recent projects that demonstrate our relevant capabilities for this project are contained in Appendix 1.

4.2 NIWA

The National Institute of Water and Atmospheric Research Ltd, (NIWA) is one of the South Pacific's leading provider of scientific research, knowledge and consultancy services concerning air and water resources. Established in 1992, NIWA has delivered innovative and appropriate solutions to complex water and atmospheric-related management and development problems ever since. The organisation specialises in:

- Freshwater
- Coast and Oceans
- Atmosphere and Climate
- Fisheries
- Aquaculture

NIWA is a Crown Research Institute and is a duly incorporated company with all shares owned by the New Zealand Government. It is both financially and scientifically a robust company, with financial reports available at http://www.niwa.co.nz/pubs/ar

NIWA employs more than 750 personnel, including scientists, engineers and support staff. An extensive programme of ongoing strategic research underpins NIWA's technology base and ensures that its scientists remain at the forefront of knowledge in their specialist areas. Technical expertise within NIWA covers almost all aspects of the marine environment.

NIWA has wide experience in conducting development projects throughout the Pacific and assessing environmental issues on small island states and fully appreciates the issues and responsibilities required in developing appropriate solutions in such environments.

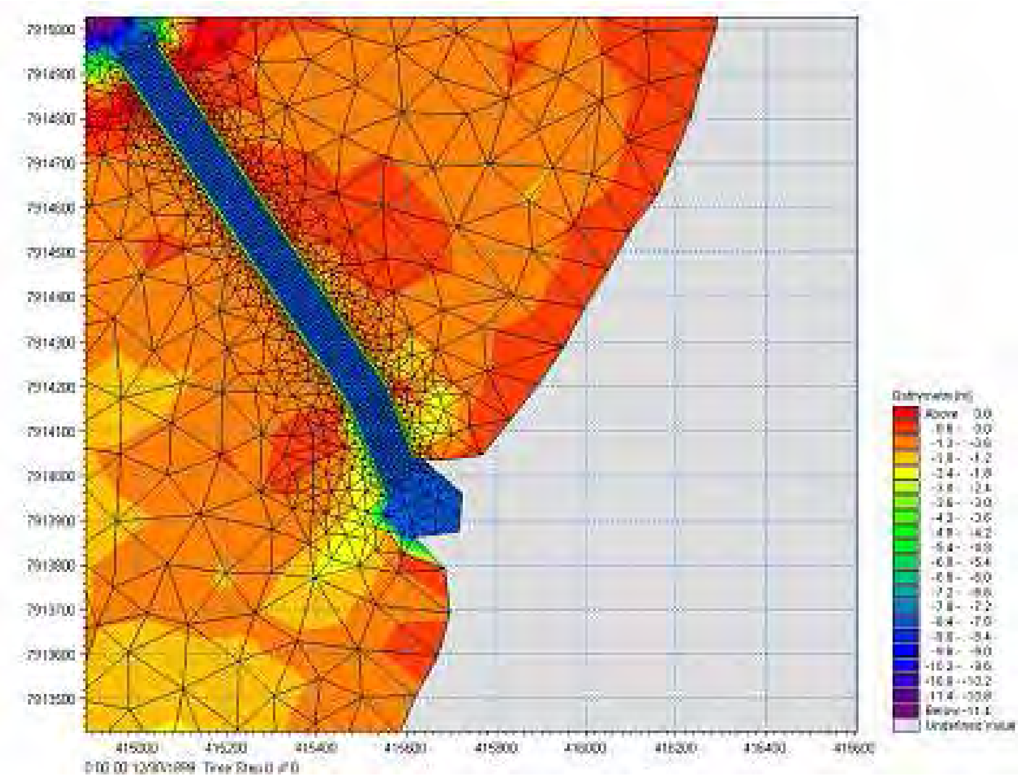
Research and consultancy services in the coastal and marine environment have figured prominently in the work carried out by NIWA in the Pacific. NIWA's coastal staff are well accustomed to addressing and accommodating the many conflicting demands that occur within the coastal zone and have wide experience of working in the South Pacific region. This enables project staff to perform effectively within cross-sectoral teams dealing with holistic environmental and multi-disciplinary issues.

Further information on recent projects that demonstrate our relevant capabilities for this project are contained in Appendix 2

Appendix 1

SOPAC: Selected recent projects that demonstrate capability of relevance to this project

Hydro-Environmental Assessment of Proposed Capital Dredging in Aitutaki Lagoon

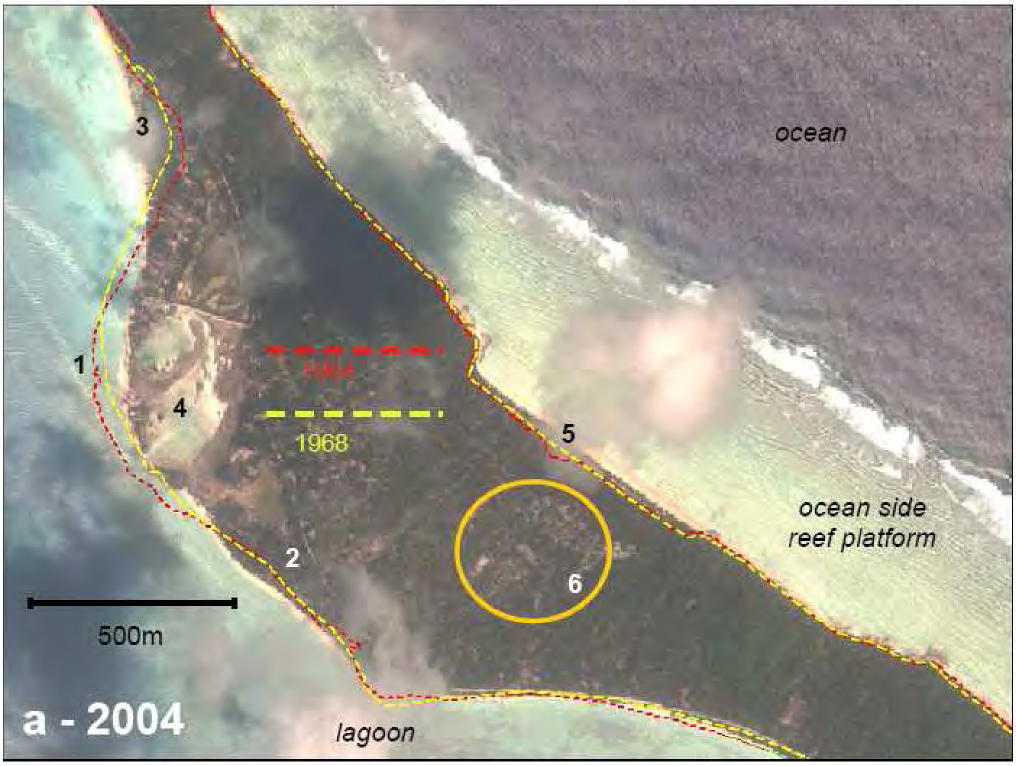


Client: Government of Cook Islands

Year: 2008

The almost-atoll of Aitutaki, one of Cook Island's tourism hot spots, features an enclosed lagoon that is only open to the ocean through the Arutanga Passage, a narrow and shallow navigational channel. The channel and harbour are to be developed to open up Aitutaki as a destination for yacht tourism. The shipping channel will be deepened and extended while the wharf will be re-designed to enable bigger ship to moor on Aitutaki's shore. SOPAC is using numerical modelling tools to evaluate possible impacts from such a project in regards to water circulation, surface elevation, and current speed.

Analysis of Coastal Change and Erosion, Tebunginako Village, Abiang, Kiribati

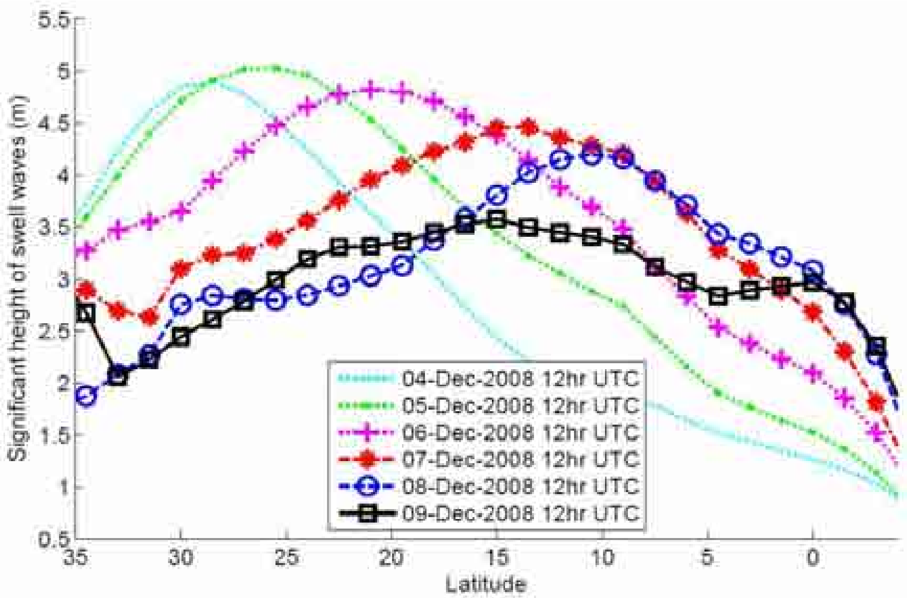


Client: Government of Kiribati

Year: 2006

This study used multi-temporal aerial photographs and satellite image comparisons, combined with detailed interpretation of digitally enhanced historical images to develop a more comprehensive understanding of coastal processes in this area. It was found that immediately south of Tebunginako Village was previously (*ca*.100 - 150 years ago) the site of an ocean / lagoon passage. The extensive shallows immediately off the lagoon shore from the village, are the result of sand transport through this former passage (depositional fan). Likewise, the widening of the island at Tebunginako is the result of shoreline processes consistent with an ocean / lagoon passage.

Extreme Event Analysis for December 2008 Destructive Swell Event, PNG

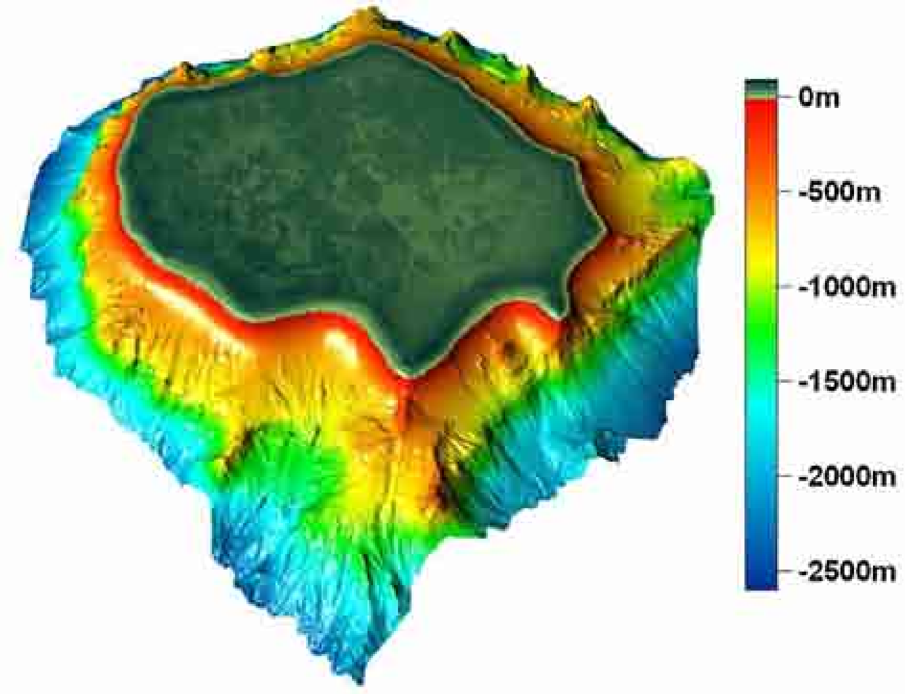


Client: OIP, SOPAC, in-house

Year: 2009

On the 10 December 2008, SOPAC received reports of coastal damage from sea inundation or large waves from member countries. This was a regional event that impacted across the majority of islands in the central west Pacific. SOPAC collaborated with ECMWF and WMO and used global model and satellite derived metocean data to analyse the event. An extra-tropical storm in the higher latitudes of the northern Pacific Basin generated waves that travelled south over several days before inundating low lying coastal areas, displacing some 50,000 people. Extreme value analysis carried out by SOPAC suggests that the extreme wave event had a return period of about 20 years. The analyses of such events are critical to the issue of coastal vulnerability and have obvious applications in climate change science and adaptation response.

Bathymetry Survey of Niue



Client: Government of Niue

Year: 2006

A high-resolution bathymetric mapping survey of the seabed surrounding the island of Niue was conducted. The survey was carried out over a period of six days in May 2005, resulting in the acquisition of over 550 km of multibeam echosounder data. A temporary tide gauge was also installed at the Alofi Wharf for the duration of the survey. The survey achieved 100 % coverage of the seafloor from approximately 50 m depth in the nearshore area to an average offshore distance of 5 km, reaching water depths of some 2000 m. The seafloor terrain was found to be highly irregular with an average slope of 22º. A review of external sources of available bathymetry was also undertaken, and the survey data was supplemented with publicly available data for Niue's EEZ. The resultant data compilation was used to produce bathymetry charts of Niue at a scale of 1:50 000, and a more detailed chart of Alofi Bay at a scale of 1:10 000. These new bathymetric maps give a descriptive picture of the ocean bottom terrain, vividly revealing the size, shape and distribution of underwater features, and serve as the basic tool for scientific, engineering, marine geophysical and environmental studies, as well as marine and coastal resource management.

Coastal Survey of Saipan

Client: Coastal Resource Managament Office, Saipan, CNMI

Year: 2010

A Trimble R8 Global Navigation Satellite System (GNSS) was used to conduct reef and shoreline surveys in Saipan. The system was operated in a Post-Processing Kinematic (PPK) mode, which involved two roving receivers and one reference receiver that remained stationary over a known control point. GNSS data were then simultaneously collected at the reference and rover receivers during the survey operation. The rovers were attached to 2 m long survey poles and used in a stop and go survey mode logging 5 epochs at each point of interest. Elevations were vertically controlled through simultaneous observations made at the NOAA tide gauge. The data was used to accurately map the height of the reef, as this is an important input parameter for wave modelling that is currently underway.

Appendix 2

NIWA: Selected recent projects that demonstrate capability of relevance to this project

Kiribati Adaptation Project: Climate Information for Risk Management

Client: Government of Kiribati

Year: 2007 - 08

NIWA have been involved with one component of Phase II of the World Bank funded Kiribati Adaptation Project. NIWA's involvement consisted of deriving design parameters for extreme rainfall, drought and coastal conditions and how these extreme conditions may change by 2100 due to different climate change scenarios.

For the coastal aspects, the project involved the derivation of extreme offshore wave conditions on the ocean coasts of all Kiribati islands and also along the lagoon shoreline of Tarawa. Analysis of the SEAFRAME gauge at Tarawa and use of a hydrodynamic model of Tarawa lagoon enabled the derivation of extreme water levels around the lagoon shoreline. The extreme wave and water levels were then analysed to develop joint probability curves of extreme waves and water levels. This information was then developed in to a database which allowed site specific calculations of wave set-up, run-up and overtopping for a range of natural and engineered shorelines on Tarawa and also permitted an assessment of the impact of different climate change scenarios and timeframes on these design conditions.

Training workshops were held in Kiribati to build capacity within Kiribati Government Departments in using the data and information within adaptation planning.

Reducing the risks of cyclone induced storm surges on the atolls of Tokelau

Client: UNDP

Year: 2005-06

In the aftermath of Cyclone Percy (February 2005), the United Nations Development Programme (UNDP) in Samoa commissioned NIWA to provide technical support to the Government and people of Tokelau to assist in the future reduction of coastal hazard risks, particularly associated with cyclonic storm surge and wave overtopping and inundation. The main purpose of this study was to provide the UNDP with recommendations for potential priority assistance to Tokelau for reducing the risks associated with cyclone storm surge inundation. This including developing appropriate hydrodynamic design conditions taking account of the future impacts of climate change. In conjunction with each Tokelau community, this has been developed within a more detailed strategic framework aimed at the long-term reduction of the risks associated both with episodic cyclone storm surge inundation and longer-term adaptation to climate change. This framework focused around four main themes:

- Identifying and reducing detrimental human impacts on the natural coastal defences.
- Community village planning to reduce hazard risks.
- Risk reduction through building design.
- Identifying the need for, and developing appropriate coastal defences.

The influence of climate change on extreme sea levels around Auckland City

Client: Auckland City Council

Year: 2008

Auckland City Council commissioned NIWA to assess rainfall intensity curves and extreme sea levels for Auckland City and associated Hauraki Gulf Islands. The purpose of the work is to derive information to ensure that the effects of climate change on rainfall patterns and long term sea-level rise are adequately incorporated in Council's long term planning.

For the coastal component climate change influences on local sea-level rise and other coastal hazard drivers were assessed. The effect this may have on Mean High Water Spring position, and on 2% and 1% Annual Exceedance Probability (AEP) water levels for three future time periods, the present day, 2050s (2040-2059), 2100's (2090-2119), and 2150s (2140-2159) were assessed.

Based on these extreme water levels and how they may change due to climate change and sea-level rise, land areas that are below these levels and potentially prone to episodic inundation have been derived based on the LiDAR topography data supplied by Auckland City Council.

NIWA Taihoro Nukurangi

SOPAC PACIFIC ISLANDS APPLIED GEOSCIENCE COMMISSION

Review of rainfall intensity curves and sea levels in Manukau City

Client: Manukau City Council

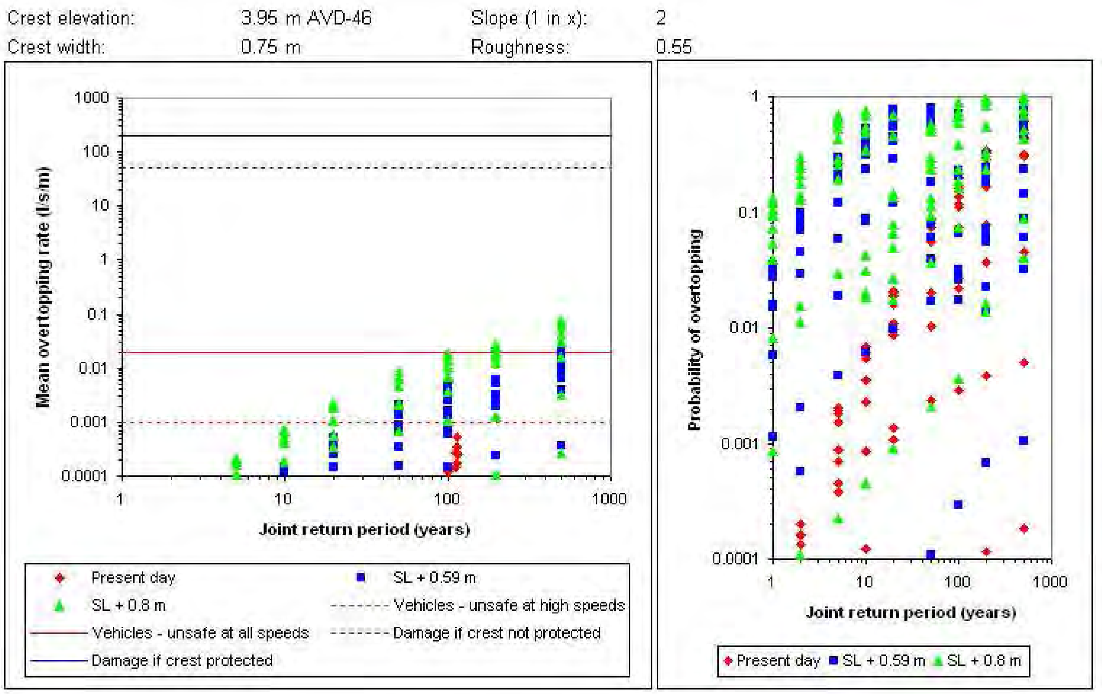
Year: 2008

Manukau City Council commissioned NIWA to assess rainfall intensity curves and extreme sea levels for Manukau City. The purpose of the work is to ensure that the effects of climate change on rainfall patterns and long term sea-level rise are adequately incorporated in Council's design procedures for infrastructure development. It is intended that the outcomes and findings of this project will update the Council's Engineering Quality Standards.

For the coastal component climate change influences on local sea-level rise and other coastal hazard drivers were assessed. The effect this may have on Mean High Water Spring position, and on 2% and 1% Annual Exceedance Probability (AEP) water levels for two future time periods, the present day, 2050s (2040-2059) and 2080's (2070-2099) were assessed.

Based on these extreme water levels and how they may change due to climate change and sea-level rise, land areas that are below these levels and potentially prone to episodic inundation have been derived based on the LiDAR topography data supplied by Manukau City Council. Based on the study recommendations were also suggested for revision of the building site level requirements.

North West Motorway (SH16) upgrade: Waterview to Royal Road. Hydrodynamic design conditions



Client: Connell Wagner

Year: 2007-09

NIWA derived probabilistic hydrodynamic data as input to the engineering design being carried out by Connell Wagner Ltd for Transit NZ (TNZ) associated with the upgrade of the section of North Western Motorway (SH16) between Waterview Interchange and Royal Road in Auckland.

The study assessed extreme wave and water level conditions (anf their correlation using a joint probability approach) along the length of the Waterview to Rosebank causeway section, and seaward of the Whau River Bridge. The effects of climate change on sea levels and wave conditions within the middle Waitemata Harbour were also derived the year 2100.

The extreme wave and water level conditions for a range of average return periods of between 1 year to 500 years were then used to assess potential mean overtopping volumes and probability of wave overtopping for different causeway configurations and associated coastal protection on the northern flank. The sensitivities of different combinations of causeway elevation, crest width of rock armour protection, rock revetment slope and rock armour layer thickness on overtopping and armour stability were assessed. The analysis allowed Connell Wagner and Transit NZ to set causeway elevation / coastal protection configurations based on judgements of serviceable limit state requirements for overtopping (e.g. safe volumes for vehicle movements) and return periods (both present-day and in the context of changed climate in 2100).

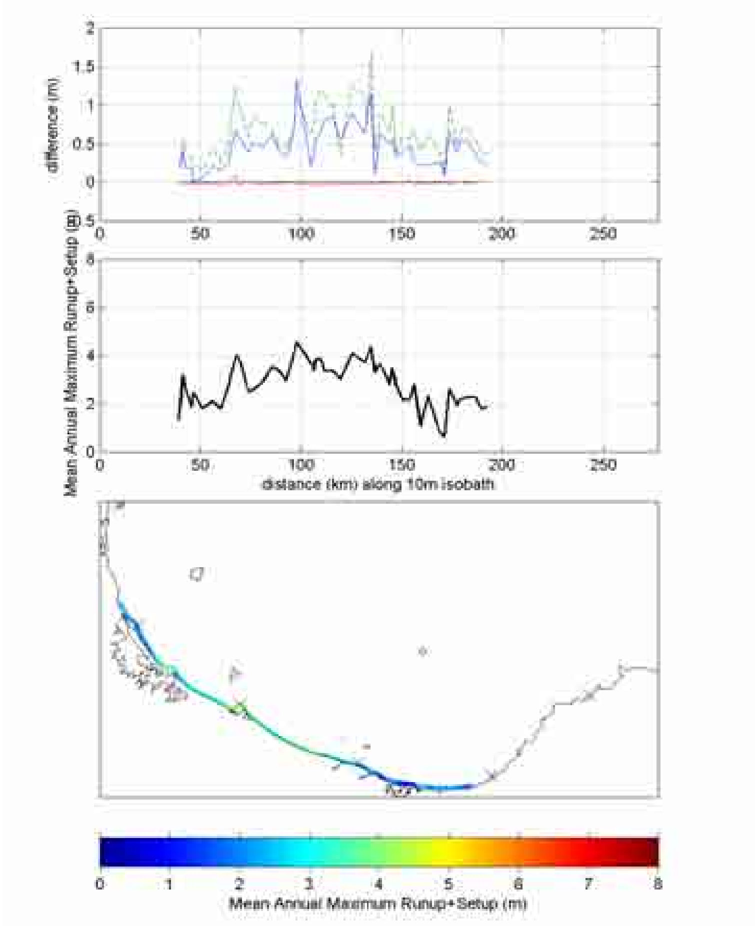
Managing and adapting to coastal erosion on the West Coast

Client: West Coast Regional Council

Year: 2006 - 2009

NIWA have been providing advice to West Coast Regional Council to aid the decision-making processes associated with ongoing erosion problems being experienced by a number of small communities in the region. Assessments of coastal processes and the dominant drivers of coastal change have been made including the potential impacts of sea-level rise and other climate change influences on future coastal change. Potential management and adaptation options have been identified in consultation with the Council and affected communities. Public awareness factsheets have been developed for community to help raise awareness of the processes, both natural and human-induced causing erosion and the measures that individuals and the communities can take to help slow the rate of coastal change.

Impacts of climate change on the coastal margins of the Bay of Plenty



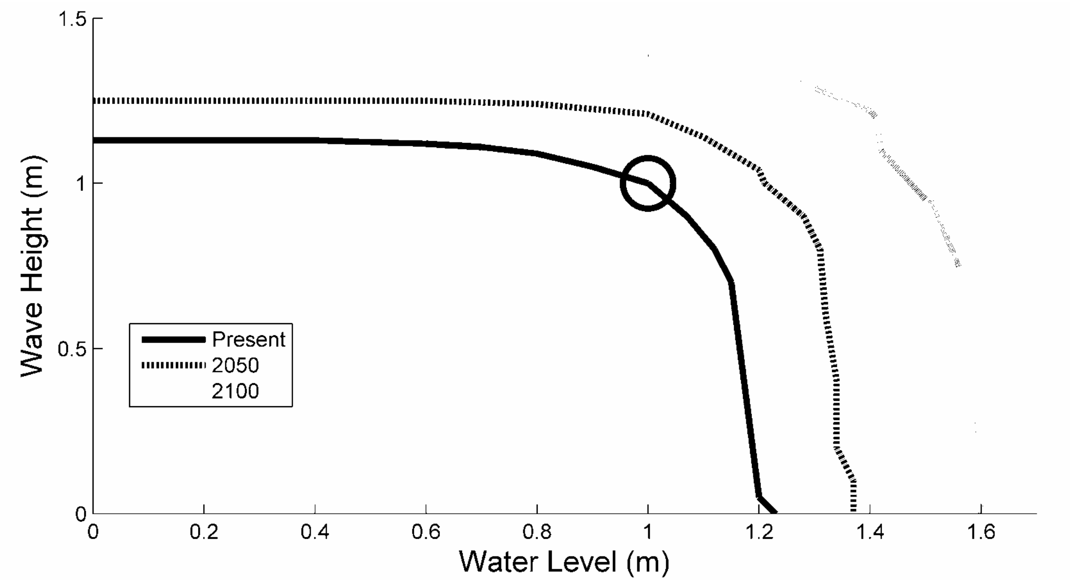
Client: Environment Bay of Plenty (Bay of Plenty Regional Council)

Year: 2005-06

Environment Bay of Plenty commissioned NIWA to assess climate variability and changes in the "drivers" of coastal physical processes and hazards, and assess the potential impacts these changes or trends may have on the coastal margin of the Bay of Plenty region over the coming 50 to 100 years. In particular it looks to summarise our present knowledge, in the context of the Bay of Plenty region, of the impacts of potential climate change on:

- Tides, storm surges and sea levels within the Bay of Plenty.
- Wave conditions along the Bay of Plenty coastline.
- Sediment supply from rivers in the Bay of Plenty to the coastline.
- The potential movements of beach sediment and hence impact on the patterns of coastal erosion or accretion along the Bay of Plenty coastline.

Impacts of long-term climate change on the weather and coastal hazards for Wellington City



Client: Wellington City Council

Year: 2005-06

This study was conducted to assist Wellington City Council with ensuring appropriate climate-change impacts are taken account of within the Council's long-term urban development planning. The issues of particular interest, and which were covered by this study, include:

- Expected rainfall intensity changes
- Expected annual rainfall changes
- Potential changes to extreme wind patterns
- Extreme sea level and storm surge probabilities and expected mean sea level rise for the harbour frontage of Wellington City
- Wave climate and extreme wave conditions along the harbour frontage of Wellington City, and potential effects of climate change on the wave climate
- Assessment of the probability of the joint occurrence of high water levels and wave conditions.
- A key part of the study was assessing the correlation between extreme water level and extreme wave conditions and how this may change by 2050 and 2100. The plot above shows an example of the range of combinations of extreme water level and wave conditions for a joint probability average return interval of 100 years for the present day and for the years 2050 and 2100.

Appendix 3: CV's

Douglas L. Ramsay

Present position

Manager, Pacific Rim & Coastal Consultant

Present employer

NIWA (National Institute of Water & Atmospheric Research Ltd)

Present work address

Gate 10 Silverdale Rd, P O Box 11115, Hamilton

Specialist Skills

- Integrated coastal hazard management and coastal engineering
- Climate change impacts and adaptation
- Disaster risk reduction
- Pacific Islands environments and communities

Academic qualifications

2003	MBA Environmental Management, University of Southern Queensland
1992	MSc Water Engineering, University of Strathclyde
1991	BEng (Hons) Civil Engineering, University of Aberdeen

Honours / distinctions / membership of societies, institutions, committees

- Selected as a participant in the Emerging Pacific Leaders Dialogue, 2010
- NZ Coastal Society Management Committee (2003-08), Deputy chairperson (2007-08)
- Member of the Institution of Civil Engineers, UK (MICE) and Chartered Engineer (CEng)
- Member of the Chartered Institute of Water & Environmental Management, UK (MCIWEM)
- Fellow of the Royal Geographical Society, UK (FRGS)

Professional positions held

2008 -	Manager, Pacific Rim, NIWA
2004 - 08	Leader, Natural Hazard Centre, NIWA
2003 -	Coastal Consultant, NIWA
2000 - 03	Project Manager & Coastal Engineer, HR Wallingford Ltd, UK
1998 - 00	Coastal Management Advisor, Development Review Commission, Government of Kosrae, Federated States of Micronesia
1992 - 98	Project Manager & Coastal Engineer, HR Wallingford Ltd, UK
1992	Research Hydrologist, Clyde River Purification Board, UK

Countries of work experience

- American Samoa
- Bahamas
- Bahrain
- Federated States of
- Hong Kong
- Ireland
- Italy
- Kiribati
- South Korea
- Tuvalu
- Tokelau
- Tonga

- Micronesia
- Guyana
- Malaysia
- New Zealand
- United Kingdom
- Venezuela

Professional experience

Doug is a Professional Civil Engineer, Member of the Institution of Civil Engineers (UK), Chartered Member of the Institution of Water and Environmental Management (UK) and Fellow of the Royal Geographical Society (UK). He has nineteen years post-graduate experience of international coastal-related research and consultancy projects with wide experience of assessing natural coastal processes and the impacts of human activities on the coastal zone. His expertise covers a broad range of technical disciplines, with particular skills in the areas of coastal engineering and shoreline management, coastal hazard and risk assessment, climate change, environmental assessment, and community participation.

His early career has been spent as a consultant for HR Wallingford, a UK based international environmental and engineering research and consultancy organisation, where he gained worldwide experience of conducting applied research and consultancy studies for private clients, government and non-government organisations (NGOs).

He has ten years experience in the Pacific region, having worked for the Government of Kosrae, in the Federated States of Micronesia, between 1998 and 2000. During this time he was employed specifically to develop strategies and the capacity of environmental staff on the island to manage coastal erosion and inundation risk, but was also involved with watershed issues, water quality, environmental impact assessment, marine pollution containment, coral reef and mangrove impacts and development planning.

Since joining NIWA in 2003 he has continued to work in the Pacific region. For NZAid he led a review, in conjunction with SOPAC, of the environmental and socio-economic impacts of development assistance to create reef channels and improve small boat landing facilities on the eight outer islands in Tuvalu. For the UNDP and Government of Tokelau he completed an in-country assignment to develop a long-tem strategy, with each of the Tokelau communities, to reduce the risks of storm surge inundation to the three atolls of Tokelau. More recently he has led a NIWA team involving climate and coastal scientists carrying out one component of the World Bank funded *Kiribati Adaptation Programme*, to provide climate change science data and information to underpin future climate change adaptation activities within Kiribati.

He has also been a member of a number of international teams involved in projects within the Pacific including providing a review of the coastal protection function and value of coral reefs in American Samoa for Jacobs UK, an environmental consultancy carrying out the *American Samoa Coral Reef Economic Valuation Study*. He was also responsible for the cyclone and coastal hazard components as part of a BECA/Landcare/GNS team carrying out the World Bank funded *cyclone emergency management and preparedness project* in Tonga.

Over the last six years in New Zealand he has been involved in a wide range of coastal hazard risk assessment and climate change studies. He has wide experience of managing project teams, winning and delivering consultancy projects for a range of private, central and local government clients. Most recently he has led the revision of the recently released Ministry for the Environment guidance on *Coastal hazards and climate change: a guidance manual for local government in New Zealand*. Within NIWA he is also Manager of NIWA's Pacific and Asia applied science activities.

Reports and publications

Pacific Island related client reports

Ramsay, D.L., Stephens, S.A., Gorman, R., Oldman, J., Bell, R. (2008) Kiribati Adaptation Programme. Phase II: Information for Climate Risk Management. Sea levels, waves, run-up and overtopping. NIWA Client Report HAM2008-022, February 2008

Ramsay, D.L. (2005). Reducing the risks of cyclone storm surge on the atolls of Tokelau: An overview of cyclone related coastal hazards. Fakaofo. NIWA Client Report HAM2005-077, June 2006.

Ramsay, D.L. (2005). Reducing the risks of cyclone storm surge on the atolls of Tokelau: An overview of cyclone related coastal hazards. Nukunonu. NIWA Client Report HAM2005-78. June 2006.

Ramsay, D.L. (2005). Reducing the risks of cyclone storm surge on the atolls of Tokelau: An overview of cyclone related coastal hazards. Atafu. NIWA Client Report HAM2005-119.

Ramsay, D.L. (2005). Reducing the risks of cyclone storm surge on the atolls of Tokelau: An overview of cyclone related coastal hazards. NIWA Client Report HAN2005-120.

Ramsay, D.L. (2005). Tokelau seawall project: De-briefing report for UNDP. NIWA Client report HAM2005-118, August 2005.

Ramsay, D.L. (2005). Tokelau Seawall Project: Inception report for UNDP. NIWA Client report HAM2005-117, June 2005.

Glassey, P.; Heron, D.; Ramsay, D. & Salinger, J. (2005). Identifying natural hazards and the risks they pose to Tonga. Study Report 4: Geosource Tonga. Cyclone emergency recovery and management project. Component B2: Land Hazards and Information Management

Spurgeon, J.; Roxburgh, T.; O'Gorman, S.; Lindley, R.; Ramsay, D. & Polunin, N. (2004). Economic valuation of coral reefs and adjacent habitats in American Samoa. Report for the Department of Commerce, Government of American Samoa. June 2004.

Ramsay, D.L. & Kaly, U. (2004). Tuvalu Reef Channels Review. NIWA Client Report HAM2004-137, June 2004.

Ramsay, D.L. (2000). *The Kosrae Shoreline Management Plan*. Development Review Commission, May 2000. Available from: http://www.kosraecoast.com/summary.pdf

Ramsay, D.L. (2000) Reducing the impact of sand mining on Kosrae and the provision of a long-term supply of sand aggregate for construction: A proposed way forward. Development review commission. January 2000. Available from: http://www.kosraecoast.com/sand-mining-full-updated.pdf

Pacific Island related presentations and popular articles

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NIWA Taihoro Nukurangi

SOPAC PACIFIC ISLANDS APPLIED GEOSCIENCE COMMISSION

Scott A. Stephens

Present position

Coastal Scientist

Present employer

NIWA (National Institute of Water & Atmospheric Research Ltd)

Present work address

Gate 10, Silverdale Road, P O Box 11-115, Hamilton.

Specialist Skills

- Hydrodynamic modelling
- Wave measurement, analysis and modelling
- Extreme value analysis
- Sea level analysis and modelling
- Joint-probability applications
- Larval transport modelling
- Coastal instrumentation and data analysis

Academic qualifications

2002	Doctor of Philosophy, PhD (Earth Sciences), University of Waikato 1996 Master of Science, MSc (Earth Sciences), University of Waikato
1994	Bachelor of Science, BSc (Physics & Earth Sciences).

Years as a practising researcher

10

Honours / distinctions / membership of societies, institutions, committees

New Zealand Coastal Society
New Zealand Marine Sciences Society

Professional positions held

2001 – Present	Coastal scientist – NIWA.
1996-2001	Assistant Lecturer, University of Waikato.
1996-1997	Project Manager: Assessment of Environmental Effects for the proposed expansion of Port Gisborne.

Professional experience

Experience Summary

Dr Stephens has 10 years experience as a coastal oceanographer/ numerical modeller in environmental research and consulting for private, government and NGO clients. He has undertaken a wide variety of environmental research and commercial consultancies including interdisciplinary water related environmental studies, and projects combining field studies, large-scale instrument deployments and numerical modelling. His expertise covers a broad range of technical disciplines, with particular skills in the areas of wave analysis and modelling, extreme-value and joint-probability techniques, and hydrodynamic and particle-tracking modelling. He has contributed to 57 consultancy reports and first-authored 25 of these for commercial clients and has appeared as an expert witness in the Environment Court.

Key Project Experiences

- Lead several field deployment programmes, most recently a six-month oceanographic data collection for North Shore City Council tunnel and outfall.
- Project leader and principal modeller to design the position and investigate the position of diversion wall to remove nutrient from Lake Rotoiti, EBOP.
- Set up a hydrodynamic model of the Firth of Thames as part of an ecological sustainability assessment for shellfish aquaculture, for clients ARC, EW and FoT consortium.
- Modelled wave effects on sediment and water clarity in Lake Waikare, for Environment Waikato.
- Project leader and principal modeller for a field and modelling study of hydrodynamics and larval dispersal in the Te Tapuwae O Rongokako Marine Reserve, for the Department of Conservation.
- Scott has participated in a number of studies including coastal hazards and climate change undertaking extreme sea level analysis and joint-probability analysis for combined wave and storm surge height along coasts for design of minimum ground levels. Clients include Auckland, Manukau and Nelson City Councils and the Government of Kiribati.
- Author of expert guidance for assessing extreme sea levels that formed one of a series of “toolboxes” for Territorial Local Authorities in New Zealand.
- Project leader and principal modeller during modelling of sand transport and deposition in the Kaipara tidal inlet to estimate capacity for sand extraction in the harbour.

List of major achievements relevant to this research proposal

Stephens SA, Bell RG, Black KP (2001) Complex circulation in a coastal embayment: shelf current, wind and density-driven circulation in Poverty Bay, New Zealand. Journal of Coastal Research Special Issue 34, ICS 2000 proceedings, 45-59.

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Marine Reserve during September-October 2003. NIWA consulting report to the Department of Conservation, HAM2003-138, Hamilton.

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Stephens, S. A.; Coco, G. ; Bryan, K. R. accepted for publication: Numerical simulations of wave setup over barred beach profiles: implications for predictability. *Journal of Waterway Port Coastal and Ocean Engineering-ASCE*

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Dr Richard M. Gorman

Present position

Scientist – Coastal Hydrodynamics

Present employer

NIWA (National Institute of Water & Atmospheric Research Ltd)

Present work address

Gate 10 Silverdale Rd, P O Box 11115, Hamilton

Specialist Skills

- Numerical wave modelling
- Wave dynamics
- Beach dynamics
- Coastal physical processes
- Hydrodynamic, sediment transport, and dispersion modelling

Academic qualifications

1980	BSc (Hons) in Physics, University of Melbourne
1987	PhD in Physics, University of Melbourne

Honours / distinctions / membership of societies, institutions, committees

- Member, Expert Team on Wind Waves and Storm Surges of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)
- Member, New Zealand Coastal Society
- Member, New Zealand Marine Sciences Society
- Member, Meteorological Society of New Zealand
- Member, American Geophysical Union
- Honorary Lecturer, University of Waikato
- 2003 Kevin Stark Memorial Award for papers presented at the biennial Australasian Conference on Coastal and Ocean Engineering

Professional positions held

1997 -	Scientist/Modeller, NIWA, New Zealand
1995 - 97	Lecturer, University of Waikato, New Zealand
1993 - 95	Research Scientist, Victorian Institute of Marine Sciences, Australia
1992 - 93	Research Associate, Department of Civil and Maritime Engineering, Australian Defence Force Academy, Canberra, ACT, Australia

1992	Consultant Meteorologist, Bureau of Meteorology Research Centre, Australia
1991	Visiting Research Fellow, Istituto di Costruzioni Marittime e di Geotecnica, Facolta di Ingeneria, Università di Padova, Italy
1988 - 91	Postdoctoral Research Fellow, Department of Civil and Maritime Engineering, University College, Australian Defence Force Academy, Canberra, ACT, Australia

Professional experience

Key Project Experiences Relevant to this Proposal

Studies of Wave Spectral Transformation

Investigated the transformation of wave spectra subject to dissipation by bed friction, and nonlinear wave-wave interactions, using the SWAN 3rd generation spectral wave model. Investigated wave processes within Manukau Harbour, a large New Zealand tidal estuary, subject to varying fetch, water depth and currents through the tidal cycle, with particular emphasis on the role of nonlinear four-wave interactions. The subsequent paper was the first SWAN application published in a peer-reviewed scientific journal.

Wave Hindcasting and Forecasting

Implemented the WAM and Wavewatch III wave models for hindcasting and forecasting applications globally and within the Australian and New Zealand regions. Applied numerical wave modelling to provide long-term hindcasts of wave conditions at the New Zealand coast. Implemented operational numerical wave forecasts providing daily outputs as part of a web-based Hazards Information System.

Nearshore Wave Climate and Sediment Transport Studies

Developed methods to simulate wave climate by implementing the SWAN 3rd generation spectral wave model in a scenario-based approach, allowing long-term (decadal-scale or longer) simulations to be carried out. This also allows impacts on nearshore sediment transport to be assessed. Applications to date include the Hauraki Gulf, Canterbury coast, Wellington Harbour, and the Bay of Plenty.

Near-Shore Wave Refraction-Diffraction Studies

Developed numerical models for wave refraction and diffraction, for applications to harbour wave simulations with associated wave measurement studies. Commissioned research has been undertaken associated with proposed harbour modifications for Taranaki and Gisborne ports (New Zealand), including model studies of harbour wave properties, and analysis of wave data for application to ship motion studies.

Hydrodynamic/Dispersal Studies

Played a leading role in several applied studies of physical processes, combining field measurement, data analysis and numerical modelling. These include current and sediment dynamics investigations for port and marina developments and discharge studies for the Marsden Power Station cooling water outfall and Manukau Wastewater Treatment Plant (New Zealand). Other areas of previous research include investigation of current circulation through Australia's Great Barrier Reef, with application to the dispersal of Crown-of-Thorns starfish larvae.

Hydrodynamic/Sediment Transport Modelling in Rivers

Implemented models to address the transport of contaminated sediments in the Fox and Kalamazoo Rivers in the U.S. Great Lakes Basin. These studies were carried at Limno-Tech, Inc.

Beach Processes

Investigated wave dynamics on beaches and associated mechanisms for sediment transport and bar formation in the surf zone. Developed numerical modelling techniques for cross-shore transport, and image analysis methods to provide objective measures of bar movement from video records.

List of major achievements relevant to this research proposal

Major publications

Refereed journal articles

Popinet, S.; Gorman, R.M., Rickard, G.J; Tolman, H.L. (2010). A quadtree-adaptive spectral wave model. Ocean Modelling (34): 36-49.

Gorman, R.M. (2009). Intercomparison of methods for the temporal interpolation of synoptic wind fields. Journal of Atmospheric and Oceanic Technology 26(4): 828-837.

Vaughan, G.L.; Healy, T.R.; Bryan, K.R.; Sneyd, A.D.; Gorman, R.M. (2008). Completeness, conservation and error in SPH for fluids. International Journal for Numerical Methods in Fluids 56: 37-62.

Snelder, T.H., Leathwick, J.R., Dey, K.L., Rowden, A.A., Weatherhead, M.A., Fenwick G.D., Francis, M.P., Gorman, R.M., Grieve, J.M., Hadfield, M.G., Hewitt, J.E., Richardson, K.M., Uddstrom, M.J., Zeldis, J.R. (2006). Development of an ecological ocean classification in the New Zealand region, Environmental Management 39 (1): 12-29.

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Healy, T.; Stephens, S.; Black, K.; Gorman, R.; Cole, R.; Beamsley, B. (2002). Port redesign and planned beach renourishment in a high wave energy sandy-muddy coastal environment, Port Gisborne, New Zealand. Geomorphology 48(1-3): 163-167.

Smith, M.J.; Stevens, C.L.; Gorman, R.M.; McGregor, J.A.; Neilson, C.G. (2001). Wind-wave development across a large shallow intertidal estuary: a case study of Manukau Harbour, New Zealand. New Zealand Journal of Marine and Freshwater Research 35: 985-1000.

Refereed Conference Proceedings

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Stevens, C., Smith, M; Gorman, R; Popinet, S. and Walters, R. (2007). "Marine renewable energy research in New Zealand: a multi-scale perspective of resources and impacts", Coasts and Ports Australasian Conference, 17-20 July, 2007, Melbourne, Australia.

Gorman, R.M. (2005) "Numerical wave forecasting for the New Zealand region", Coasts & Ports Australasian Conference, Adelaide, Australia, 20-23 September, 2005, pp 179-184.

McComb, P.J.; Gorman, R.M.; Goring, D.G. (2005). "Forecasting infragravity wave energy within a harbour" Fifth International Symposium on Ocean Wave Measurement and Analysis - WAVES 2005, IAHR, Madrid, Spain, 3-7 July, 2005.

Gorman, R.M.; Coco, G. (2005). "Statistical description of swash motion on a beach during cusp formation." Coastal Dynamics 2005, Barcelona, Spain, 4-8 April, 2005.

Gorman, R.M.; Stephens, S.A. (2003). "The New Zealand wave climate derived from buoy, satellite and hindcast data." Coasts & Ports Australasian Conference, Auckland, New Zealand.

Swales, A.; Hume, T.M.; Hawken, J.; Liefting, R.; Gorman, R.M. (2003). "How different minerals change in particle size and shape during transport along a black-sand coast." Coastal Sediments '03, Clearwater Beach, Florida, USA, May 18-23.

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Outreach

Bell, R.G.; Gorman, R.M. (2007). Coastal hazards – rising problems, Water and Atmosphere, 15(3): 16-17.

Stevens, C.L.; Smith, M.J.; Gorman, R.M. (2005). Ocean bounty: energy from waves and tides, Water and Atmosphere, 13(4): 16-17.

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Gorman, R.M.; Revell, M.J. (2002). Reconstruction of the Wahine storm by computer modelling. Coastal News 21: 15.

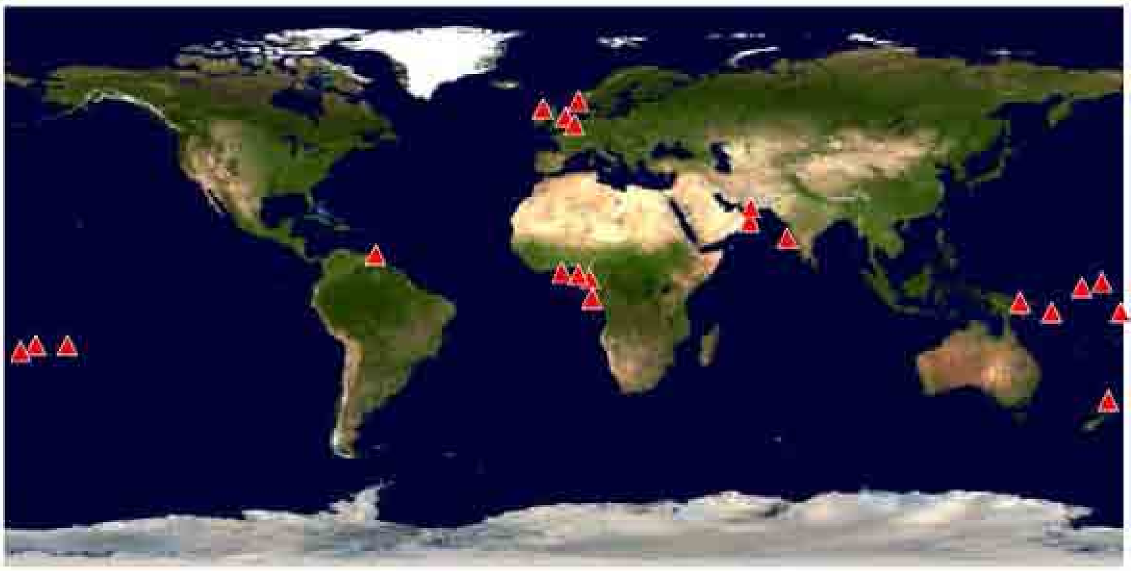
Jens Kruger - Resume

Pacific Applied Geoscience Commission, SOPAC
Private Mail Bag, Suva, Fiji Islands
phone: +679 3381377
email: jkruger@sopac.org

PROFILE

Name	Jens Kruger, BSc, MSc (First Class Honours)
Postal Address	SOPAC, P.M.B., Suva, Fiji Islands
Email / Phone	jkruger@sopac.org / (+679) 3370040
Citizenship	German
Marital Status	Married with two children
Languages	English, German and Melanesian Pidgin
Experience	Physical Oceanographer with over ten years of experience in the design and execution of multi-disciplinary marine mapping and applied research projects. Excellent broad skills base in coastal & marine surveying, numerical modelling and data interpretation & reporting. High level skills in liasing with National and International government organisations, non-state actors, research organisations, consultants, and local community members. Preparation of project proposals, project briefs, resourcing projects, project management and technical staff supervision. Experience in mentoring and training technical staff and conducting workshops.

Worldwide Experience



NIWA Taihoro Nukurangi

SOPAC PACIFIC ISLANDS APPLIED GEOSCIENCE COMMISSION

PROFESSIONAL DEVELOPMENT

Pacific Islands Applied Geoscience Commission, SOPAC, Suva, Fiji Islands
Physical Oceanographer, since September 2004
Team Leader for regional (14 countries) marine survey programme. Consultation, planning, mobilisation, acquisition, post-processing, interpretation, charting and reporting of hydrographic, oceanographic, and geophysical data. Applied research using hydrodynamic numerical modelling, remote sensing oceanography and habitat mapping. Post-survey data application and integration for adaptation and resource management options.

Gardline Geosurvey, Great Yarmouth, United Kingdom
Marine Geophysicist, November 2001 - August 2004
Quality control of geophysical data acquired on survey vessels operating worldwide. Interpretation of data and liaison with client representatives. Preparation of charts and reports.

Pine Harbour Marina Ltd., Beachlands, New Zealand
Coastal Geologist, June - October 2000
Responsible for cost-minimisation and environmental impact assessment on dredging works in a marina basin.

Centre of Excellence in Coastal Oceanography and Marine Geology, Hamilton, New Zealand
Research Assistant, part-time, July 1998- June 1999
Sidescan sonar surveys. Seabed mapping tutor.

Pacific Islands Applied Geoscience Commission, SOPAC, Suva, Fiji Islands
Project Assistant, June 1995- February 1997
Studies on beach processes and coastal vulnerability to sea level rise. Implementation of a GIS-based borehole database.

EDUCATION

University of Waikato, New Zealand
MSc. (Coastal Marine Science) with First Class Honours, graduated March 1999.
Research on sediment transport processes responsible for shoaling of shipping channels.

University of the South Pacific, Fiji Islands
BSc. (Environmental Physics), graduated 1995.

TECHNICAL SKILLS

Equipment & Data

- Sidescan sonar, single & multibeam echosounder, magnetometer, subbottom profiler, high-resolution seismic systems.
- Oceanographic instruments to measure water quality, waves/currents/sediments, particularly ADCPs.
- Sediment sampling techniques including piston and vibrocoring.
- Theodolite and electronic total station, differential and RTK GPS surveying equipment

- PADI Rescue SCUBA diver with 500 dives. Experience in the application of AUV, ROV, ROTV.
- World-wide small boat and large survey vessel experience.
- Post-processing and application of multispectral satellite imagery
- European Union drivers licence

Software

- Windows and Linux with Microsoft and Open Office packages.
- Hydrodynamic numerical modelling using MIKE 21.
- Multibeam acquisition and processing using Hypack.
- Sonar and seismic processing suites from Coda, TEI.
- Data analysis and visualisation using Matlab, R, Python, MapInfo, Surfer, ArcGIS, Quantum GIS/GRASS, and ERDAS Imagine.

TRAINING COURSES & CERTIFICATES

- Fledermaus Professional training course, Acoustic Imaging, one week, August 2010, Fiji.
- Multibeam Training Course, University of New Brunswick, one week, November 2007, Australia
- Geocap software training course, one week, June 2007, Geoscience Australia, Australia
- Marine habitat mapping workshop, three days, May 2007, Geoscience Australia/SOPAC, New Caledonia.
- GIS training course "Introduction to ArcGIS 9 for ArcView and Arcinfo stage I & II", one week, March 2007, Eagle Technology, Fiji.
- Marine remote sensing workshop, one day, November 2006, University of the South Pacific, Fiji.
- Hydrodynamic numerical modelling training course, one week, March 2005, DHI, Fiji.
- Technical hydrographic workshop, three days, November 2004, Southwest Pacific Hydrographic Commission, Fiji.
- Drilling and geohazards conference, three days, February 2003, Society for Underwater Technology, U.K.
- Sonarmosaic and Seismic processing training course, three days, November 2002, Triton Elics International, France
- Multibeam sonar and seabed classification training course, three days, June 2002, Simrad, Norway
- PADI Rescue SCUBA diver with 500+ dives and DAN course in oxygen for dive accidents.

BIBLIOGRAPHY

Publications & Proceedings

Frohlich, C., Hornbach, M.J., Taylor, F.W., Shen C-C., Moala, A., Morton, A.E., Kruger, J., 2009. Huge erratic boulder in Tonga deposited by a prehistoric tsunami. Geology, 37(2), 131-134.

McAdoo, B.G., H.M. Fritz, K.L. Jackson, N.Kalligeris, J. Kruger, M. Bonte-Grapentin, A.L. Moore, W.B. Rafiau, D. Billy, and B. Tiano, 2008. Solomon Islands tsunami, one year later, EOS, 89 (18), 169-176.

Kruger J. C., and Healy T. R., 2006. Mapping the morphology of a dredged ebb tidal delta, Tauranga Harbour, New Zealand. Journal of Coastal Research, 22(33), 720-727.

Kruger, J., 2006, Hydro-environmental impacts of foreshore reclamation, Suva lagoon, Fiji. In: Morisson, R.J., and Aalbersberg, B., (eds.), At the crossroads: science and management of the Suva lagoon. Institute of Applied Sciences, University of the South Pacific, Suva. 156-164.

Healy T., Kruger J., and Black K., 2005, Contaminant Mud Dispersion Represented by a Fluorescent Tracing Experiment, Proceedings of the Contaminated Sediments Conference, New Orleans.

Solomon S.M., Kruger J., Forbes D.L., 1997, An approach to the analysis of storm-surge and sea-level vulnerability using GIS: Suva, Fiji, South Pacific, Proceedings of the 1997 Canadian Coastal Conference, Canadian Coastal Science and Engineering Association, Guelph, Canada.

Reports

Lead authour on over twenty separate reports for the Pacific Islands Applied Geoscience Commission. Predominantly seabed mapping and oceanographic monitoring for National Governments in the Pacific Region.

Co-author on thirteen separate reports for Gardline Geosurvey in 2001-2004. Predominantly debris, habitat, hazard, pipeline / cable inspection, and geophysical reconnaissance surveys for the oil and gas industry. Clients: Amerada Hess, Snamprogetti, TotalFinaElf, Maersk, Subsea7, BP. Locations: Cameroon, India, Iran, Nigeria, Netherlands, Norway, Gabon, Oman, Trinidad and Tobago, and U.K.

NIWA Taihoro Nukurangi

SOPAC
PACIFIC ISLANDS APPLIED GEOSCIENCE COMMISSION

Curriculum Vitae

Herve Damlamian
SOPAC
e-mail: herve@sopac.org

Master of Science in the field of hydrodynamic science and coastal engineering with a significant knowledge in remote sensing, communication and marketing.

A flexible and hard working person with a four years working experience in the Pacific.

KEY SKILLS AND ACHIEVEMENTS

- Proven education background in mathematics and physics.
- Skilled in numerical modelling, including hydrodynamic modelling, particle analysis modelling, wave modelling and tsunami modelling.
- Fouṛyear working experience in a regional organisation (SOPAC) based in Fiji.
- Used to fieldwork, conference and workshop in various Pacific Island countries.
- Produced technical reports
- Language skills including fluent French and English, strong knowledge in Fijian.
- Up to date Information Technology Skills include using computer applications in Microsoft Office and linux, programming (C-Language, Fortran, python), Matlab, Mapinfo, Hypack, Mike 21, Telemac, ANUGA, URS code, SWAN, ANSYS, Global mapper, Surfer.

Educational Background

2005	Hydrodynamic modelling certificate delivered by DHI, financed by SOPAC/European Union, Fiji, Suva.
2004	TOEFL
o	Centrale Marseille M.Sc in Coastal Engineering Member of the French “Grandes Ecoles”
1999-2002	Lycée St-Joseph – School preparing to enter engineering school
1998-1999	Diploma “Baccalaureat”, speciality in Mathematics

Work Experience

Jan 2007- Dec 2008	Numerical modeller for the Pacific Tsunami Hazard Project, funded by AusAid, in SOPAC, Fiji

- 3 month training in Geoscience Australia on Tsunami inundation modelling using ANUGA and the URS code
- Developed recent tsunami events (2007 Solomon tsunami, 2006 earthquake at the Tongan Trench)
- Developed potential tsunami hazard impact (Tongatapu, Tonga).

Feb 2005- Dec 2008	Numerical modeller, for the EU project, EDF8/9: reducing the vulnerability of pacific states, in SOPAC, Fiji.

- Developed numerical modesl including:
  - Water circulation
  - Impact of dredging operation
  - Water Quality
  - Wave model
- Produced technical reports
- Worked on satellite derived bathymetry
- Fieldtrip in various SOPAC member countries using ADP, ADV, Hydrolab, Venturi,etc…
- Presentation: SOPAC Annual Session 2008_ Funafuti, GEOHAB 2007_Noumea, GIS Conference_Suva,…)

2004	3 months internship at HIPHOP Master, Paris Organizing the national display campaign for the concert Urban Peace 2 (50 000 people).

Languages

French:	Mother Tongue
English:	written, spoken and read fluently
Fijian:	Good knowledge
Spanish:	Good knowledge

Skills & Interests

Computing Skills	Microsoft Office, Linux, programming skills (C-Language, Fortran, Python), professional software (Mapinfo, Hypack, Mike 21, URS code, ANUGA, Matlab, ANSIS, ABAQUS, TELEMAC, GLOBAL MAPPER, SWAN)
Sports:	Played volley-ball and soccer for 10 years (competition), practised diving, snowboard and ski (competition)
Hobbies:	Photography, sports, music.

Other Information

Date of Birth:	28 October 1981
Nationality:	French
Marital Status:	Fiancée, 1 child
Driving Licence	Full clean current driving licence
Diving licence	Open water
Associative life	Vice president of the SOPAC social committee 2006-2007 Organised private party in the south of France (between 400 and 800 people), 2003-2005

Name: Salesh Kumar

CONTACT INFORMATION

SOPAC Secretariat
Private Mail Bag
GPO, Suva
Fiji

Phone Office: (679) 3381377 (ext) 282
Mobile: (679) 9320238
Fax: (679) 3370040
E-mail: salesh@sopac.org

PERSONAL INFORMATION

Nationality:	Fijian
Resident of:	Fiji
Birth date:	8th August, 1969
Gender:	Male
Marital Status:	Married

PROFESSIONAL EXPERIENCE

March 2006 – Present: **Senior Technical Officer**
Pacific Islands Applied Geoscience Commission (SOPAC)
Suva, Fiji.

Major Functions

1. Project Implementation
Facilitate the planning, logistics, preparation and implementation for field work activities for data acquisition. Assist in attracting funding and prepare project proposals and tenders, ensure that projects meet deadlines and are finished within budget.

4.2.1 2. Field Surveys and Data Acquisition

Improve the collection of information on, and monitoring of, natural resources, and systems. Responsible for the operation of marine survey equipment and quality control of acquired data.

3. Data Processing and Management
Process, analyse, interpret, report, chart, and produce applications after the completion of marine and coastal survey and field activities. Report results, provide recommendations and advice.

4. Capacity Building and Supervision
Represent SOPAC and transfer knowledge and skills through public awareness campaigns, workshop and conference presentations and university lectures.

January 2004 – February 2006: **Scientific Officer**
Department of Mineral Resources,
Suva, Fiji.

Accountabilities

- Geological, geochemical, and aggregate mapping
- Assisting in seismic and resistivity surveys
- Preparation and analysis of geological samples
- Post processing, map production, report writing, cataloguing and storage of field data.

EDCUCATION and TRAINING

August 9 – 13 2010 **Fledermaus Professional Training Course**

May 2009 **Rescue Diver Certification**

March 2004 – June 2008: **Post graduate Diploma in Environmental Science**
University of the South Pacific
Suva, Fiji

26 November – 1 December 2007 **45th Multibeam Sonar Training Course**
Cairns, Australia
Hosted by: OMG/UNB/CCOM/JHC/UNH

May 2006: **Certificate in First Aid at Sea**
Fiji Red Cross Society
Suva, Fiji

May 2006 **Open Water Diver**

March 2001 – November 2003: **Bachelor of Science (Earth Science and Chemistry majors)**
University of the South Pacific
Suva, Fiji

1988: Grade 12 (High School)
Mabel Park State High School, Brisbane, Australia

1986 – 1987: Forms 5 and form 6 (High School)
Labasa College, Labasa, Fiji.

1984 – 1985: Forms 3 and 4 (High School)
Naleba College, Labasa, Fiji.

1976 – 1983: Classes 1 to 8 (Primary School)
Nagigi Indian School, Labasa, Fiji.

SKILLS

Skill	Level	Years practiced
MS word, MS Excel, Power point ,	very good	more than 10 years
MapInfo, ERDAS,	very good	5 years
MATLAB	working knowledge	2 year
Open Water Diver	very good	4 years
Rescue Diver	good	1 year
Bathymetry Mapping softwares		
Hypack data acquisition and processing (Reson 8101 & 8160)	very good	4 years
SeaBird softwares	very good	4 years
Surfer	very good	4 years
Sontek softwares	very good	4 years
Simrad EM120	working knowledge	

EXPERIENCE

Marine surveys	Country	Role	Date
Charting of Yasawa waters	Fiji	Technical Officer	28/04/06 to 30/04/06
Lae port and Harbour surveys	PNG	Technical Officer	18/05/06 to 27/05/06
Madang Harbour and Lagoon	PNG	Technical Officer	28/05/06 to 03/06/06
Sissano	PNG	Technical Officer	04/06/06 to 08/06/06
Vanimo	PNG	Technical Officer	09/06/06 to 15/06/06
Pohnpei Harbour & offshore	FSM	Technical Officer	01/07/06 to 12/07/06
Majuro Lagoon & offshore	Marshall Is.	Technical Officer	20/07/06 to 28/07/06
Nabouwalu Port	Fiji	Surveyor	30/08/06 to 08/09/06
Manihiki Plateau (R.V. Sonne)	Cook Is.	Observer	19/05/07 to 29/06/07
Aitutaki,	Cook Is.	Surveyor	09/04/08 to 16/04/08
Charting of Yasawa waters	Fiji	Surveyor	27/09/08 to 05/10/08
Funafuti	Tuvalu	Surveyor	22/10/09 to 26/11/10
Saipan	CNMI	Assistant Surveyor	April to July 2010

Field surveys			
Geological mapping of Kioa Island, Vanua Levu	Fiji	Scientific Officer	05/2004 to 07/2004
Nawaka river dam site Investigation	Fiji	Scientific officer	2005
Navua river gavel deposit Assessement	Fiji	Scientific officer	2005
Geological Mapping of Buca Bay, Vanua Levu.	Fiji	Scientific officer	03/2005 to 06/2005

CURRICULUM VITAE

PERSONAL PARTICULARS

NAME	:	**Ashishika Devi Sharma**
POSTAL ADDRESS	:	12 Charlton Avenue, Nasese, Suva, Fiji
RESIDENTIAL ADDRESS	:	12 Charlton Avenue, Nasese, Suva, Fiji
TELEPHONE CONTACT	:	9264816 (M) or 3381377 (W)
EMAIL ADDRESS	:	Ashishika@sopac.org
GENDER	:	Female
NATIONALITY	:	Fiji Islander
MARITAL STATUS	:	Married
CURRENT OCCUPATION	:	Senior Technical Officer SOPAC

11.1 HOBBIES AND INTERESTS

Science	Netball	Diving	Cooking
Reading	Socializing	Music & Movies	Shopping

COUNTRIES WORKED IN

Fiji	Australia	New Zealand

Cook Islands	Vanuatu	Niue
Tonga	Tuvalu	

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13 EDUCATION

YEAR	13.2 INSTITUTION	13.3 QUALIFICATION ATTAINED
Current	University of Wollongong	Part-Time Doctor of Philosophy student.
2008	University of the South Pacific	Master's thesis in Marine Science. Gold Medal award for most outstanding Master of Science thesis. Masters research on Foraminifera taxonomy and distribution.
2003	University of the South Pacific	Post-Graduate Diploma in Marine Science.
2002	University of the South Pacific	Bachelor of Science in Marine Sciences.
1999	Mahatma Gandhi Memorial High	Fiji Seventh Form Examination
1996	Mahatma Gandhi Memorial High	Fiji School Leaving Certificate Examination

OTHER SKILLS/QUALIFICATIONS

YEAR	INSTITUTION	QUALIFICATION ATTAINED
2010	Acoustic Imaging Pty Ltd	Fledermaus Professional Training Course
2009	Skin Deep Ltd	Rescue Diver
2009	St. John Ambulance Brigade	Certificate in Basic First Aid
2008	DAN Asia Pacific	Course in Oxygen for Dive Accidents
2007	Australian Hydrographic Service & University of New Brunswick	Certificate in Multibeam Sonar Training Course
2006	Aqua-Trek Beqa	Open Water Diver's Certificate (PADI)
2006	Red Cross Fiji	Certificate in First Aid at Sea
2004	Training and Productive Authority of Fiji	Certificate in Occupational Health and Safety

COMPUTER KNOWLEDGE

MS Word	Paintshop Pro	Hypack

MS Excel	Adobe Photoshop	Surfer
MS Powerpoint	Web Designing	Global Mapper
MS Access	Matlab	Map Info
MS Publisher	CARIS	Erdas Imagine
Internet and emailing	ARC GIS	Quantum GIS
Fledermaus		

WORK EXPERIENCE

1. **Employer**: SOPAC Secretariat

Period: March 2006 to Date

Role: Senior Technical Officer – Ocean and Islands Programme.

13.7 Responsibilities/Achievements

- Collection, interpretation and deliverance of oceanographic data to Pacific Island Countries.
- Writing proposals, budgets and reports for raising funds for the project works across Pacific Island countries.
- Bathymetry data collection during surveys.
- Benthic habitat mapping for shallow area in South Pacific countries.
- Post-processing data collected from field surveys.
- Sediment sample collection and analysis.
- Water quality analysis in Pacific Island lagoons.
- Creating bathymetry maps and writing technical reports for South Pacific countries.
- Mapping of geo-morphological features around South Pacific Island countries.
- Preparation of project proposals, synthesis articles, and scientific papers.
- Managing and coordinating the operation and running of the survey vessel.
- Creating awareness of the work done by SOPAC via oral presentations to schools and countries.
- Mentoring, lecturing and supervising undergraduate and postgraduate students in their research in oceanography.

2. **Employer**: Mineral Resources Department, Government of Fiji

Period: March 2005 to March 2006

Role: Scientific Officer in Offshore Marine Geology.

13.8 Responsibilities/Achievements

- Offshore geological mapping.
- Conducting EIAs for the department.
- GIS Mapping.
- Hydro-geological field work for boreholes.
- Publications of bulletins, annual reports and the *Bibliography of the Geology of Fiji vol. 13.*
- Development of posters and pamphlets for awareness of work by MRD

- Assisting in the development of a virtual database for the library.

3. **Employer**: Fisheries Consultant, Dr. P. J. Kailola

Period: April to July 2004

Role: Technical Assistant, Environmental Impact Assessment of Fisheries Jetty, Lami.

Responsibilities/Achievements

- Documenting the geology, topography, meteorology and hydrology of the area.
- GIS mapping.
- Field and laboratory analysis of rocks and sediments in the area.

4. **Employer**: Marine Studies Programme, University of the South Pacific

Period: February 2004 to December 2004

Role: Graduate Assistant in Marine Science

13.9 Responsibilities/Achievements

- Masters thesis research work on Foraminifera taxonomy and sediment analysis.
- Tutoring in Marine Science units.
- Laboratory research work for the Marine Department and the University.
- Assisting in the development of the Marine Geology website.
- Conducting lectures in the absence of lecturers.
- Lab demonstration, and supervision during project and laboratory work
- Conducting of and supervision during field trips.
- Marking of labs and assignments.

5. **Employer:** Biology Department, University of the South Pacific

Period: February 2003 to June 2004

Role: Part-time Tutor, Demonstrator and Marker for Marine Biology (BI/MS 305), Fish and Fisheries Biology (BI308), Population Biology (BI 201) and Animal Biology (BI 108)

13.10 Responsibilities/Achievements

- Conducting tutorial classes
- Demonstration and supervision of lab work during laboratory classes.
- Supervision during field trips
- Marking of assignments and laboratory reports.

6. **Employer**: Institute of Marine Resources, University of the South Pacific

Period: February 2003 to November 2003

Role: Trainee Attachment for Aquaculture and Hatchery Production of Black Tiger Shrimps, *Penaeus monodon,* and freshwater prawns, *Macrobrachium rosenbergii.*

13.11 Responsibilities/Achievements

- Hatchery management
- DNA analysis
- Water quality analysis
- Microbiology culture and study
- Algae culture
- Broodstock selection, ablation and maintenance
- Larval rearing till post-larval and pond stocking

PUBLICATIONS

- Krüger, J., Kumar, S., Damlamian, H. and Sharma, A. 2010. Oceanographic Survey, Shoreline Mapping and Preliminary Hydrodynamic Modelling Report, Saipan, Commonwealth of the Northern Mariana Islands. *SOPAC Data Release Report 26*. Pacific Islands Applied Geoscience Commission: Suva, Fiji, 61 p.
- Sharma, A. (2010) Field Survey and Analysis of Bottom Material, Funafuti, Tuvalu. *SOPAC Data Release Report 21.* Pacific Islands Applied Geoscience Commission: Suva, Fiji, 92 p.
- Sharma, A. (2010) Field Survey and Analysis of Water Samples, Funafuti, Tuvalu. *SOPAC Data Release Report 22.* Pacific Islands Applied Geoscience Commission: Suva, Fiji, 19 p.
- Krüger, J., Sharma, A. and Kumar, S. 2008. High-Resolution Bathymetric Survey of Aitutaki, Cook Islands. *EU EDF9 - SOPAC Project Report 122*. Pacific Islands Applied Geoscience Commission: Suva, Fiji, vi + 41 p. + 1 chart.
- Sharma, A. and Krüger, J. 2008. High-Resolution Bathymetric Survey in Kiribati. *EU EDF 8/9– SOPAC Project Report 114*. Pacific Islands Applied Geoscience Commission: Suva, Fiji., vi + 56 p. + 5 charts.
- Krüger, J. and Sharma, A. 2008. High-Resolution Bathymetric Survey of Nauru. *EU EDF 8/9– SOPAC Project Report 116*. Pacific Islands Applied Geoscience Commission: Suva, Fiji, vi + 28 p. + 1 chart.
- Krüger, J. and Sharma A. 2008: High-Resolution Bathymetric Survey in Solomon Islands. *EU EDF 8 – SOPAC Project Report 113*. Pacific Islands Applied Geoscience Commission: Suva, Fiji, vi + 52 p. + 4 charts.
- Krüger, J. and Sharma, A. 2008. High-Resolution Bathymetric Survey of Tongatapu and Niuafo'ou, Tonga. *EU EDF 8 – SOPAC Project Report 111*. Pacific Islands Applied Geoscience Commission: Suva, Fiji, vi + 38 p. + 3 charts.
- Krüger, J. and Sharma A. 2008: High-Resolution Bathymetric Survey of Efate, Vanuatu. *EU EDF 8 – SOPAC Project Report 110*. Pacific Islands Applied Geoscience Commission: Suva, Fiji, vi + 50 p. + 10 charts.
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