ASIA-PACIFIC NETWORK FOR
GLOBAL CHANGE RESEARCH

2018 Final Report
CRRP2016-03MY-Nunn

Risk and Resilience in the Pacific: Influence of Peripherality on Exposure and Responses to Global Change

The following collaborators worked on this project:

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2. Mr. Eugene Joseph, Conservation Society of Pohnpei, Federated States of Micronesia, csp@serehd.org

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Project Overview

Project Duration	**:**	Three Years
Funding Awarded	**:**	US$ 68,506 for Year 1; US$ 39,684 for Year 2; US$ 55,330.02 for Year 3
Key organizations involved	**:**	1. The University of the Sunshine Coast, Australia *Contacts: Prof. Patrick Nunn, Ms Roselyn Kumar* 2. The Institute of Applied Sciences, University of the South Pacific, Fiji *Contacts: Dr Isoa Korovulavula, Teddy Fong, Alfred Whippy* 3. The Fiji Museum, Fiji Islands *Contacts: Sipiriano Nemani (Director)* *Elia Nakoro, Mereoni Bekanimoli* 4. The Conservation Society of Pohnpei, Pohnpei, Federated States of Micronesia *Contacts: Eugene Joseph (Director), Iakob Ioannis, Francisca Sohl* 5. The Historical Preservation Office, Yap, Federated States of Micronesia *Contacts: Francis Reg (Director), John Runman* 6. Micronesia Conservation Trust *Contact: Tamara Greenstone-Alefaio* 7. Kosrae Conservation Safety Organization *Contact: Andy George (Director), Dison Kephas*

Project Summary

In order to understand the nature of peripherality in Pacific Island communities and its potential for enhancing the design/communication of assistance for climate change adaptation, a series of 73 communities were visited in the Federated States of Micronesia and Fiji. Spaced out along core-periphery gradients in these archipelagic countries, a comprehensive questionnaire was administered in each community, data from which allowed the development/calculation of three 'peripherality indices' to capture community understanding of global climate change as well as their autonomous capacity for coping with environmental adversity.

It is clear that peripherality could be used in other geographical contexts, especially in developing countries, to map community diversity, identifying those that require most external

assistance and those that require least. One thing became clear is how there are trends of increasing dependency (on funding and outside assistance) in most communities for coping with environmental adversity, including the effects of climate change. Given the likely funding futures, this trend is dangerous, even maladaptive, and should be reversed. It is in the interest of all actors to promote greater autonomy among such communities.

Keywords: Peripherality; climate change; traditional knowledge; autonomous coping capacity; dependency.

Project outputs and outcomes

Project outputs

The outputs of this project, as per the original Logical Framework Matrix, are summarized below (Figure 1). Publications refer to those listed in the relevant section.

Summary of project outputs			
Headings (from Logical Framework Matrix)	**Completed (y/n)**	**Outputs**	**Publications**
Results			
A1 - identify communities	y		
A2 - determine risk criteria	y	publications	5, 7, 8
A3 - determine geographic criteria	y	publications	3, 4, 0, 10
A4 - collect data	y	73 communities visited/surveyed	
B1 - analyse data	y (some in progress)	publications	1, 3, 4, 5, 7, 8, 11
B2 - segment intervention	y (some in progress)	publications	3, 4, 7, 8
B3 - map segments	y (some in progress)	publications	3, 7
B4 - extrapolate results	y (much in progress)	publications	6, 9, 10
B5 - communicate results	y	workshops/lectures	
Outputs	y	12 publications, 14 presentations, 4 posters	
Activities/Process			
A1 - core-periphery continuum	y (some in process)	publications	3, 7
A2 - literature survey	y	publications	all 14
A3 - literature survey	y	publications	all 14
A4 - data collection	y	73 communities visited/surveyed	
B1 - calculate peripherality	y	publications	3, 7 (more to come)
B2 - optimal interventions	Y	publications	all 14
B3 - peripherality mapping	y (some in progress)	publications	3, 7
B4 - extrapolated peripherality mapping	y (some in progress)	publications	3, 8
B5 - communication of results	y	workshops, publications etc.	all 14
Means/Input			
A1 - core-periphery continuum	y	publications	3, 7
A2 - literature survey	y	publications	all 14
A3 - literature survey	y	publications	all 14
A4 - data collection	y	73 communities visited/surveyed	
B1 - calculate peripherality	y	publications	3, 7 (more to come)
B2 - optimal interventions	Y	publications	all 14
B3 - peripherality mapping	y	publications	3, 7
B4 - extrapolated peripherality mapping	y	publications	3, 8
B5 - communication of results	y	workshops, publications etc.	all 14

Figure 1. Summary of project outputs

All outputs were produced as intended. The main exception was that rather than 24 communities being identified, a total of 73 communities were identified to capture the diversity of community attributes – something that was uncertain before this survey began. Gathering data from 73 communities (from 18 islands) produced more data than expected when this project was designed, meaning that some of the analysis and write-up is still underway. It is expected that all this will be completed around the end of 2019.

This project has resulted in 12 publications, 14 presentations (including workshop) and four posters. These are listed in the relevant sections and appendices below.

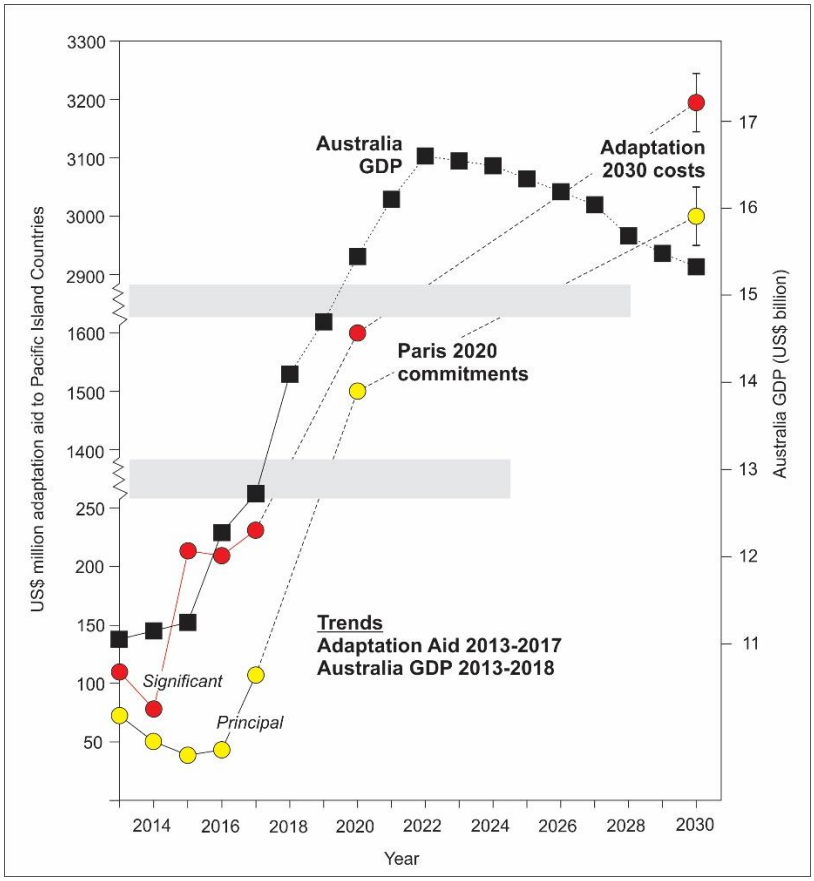
Specific outputs include:

- An extensive socio-cultural-economic database for 73 communities in the FSM and Fiji (see maps below).
- The development of three "peripherality indices" intended to readily capture information from individual communities that allows their degree of peripherality to be measured (Publication 7 and Appendix 2).
- The demonstration that peripherality is a good measure of (traditional) community coping capacity, suitable for informing external interventions for climate change adaptation in the island and in developing-country contexts that are optimally configured to be effective and sustainable (Publications 3, 7).
- The communication to a range of stakeholders of the nature and measurement (using peripherality) of community diversity in non-urban contexts in developing-country (specifically island-archipelagic) contexts (all Publications, but especially 1, 3, 7, 8, 9, 10, 11).
- The demonstration that the loss of traditional knowledge (and community self-belief) is anathemic to future climate-change adaptation, requiring that trends of growing dependency on outside solutions/funding should be reversed (specifically Publications 3, 6, 12).

Project outcomes

The intention of developing an easily-usable tool for the rapid characterization of community peripherality was achieved in this project. Through current, impending and future communication, it is expected that this tool will become used widely to help governments, donor agencies and other actors understand the diversity of communities in places like archipelagic countries in the Pacific (and other developing countries in the Asia-Pacific) – and in turn move away from the widespread "one size fits all" approach that has demonstrably failed to produce effective or sustainable adaptation to climate change.

This project has identified the diversity of community needs for achieving optimal adaptation to future climate change, and it is expected that the communication of project results to governments and other agencies will result in better-aligned adaptation in the future. In particular, several of the papers and presentations have highlighted the need to reverse trends of decreasing self-reliance (falling resilience) and increasing dependency, especially because it is unlikely that external funding to underwrite costs of future climate change adaptation will continue to increase. This point is illustrated in Figure 2, a figure from Publication 6.



Graph showing the trends of recent adaptation aid to Pacific Island Countries together with Paris 2020 commitments and likely 2030 adaptation costs (left-hand axis) plotted against GDP data, actual and projected for Australia (right-hand axis). While there remain sizeable gaps between projected needs and commitments, this paper argues that these gaps will become even wider as donor countries divert increasingly amounts of revenue towards domestic adaptation over the next decade and beyond. Data on the left-hand axis are total adaptation aid (2016 constant US$ million) from OECD DAC donors with projected proportions (averaged from % Oceania over total Developing Country adaptation aid, 2013-2017, separated by principal [1.5%] and significant [1.6%]) (stats.oecd.org), yellow and red circles respectively, applied to Paris Agreement commitment of $100 billion/year for adaptation in developing countries by 2020, and based on 2014 and 2016 Adaptation Gap Reports (unenvironment.org) for costs (estimated $200±50 billion) of developing-country adaptation in 2030. Data on the right-hand axis (black squares) are GDP data (OECD in US$ billion) for 2013-18 assumed to continue average growth until 2022 when the 1.5 degree Celsius threshold is crossed and GDP drops for Australia by $6.58 billion/year; thence until 2025 when the 2 degree

Figure 2. Trends of adaptation aid to the Pacific Island countries

Results of this project have been communicated widely, including direct community feedback in FSM (March 2019) and Fiji (June-July 2019). Community-level knowledge and behaviour have been tangibly informed by this project, which localized results (stressors and solutions), and which focused on growing community self-belief in their abilities to adapt to climate change – without waiting for external assistance.

Through engaging with Pacific Island nationals in the conduct of research and the presentation and dissemination of project results, this project has unarguably empowered early-mid career academics from the Pacific region to question the efficacy of past approaches and drive evidence-based solutions that are more likely to be effective and sustainable. The important issue of Pacific Island people "owning" climate-change adaptation has also been addressed, through the communication of the issue with key decision-makers using their preferred vernacular languages.

Key facts/figures

Using a detailed questionnaire survey, peripherality was measured in 49 communities in Fiji (see Figure 3) and 24 communities across three States in FSM (4 in Kosrae, 16 in Pohnpei, 4 in Yap – see maps below).

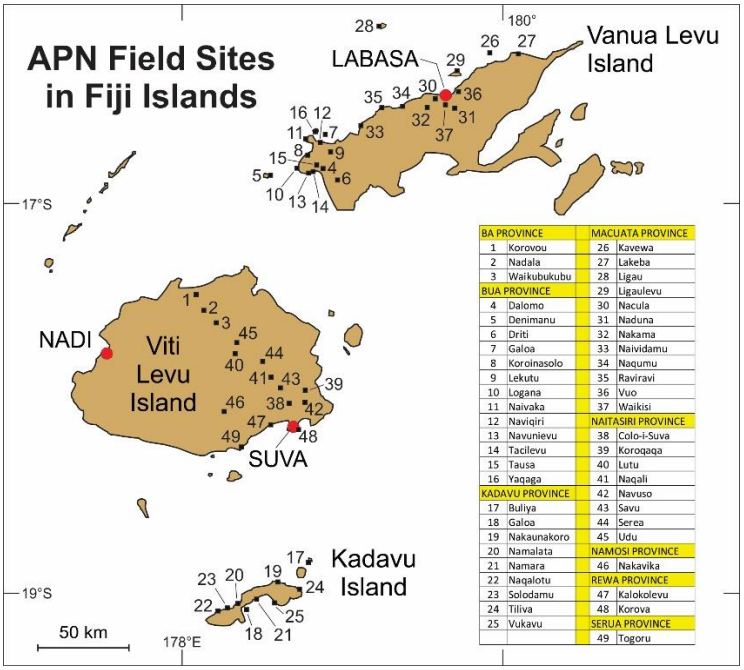


Figure 3. Field sites in Fiji Islands

In the Fiji Islands, the pilot study was done in western Vanua Levu Island (publications 4 and 7 below) and subsequently extended along the island's north coast. In association with the Fiji project partner, a study was carried out of communities along the cross-island road on Viti Levu Island (publication 3 below) and in the remote/peripheral Kadavu Island.

In the FSM, initial research was completed on islands (including outlying Pakin) in Pohnpei State (Figure 4) where the project partner focuses.

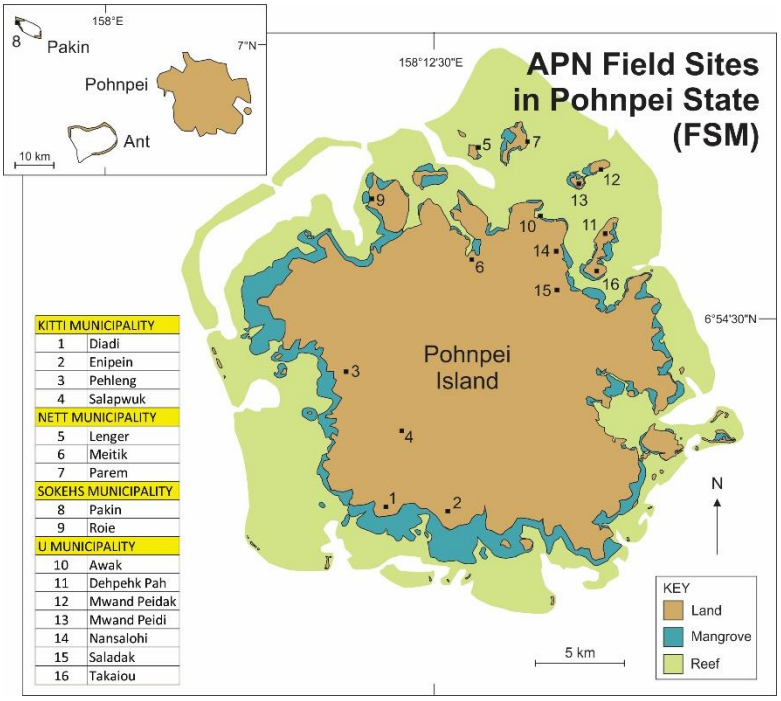


Figure 4. Field sites in Pohnpei State

Also in FSM, together with local project partners, peripherality was measured for a range of peripheral communities in Kosrae and Yap States (Figure 5).

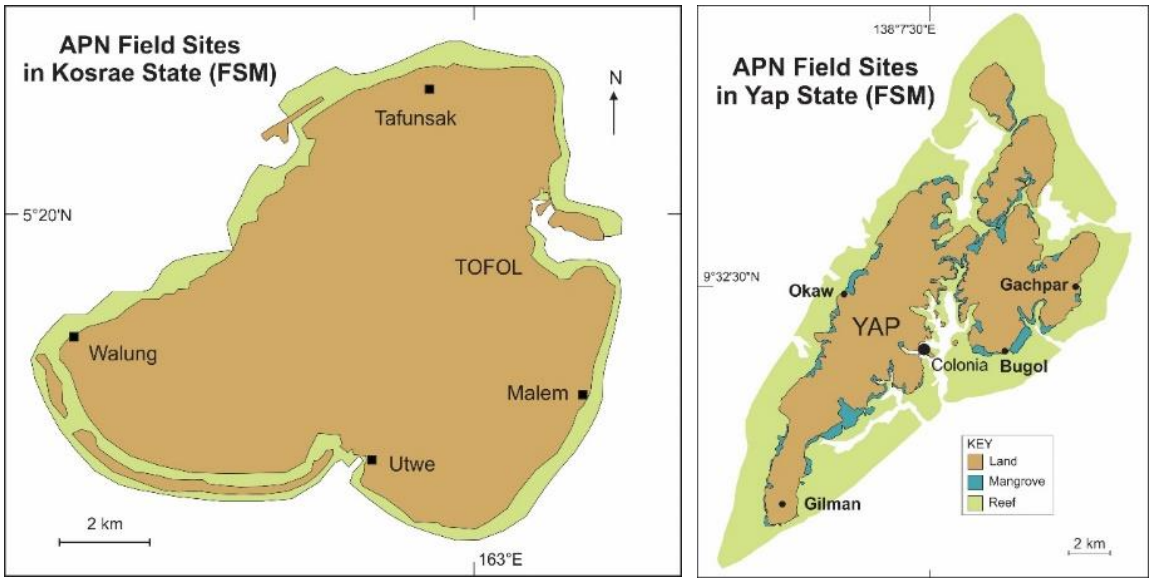


Figure 5. Field sites in Kosrae State and Yap State

As an example of data analysis, the following table calculates the peripherality indices (Figure 6; developed in Paper 7 below) for most FSM and Fiji communities and draws out information about traditional/western medicine preferences and the likely explanations of these, something discussed in Paper 3 below that will also be the subject of a future publication.

COUNTRY / DISTRICT / COMMUNITY NUMBER (on map)	COMMUNITY NAME	PERIPHERALITY INDICES			QUESTION 4a	QUESTION 4c	QUESTION 4d	QUESTION 4l
		Index 1 (Geography)	Index 2 (Population and Employment)	Index 3 (Tradition and Global Awareness)	How long to hospital (hours one way)?	How much to hospital (US$ one way)?	Average frequency of hospital visits (annual)?	Community preference (traditional or western medicine)
FEDERATED STATES OF MICRONESIA								
KITTI MUNICIPALITY								
1	Diadi	5.00	1.67	3.26	0.75	$1.00	12	w
2	Enipein	2.81	3.54	2.32	1	$5.00	15	t
3	Pehleng	5.00	3.54	3.17	0.75	$2.00	10	t
4	Salapwuk	2.81	2.08	2.75	2	$5.00	36	t
NETT MUNICIPALITY								
5	Lenger	5.00	1.98	2.30	0.2	$5.00	3	t
6	Meitik	5.00	0.42	3.80	0.33	$1.00	12	w
7	Parem	3.75	3.44	1.62	0.67	$12.00	20	t
SOKEHS MUNICIPALITY								
8	Pakin	2.50	1.98	2.72	3	$50.00	24	t
9	Roie	2.50	4.17	2.85	0.75	$1.00	12	t
U MUNICIPALITY								
10	Awak	5.00	2.71	2.92	0.42	$2.00	40	t
11	Dehpehk Pah	5.00	1.88	1.06	0.33	$2.00	24	t/w
12	Mwand Peidak	3.75	1.67	1.65	0.67	$20.00	5	t
13	Mwand Peidi	3.75	1.77	1.50	0.2	$2.00	10	t
14	Nansalohi	5.00	1.98	1.92	0.67	$2.00	10	tt
15	Saladak	5.00	2.08	1.76	0.42	$2.00	12	t/w
16	Takaiou	3.75	2.08	2.67	1	$15.00	3	t/w
FIJI								
BA PROVINCE								
1	Korovou	5.00	1.88	2.95	0.12	$0.44	4	t/w
2	Nadala	5.00	2.60	2.35	5	$6.30	1	t
3	Waikubukubu	5.00	1.77	1.90	1	$12.00	3	w
BUA PROVINCE								
4	Dalomo	2.50	1.04	2.76	3	$5.60	2	w
5	Denimanu	0.16	1.15	2.66	3.5	$71.00	12	t
6	Driti	1.41	1.98	2.83	3.5	$31.50	6	t
7	Galoa	1.56	2.60	1.67	2.15	$23.63	14	t
8	Koroinasolo	0.16	1.88	1.32	5	$41.11	12	t
9	Lekutu	5.00	2.71	3.26	1.5	$4.70	12	t/w
10	Logana	0.31	0.00	1.37	3.5	$44.00	12	t
11	Naivaka	0.47	2.60	0.70	3.45	$55.00	18	t
12	Naviqiri	1.56	1.77	1.25	2.5	$37.80	24	t
13	Navunievu	1.56	0.21	1.68	3	$26.46	9	t
14	Tacilevu	1.56	2.60	2.78	3	$23.81	24	t/w
15	Tausa	2.50	0.94	2.40	3	$7.56	24	t/w
16	Yaqaga	0.47	1.77	0.87	3.5	$25.50	24	t
KADAVU PROVINCE								
17	Buliya	3.75	3.33	1.86	2.5	$102.00	3	t
18	Galoa	5.00	1.98	2.87	0.42	$18.90	12	t
19	Nakaunakoro	3.75	1.88	2.09	1.5	$67.00	8	t
20	Namalata	5.00	4.17	2.82	0.2	$3.15	8	t/w
21	Namara	5.00	2.60	2.27	0.5	$34.65	12	t
22	Naqalotu	5.00	0.94	2.33	0.33	$56.70	15	t
23	Solodamu	3.75	1.98	1.94	0.29	$31.50	12	t
24	Tiliva	3.75	2.71	2.60	1	$69.20	3	t
25	Vukavu	5.00	1.88	2.81	0.58	$94.50	12	t
MACUATA PROVINCE								
26	Kavewa	3.75	0.42	2.00	1.5	$48.00	3	t
27	Lakeba	3.75	0.21	1.75	1	$3.15	3	t
28	Ligau	3.75	0.94	1.74	0.83	$12.60	2.5	t
29	Ligaulevu	3.75	0.21	2.39	0.5	$10.90	4	t
30	Nacula	5.00	3.33	2.21	0.17	$2.52	4	t/w
31	Naduna	5.00	5.00	2.88	0.33	$0.82	11	w
32	Nakama	5.00	1.67	2.88	0.83	$1.10	25	w
33	Naividamu	2.50	1.67	2.33	2.5	$3.40	2	t/w
34	Naqumu	5.00	1.98	2.38	1.5	$3.00	1	t/w
35	Raviravi	3.75	1.88	2.58	0.87	$6.30	12	w
36	Vuo	5.00	0.31	3.30	0.5	$0.69	9	w
37	Waikisi	5.00	4.17	2.87	0.75	$1.16	13.5	w
NAITASIRI PROVINCE								
38	Colo-i-Suva	5.00	1.15	2.76	0.58	$1.13	8	t/w
39	Koroqaqa	5.00	3.33	2.48	0.42	$0.72	2	w
40	Lutu	3.75	0.52	2.41	3	$6.02	1	w
41	Naqali	5.00	1.77	3.31	0.5	$1.76	4	w
42	Navuso	5.00	1.98	3.46	0.1	$0.44	8	w
43	Savu	5.00	2.71	2.67	0.75	$0.72	2	t
44	Serea	5.00	2.08	3.39	0.5	$0.69	8	w
45	Udu	3.75	0.31	1.73	1.5	$6.21	1	t/w
NAMOSI PROVINCE								
46	Nakavika	2.81	3.33	1.02	1.5	$31.50	3	t
REWA PROVINCE								
47	Kalokolevu	5.00	5.00	2.93	0.5	$0.95	3	t/w
48	Korova	5.00	1.15	2.85	1	$0.88	3.5	w
SERUA PROVINCE								
49	Togoru	5.00	0.21	3.11	0.33	$5.10	5.1	w

Figure 6. Calculation of the peripherality indices

General statistics –

- In most communities visited as part of this project, data was gathered from 2-5 focus groups and key persons. In this way, an estimated 630 people gave their informed consent and participated in this project.
- From project partners, 13 people (listed above) were involved in this project, all Pacific Island nationals. The Research Assistant employed part-time on this project (Roselyn Kumar), who helped gather data from communities in FSM and Fiji, is also a Pacific Islander completing her PhD.
- Seven early-career scientists from the Pacific Islands region have (to date) contributed to publications emanating from this project, some (Fong, Korovulavula, Kumar) to more than one.

Potential for further work

This project has raised many questions that merit further research, as elaborated in Section 5 below. These include

- the extension of peripherality studies from the two case-study nations in the Pacific to developing countries elsewhere;
- the growing need to reverse trends of increasing dependency and replace them with ones involving increasing (community/national) autonomy and self-belief; and
- the pressing need to educate external actors (like donor agencies) about the dangers of dependency and urge them to embrace more sustainable models of assistance for climate-change adaptation.

Publications

This section lists the 12 publications (to date) to have resulted from this project. The names of people directly involved in this project are underlined.

Publications

1. Fink, M., Klöck, C., Korovulavula, I., & Nunn, P. D. (in review). Community participation, situated knowledge and climate change (mal-)adaptation in rural island communities: evidence from artificial shoreline-protection structures in Fiji. In S. Moncada, L. Briguglio, H. Bambrick, I. Kelman, C. Iorns, & L. Nurse (Eds.), *Climate Change and Development in Small Island Developing States*. Berlin: Springer.

2. Klöck, C., & Nunn, P. D. (2019). Adaptation to climate change in Small Island Developing States: a systematic literature review. *Journal of Environment and Development*. doi:10.1177/1070496519835895

3. Korovulavula, I., Nunn, P. D., Kumar, R., & Fong, T. (in review). Peripherality as key to understanding opportunities and needs for effective and sustainable climate-change adaptation: a case study from Viti Levu Island, Fiji. *Climate and Development*.

4. Martin, P. C. M., Nunn, P. D., Leon, J., & Tindale, N. (2018). Responding to multiple climate-linked stressors in a remote island context: the example of Yadua Island, Fiji. *Climate Risk Management, 21*, 7-15. doi:10.1016/j.crm.2018.04.003

5. Nunn, P. D., & Kumar, R. (2018). Understanding climate-human interactions in Small Island Developing States (SIDS): implications for future livelihood sustainability. *International Journal of Climate Change Strategies and Management, 10*(2), 245-271. doi:10.1108/IJCCSM-01-2017-0012

6. Nunn, P. D., & Kumar, R. (forthcoming-a). Cashless adaptation to climate change in developing countries: unwelcome yet unavoidable? *One Earth*.

7. Nunn, P. D., & Kumar, R. (forthcoming-b). Measuring peripherality to improve and sustain climate-change adaptation in island contexts: a case study of Bua Province, Fiji Islands. *Social Sciences*.

8. Nunn, P. D., McLean, R. F., Dean, A., Fong, T., Iese, V., Katonivualiku, M., . . . Tabe, T. (forthcoming). Adaptation to climate change: contemporary challenges and perspectives. In L. Kumar (Ed.), *Climate Change and Impacts in the South Pacific*. Berlin: Springer.

9. Nunn, P. D., & McNamara, K. E. (in review). Failing adaptation in island contexts: the growing need for transformational change. In C. Klock & M. Fink (Eds.), *Dealing with Climate Change on Small Islands: Towards Effective and Sustainable Adaptation*. Gottingen: Gottingen University Press.

10. Piggott-McKellar, A., McNamara, K., Nunn, P. D., & Watson, J. (2019). What are the barriers to successful community-based climate change adaptation? A review of grey literature. *Local Environment*. doi:10.1080/13549839.2019.1580688

11. Piggott-McKellar, A., McNamara, K. E., Nunn, P. D., & Sekinini, S. (2019). Moving people in a changing climate: lessons from two case studies in Fiji. *Social Sciences, 8*, #133. doi:10.1080/13549839.2019.1580688

12. Westoby, R., McNamara, K. E., Kumar, R., & Nunn, P. D. (in review). Is community-led adaptation the way forward? *Global Environmental Change*.

Awards and honours

The proponent's background and interests in the areas of climate change, in addition to his recent work in this area in the Pacific as result of this APN-funded project, led to the proponent being invited in mid-2017 to prepare a new **National Climate Policy** for the Government of Fiji, which was presented to the COP23 summit in Bonn, Germany in November 2017.

The proponent's expertise in the areas of climate change in the Pacific and numerous publication outputs led to his nomination by the Government of the Federated States of Micronesia, the Government of Fiji, and the Government of Australia to the 6th Assessment Report of the **Intergovernmental Panel on Climate Change** in June 2018. Note especially the role of this APN project, which focused on the Federated States of Micronesia and on Fiji. The proponent was subsequently appointed as Lead Author on the 'Small Islands' chapter of the 6th Assessment Report.

The proponent was awarded the **J. P. Thomson Gold Medal** of the Royal Geographical Society of Queensland in May 2018 for his novel research linking oral histories to periods of significant changes in the environment. The APN project provided the proponent with opportunities to visit various communities in the Pacific to collect a range of relevant data about traditional knowledge for coping with environmental adversity. The proponent also presented the 2018 **Thomson Oration** at the Society.

Pull quote

"Treat Climate Change as a Challenge and not a Threat"

Professor Patrick Nunn, University of the Sunshine Coast, Proponent on the APN Project, CRRP2016-03MY. The above quote was used by a staff member of the **Fiji Museum, Ms. Mereoni C. Bekanimoli (Field Archaeologist)** at a conference in Japan. Ms. Bekanimoli provided technical assistance to the APN project in Fiji. This quote goes to the heart of the research conducted in this project, which is that external solutions for climate-change adaptation are sometimes poorly designed and indifferently received (because they appear alien) by rural Pacific Island communities which often have considerable (culturally-grounded) knowledge for coping with environmental adversity.

Acknowledgments

The APN project would not have been successful and the results equally illuminating without the constant support and assistance of the following;

Institutions

- Conservation Society of Pohnpei (CSP)
- Fiji Museum
- Historical Preservation Office, Yap (HPO)
- Institute of Applied Sciences, University of the South Pacific (IAS)
- Kosrae Safety and Conservation Office
- Micronesia Conservation Trust
- Ministry of Education, Fiji
- Ministry of *iTaukei* (Fijian) Affairs
- National FSM Historic Preservation Office- Pohnpei
- Provincial Offices for Bua, Kadavu, Macuata, Nadroga Rewa, Serua in Fiji
- University of the Sunshine Coast (USC)

Technical Resource Personnel

- Andy George (Director, Kosrae Safety and Conservation Office
- Augustine Kohler, (National Historical Preservation Officer, FSM)
- Dr Isoa Korovulavula (Institute of Applied Sciences, University of the Sunshine Coast)
- Elia Nakoro (Manager, Archaeology, Fiji Museum)
- Eugene Joseph (Director, Conservation Society of Pohnpei)
- Francis Reg, (Yap State Historical Preservation Officer)
- Francisca Sohl Obispo (Terrestrial Program Manager, Conservation Society of Pohnpei)
- Iakob Ioannis (Environmental Educator, Conservation Society of Pohnpei)
- Kirino (Conservation Society of Pohnpei)
- Losalini Makareta (Resident, Savu village)

- Mereoni Camailakeba Bekanimoli, (Senior Archaeological Field Officer, Fiji Museum)
- Tamara Greenstone-Alefaio (Conservation Program Manager, Micronesia Conservation Trust)
- Ratu Sakiusa Nagata (Chief of Gusuituva)

Communities
Fiji:
Buliya, Colo-i-Suva, Dalomo, Denimanu, Driti, Galoa (Bua), Galoa (Kadavu), Kalokolevu Kavewa, Koroinasolo, Koroqaqa, Korova, Korovou, Lekutu, Ligau, Ligaulevu, Lutu, Nacula, Nadala, Naduna, Nakama, Nakaunakoro/Nakasaleka, Naivaka, Nakavika, Naqali, Naqalotu, Naqumu, Naividamu, Namalata, Namara, Naviqiri, Navunievu, Navusa, Raviravi, Savu, Serea, Solodamu, Tacilevu, Tausa, Tiliva, Togoru, Udu, Vukavu, Vuo, Wakisi, Waikubukubu, Yaqaga.

Federal State of Micronesia (FSM):
Pohnpei:
Awak, Depehk, Diadi, Enipein, Lenger, Meitik, Mwand Peidak, Mwand Peidi, Nansalohi, Nan-welin-rohi, Pakin Atoll, Parem Atoll, Pehleng, Roie, Saladak, Salapwuk, Takaiou.

Yap:
Bugol, Gachpar, Gilman, Okaw

Kosrae:
Malem, Walung, Tafunsak, Utwe.

1. Introduction

The impacts of climate change will be felt by communities in the Pacific in different geographical locations differently. In particular, it is imperative to understand the effects of climate change in communities far from (peripheral) and near town centres (cores) to avoid applying generic global interventions across all communities – the ubiquitous "one size fits all" - that is rarely effective and sustainable (Piggott-McKellar, McNamara, Nunn, & Watson, 2019). To ensure that external interventions address climate change issues in Pacific Island communities, it is essential to apply meaningful localized adaptations that incorporate traditional knowledge to cope with environmental adversities (Lebel, 2013; Mazmanian, Jurewitz, & Nelson, 2013).

The imposition of generic/global solutions in peripheral and poorer communities may not be as effective as expected because many stakeholders and community members may not be aware of the science behind or convinced of the long-term success of the proposed interventions. This is especially true where key decision-makers have insufficient science education to evaluate the interventions. Also, it is clear that many peripheral/poorer Pacific Island communities favour spiritual rather than science-based solutions. Therefore, there is a need to understand societal dynamics and recognise the value and utility of traditional/local worldviews in such communities. Such a shift seems likely to increase community ownership of adaptation solutions that will optimize their sustainability (Granderson, 2017; Leon et al., 2015; Nalau et al., 2018).

This study addresses global/local issues related to climate change in a range of traditional communities in an insular developing-world context. Communities exhibit various degrees of coping with environmental adversity depending on largely on their degree of peripherality: the distance/time of a particular community from a globally-connected (urban) centre. As proposed by Nunn and Kumar (2018), more-peripheral communities usually have a greater stock of traditional knowledge and use it more often than do less-peripheral (near-core) communities that are usually more globally exposed. This study assesses whether, as many interventions implicitly assume, increasing global awareness is key to effective and sustainable adaptation in such contexts or whether growing the support for local/traditional methods of coping is at least of equal importance.

The study reported here is based on detailed surveys of 73 communities in Fiji and Federated States of Micronesia. The methods involved in data collection from all the communities in Fiji and FSM are described in Section 2. Section 3 describes the results and discusses how key data can be used to assess peripherality and thereby influence interventions for climate change in such developing-country communities. Section 4 provides concluding remarks about the rapid large-scale assessment of peripherality that guide the development of optimal solutions for future climate change adaptation. Section 5 explains how the results of the study show the need for additional investigations into sustainable cash-minimised adaptations for vulnerable communities to address future climate change.

2. Methodology

This section describes the steps taken to carry out the research activities.

All research permits were obtained in 2017 from the relevant state governments of Federated States of Micronesia (FSM) and Fiji. This was necessary before any fieldwork could take place in these two countries. It took almost one year to obtain research permits. The policies and internal management practices of both countries were observed to obtain the permits. Once the permits were issued, it was possible to carry out the fieldwork in Fiji and FSM.

Both research partners from FSM and Fiji have been involved with conducting fieldwork as per the project proposal. To save time and to keep costs within budget, local assistance was sought – with APN's explicit approval - from the Historical Preservation Office in Yap and Kosrae Safety and Conservation Office in Kosrae to help collect data from sample communities.

Community-based questionnaire survey

The survey was designed after multiple consultations with the research partners about how best to collect information on key socio-economic, education, traditional, health, diet, components of communities to understand the vulnerability/resilience of a community concerning its distance from a core centre.

Only those communities in areas, districts and provinces for which we had research permits and formal permissions to interview were engaged. There was no bias in selecting the communities other than they had to be accessible either by vehicle and/or by boat.
Each community was approached in a culturally appropriate manner to strengthen the relationships between the various stakeholders involved and maintain cultural sensitiveness.

All data were collected through the use of a detailed set of questions about a range of topics: population and economy; transport and infrastructure; government services and education; health; communications and technology; culture, tradition and religion; climate, natural disaster prediction and response; water, diet and food production (questionnaire in Appendix 1).

Data were collected from communities mostly through focus-group discussions, the preferred and generally most effective way of gathering information in such contexts (Lata & Nunn, 2012). In most communities, more than one set of data was acquired from groups organized by age group and gender to maximize the chances of gathering all pertinent information and identifying all key issues. Respondents over the age of 18 were considered adults for this project.

The interviews mostly occurred either in community halls, traditional houses, by the beach, and mostly in front of ceremonial drinks in an informal free-flowing style to encourage responses from all gender and age groups (over 18). This less regimented style of interviews is effective in these contexts.

Each survey took approximately three to four hours to complete. All responses to the questions were handwritten during the time of the interviews and later brought to the University of the Sunshine Coast (USC) for analysis.

3. Results & Discussion

All raw data for Fiji and FSM were entered and stored in a large data bank (R Drive) at USC. All primary data were analysed to calculate indices, numerical values that reflect a community's level of vulnerability and resilience (see Appendix 2). The indices have been successfully used to measure peripherality of communities in both FSM and Fiji.

The indices were used to carry out the segmentation of the communities in FSM and Fiji along a core-peripherality continuum so that this information might be used by policymakers and stakeholders to implement appropriate and sustainable climate change intervention pathways for communities. Three examples are given below.

EXAMPLE 1

This example uses the results of surveys in 14 communities in Bua (Fiji) to understand how peripherality 'predicts' community preferences for western or traditional medicine.

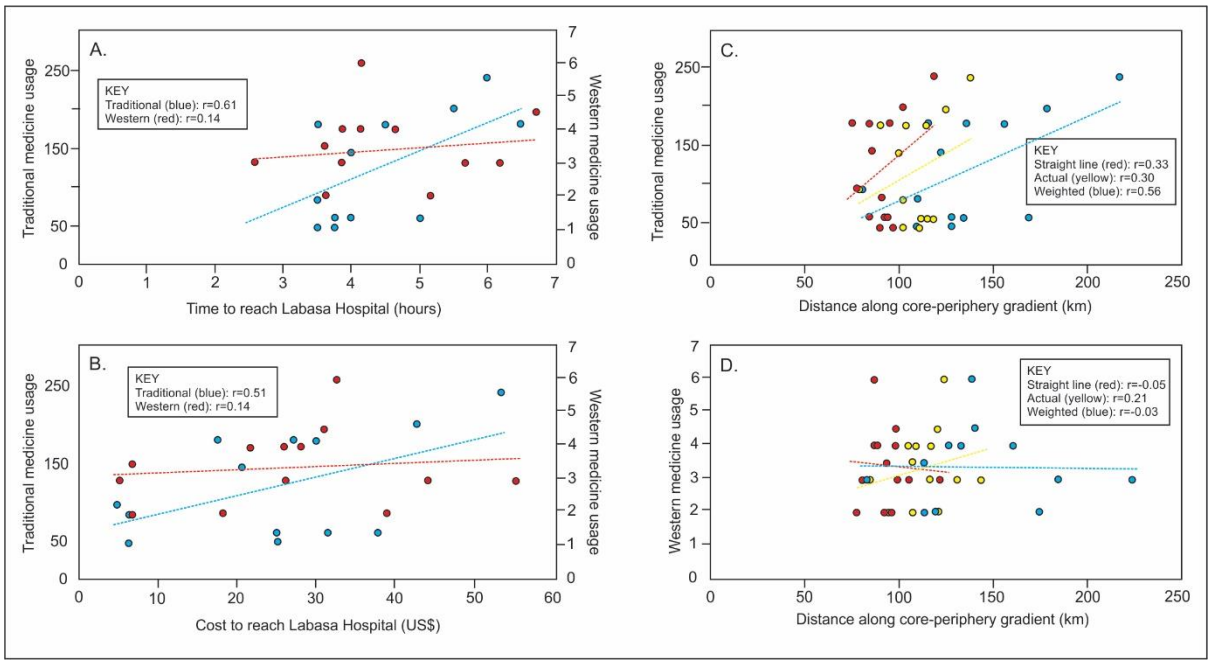


Figure 3.1. Graphs illustrating the comparative usage of traditional and 'western' medicines in the communities of Bua (Fiji). Graphs A and B show that there is a strong relationship between traditional medicine usage and peripherality (as measured respectively by time and cost involved in reaching the full-service hospital in Labasa). This relationship is borne out by the correlations between the three distance measures and traditional medicine use in Graph C; note that the strongest relationship is with weighted distance. The absence of clear relationships between distance and 'western' medicine use (Graph D) suggests the latter is not readily explainable by community peripherality, a conclusion also suggested by Graphs A and B.

EXAMPLE 2

This example considers 11 communities along the cross-island road on Viti Levu Island (Fiji) and reports their medicine preferences as well as their autonomous coping capacity, both of which are readily explained by peripherality.

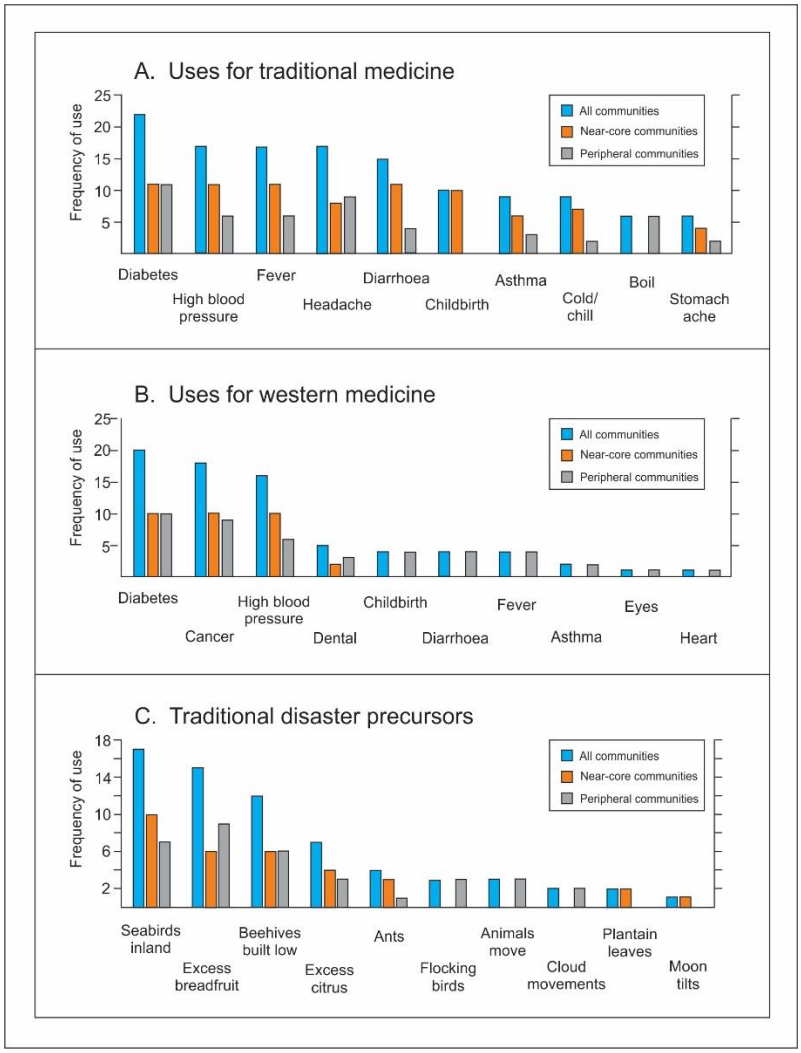


Figure 3.2. Various data related to autonomous community coping. A: Frequency of use of traditional remedies for various ailments (top ten). B: Frequency of use of western (non-traditional) remedies for various ailments (top ten). C: Frequency of use of traditional disaster precursors (top ten).

EXAMPLE 3

Segmentation analysis is almost complete but is illustrated by the map below – from Bua (Fiji) – showing peripherality segments defined by each of Peripherality Indices 1-3 (see Appendix 2).

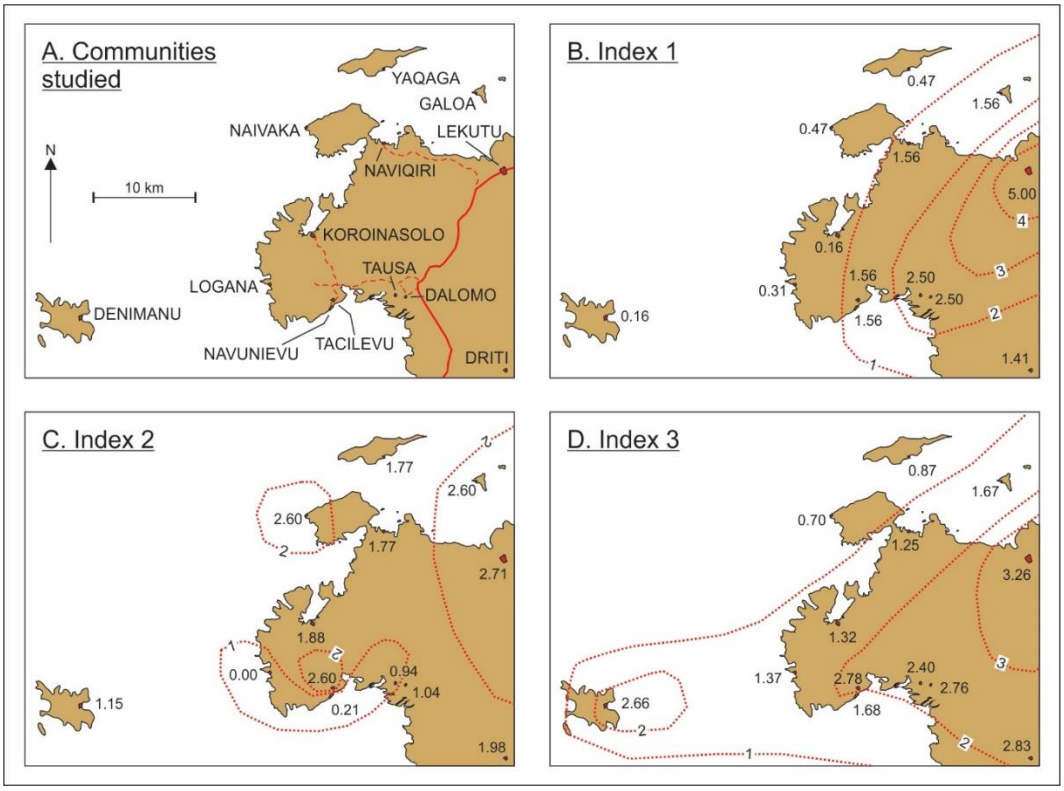


Figure 3.3. Bua peripherality data for Indices 1-3.

Results of data analysis have been communicated to stakeholders in FSM (Pohnpei) and Fiji and numerous outputs (publications, posters, presentations) produced.

The degree of peripherality of a community in FSM and Fiji can be linked with community autonomy, expressed through both the use of traditional medicines and the ability of the community to recover after environmental shocks without external assistance. In the case of traditional medicine, it is clear that its usage can effectively measure peripherality in this situation; the proportion of traditional healers in such communities also appears to be a robust measure of peripherality. In the case of coping (with disasters), it is also clear that traditional knowledge and societal cohesion give more-peripheral communities in the study area the self-belief and ability to recover largely without outside assistance; conversely, near-core communities are generally more dependent on outside assistance in such situations. Both these measures (traditional-medicine usage and traditional-coping ability) can be used as proxies for community autonomy.

More peripheral communities exhibit much higher degrees of autonomy than near-core communities that are more dependent on national/global networks. While not entirely unexpected, this finding is important in many ways, including for understanding which external interventions for climate-change adaptation are likely to succeed and which are likely to fail in particular communities. Clearly, as anticipated by Nunn and Kumar (2018), interventions requiring an understanding of global climate change/science are more likely to succeed in near-core communities; interventions likeliest to be both effective and sustainable in more peripheral communities are those that acknowledge and build on traditional coping abilities and are culturally-grounded rather than framed solely in global/scientific terms (Nunn, Aalbersberg, Lata, & Gwilliam, 2014).

Comparable examples have been documented elsewhere. In outer-island (peripheral) communities in Micronesia, for example, autonomous coping capacity is greater than among those on core islands (Monnereau & Abraham, 2013) but current climate-change impacts are straining this capacity. In such situations, limits to autonomous coping have become clear, particularly in the aftermath of saltwater inundation (attributable to extreme waves produced by rising sea level). In contrast, peripherality is not the key determinant of coping ability among Jamaican fishing communities where gender and occupation/role are of comparable importance (Baptiste & Kinlocke, 2016). A parallel also exists in responses to climate-associated stressors in Nairobi slums (Thorn, Thornton, & Helfgott, 2015) where (more-peripheral) responses in the poorest areas are autonomous but in other (less-peripheral) areas where residents are more prosperous, responses become more informed (and better-funded) just as they are in near-core settings in island archipelagoes.

The practical nature of this research is in developing an easily-calculated and effective tool for measuring the diversity of rural communities in island nations, especially archipelagic ones like Fiji. The motivation for this research was the discovery that many agencies, both national and supranational in island countries, tend to treat *all* rural communities as having the same strengths and frailties, an approach that ignores community diversity of the kind explored here. Given the long history of failed interventions for livelihood sustainability, particularly in the face of future climate change, it was felt important that the efficacy of external investments of time and money should be optimized. Through the calculation of tools like Indices 1-3, it is unequivocally possible to capture the diversity of autonomous community coping capacity. In this way, it should also be possible to design interventions that acknowledge the strengths and weaknesses of a particular community through measurement of its peripherality.

For example, it seems clear that many of the communities that score low on Index 3 have considerable ability to help themselves and are accustomed to doing so. Any externally-driven approach that seeks to sideline the autonomous coping ability of such communities will endanger their sustainability and may prove maladaptive. It is much better in such communities for external interventions to acknowledge inherent community coping capacity and incorporate it into their design.

4. Conclusions

This research explains how three indices that adequately capture community peripherality were calculated in rural archipelagic contexts, something applicable to other peripheral contexts, particularly in developing countries. This approach provides a tool for the rapid assessment of peripherality in similar geographical situations. Among the main applications of calculating peripherality in this way is the demonstration that the autonomous (traditional) capacity of such rural communities to cope with environmental adversity (like climate change or natural disasters) is something that varies. Such information could be used to inform the design of strategies for disaster risk management or climate change adaptation rather than making glib assumptions about all rural communities being equally unequipped to deal with such challenges (Maru, Smith, Sparrow, Pinho, & Dube, 2014; Nunn et al., 2014).

As the pace of 21st-century climate change increases over the next few decades, it will become increasingly important to devise and implement pathways for sustaining such communities in the face of its multifarious impacts. Understanding community peripherality, its implications for vulnerability and resilience, and all this imply permits the development of precise (community-specific) interventions for community sustainability. In addition, as external funding for climate-change adaptation diminishes – as appears probable as problems multiply in donor countries – it will become increasingly important to support the autonomous coping capacity of such rural communities by engaging with their strengths and underwriting their frailties.

5. Future Directions

The demonstration that peripherality is a good measure of *both* community vulnerability and autonomous coping capacity among rural communities in island-archipelagic contexts is something that could be extended to other developing-country contexts, especially in the Asia-Pacific. This could allow country/region-specific tools for the rapid assessment of community diversity/needs to be developed. These tools could be key to future interventions for effective and sustainable adaptation to climate change.

As a result of this project, it is also clear that the autonomous capacity of Pacific Island communities for coping with environmental adversity has been (and is being) significantly eroded by globalization, especially through the growing dependency of such communities on external assistance. This is not a sustainable situation and identifies a trend (growing dependency) that is potentially maladaptive and should be reversed for these communities to remain viable in the next few decades. More research is needed into how to reverse this trend, how to give rural communities in developing countries greater self-belief in their ability to manage and cope with the effects of climate change. Key to this is something the APN research team identified in numerous communities is the potential to reduce their dependency (for climate-change adaptation) on money; in other words, moving towards the cash-minimized adaptation of the kind that proved effective in pre-globalization times in many such communities (see Publication 6 above).

Related to this is the need to educate outsiders, be they aid-donor countries or national governments, about the dangers of the growing dependency of developing countries (and specifically the rural communities within them) on outside assistance to cope with climate change. The current model whereby climate-change adaptation is largely funded by outside funding is not sustainable, especially if, as seems likely, current levels of donor funding are likely to fall in the future. In response, rural communities in the Pacific Islands (and other developing countries) need to acquire more autonomy (less dependency) and to tap into their traditional knowledge to design and drive local strategies for climate change adaptation.

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7. Appendices

Appendix 1. Questionnaire

Name of Community:
Island/Province/Country:
Date when the information was collected (and name of interviewer):
Name(s) and Gender of Key Informants:
Languages used in Interview

1 Population and Economy

a How many people live in this community?
b How many households are there?
c How many people under 21 are normally resident in this community?
d How many people over 65 are normally resident in this community?
e How many people are in in full-time employment at present?
f How many people are in casual/seasonal employment?
g What is the average household income (in US dollars) in this community?

2 Transport and Infrastructure

a What are the three most common types of transport used by people in this community?
b How much does it cost (US$) a person to travel (one way) from their home to the nearest town (see definition below) by the cheapest route?
c How long (hours) does it take a person to travel from their home (one way) to the nearest town by the cheapest route?
d Does the community have any motor vehicles? If yes, what kind and how many of each kind?
e How many households in the community have electricity?
f How is this electricity supplied (what are the sources of electricity)?
g How many solar panels are there in the community?

3 Government Services and Education

a How many people in this community attend primary school?
b Do primary school students go to school and come home every day - or every week - or longer?
c How many people in this community attend secondary school?
d Do secondary school students go to school and come home every day - or every week - or longer?
e How many people staying in this community have completed high school/secondary education?
f How many people from this community attend tertiary institutions (vocational/college/university)?
g Do tertiary students go to college and come home every day - or every week - or longer?
h How many people staying in this community have completed a program of tertiary study?
i How much does it cost (US$) one student to travel to primary school and back?
j How long does it take (hours) one student to travel to primary school and back?
k How much does it cost (US$) one student to travel to secondary school and back?

l How long does it take (hours) one student to travel to secondary school and back?
m Which government departments have offices within 30 minutes walk of the community

4 Health

a How long (hours) does it take to reach the closest hospital (defined as a place where surgery can be performed)?
b How do you get to this hospital (what means of transport do you use)?
c How much does it cost (US$) to reach this hospital (one way)?
d How many times each year does a typical member of an average household in this community visit this hospital?
e How long (hours) does it take to reach the closest medical post (nursing station, dispensary)?
f How do you get there (means of transport)?
g Can the community access an ambulance service?
h If there is a medical emergency, how does the patient get medical treatment in the main hospital by a doctor?
i Do people in this community use traditional (non-western) medicines commonly or rarely (including not at all)?
j What are the main uses for traditional medicines in this community?
k Does the community have any traditional healers? If yes, how many?
l Which does your community mostly prefer, western or traditional medicine?
m Which ailments or diseases do people in the community prefer to treat using western medicine?
n How many times each month does a typical member of an average household in the community use traditional medicine?

5 Communications and Technology

a How many televisions are there in the community?
b Is the television signal reliable and the reception quality good?
c How many television channels can the community receive well?
d How many mobile phones are there in the community?
e Do people have reliable phone reception?
f What sources of information do most people in the community use to find out what is happening on other islands and overseas?
g How many people access internet services in the community?
h What do people in this community use to access internet?
i Do people in the community use Facebook, Facebook messenger, Twitter, Viber and Instagram?
j Which social platform do people in this community use most?
k Is there a (working) radiotelephone (RT) or similar in the community?

6 Culture, Tradition and Religion

a How many different religions are followed by people in this community?
b How many churches/temples are there in or close to this community that serve its members?
c What are the most common types of equipment that community members use to garden or farm?

d Do members of this community use mechanized aids (like tractors) to help them garden/farm?
e How do members in the community water their food gardens?
f What are the most common types of equipment that community members use to fish?
g What are the most common types of equipment that community members use to hunt feral land animals?
h Which materials do members of the community commonly use to build their houses?
i How often do most (>80%) of heads of households in this community meet?

7 Climate, Natural Disaster Prediction and Response

a What are the three most common types of natural disaster that affect this community?
b Explain the main impacts (maximum two) of each type of the natural disaster.
c How does the community know when a disaster is about to strike them?
d Does the community have any traditional knowledge (passed down by older generations) about the signs of imminent disaster? If yes, please explain.
e In the last five years, how many times has this community been affected by a natural disaster?
f In the last five years, how many times did the government provide assistance after a natural disaster?
g What type of assistance do you receive from the government/others after such disasters?
h Is this assistance adequate?
i Does your community have traditional ways (passed down from ancestors) about how to cope with the effects/impacts of natural disasters? If yes, please provide more detail.
j What are some of the changes you have noticed taking place in the environment?
k Why do you think these changes are taking place?
l What have you tried doing to prevent/slow these changes in the environment from taking place? Did these actions help?
m Has the community received any outside support or advice about how to cope with environmental changes?
n If yes (to Question 7m), then which organisations gave this support/advice, and has it helped or not?

8 Water, Diet and Food Production

a How do members in the community obtain drinking water?
b Do members of the community use rainwater for drinking?
c Do members of the community use rainwater for washing?
d Is the supply of water adequate for community needs? If no, then how does the community cope?
e Is the quality of water suitable for drinking? If no, then what does the community practice to make the water safe to drink?
f Have you experienced drought affecting the community's water supply? If yes, how often does drought occur?
g If yes, how did you cope?
h How much of the food consumed by this community does it produce (%)?
i What are the ten most common foods that the community produces for its own consumption?
j Does the community have enough land for producing food?
k Does the community have enough access to ocean for obtaining seafood?

l How many shops are there within 30 minutes walk of this community?
m What are the five most common items the community purchases from these shops?
n How much does each of these five items cost (per unit) in these shops?
o How many times each week does the average household in the community buy food from the shops?
p In one week for an average household, how many meals (from 21 meals per week) are eaten with mainly food from the garden or sea?
q In one week, does the average household eat more shop-bought food than food they get by themselves from the land and sea?

Appendix 2. Calculation of Indices A-C (in Bua, Fiji)

Each of the ten variables (contributing to three indices) discussed below are scored linearly or non-linearly, depending on what the researchers – through expert knowledge (see above) - consider to be appropriate values for separating the range of Bua communities along a notional core-periphery gradient. For example, there are four scores available for variable 3A (mobile phones per capita) that weight low numbers disproportionately, something considered to capture difficulties of mobile phone reception in a particular community as well as the often prohibitive cost of purchasing phone credit by its residents. In another example, again reflecting the nature of the periphery-biased Bua data, variable 2C (% community residents in fulltime employment) is weighted towards lower numbers yet gives disproportionately high scores to higher numbers (>35%) both because this is an unusual situation in such geographical contexts but also because it proxies community income which is itself considered a good proxy for engagement with 'cores' irrespective of distance.

Note that some of the ways in which particular variables below are scored are specific to the (periphery-weighted) situation in Bua; it is anticipated that these variables might be scored slightly differently in other situations.

B1. Index 1: Geography

Travel time to the nearest town (A) is the first variable in Index 1, measured in hours of usual/normal (not express) travel from the community to town. Note this is travel time not waiting time (for buses, for example). Thus, A=0.6 if usual travel time is >6 hours; A=0.75 if usual travel time is >5-6 hours; A=0.9 if usual travel time is >4-5 hours; A=1.8 if usual travel time is 3-4 hours; and A=3 if usual travel time is <3 hours. The underlying assumption is that the closer a community is to town, the better its access to services, (government) outreach, and global information sources. Conversely, the further a community is from town, the more likely it is to be globally uninformed/unaware.

Cost of travel to the nearest town (B) is the second variable in Index 1 and is the one-way cost (in US$) for an adult using the usual/normal method of travel. Thus, B=0.6 if cost is ≥US$50; B=0.75 if cost is US$>25-<50; B=0.9 if cost is US$>15-25; B=1.8 if cost is US$>5-15; and B=3 if cost is <US$5. The assumption is that the cheaper it is for members of a community to reach the town, the more likely they are to access services available there. Conversely, the costlier it is for members of a community to reach the town, the less likely they are to (routinely) access the services available there.

In order to scale Index 1 for direct comparison with other peripherality indices in this study, the sum of A and B are adjusted as follows –

Index 1 = [(A + B) – 1.2]/0.96

Low scores (≤2) suggest comparatively high peripherality while high scores (≥4) suggest the opposite[1].

B2. Index 2: Population and employment

Community size (A) is the first variable used in Index 2 and is the usual number of residents, excluding temporary ones like children boarding to attend school. It is clear that this variable does not necessarily correlate with distance along the core-periphery gradient because community size is determined not only by opportunities (for wage employment, for perceived high quality of education, better access to services) that can be realized close to core areas but also by land and (food) resource availability, by livelihood opportunities, and by traditional ties to place and obligations to those living there. Five categories are recognized: A=0.6 if community size is <30; A=0.75 if size is 30-79; A=0.9 if size is 80-149; A=1.8 if size if 150-249; and A=3 if size is ≥250. Note that the use of a non-linear scale here weights higher community sizes more than lower ones, a reflection of the finding from Bua that a large community is – irrespective of location – potentially more coherent and generally better able to cope as a unit with environmental challenges.

Age distribution (B) is the second variable used in Index 2 and is calculated from the percentage (plus 100) of the population over 65 years minus the percentage of the population below 21 years of age. The older population crudely measures the amount of traditional knowledge available while the younger population crudely measures the amount of global knowledge available. Thus, B=0.6 if calculated age distribution is <95; B=0.75 if calculated age distribution is >90-95; B=0.9 if calculated age distribution is >85-90; B=1.8 if calculated age distribution is >70-85; and B=3 if calculated age distribution is ≤70. The assumption is that the higher the proportion of older people in a community, the greater its potential autonomous (tradition-based) coping ability. Conversely, the higher the proportion of younger people, who commonly undervalue the efficacy of traditional coping strategies, the more dependent the community is likely to be on external guidance, especially for coping with environmental adversity.

Persons in fulltime waged employment (C) is the third and final variable used to calculate Index 2 and is calculated as a percentage of the total population in a community. Thus, C=0.6 if waged proportion is 0; C=0.75 if waged proportion is >0 but <5%; C=0.9 if waged proportion is 5-<15%; C=1.8 if waged proportion is 15-35%; and C=3 if waged proportion is >35%. The assumption is that the more wage earners in a community, the more financial resources it has available to cope with environmental adversity and to adopt adaptive solutions informed by global knowledge.

In order to scale Index 2 for direct comparison (lowest possible value of 0, maximum 5) with other peripherality indices in this study, the sum of A, B and C is adjusted as follows –

Index 2 = [(A + B + C) – 1.8]/1.44

[1] Note that the arithmetic changes to the sum of A and B first require that the lower bound is set to zero (the lowest possible score is 0.6+0.6=1.2) by subtracting 1.2 from the total. Then to make the total out of 5, scores are in this case divided by 0.96.

Low scores (≤2) suggest comparatively high peripherality while high scores (≥4) suggest the opposite[2].

B3. Index 3: Tradition and global awareness

Mobile phones *per capita* (A) is the first variable used to calculate Index 3. Thus, A=1.5 if mobile phones *per capita* is <20%; A=1.8 if mobile phones *per capita* is >20-<30%; A=2.2 if mobile phones *per capita* is >30-<50%; and A=3 if mobile phones *per capita* is ≥50%. The assumption is that the more (routinely functional) mobile phones in a community, the more globally exposed it is – and thus more potentially able to access global knowledge for coping with environmental adversity. The fewer the mobile phones in a community, the less globally exposed it is expected to be – and therefore less informed about non-traditional ways for coping with environmental adversity.

The use of western versus traditional health solutions (B) is the second variable used to calculate Index 3 and is measured by answers to three questions (B1-B3) about preferences, uses, and the number of (traditional) healers in a community. Thus, B1=1 if people prefer traditional over western medicine; or B1=2 if people prefer western over traditional medicine. Then B2=1 if people frequently/routinely use traditional medicines; or B2=2 if people rarely/never use traditional medicines. Then B3=1 if the community has resident traditional healers, or B3=2 if the community does not have traditional healers.

Thus,

$B = (B1 + B2 + B3)/2$

The assumption is that greater the use of traditional medicines and the existence of people practised in their use, the more traditional knowledge the community is likely to have, knowledge that probably extends to other aspects of community life and is, therefore, a measure of traditional community resilience.

The nature of coping with natural disasters (C) is the third variable used to calculate Index 3 and is measured by answers to four questions (C1-C4) about the traditional knowledge of disaster precursors, post-disaster external/government support, traditional coping, and the use of outside advice/support. Thus, C1=1 if people have meaningful traditional knowledge of disaster precursors; or C1=2 if people do not have meaningful traditional knowledge of disaster precursors. Then C2=1 if government assistance was received promptly in the aftermath of <70% of disasters; or C2=2 if the government assistance was received promptly in the aftermath of >70% of disasters. Then C3=1 if the community uses traditional coping methods; or C3=2 if the community does not use traditional coping methods. Then C4=1 if the community has not received outside support/advice about how to cope with the impacts of natural disasters; or C4=2 if the community has received such support/advice.

Thus,

[2] Note that the arithmetic changes to the sum of A and B and C first require that the lower bound is set to zero (the lowest possible score is 0.6+0.6+0.6=1.8) by subtracting 1.8 from the total. Then to make the total out of 5, scores are in this case divided by 1.44.

C = (C1 + C2 + C3 +C4)/2.67

The assumption is that the greater the traditional knowledge and (autonomous) coping capacity of a community, the less dependent it is on external assistance. Conversely, a community that has no or little traditional knowledge is likely to be more dependent on outside assistance for coping with environmental adversity – and to make uninformed decisions when that assistance is absent.

Diet (D) is the fourth variable used in the calculation of Index 3 and reflects the relative use of locally-acquired foods and shop-bought foods, as measured by answers to four questions (D1-D4) about the consumption of local produce, the number of nearby shops, the frequency of shop-bought food consumption, and the number of shop food-based meals per week. Thus, D1=1 if the community produces/catches ≥80% of the food it routinely consumes; or D1=1.5 if the community produces/catches 60-<80% of the food it routinely consumes; or D1=2 if the community produces/catches <60% of the food it routinely consumes. Then D2=1 if there are no shops within 30 minutes walk of the community; or D2=1.5 if there is one shop within 30 minutes walk of the community; or D2=2 if there is more than one shop within 30 minutes walk of the community. Then D3=1 if an average household buys food from shops ≤3 times a week; or D3=1.5 if an average household buys food from shops 4-5 times a week; or D3=2 if an average household buys food from shops more than 5 times a week. Then D4=1 if an average household eats mostly shop-bought food for 0-6 meals (out of 21) each week; or D4=1.5 if an average household eats mostly shop-bought food for 7-11 meals (out of 21) each week; or D4=2 if an average household eats mostly shop-bought food for ≥12 meals (out of 21) each week.

Thus,

D = (D1 + D2 + D3 + D4)/2.67

The assumption is that the less reliant a community is on shop-bought food, the more resilient it is to economic challenges although, conversely, the more vulnerable it may be to environmental ones.

Water and energy security (E) is the fifth and final variable used to calculate Index 3. It reflects the adequacy of water and energy (electricity) in particular communities, based on the answers to five questions (E1-E5) about water supply/quality and electricity. Thus, E1=1 if the community obtains its drinking water from a single source; or E1= 2 if the community obtains its drinking water from more than one source. Then E2=1 if the supply of water is adequate for the community's needs; E2=2 if the supply of water is inadequate for the community's needs. Then E3=1 if the quality of water is generally suitable for drinking (and/or if the water is treated), or E3=2 if the quality of water is often unsuitable for drinking (and perhaps requires boiling before consumption). Then E4=1 if <10% household in the community have regular electricity; or E4=1.5 if 10-60% households in the community have regular electricity; or E4=2 if >60% households in the community have regular electricity. Then E5=1 if the community receives electricity from a single source (multiple household generators count as just one source); or E5=2 if the community receives electricity from more than one source (multiple household generators count as just one source, community generators count as one, solar as one, mains as one).

Thus,

E = (E1 + E2 + E3 + E4 + E5)/3.33

The assumption is that the fewer the sources and less reliable the water supply, the fewer houses with electricity and the fewer the electricity supply sources, the more vulnerable a community is to economic and environmental changes that impact water and energy.

In order to scale Index 3 for direct comparison with other peripherality indices in this study, the sum of A, B, C, D and E is adjusted arithmetically as follows –

Index 3 = [(A + B + C + D + E) – 7.5]/1.5

Low scores (≤2) suggest comparatively high peripherality while high scores (≥4) suggest the opposite[3].

[3] Note that the arithmetic changes to the sum of A and B and C and D and E first require that the lower bound is set to zero (the lowest possible score is 1.5x5=7.5) by subtracting 7.5 from the total. Then to make the total out of 5, scores are in this case divided by 1.5.

Appendix 3. Conference presentations and posters produced as a result of this project

A list of the 14 conference presentations (including three Keynote addresses) plus the four posters is given below. Names of people directly associated with this project are underlined.

Conference Presentations

1. Nunn, P.D. 2017. Sustaining ecosystem services under a changing climate: an agenda for younger people. *Keynote Address, Oceania Ecosystem Services Forum, Brisbane, Australia* [30.3.17].

2. Nunn, P.D. and Kumar, R. 2017. Through the lens of peripherality: climate-driven changes to ecosystem services for communities in Bua, western Vanua Levu Island (Fiji). *Oceania Ecosystem Services Forum, Brisbane, Australia* [30.3.17].

3. Nunn, P.D. and Kumar, R. 2017. Capturing community diversity for adaptation in the Pacific Islands: the role of peripherality. *11th Conference of the European Society for Oceanists, Munich, Germany* [1.7.17].

4. Nunn, P.D. and Betzold, C. 2017. False promises: seawalls as maladaptations throughout the rural Pacific Islands. *11th Conference of the European Society for Oceanists, Munich, Germany* [1.7.17].

5. Nunn, P.D. 2017. Maladaptation in Pacific Island countries: why the widespread and sustained failure of externally-sponsored interventions for climate-change adaptation in rural communities? *Institute of Australian Geographers' Conference, University of Queensland* [5.7.17]

6. Nunn, P.D. 2018. Climate-Human Interactions in Fiji. *Ministry of iTaukei (Indigenous) Affairs, Government of Fiji, Suva* [22.1.18].

7. Nunn, P.D. 2018. Améliorer la préparation aux catastrophes et l'adaptation au changement climatique en Australie et dans les îles du Pacifique: le rôle des histoires anciennes (Improving disaster preparedness and climate-change adaptation in Australia and the Pacific Islands: the role of ancient stories). *Faculté des Lettres, Langues et Sciences humaines, Université du Maine, France* [4.4.18].

8. Nunn, P.D. 2018. Changements côtiers Holocènes rappelés dans les histoires anciennes: exemples de l'Australie, du Pacifique Sud-Ouest et du Nord-Ouest de la France (Holocene coastal change recalled in ancient stories: examples from Australia, the Southwest Pacific, and Northwest France). *Faculté des Lettres et Langages, Université de Nantes, France* [11.4.18].

9. Nunn, P.D. 2018. Barriers have two sides: the challenges of transformational adaptation in island contexts. *Keynote Speech, Adaptation Futures 2018, Cape Town, South Africa* [June 2018].

10. Nunn, P.D. 2018. Failing adaptation in island contexts: the growing need for transformational change. *Opening Keynote Address, Symposium on Dealing with Climate Change on Small Islands, Hannover, Germany* [25.7.18].

11. Nunn, P.D. 2018. Improving the Effectiveness and Sustainability of Climate-Change Adaptation Outcomes in the Pacific Islands: A Role for Faith-Engaged Approaches? *Griffith University Climate Change Response Program (Gold Coast Campus), Australia* [21.8.18].

12. Nunn, P.D. 2018. Climate change and faith in the Pacific Islands. *Griffith University, Multi-Faith Centre (Nathan Campus), Australia* [6.11.18].

13. Nunn, P.D. and Kumar, R. 2019. *Climate-Human Interactions in the Federated States of Micronesia*. Public Talk, Conservation Society of Pohnpei, Pohnpei, Federated States of Micronesia [27.3.19].

14. Nunn, P.D. 2019. Is Policy Necessary? A Climate Scientist's Reflections on Climate-Driven Relocations in the Pacific Islands. *Monash University Centre for Commercial Law and Regulatory Studies, Melbourne, Australia* [12.4.19].

Conference Posters

1. Nunn, P.D. 2017. Harnessing spiritual wellbeing for effective climate-change adaptation in Pacific Islands. *University of the Sunshine Coast, USC Research Showcase* (July 2017).

2. Lykins, A., Kumar, R. and Nunn, P.D. 2017. Climate change and mental health in rural Fiji (Southwest Pacific). *University of the Sunshine Coast, USC Research Showcase* (July 2017).

3. Nunn, P.D. 2017. Underestimating God: spiritual beliefs and climate-change adaptation in the Pacific … and the pitfalls of ignoring them. *Institute of Australian Geographers' Conference, University of Queensland* [5.7.17].

4. Scott-Parker, B. and Kumar, R. 2017. Fiji adolescents' understanding of climate change: the importance of bringing it closer to scientific projections. *Institute of Australian Geographers' Conference, University of Queensland* [5.7.17].

Appendix 4. Funding sources outside the APN

Work on this project benefitted from a project funded by the Australian Research Council through its Linkage grant LP160100941 to Dr Karen McNamara, Prof Patrick Nunn and Dr James Watson for research into intervention failure in Federated States of Micronesia, Fiji, Kiribati, Solomon Islands and Vanuatu.

Appendix 5. List of Young Scientists

Roselyn Kumar (Fiji) – PhD candidate at University of the South Pacific

"*Being involved in this APN project allowed me insights into how Pacific islanders think about environmental risk; it also allowed me to travel throughout Micronesia and work with local communities and understand their similarities to those in my Fiji homeland*"