Comparing perceived effects of climate-related environmental change and adaptation strategies for the Pacific small island states of Tuvalu, Samoa, and Tonga

Katharina Beyerl
Institute for Advanced Sustainability Studies, Germany
Humboldt-Universität zu Berlin, Germany
katharina.beyerl@iass-potsdam.de (corresponding author)

Harald A. Mieg
Humboldt-Universität zu Berlin, Germany
harald.mieg@hu-berlin.de

Eberhard Weber
University of the South Pacific, Fiji
eberhard.weber@usp.ac.fj

ABSTRACT: Inhabitants of Pacific small island states are facing multiple socio-ecological pressures, with climate change being one of the most prominent. Nevertheless, the agency of local stakeholders in decisions on how to adapt to climate-related environmental change has been largely underappreciated in the climate change sciences as well as in policy decisions. We, therefore, conducted a survey study in Tuvalu, Samoa, and Tonga, asking specifically how residents perceive their situation regarding climate-related challenges, what adaptation strategies they have devised and implemented, and what they expect of governmental and nongovernmental organisations in these efforts. In contrast to the common perception that Pacific small island states are primarily threatened by rising sea levels, residents' perceptions indicate that drought, cyclones and other flood-related problems pose a far more imminent danger. Our results suggest that further research on those perceived environmental changes is advisable to provide reliable data for scientific models and policy decisions.

Keywords: perception, climate change adaptation, environmental change, Pacific small island states, Samoa, Tonga, Tuvalu

https://doi.org/10.24043/isj.53

© 2018 – Institute of Island Studies, University of Prince Edward Island, Canada.

Introduction

Inhabitants of Pacific small island states are facing multiple socio-ecological pressures. These arise from specific characteristics of island environments combined with modernisation and urbanisation, population growth, as well as increasingly globalised consumption patterns and lifestyles. The impacts of global climate change aggravate the situation (see Figure 1; Hay, 2013; Nurse et al., 2014; Barnett & Campbell, 2010; Barnett & Waters, 2016). The resulting challenges and diverse aspects of island vulnerability and resilience have received growing attention over the past years. Particularly since the debate on global climate change has gained momentum, specific focus has been placed on adaptation in Pacific island states as they are

often understood as outstandingly vulnerable and threatened in their long-term inhabitability (Barnett & Waters, 2016; Betzold, 2015; Lazrus, 2012; Farbotko, 2010; Nunn, 2009; Campbell, 2009; Kelman & West, 2009; Barnett & Campbell, 2010).

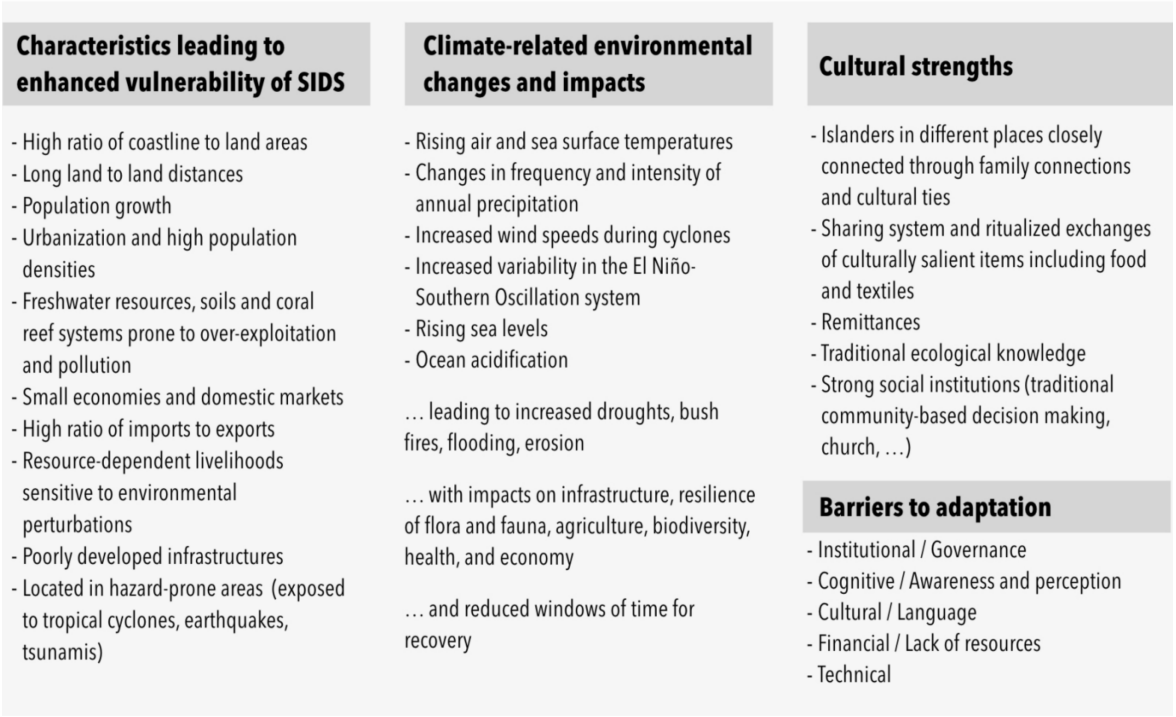


Figure 1: Summary of 1) characteristics of island vulnerability, 2) climate-related environmental changes and impacts, 3) specific cultural strengths, and 4) barriers to adaptation. (Compilation based on Barnett & Waters, 2016; Betzold, 2015; Kuruppu & Willie, 2015; Shackleton, 2015; McMillen et al., 2014.)

The focus on adaptation has resulted in a thorough investigation of needs, practices and barriers to adaptation in the context of historical developments, currently observed changes, and projected future challenges (Nunn, 2009; Grasso et al., 2014; Kuruppu & Willie, 2015; Betzold, 2015). Traditional practices of adaptation and modern technological opportunities, as well as questions of governance and communication have been examined in order to assess the abilities of the island communities to cope with impacts of rising sea levels or extreme weather events including storms, flooding, and drought (Kelman & West 2009; McMillen, 2014; Campbell, 2009; Lefale, 2010; Fakhruddin et al., 2015; Nunn 2009; Lata & Nunn, 2012; McNaught et al.; 2014). In light of the disruptive nature of climate-related environmental change, the benefit of integrating climate change adaptation and disaster risk management has been acknowledged, and community-based coping strategies are increasingly seen as advantageous and promising approaches (van Aalst, et al., 2008; Mercer, 2010; Gero et al., 2011; Pacific Community et al., 2016).

Among the diverse adaptation strategies that have been studied over the past years, specific attention has been paid to the controversial topic of large-scale resettlement of island inhabitants to other countries (Burson, 2010; Campbell & Warrick, 2014; Weber, 2014). Yet interestingly, most studies show that except for communities that already face severe coastal erosion or flooding due to subsidence, until now, other means of adaptation and more sustainable management are often not only possible, but also favoured by island populations before such drastic measures would need to come into play (Betzold, 2015; Barnett & O'Neill, 2012; Lazrus, 2012; Farbotko & Lazrus, 2012; Farbotko, 2005, 2010; Shen & Gemenne, 2011; Mortreux & Barnett, 2009; Donner, 2015; Connell, 2016). The results of

these studies exemplarily demonstrate that despite the fact that outsiders might view island environments as extremely vulnerable and retreat as a logical consequence, the international dialogue has often failed to include the diversity of local perspectives. Betzold (2015, p. 482) writes in her review of the literature on climate change, adaptation and small island states that "islanders' own perspectives, as well as comparative studies—comparisons across different islands, [and] different island states" are still largely missing from the peer-reviewed literature (see also McMillen et al., 2014; Kelman, 2010; Nurse, 2014). Similarly, Barnett and Waters (2016, p. 740) state that "the agency of people on islands is under-appreciated and under-researched, which results in assumptions of vulnerability, fragility, and low adaptive capacity, dominating climate change science and policy."

Betzold's observation can be broken down even further. A small number of authors has actually studied what kinds of climate-related environmental change people in Pacific small island states perceive and how much they are aware of climate change in general (Kuruppu & Liverman, 2011; Kuruppu & Willie, 2015; Lata & Nunn; 2012; Lebel, 2013; Aswani et al. 2015; Scott-Parker et al., 2016). Yet, it is striking not only that comparisons of potential differences in perceptions between island states are rare, but also that it has so far hardly been studied how islanders actually perceive their options to adapt: Though the perception of climate change itself is a prerequisite to adaptive behaviour, the perception and assessment of adaptation strategies, personal abilities, and self-efficacy, as well as people's expectations of other actors and institutions play an equally, if not even more important role in motivating protective action (Beyerl et al., 2016; Grothmann & Patt, 2005; Grothmann & Reusswig, 2006). Spiritual beliefs are among the few exceptions that have been discussed in this context as potentially hindering adaptive action (Nunn et al., 2016; Lata & Nunn, 2009; Kuruppu & Liverman, 2011; Kuruppu, 2009; Mortreux & Barnett, 2009; Lazrus, 2015; Rudiak-Gould, 2012, 2014). Apart from that, specific perceptions of self-efficacy and expectations that islanders have of other actors have hardly been studied and were scarcely considered in the design of communication approaches (McNaught et al., 2014).

As individuals naturally live embedded in a social context, individual behaviour is also affected by perceptions of the social environment and expectations that a person has of other people and institutions (Beyerl et al., 2016). In the context of climate change adaptation, other relevant stakeholders include local community members, but also larger institutions such as governments and nongovernmental organizations (NGOs). For example, expectations of aid and support are likely to shape people's perceptions of the need for personal protective action, understandings of responsibilities, and consequent behaviour (Barnett, 2008; Nunn, 2009; Barnett & Campbell, 2010; Kuruppu & Willie, 2015; McCubbin et al., 2015). So far, it has been described that donor organizations and adaptation finance have generated dependence on knowledge and funding that contributed to undermining adaptive capacity (Nunn, 2013; McNaught et al., 2014). Yet, despite the fact that adaptation can require modest technical and financial assistance to be effective (Limalevu et al., 2010), empirical data and systematic surveys on local residents' perceptions and expectations of donors and aid are underrepresented in the literature.

In order to contribute to a better understanding of adaptive behaviour and to compare perspectives across different island states, the current study aims to address the following questions: 1) How do citizens of three Pacific small island states perceive their being affected by different climate-related environmental changes? 2) What kind of adaptation strategies have citizens in these countries a) already implemented, and b) what are they planning for the future? 3) What do people think governments and NGOs can do to assist residents in coping with climate-related environmental change? 4) How do citizens of three Pacific small island states assess responsibilities for adaptive action, their own self-efficacy, and their own opportunities to adapt?

Method

Three island states to compare

Three Pacific small island states that represent the main geological formations of island types in the Pacific Island region (Barnett & Campbell, 2010) were selected for a comparison of islanders' perspectives on impacts of climate-related environmental change and strategies to cope with the challenges they perceive: 1) Tuvalu as one prominent example of an atoll island state, 2) Samoa as an example of islands of volcanic origin, and 3) a part of Tonga which serves as an example of a raised coral limestone island. All three island states are located in the tropical climate zone, with a wet season from November until April, during which tropical cyclones are a relatively common phenomenon, and a dryer season from May until October. However, the climate is characterized by a high year-to-year variability due to, for example, the El Niño-Southern Oscillation. Seasonal mean air temperatures for the period from 1950 to 2009 have been observed to increase significantly, and sea level has been rising by 4-6 mm per year (Australian Bureau of Meteorology and CSIRO, 2014). These trends are expected to intensify in the future. Annual and seasonal rainfall trends for the period of 1950 to 2009 are not statistically significant, but with tropical cyclones being expected to become more intense, extreme rain events are becoming more likely.

Interview guideline

A structured interview guideline with open and closed questions was designed in the English language. The survey templates were translated into Tuvaluan, Samoan, and Tongan languages by local research assistants, who also conducted the interviews either in their vernacular or in English. If necessary they also retranslated the responses. The questionnaire consisted of open questions about the impacts of environmental change on people's lives and respective coping strategies. In addition, closed questions were asked about the assessment of responsibilities, self-efficacy, and personal opportunities to implement coping strategies. Furthermore, respondents were asked about socio-demographic characteristics and challenges in everyday life. The quantitative closed questions had answer options in the structure of 7-point Likert scales reaching from 0 to 6 with the ends points 'not at all' – 'severely' or 'don't agree' – 'agree strongly'.

Sample

For each country, a team of three local research assistants was asked to interview 60 participants living close to the sea, covering a broad age range, with equal numbers of men and women. However, the samples vary in their composition (Table 1): With regard to age, for example, the mean values differ markedly, with 63.57 years for the Tuvaluan sample, 46.00 years for the Tongan sample, and 32.25 years for the Samoan participants. The numbers of inhabitants of the settlements and their distance to the sea also show some variance due to specific characteristics of the islands that interviewees live on. These islands are Funafuti and Vaitupu in Tuvalu, Upolu in Samoa, and Tongatapu and Lifuka in Tonga. Approximately half of the respondents engage in fishing and farming activities, although fishing is less prevalent in the Samoan sample that partially consists of rather young university students (25 of 60 respondents). One explanation for the relatively high age of the Tuvaluan sample may also reflect the tendency of young adults to migrate from outer islands. Yet, despite the differences in the composition of the samples, the results can be expected to provide an overview of perceptions of environmental change and coping strategies.

During the time of the survey from February 2011 to February 2012, La Niña had a considerable effect on local weather patterns of the selected island states. The impacts were particularly felt in Tuvalu, where the government declared a state of emergency due to severe water shortages in September 2011. For Samoa and Tonga it is noteworthy that several tropical cyclones had hit the region in the recent past and caused destruction, flooding, and erosion due to heavy wind and extreme precipitation so infrastructure as well as plants and plantations were affected.

Table 1: Island and sample characteristics

	Tuvalu	Samoa	Tonga
Island characteristics			
Size	26 km²	2,842 km²	748 km²
Number of inhabitants	10,837 (in 2012)	194,320 (in 2012)	103,036 (in 2011)
Topography	Low-lying and narrow coral atolls	Narrow coastal plains, interior mountains	Coral formation, volcanic
Highest elevation	5 m	1,857 m	1,033 m
Tropical cyclones per decade on average	8	10	17
Sea level rise measured by satellite altimeters since 1993	about 5 mm per year near Tuvalu	about 4 mm per year near Samoa	over 6 mm per year near Tonga
Sample characteristics			
Time of interview	May - June 2011	February 2012	February - March 2011
Island	47 (79.7%) Funafuti 12 (20.3%) Vaitupu	57 (95.0%) Upolu 3 (3.3) Samoa	20 (33.3%) Lifuka 39 (65.0%) Tongatapu
Gender	*Female* 24 (40.7%) *Male* 33 (55.9%) *Missing* 2 (3.4%)	*Female* 36 (60.0%) *Male* 24 (40.0%) *Missing* 0 (0%)	*Female* 41 (68.3%) *Male* 19 (31.7%) *Missing* 0 (0%)
Age (years)	*M* 63.57 *SD* 11.688 *Min* 35 *Max* 86 *Missing* 1	*M* 33.25 *SD* 17.498 *Min* 16 *Max* 84 *Missing* 1	*M* 46.00 *SD* 12.562 *Min* 24 *Max* 72 *Missing* 1
Number of inhabitants of settlements	*M* 660.42 *SD* 441.264 *Min* 8 *Max* 2000 *Missing* 16	*M* 1802.29 *SD* 1608.119 *Min* 10 *Max* 5000 *Missing* 9	*M* 572.50 *SD* 504.867 *Min* 150 *Max* 2000 *Missing* 0
Distance from home to the sea	*M* 112.29 *SD* 175.4 *Min* 10 *Max* 1250 *Missing* 1	*M* 542.34 *SD* 1136.645 *Min* 2 *Max* 7000 *Missing* 13	*M* 19.12 *SD* 16.946 *Min* 0 *Max* 65 *Missing* 1
House and land ownership	*Yes* 45 *No* 12 *Missing* 2	*Yes* 52 *No* 1 *Missing* 7	*Yes* 29 *No* 29 *Missing* 2
Plant for own daily consumption	*Yes* 40 *No* 19 *Missing* 0 *Sell* 7	*Yes* 30 *No* 28 *Missing* 2 *Sell* 12	*Yes* 28 *No* 32 *Missing* 0 *Sell* 3
Fish for own daily consumption	*Yes* 35 *No* 24 *Missing* 0 *Sell* 7	*Yes* 10 *No* 48 *Missing* 2 *Sell* 6	*Yes* 43 *No* 17 *Missing* 0 *Sell* 17

Results

Figure 2 shows a summary of the most frequently mentioned impacts of climate-related environmental change, resultant personal adaptation strategies, as well as expectations that respondents have of local governments and NGOs with regard to their supportive action. These results will be explained in detail in the following sections.

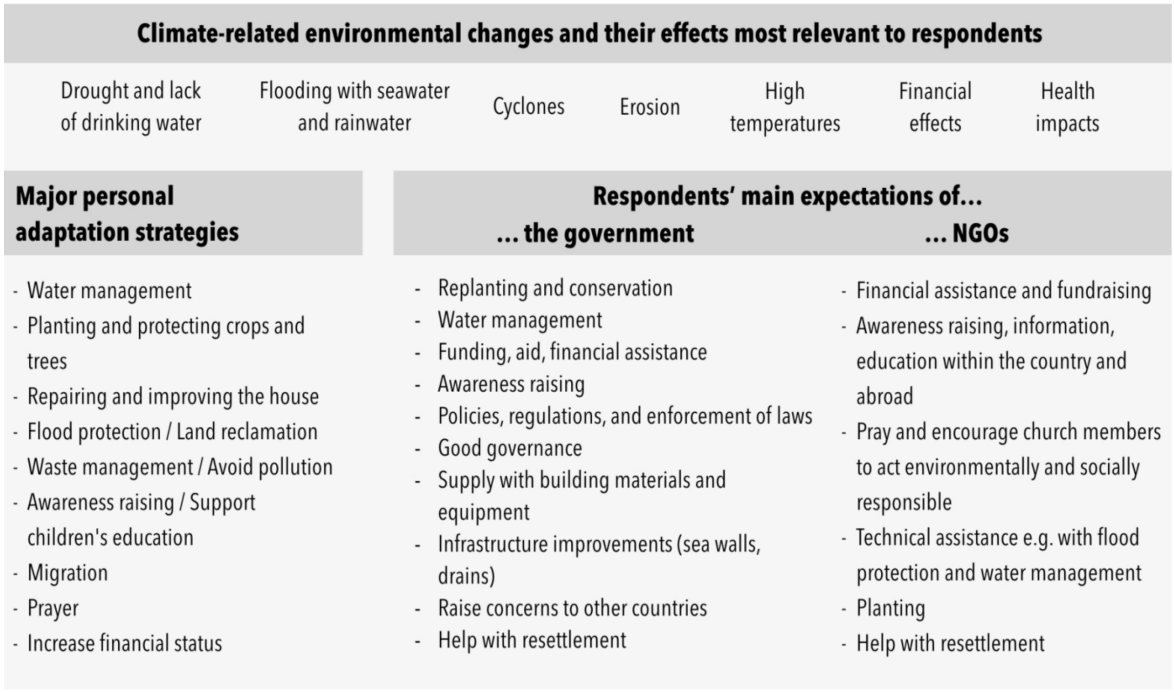


Figure 2: Summary of qualitative results.

Environmental events affecting people's lives most: drought, cyclones, and floods

The analysis of the qualitative and quantitative data shows that the kind of climate-related environmental changes that affect the respondents' lives most, as well as the assessment of the severity of this affectedness vary between and within the three countries (Figure 3 and Table 2). With regard to the quantitative data it is noticeable that the Tongan respondents show a higher level of agreement to many questions compared to participants from Tuvalu and Samoa who follow more central tendencies in their replies. Three factors that stand out as potential explanations for these differences in the answer tendencies between the countries should be kept in mind when interpreting the results below. Firstly, the patterns could be related to differences in the actually observable affectedness, for instance, impacts of extreme events such as heavy tropical cyclones that hit Tonga in the recent past. Secondly, age differences between the samples might have an effect: e.g., the young Samoan sample, that mainly consists of university students, has probably not yet built their own houses, but is likely to do so in the future, and, therefore, also expects to be affected more severely by impacts of environmental change. Thirdly, despite precise instructions that the local research assistants received, interviewer effects cannot be ruled out as impacting the comparability between the three samples since the interviews were done by three local teams. Nevertheless, the results provide an overview of the magnitude of single impacts, both, within but also between the samples.

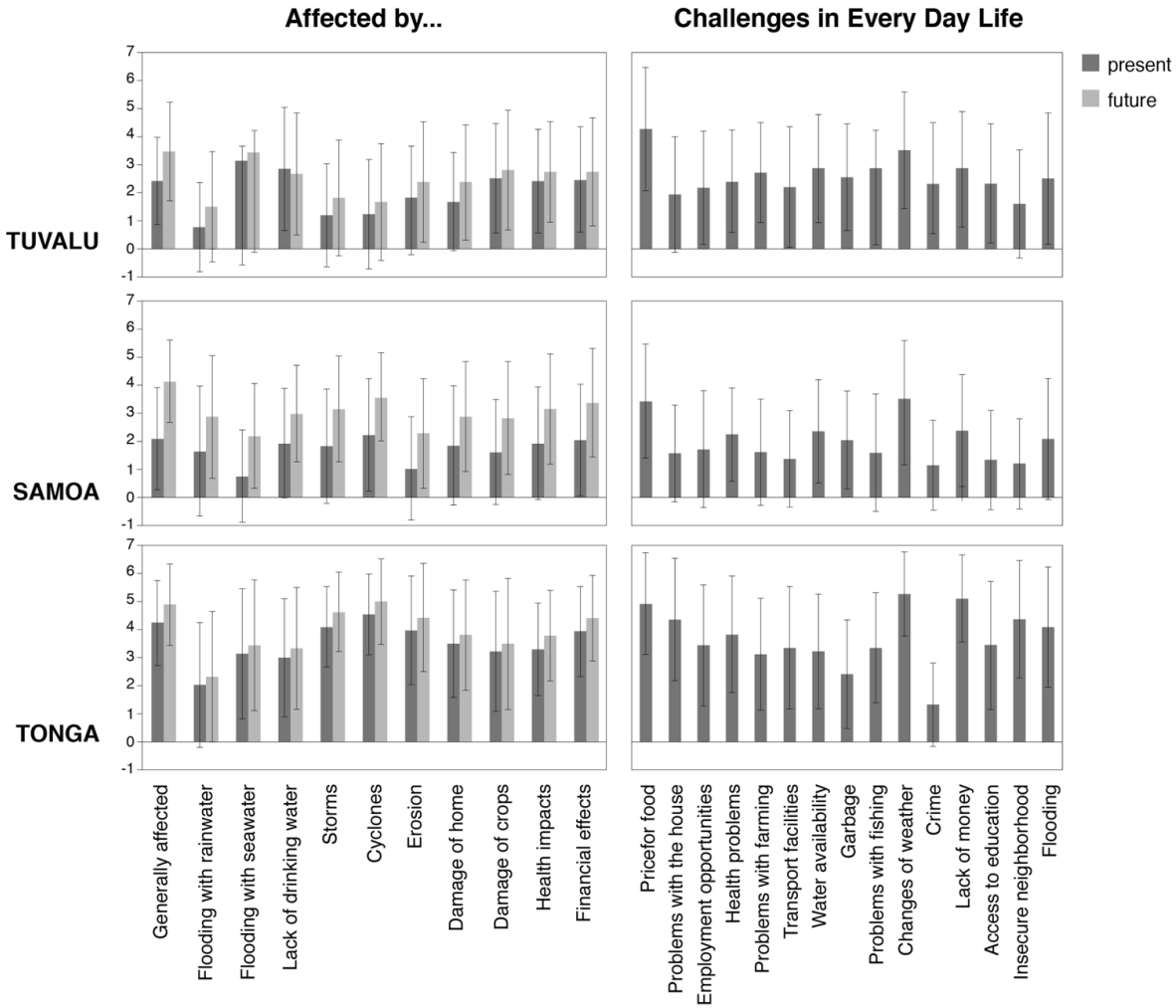


Figure 3: Mean values and standard deviations for present and expected impacts of environmental change and challenges in everyday life.

Table 2: Sample quotes about environmental changes that impact people's lives most.

Environmental changes most affecting people's lives	Quote
Drought/ lack of drinking water	**Tuvaluan male, 64 years old, 5 children**: "I can firmly admit that health impact due to drought, flooding, storms, heat or lack of clean drinking water is the major cause for my daily life - due to the following factors: When it is drought season, there are many kinds of diseases could happened. Beside that plants, animals, soil and human beings suffered seriously because of lack of water to drink, wash the dirts away from eating utensils, clothes etc. Because the soil is always dry, the dust is greatly formed up to spread diseases etc. This nature of disaster affects the lives of all living things on the particular environment. That is why I consider it to be worst of all." **Samoan female, 32 years old, 4 children:** "The lack of drinking water has the greatest influence on my daily life the most because it usually means we have to purchase drinking water from the shops which is very costly. The lack of rainfall causing droughts also influences or affects the way my crops grow and the fruits they bear. The unreliable rainy season doesn't produce enough rain and the dry season is also too hot with soaring temperatures hindering or affecting the produce of my crops. Accordingly because of the bad / poor yields most cannot be sold and that means less income to provide for my family."

Flooding	**Samoan female, 42 years old, 4 children** "Since our home is close to a swampy area, so every year our yard got flooded and after every flood my children get really sick. And mosquitoes population increase." **Samoan male, 29 years old, no children:** "When rivers and creeks overflow it floods my family's plantation and damages crops which my family relies on as a source of income. **Samoa male, 30 years old, 3 children**: "Sea level rise - my family depends heavily on the sea for food and little income. The coastal erosion and sea water flooding has been affecting our home gardening (salinity). Food security is now an issue for me and my family."
Cyclones	**Tongan female, 63 years old, 2 children**: "Cyclones influence my daily life the most. It damage my house, crops, my grandchild afraid of strong winds, thunderstorm and lights. During cyclone it brings strong heavy rain which cause leaking into my house. We move to another house for retreat because the stronger the winds blow the housing getting move around. King tides wash out most our land even our piggery are affected by erosion of land. Loss of our coastal trees, bananas and other trees damaging by cyclone. After cyclone lack of food available for my family, more work to do such clean up all broken glasses, rubbish, put everything in order etc." **Tongan female, 48 years old, 1 child**: "Damage of the house due to storms. This is the worsiest environmental change that influence my daily life most. It brings heavy rain, strong winds and the water comes inside our house because our house is very old. The wood are rotten easily water comes in, leaking occurs due to combination of rain water and sea water cause rotten in the iron of the roof. It also wash off our land, damage our fruits, trees at home. My family health too threaten due to this environmental change."
Erosion	**Tongan female, 33 years old, 4 children:** "Erosion - The sea takes away my land and threatens my house and plants. This environmental event affected me and my family the most. Most of my land has been taken by the sea water, half of my house covered by the sea, plants were plant beside our house has been wash out into the sea. This is due to Erosion happens from high sea level, storms, cyclones, heavy rains and all the other environmental changes that threatens myself and my family. This is really shows the influence of environmental event on us human being. Lastly, our house, our land is on the sea brings the idea for me to say that erosion and their effects influence my daily life the most." **Tongan female, 33 years old, 1 child:** "As we are staying very close to the beach and in a low lying areas big waves from the sea wash off most of my land, damaging my house especially when rough seas during cyclone and strong winds. The sea water reach our house when cyclone comes and the sand covered our land. Even our tank of water the sea water moves it from its location to another. My garden at home are getting loss due to much erosion happening from the seawater."
Financial effects	**Tongan female, 49 years old, 6 children:** "Financial effects due to environmental events. From all my daily activities they are all close in touch with nature. When the environmental changes occurs it affects my daily life mostly financial effects. Changes of the environment sometime makes me sick and I can't go to work and do weaving at home. This cause less income earn by the family. When it heavy rains, strong winds I can't go fishing or cutting pandanus for weaving. This leads to financial effects because if I can't go fishing we won't get food also takes long to get money from weaving because the process of making pandanuns will be depend from the weather. Long rain damage the pandanus sometime not worth for weaving leads to financial effects."

The majority of the Tuvaluan participants named drought when they were asked what environmental change affects their daily life most. The lack of rainfall and limited water storage capacity led to scarcity of drinking water on the coral atoll, in particular in the year of the survey. Although the respondents also described effects of storms, flooding, erosion, and high temperatures, the main focus of the answers to the open question was on drought-related problems. These statements are also supported by the quantitative data.

Samoan participants emphasized impacts of drought, lack of drinking water, and water pollution on plants and human health when asked about environmental changes that affect their lives most. Also, high temperatures and flooding caused by rainwater and seawater were often mentioned as pressing issues. Compared to the Tuvaluan and Tongan samples, the rather young Samoan participants mentioned financial impacts of environmental effects in their replies to the open question more often than damages of houses.

Tongan respondents described a multitude of environmental changes that severely affect houses, plantations, and human health. These include cyclones, heavy rainfall, flooding with rainwater and seawater, soil erosion, lack of drinking water, as well as high temperatures. Combined with material damage and health impacts, financial burdens were highlighted. The quantitative rating shows, for instance, that the majority of the Tongan participants has been affected severely by cyclones (56.7%) and erosion (51.7%). For the future, the participants from all three countries expect to be affected even more severely by the impacts of environmental change.

Most prominent adaptation strategies on household level

Despite the diversity of individual coping strategies that the respondents described, it was possible to identify ten main categories. The most prominent strategies that participants from all three countries have already taken to address impacts of environmental change on their lives are related to water management and the planting of crops and trees. Among other frequently mentioned measures were house repairs, flood protection, waste management and awareness raising. Less frequently named options are migration and prayer.

1) Water management. Water management includes the building of new water tanks and cisterns, digging wells, water budgeting, boiling water, or resorting to bottled water. However, tanks were described as expensive and difficult to afford.

2) Planting. Planting crops and trees was depicted as an option to reduce erosion, as windbreakers, and to ensure food security. In this context, preparing the land and improving gardening techniques were also mentioned. In addition to planting new trees and plants, respondents highlighted several times that it would be important to stop cutting trees.

3) Repairing the house. Repairing and preparing the house to withstand cyclones, heavy rain, and flooding was another frequent coping strategy. These repairs and preparations include putting galvanized iron around the windows and doors to avoid water leakage, repair rotten wood, raise the house to avoid flooding impacts, or putting cement underneath the house. Samoan respondents also mentioned that it would be helpful to build traditional Samoan houses. These 'fales' are houses built of natural materials where wooden posts hold a doomed roof made of dry leaves, and instead of solid walls, woven mats are used as drop-down blinds. Having evolved in their shape and structure over generations, these traditional houses are well adapted to the local climate, and the use of locally available materials makes rebuilding theoretically easier than purchasing imported materials. However, user expectations and needs in the 21st century are not always met by these traditional homes, making other structures often more desirable.

4) Flood protection. Raising and protecting the house are further practical preparations that were mentioned by many participants. Here, collecting rocks to put around the house, filling the area with additional soil, and by doing this, reclaiming land were frequently brought up as strategies to reduce flooding from heavy rain and land erosion. However, soil is rare,

especially on coral atolls, and it is often a challenge getting materials. Sand and coral mining are counterproductive options, and several respondents said that this practice should be stopped. Alternatively, some participants resort to collecting rubbish to raise the land, e.g.: "Put all our rubbish beside our house face the sea to stop damaging cause by waves such as soil erosion, damage my house" (Tongan man, 49 years old, 6 children). Again, it is questionable, if this is the most sustainable option or if it would further advance pollution-related problems. In addition to such personal adaptation measures, several respondents mentioned that they contributed to the construction of a community sea wall to withstand high waves. As prevention to rainwater flooding, two Samoan individuals suggested digging proper drains.

5) Waste management. Another common measure that was highlighted more frequently by Samoan individuals than by Tongan and Tuvaluan participants is waste management. Answers included mainly a halt to the burning of rubbish, pollution, and littering. Instead, it was suggested to initiate clean ups. However, it is unclear to what extent these behaviors are actually realized, especially when there are insufficient waste management alternatives.

6) Reduce burning of fossil fuels. Although technically a mitigation strategy rather than an adaptation strategy, an option that was raised mainly by the Samoan participants was the reduction of fossil fuel use, for example, by driving less with private cars, but using the bus instead, or walking. Yet, since no direct behavior was measured in this study, it would be worthwhile to see if the survey participants mentioned mainly possible ideas and good intentions, or actually act accordingly.

7) Raising awareness. A more indirect strategy to cope with environmental change that was brought up frequently is raising awareness. Respondents from all three countries said that awareness-raising would be important within the families and communities, but also via the media, at school, at church, and in workshops.

8) Saving and earning money. In particular Tongan participants said they would try to save and earn money for food, education, family functions, church, and for times when problems occur. Only one person mentioned explicitly insuring the house.

9) Migration. Although considerable media attention has been paid to migration to other countries as an option to adapt to climate change in small island states, it seems surprising that this strategy is rarely represented in the replies to the open questions. Indeed, relocation and migration were mentioned in all three countries as an answer to the open question of how people already adapt, yet mostly in the context of moving inland and seeking shelter (from cyclones) elsewhere. Only one individual from Tuvalu (female, 80 years old) explicitly mentioned "evacuation to other countries." Generally, the concepts of migration, relocation and evacuation were used interchangeably by the respondents and only when considering the further context of the replies could a distinction be made between inland relocation and migration to other countries.

10) Prayer. More often than naming retreat as an option of adaptation, participants from Tonga and Tuvalu mentioned fasting and praying to God for help as strategies to cope with environmental change. In the Samoan sample, prayer did not occur in the replies to the open question about what people already do to address environmental change.

Distinctions between country-specific adaptation strategies

Most of the aforementioned adaptation strategies on the household level as well as their expectations of the government and NGOs were similar across the three samples. Overall, the respondents' expectations of the government focus mainly on funding, policies, and awareness raising within the countries and abroad. In terms of practical support, people hope for assistance with water management, protective measures to reduce erosion, and improvements to infrastructure and income opportunities. The role of NGOs is mainly seen in providing financial assistance, awareness raising within the communities and abroad, as well as spiritual guidance and practical support to address environmental and infrastructural problems. Thereby, they are

seen as supporting the government in practical terms, but also helping with encouragement, spiritual care, and advice. As shown below, there were several specific differences between the three samples not only with regard to coping measures on a household level but also concerning the expectations that citizens have of the government and NGOs.

Tuvalu: coping with drought

In Tuvalu, the most important adaptive action is clearly seen in the improvement of water management. Regarding household-based adaptive action, the greatest emphasis is placed on expanding water storage capacity and water conservation. The main role of the government and NGOs is seen in funding and providing water storage facilities. Many agencies also responded to this immediate need.

Apart from that, other strategies that were mentioned frequently on household level involve planting crops and plants, repairing, improving, and raising the house, as well as reclaiming land. More general strategies include awareness raising, general protection and self-assistance, increasing one's own financial status, and supporting children's education. Interestingly, migration was only mentioned once in the current adaptation strategies, although it occurred three times in the future plans. The introduction of new technologies, building of sea walls, and prayer are measures that were less prominent.

The Tuvaluan respondents' expectations of the government and NGOs that go beyond water management were related to funding, aid, and financial assistance. The most relevant examples of specific measures for which funding was needed are water tanks, materials for houses and gardens, a sea wall, and the easing of soil erosion. Furthermore, people wished for more awareness raising and sharing of information on the importance of soil, the protection of plants, home gardening, and water management. Apart from raising awareness within the country, it was suggested that it was important to raise the country's concerns to the United Nations and big countries to seek external assistance in order to reduce global greenhouse gas emissions and help small countries address the impacts of climate change. Moreover, specific expectations towards NGOs include finding a safe place to live and helping with evacuation.

Samoa: planting, education, regulation

Regarding their adaptation strategies, Samoan participants mainly expressed that they plan to plant and preserve plants. Apart from that, replies were rather diverse, with no clear key focus areas. Interestingly, having no specific adaptation plans for the future was the second-most frequent category. Moving inland followed at number three, followed by avoiding pollution, organizing an additional water tank, earning money, and raising the land. Other options, such as awareness raising, changing fishing practices, stopping the cutting of trees, building traditional houses, and building a sea wall were only mentioned once or twice each.

The Samoans' expectations of the government and NGOs were rather diverse as well. Most emphasis was placed on education and raising awareness about environmental and climate change, how to prevent it, and how to address its impacts.

A specific expectation of the government concerned policies and regulations, the enforcement of laws, and penalties for those who break them. For instance, a 47-year-old Samoan man said that "The government should enforce strict policies in prohibiting people from cutting down trees, dumping of toxic waste in the sea, using dynamite to catch fish and general use of chemicals that can harm the environment."

The second-most frequent category of expectations that the respondents have of NGOs referred to the role of the church. "The church especially should be one of the leading institutions to address problems. This is because almost every Samoan attends a particular church, and it would be easier when having this issue integrated in church matters like from a Christian perspective" (Samoan man, 18 years). Respondents also said that the "Church should always pray to God for mercy and protection over our people" (Samoan man, 84

years) and that the church "must give Godly direction" (Samoan woman, 79). Others emphasized that the church "should include environmental issues in their weekly discussion" (Samoan woman, 18 years). One individual mentioned specifically that "the church should provide psychological assistance to people during hard times" (Samoan woman, 32 years).

Other less prominent expectations of the government and NGOs concern water management, replanting, building sea walls, and constructing proper drains to avoid flooding. Suggestions referring to environmental protection include marine reserve programs, stopping of sand mining, environmental impact assessments, and the reduction of greenhouse gases. Moreover, the provision of assistance for farmers and poor people, free medicine for poor families, improved health centers, public transportation, and infrastructure were also named occasionally and illustrate the breadth of issues that cannot all be described in detail here. Appropriate zoning for land use and limiting unwanted ships are just two more examples that might be specific to a Pacific island environment.

Tonga: struggling with cyclones, flooding, and erosion

The adaptation strategy that two-thirds of the Tongan respondents named for addressing the impacts of environmental change is planting trees and growing crops. Planting serves multiple purposes, including reducing erosion, earning money, and ensuring food security. However, Tongan participants explained that planting is difficult because they lack the soil and the money to realize their plans.

Ranked number two among personal adaptation strategies is earning and saving money. In third place, one- third of the Tongan sample listed planning to relocate or evacuate either within the country or overseas and trying to find land to live on. Further strategies include raising awareness and education for children. More specific plans refer to renovating and repairing the house and raising, reclaiming, and protecting the land using walls and a 'floorshore' (probably meaning a foreshore). Building a sea wall was suggested several times, as was waste management, the wise use of resources, water management, and working together on environmental programs as a community. Prayer was mentioned only once in connection with future plans.

Asked for their expectations as to how the government can assist in coping with the perceived environmental challenges, the Tongan respondents wished that officials would support the replanting of coastal plants, set up a nursery, and supply plants to people in order to prevent erosion and deforestation. In second place was a general plea for help, good governance, equal distribution of resources, and the wish that the government should work together with the people and local communities. In addition, and more specifically, participants asked for financial support for a sea wall, soil, building materials, fishing equipment, food, and clothes, particularly for people who are severely affected by cyclones and other impacts of environmental change and natural hazards.

A category that was specific to the Tongan sample is the provision, division, and registration of land. This is probably due to the fact that all land in the kingdom is the property of the crown, and as a result, some nobles control land leases while many other people lack land (Moala, 2014). Another typical Tongan reply was that the government should provide trucks with soil or rocks to support land reclamation. Similar to the responses of the Tuvaluans and Samoans, other expectations include renovating a sea wall, improving waste management, supplying electricity, updating and enforcing laws, and awareness raising and education with the help of schools, workshops, and the media.

The role of NGOs is seen as seeking funding for environmental programs in local communities; building sea walls; supporting water and waste management; helping with replanting and repairs; improving the standard of living; and providing soil, building materials, equipment for farming and fishing, food, and clothes. As in the Samoan sample, the role of the church was highlighted and presented the category with the second-most frequent replies

for the expectations that Tongans have of NGOs. The church should pray for the people, encourage church members to grow crops, and assist those who are affected by environmental change in rebuilding houses and funding.

In general, NGOs should work together with the government in trying to protect the environment and ensure the fair distribution of aid and resources. As in the Tuvaluan sample, several individuals from the Tongan group mentioned that NGOs should help to address the problem worldwide, visit the villages, provide footage on the effects of environmental change, inform the world, and encourage developed countries to reduce pollution.

Perceptions of responsibilities, self-efficacy, and personal opportunities

In addition to the information about the kinds of environmental change that people perceive, their individual adaptation strategies, and their expectations of other actors, several questions based on Grothmann's (2005) theory and surveys were used to gauge and compare opinions about the distribution of responsibilities, self-efficacy beliefs, as well as personal opportunities to adapt.

1) Personal responsibility. The majority of the Samoan sample (55%) agrees strongly with the statement that "Every citizen is himself/herself responsible for preventing damages due to environmental change in his/her private household." Of the Tongan sample, 40% agree strongly, and within the Tuvaluan sample there is strong agreement among 27.1%. Only few individuals completely disagree. The majority of the Tuvaluan participants (52.2%) and 43.3% of the Tongan respondents show medium agreement. However, as there was no 'don't know' option for the answer scales of the agreement questions, medium agreement could also be interpreted as indecisiveness here. Yet, upon closer inspection and particularly in consideration of the Pacific community spirit, this item is probably culturally inappropriate and should be complemented by questions regarding the community's responsibility.

2) Reliance on public adaptation. More than half of the Tongan participants strongly agreed that the government (1) would supply them with all necessities (56.7%), (2) would ensure that impacts of environmental change would not affect them (60%), and (3) would ensure that necessary structures exist to protect people from environmental change (73.3%). Samoan respondents seem to see this differently, with only 10% agreeing with the first two statements and 25% with the latter. The vast majority of the Samoan sample showed medium or no agreement. The opinion of the Tuvaluan participants is in between, with 50.8% agreeing strongly that the government would ensure that necessary structures exist to protect the people; however, the other two statements mainly received medium agreement. Although these statements are rather general and might partly measure people's attitude towards and trust in the ability of a government, they give an initial impression of the distribution of perceived responsibilities.

Although seemingly distinct constructs, the perception of personal responsibility and the expectation of governmental protective actions do not exclude each other. Thirteen percent of the participants from Tuvalu, for instance, said that every citizen is responsible for preventing damage to private property, and they also agree strongly that the government would supply them with necessities for living that they might lose due to impacts of environmental change. Between these two items, we also found a significant positive correlation of Spearman Rho = .374; p =.005; N= 54. Similarly, 10.7% of the Samoan respondents acknowledge personal responsibility and expect the government to ensure that the necessary structures exist to protect people from the impacts of environmental change. The correlation between these two items is also significantly positive (Rho = .319; p =.016; N= 56).

3) Self-efficacy vs. fatalism. The items for self-efficacy received little agreement. Most people were undecided or disagreed that they could cope effectively with the impacts of the perceived environmental change or could avoid damage with the measures they mentioned.

These results match the statements of 36.7% of the Tongan group, who agreed strongly that they are quite helpless with regard to avoiding impacts of environmental change on their lives. 27.1% of the Tuvaluan sample and 56.7% of the Samoan participants do not agree or show very little agreement here. Again, perceived self-efficacy and fatalism (helplessness) are not as independent of one another as they might seem, and several significant positive correlations could be found between the respective items in particular in the Tuvaluan and Tongan sample. For example, Tuvaluan and Tongan respondents who said that they could cope effectively with the impacts of environmental change (SE1) also often said they were quite helpless (F1; correlations between SE1 and F1 for Tuvalu: Rho =.450; p =.001; N= 53; for Tonga: Rho =.349; p =.007; N= 58). Similarly, those who said that they could cope effectively also said that they could not do much to avoid damage due to environmental change (F2; correlations between SE1 and F2 for Tuvalu: Rho =.568; p =.000; N= 53; for Tonga: Rho =.356; p =.005; N= 60).

4) Personal opportunities. Five questions aimed at investigating how people assess their opportunities and resources to realize adaptation strategies. Although few respondents disagreed with the idea that they did not know how to deal with the impact of environmental change on their houses, crops, and their lives, only very few people agreed that they had the necessary skills. This suggests that although participants might have a fair idea of what could be done, they feel they lack the skills to realize effective adaptation strategies. 43.3 % of the Tongan sample agreed strongly that they lacked the money to change anything and also said that they had more important things to worry about. However, more Tuvaluan and Samoan participants disagree (no money: 20.3% and 31.7%; other things to do: 25.4% and 56.7%) than agree (no money: 16.9% and 21.7%; other things to do: 18.6% and 6.7%) with these statements. Interestingly, hardly any participants in all three countries agreed that there was no time to address the changes, although this might be a frequent reply in Western contexts.

Discussion and conclusions

This survey study set out to investigate how residents of three Pacific small island states perceive their being affected by climate-related environmental change. On the one hand, it explored the kinds of adaptation strategies people devise and implement, while on the other hand it analyzed expectations people have of governments and NGOs when it comes to addressing such changes and resultant impacts. Five key points can be summarized:

1) The main challenges that the respondents perceive as affecting their lives are drought, cyclones, flooding, erosion, and associated impacts on health, property, and finances.
2) Current personal coping strategies mainly involve water management, planting, repairing and preparing the house and private property, waste management, and improving one's own financial situation.
3) Future plans for personal adaptation are similar to current strategies, although in addition, moving inland and finding land to resettle on are important particularly to respondents from Tonga and Samoa who suffer from flooding and erosion.
4) People's expectations of the government and NGOs relate predominantly to funding, technical assistance, supply of materials, the provision of land, raising awareness, the enforcement of policies, and the provision of spiritual and practical support.
5) Perceptions of shared responsibilities, self-efficacy, and helplessness can coexist and are not necessarily independent of one another. The perception of personal opportunities to adapt is dominated by a perceived lack of skills and money.

Methodically, the mix of open and closed questions was generally a suitable way to gauge perceptions of local respondents. However, the questions that have been translated from Grothmann's work and ask about self-responsibility, self-efficacy, reliance on public adaptation, and helplessness do not seem optimal for the Pacific context. As those questions

were rather general and unspecific, thinking regarding different adaptation strategies and scales of damage while answering could bias the replies. Therefore, more open questions or more specific closed questions that relate to single adaptation strategies would have been helpful here.

A second important point arising from these methodological considerations is that, in addition to the concepts of personal responsibility and self-efficacy, it would be advisable to include items that take into account the strong social cohesion that shapes Pacific cultures. Being based on reciprocity, the Pacific 'sharing and caring' system is an essential part of daily life and regularly gets reinforced in traditional ceremonies and celebrations. Hence, research about adaptation to climate-related environmental change as well as specific adaptation projects need to consider community norms, decisions, actions, support, and sanctions that might affect individual behaviour. Social identity and collective efficacy are also increasingly highlighted as powerful motivators for sustainability behaviour in Western contexts (Fritsche, 2017; Jugert et al., 2016; Barth et al., 2016). Including such concepts more explicitly in future research in the Pacific region as well as worldwide could therefore contribute to a better understanding of individual behavior.

Overall, the findings of the current study exemplify impacts of climate-related environmental change among a diverse set of challenges that people in Pacific small island states are confronted with (Barnett & Campbell, 2010; Fazey et al., 2011; McCubbin et al., 2015). We could also confirm that people in Pacific small island states perceive environmental change as a result of unsustainable lifestyles, and they are aware of unsustainable practices, such as sand mining, blast fishing, logging, burning rubbish, and use of fossil fuels (Aswani et al., 2015; Lata & Nunn, 2013; Ford, 2012). This also relates to Campbell's (2009) view that the vulnerability connected to 'islandness' arises from the interplay of many factors that are associated with modernity. Adaptation to prevailing challenges should therefore be integrated into broader sustainable development, and people's perceptions of unsustainable practices could be used as a basis to jointly develop alternatives.

In line with previous research, the results of the current study support that people are aware of diverse strategies to cope with environmental change and resultant impacts (e.g. McCubbin, 2015; Aswani et al., 2015; Magee, 2016). However, perceptions of low self-efficacy and lack of personal skills to cope effectively with the multitude of challenges prevail. In addition, respondents report a lack of money, materials, soil, and available land. These factors impede water management, preparing and repairing houses and property, planting, and retreat. Another prominent strategy, namely improving one's own financial situation, is also difficult to realize due to limited income-generating opportunities that often also place additional stress on local ecosystems (Aswani et al., 2015). Moreover, waste management and reducing the burning of rubbish depend on communal infrastructures and are not completely in the hands of local people. Hence, being confronted with such difficulties, respondents refer to their trust in God when it comes to coping with environmental stresses (Montreux & Barnett, 2009; Kuruppu & Liverman, 2012; Nunn et al., 2016). And although it is criticized that long-term planning often falls short in island contexts (Lata & Nunn, 2012; Nunn, 2013), this phenomenon is understandable due to the constant necessity to adapt to immediate pressures.

In general, people adapt to what they directly experience or have experienced earlier and prepare for what they see as likely to come in their immediate future. In order to enhance adaptive behavior and improve coping capacity, a holistic communicative approach needs to relate 1) to perceptions and future expectations of change, and 2) to the perceived efficiency of adaptive strategies (Grothmann & Patt, 2005; Moser, 2014; Beyerl et al., 2016). Integrated into local customs, communicative approaches should not only raise awareness about climate change *per se* but also focus on various types of effective and feasible coping strategies, training of necessary skills, assistance in obtaining essential items and materials, and support for self-efficacy (Moser, 2014; McNaught et al., 2014; Scott-Parker et al., 2016; Rudiak-Gould, 2014; Nunn, 2009; van Aalst, 2008; Mercer, 2010; Gero et al., 2011; Mercer et al. 2012).

Although barriers to adaptation exist, most of them are not impossible to overcome with joint action and commitment (Moser & Ekstrom, 2010; Biesbroek et al., 2013; Betzold, 2015).

Despite acknowledging their personal responsibility, many of the respondents in the present study see their governments as responsible for protective action, and considerable hope is also being placed in the work of NGOs (Barnett, 2008; Nunn, 2009; Barnett & Campbell, 2010; Kuruppu & Willie, 2015; McCubbin, 2015). In general, it is necessary that a shared understanding of the distribution of responsibilities for adaptive action is developed (Moser, 2014; Moser & Ekstrom, 2010). In addition to communicating what kind of support governments and NGOs can realistically contribute, it would be important to test and communicate the most effective coping strategies that these institutions could foster as well as why they do not support certain other measures. For example, many respondents expect the government and NGOs to support the construction of seawalls. However, seawalls are often ineffective in reducing shoreline erosion, they mostly shift the problem and sometimes even increase it, especially when they are not professionally built or when maintenance funding runs out (Kumar, 2007; Nunn, 2009; Ford, 2012; Yamamoto & Esteban, 2013; Duvat, 2013; Hills et al., 2013; Betzold, 2015). Such differences in perceptions, expectations, and actual efficiency need to be addressed to reach truly sustainable adaptation and development (Moser, 2014; Aswani et al., 2015; Beyerl et al., 2016). Determining the most effective strategies that do not aggravate other problems with their side-effects is crucial here. The current paper provides an overview of coping strategies that people reported, and an important next step would be to evaluate the efficiency of these strategies and, if necessary, work on sustainable alternatives.

In order to adapt to current needs and to prepare for a resilient future, sustainable options that help meet demands for energy, water, food, sanitation, waste management, transportation, construction materials, and consumer products are crucial and should receive increasing attention. People arrange their daily lives given the circumstances with which they are confronted and choose the behavioral options that they find most attractive. Sustainable behavioral options should therefore be made available and easy to realize.

Funding

This work was supported by the German Research Foundation (DFG Research Training Group GRK 780/III), The German Academic Exchange Service (D/10/43472), and The Faculty of Science, Technology and Environment at The University of the South Pacific. Conflicts of interest: none.

Acknowledgements

The authors thank the local research assistants and the people of Tuvalu, Samoa, and Tonga. We furthermore thank our colleagues at the Department of Geography at the University of the South Pacific and at Humboldt Universität Berlin. We are grateful for the support of the Institute of Advanced Sustainability Studies as well as the Pacific Centre for Environment and Sustainable Development. In particular, we thank Wilfried Endlicher, Ludwig Ellenberg, Randy Thaman, Camari Koto, Viliamu Iese, Mark Lawrence, Ortwin Renn, Stefan Schäfer, Pia-Johanna Schweitzer, Ilan Chabay, Tim Butler, Oliver Putz, and the families Tawake, Whippy, and Pratap.

References

Aswani, S., Vaccaro, I., Abernethy, K., Albert, S., & de Pablo, J.F. (2015). Can perceptions of environmental and climate change in island communities assist in adaptation planning locally? *Environmental Management*, 56(6), 1487-501. https://doi.org/10.1007/s00267-015-0572-3

Australian Bureau of Meteorology and CSIRO (2014). *Climate variability, extremes and change in the western tropical Pacific: new science and updated country reports. Pacific-Australia Climate Change Science and Adaptation Planning Program Technical Report*. Melbourne: Australian Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation.

Barnett, J. (2008). The effect of aid on capacity to adapt to climate change: insights from Niue. *Political Science*, 60, 31-45. https://doi.org/10.1177/003231870806000104

Barnett, J., & Campbell, J. (2010). *Climate change and small island states: power, knowledge and the South Pacific*. London: Earthscan.

Barnett, J., & O'Neill, S. J. (2012). Islands, resettlement and adaptation. *Nature Climate Change*, 2, 8-10. https://doi.org/10.1038/nclimate1334

Barnett, J., & Waters, E. (2016). Rethinking the vulnerability of small island states: climate change and development in the Pacific islands. In J. Grugel & D. Hammett (Eds.) *The Palgrave Handbook of International Development* (pp. 731-748). Dodrecht: Springer.

Barth, M., Jugert, P., & Fritsche, I., (2016). Still underdetected: social norms and collective efficacy predict the acceptance of electric vehicles in Germany. *Transportation Research Part F: Traffic Psychology and Behaviour*, 37, 64-77. https://doi.org/10.1016/j.trf.2015.11.011

Betzold, C. (2015). Adapting to climate change in small island developing states. *Climatic Change*, 133(3), 481-489. https://doi.org/10.1007/s10584-015-1408-0

Beyerl, K., Putz, O., & Breckwoldt, A. (2016). The role of perceptions in community-based marine resource management. *Frontiers in Marine Science*, 3:238. https://doi.org/10.3389/fmars.2016.00238

Biesbroek, G.R., Klostermann, J.E.M., Termeer, C.J.A.M., et al. (2013). On the nature of barriers to climate change adaptation. *Regional Environmental Change*, 13(5), 1119-1129. https://doi.org/10.1007/s10113-013-0421-y

Burson, B. (Ed.) (2010). *Climate change and migration: South Pacific perspectives*. Wellington: Institute of Policy Studies, School of Government, Victoria University of Wellington.

Campbell, J. (2009). Islandness: vulnerability and resilience in Oceania. *Shima*, 3(1), 85-97.

Campbell, J.R. (2015). Development, global change and traditional food security in Pacific Island countries. *Regional Environmental Change*, 15, 1313-1324. https://doi.org/10.1007/s10113-014-0697-6

Campbell, J., & Warrick, O. (2014). *Climate change and migration issues in the Pacific*. Fiji: United Nations Economic and Social Commission for Asia and the Pacific.

Connell, J. (2016). Last days in the Carteret Islands? Climate change, livelihoods and migration on coral atolls. *Asia Pacific Viewpoint*, 57(1), 3-15. https://doi.org/10.1111/apv.12118

Donner, S.D. (2015). The legacy of migration in response to climate stress: learning from the Gilbertese resettlement in the Solomon Islands. *Natural Resources Forum*, 39, 191-201. https://doi.org/10.1111/1477-8947.12082

Duvat, V. (2013). Coastal protection structures in Tarawa Atoll, Republic of Kiribati. *Sustainability Science*, 8, 363-379. https://doi.org/10.1007/s11625-013-0205-9

Fakhruddin, S.H.M., Babel, M.S., & Kawasaki, A. (2015). Assessing the vulnerability of infrastructure to climate change on the Islands of Samoa. *Natural Hazards and Earth System Sciences*, 15, 1343-1356. https://doi.org/10.5194/nhess-15-1343-2015

Farbotko, C. (2005). Tuvalu and climate change: constructions of environmental displacement in the Sydney Morning Herald. *Geografiska Annaler B*, 87(4), 279-293. https://doi.org/10.1111/j.0435-3684.2005.00199.x

Farbotko, C. (2010). Wishful sinking: disappearing islands, climate refugees and cosmopolitan experimentation. *Asia Pacific Viewpoint*, 51(1), 47-60. https://doi.org/10.1111/j.1467-8373.2010.001413.x

Farbotko, C., & Lazrus, H. (2012). The first climate refugees? Contesting global narratives of climate change in Tuvalu. *Global Environmental Change*, 22, 382-390. https://doi.org/10.1016/j.gloenvcha.2011.11.014

Fazey, I., Pettorelli, N., Kenter, J., Wagatora, D., & Schuett, D. (2011). Maladaptive trajectories of change in Makira, Solomon Islands. *Global Environmental Change*, 21, 1275-89. https://doi.org/10.1016/j.gloenvcha.2011.07.006

Ford, M. (2012). Shoreline changes on an urban atoll in the central Pacific Ocean: Majuro Atoll, Marshall Islands. *Journal of Coastal Research*, 28(1), 11-22. https://doi.org/10.2112/JCOASTRES-D-11-00008.1

Fritsche, I. (2017). 'We' turn(s) the tide!: towards a social identity approach on environmental crises. In A.K. Römpke, G. Reese, I. Fritsche, N. Wiersbinski, & A.W. Mues (Eds.) *Outlooks on applying environmental psychology research* (pp. 57-62). Bonn: Bundesamt für Naturschutz.

Gero, A., Méheux, K., & Dominey-Howes, D. (2011). Integrating community based disaster risk reduction and climate change adaptation: examples from the Pacific. *Natural Hazards and Earth System Sciences*, 11, 101-113. https://doi.org/10.5194/nhess-11-101-2011

Grasso, M., Moneo, M., & Arena, M. (2014). Assessing social vulnerability to climate change in Samoa. *Regional Environmental Change*, 14, 1329-1341. https://doi.org/10.1007/s10113-013-0570-z

Grothmann, T. (2005). *Klimawandel, Wetterextreme und private Schadensprävention. Entwicklung, Überprüfung und praktische Anwendbarkeit der Theorie privater Wetterextrem-Vorsorge*. Dissertation. http://diglib.uni-magdeburg.de/Dissertationen/2005/torgrothmann.pdf

Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Global Environmental Change*, 15, 199-213. https://doi.org/10.1016/j.gloenvcha.2005.01.002

Grothmann, T., & Reusswig, F. (2006). People at risk of flooding: why some residents take precautionary action while others do not. *Natural Hazards*, 38, 101-120. https://doi.org/10.1007/s11069-005-8604-6

Hay, J.E., (2013). Small island developing states: coastal systems, global change and sustainability. *Sustainability Science*, 8, 309-326. https://doi.org/10.1007/s11625-013-0214-8

Hills, T., Carruthers, T.J.B., Chape, S., & Donohoe, P. (2013). A social and ecological imperative for ecosystem-based adaptation to climate change in the Pacific Islands. *Sustainability Science*, 8, 455-467. https://doi.org/10.1007/s11625-013-0217-5

Jugert, P., Greenaway, K.H., Barth, M., Büchner, R., Eisentraut, S., & Fritsche, I. (2016). Collective efficacy increases pro-environmental intentions through increasing self-efficacy. *Journal of Environmental Psychology*, 48, 12-23. https://doi.org/10.1016/j.jenvp.2016.08.003

Kelmann, I. (2010). Hearing local voices from Small Island Developing States for climate change. *Local Environment*, 15(7), 605-619. https://doi.org/10.1080/13549839.2010.498812

Kelman, I., & West, J.J. (2009). Climate change and small island developing states: a critical review. *Ecological and Environmental Anthropology*, 5, 1-16.

Kumar, L., & Taylor, S. (2015). Exposure of coastal built assets in the South Pacific to climate risks. *Nature Climate Change*, 5, 988-991. https://doi.org/10.1038/nclimate2702

Kuruppu, N. (2009). Adapting water resources to climate change in Kiribati: the importance of cultural values and meanings. *Environmental Science & Policy*, 12(7), 799-809. https://doi.org/10.1016/j.envsci.2009.07.005

Kuruppu, N., & Liverman, D. (2011). Mental preparation for climate adaptation: the role of cognition and culture in enhancing adaptive capacity of water management in Kiribati. *Global Environmental Change*, 21(2), 657-669. https://doi.org/10.1016/j.gloenvcha.2010.12.002

Kuruppu, N., & Willie, R. (2014). Barriers to reducing climate enhanced disaster risks in Least Developed Country-small islands through anticipatory adaptation. *Weather Climate Extremes*, 7, 72-83. https://doi.org/10.1016/j.wace.2014.06.001

Lata, S., & Nunn, P. (2012). Misperceptions of climate-change risk as barriers to climate-change adaptation: a case study from the Rewa Delta, Fiji. *Climatic Change*, 110(1-2), 169-186. https://doi.org/10.1007/s10584-011-0062-4

Lazrus, H. (2012). Sea change: island communities and climate change. *Annual Review of Anthropology*, 41, 285-301. https://doi.org/10.1146/annurev-anthro-092611-145730

Lebel, L. (2013). Local knowledge and adaptation to climate change in natural resource-based societies of the Asia-Pacific. *Mitigation and Adaptation Strategies for Global Change*, 18(7), 1057-1076. https://doi.org/10.1007/s11027-012-9407-1

Lefale, P. (2010). Ua'afa le Aso – stormy weather today: traditional ecological knowledge of weather and climate: the Samoa experience. *Climatic Change*, 100, 317-335. https://doi.org/10.1007/s10584-009-9722-z

Limalevu, L., Aalsbersberg, B., Dumaru, P., & Weir, T. (2010). Adaptation on a small island. *Tiempo*, 77, 16-19.

Magee, A.D., Verdon-Kidd, D.C., Kiem, A.S., & Royle, S.A. (2016). Tropical cyclone perceptions, impacts and adaptation in the Southwest Pacific: an urban perspective from Fiji, Vanuatu and Tonga. *Natural Hazards and Earth System Sciences*, 16(5), 1091-1105. https://doi.org/10.5194/nhess-16-1091-2016

McCubbin, S., Smit, B., & Pearce, T. (2015). Where does climate fit? Vulnerability to climate change in the context of multiple stressors in Funafuti, Tuvalu. *Global Environmental Change*, 30, 43-55. https://doi.org/10.1016/j.gloenvcha.2014.10.007

McMillen, H.L., Ticktin, T., Friedlander, A., Jupiter, S.D., Thaman, R., Campbell, J., Veitayaki, J., Giambelluca, T., Nihmei, S., Rupeni, E., Apis-Overhoff, L., Aalbersberg, W., & Orcherton, D. F. (2014). Small islands, valuable insights: systems of customary resource use and resilience to climate change in the Pacific. *Ecology and Society*, 19(4), 44. https://doi.org/10.5751/ES-06937-190444

McNaught, R., Warrick, O., & Cooper, A. (2014). Communicating climate change for adaptation in rural communities: a Pacific study. *Regional Environmental Change*, 14, 1491-1503. https://doi.org/10.1007/s10113-014-0592-1

McNeeley S.M., & Lazrus H. (2014). The cultural theory of risk for climate change adaptation. *Weather, Climate, and Society*, 6, 506-519. https://doi.org/10.1175/WCAS-D-13-00027.1

Mercer, J. (2010). Disaster risk reduction or climate change adaptation: are we reinventing the wheel? *Journal of International Development*, 22, 247-264. https://doi.org/10.1002/jid.1677

Mercer, J., Kelman, I., Alfthan, B., & Kurvits, T. (2012). Ecosystem-based adaptation to climate change in Caribbean small island developing states: integrating local and external knowledge. *Sustainability*, 4(8) 1908-1932.

Moala, K. (2014). Inappropriate land-grabs in Tonga. *Pacific Institute of Public Policy*, 17 March. http://pacificpolicy.org/2014/03/inappropriate-land-grabs-in-tonga

Mortreux, C., & Barnett, J. (2009). Climate change, migration and adaptation in Funafuti, Tuvalu. *Global Environmental Change*, 19, 105-112. https://doi.org/10.1016/j.gloenvcha.2008.09.006

Moser, S.C. (2014). Communicating adaptation to climate change: the art and science of public engagement when climate change comes home. *WIREs Climate Change*, 5, 337-358. https://doi.org/10.1002/wcc.276

Moser, S.C., & Ekstrom, J.A. (2010). A framework to diagnose barriers to climate change adaptation. *PNAS*, 107(51), 22026-22031. https://doi.org/10.1073/pnas.1007887107

Nunn, P.D. (2009). Responding to the challenges of climate change in the Pacific Islands: management and technological imperatives. *Climate Research*, 40, 211-231. https://doi.org/10.3354/cr00806

Nunn, P.D. (2013). The end of the Pacific? Effects of sea level rise on Pacific Island livelihoods. *Singapore Journal of Tropical Geography*, 34, 143-171. https://doi.org/10.1111/sjtg.12021

Nunn, P.D., Mulgrew, K., Scott-Parker, B., Hine, D.W., Marks, A.D.G., Mahar, D., & Maebuta, J. (2016). Spirituality and attitudes towards Nature in the Pacific Islands: insights for enabling climate-change adaptation. *Climatic Change*, 136(3), 477-493. https://doi.org/10.1007/s10584-016-1646-9

Nurse, L.A., McLean, R.F., Agard, J., Briguglio, L.P., Duvat-Magnan, V., Pelesikoti, N., Tompkins, E., & Webb, A. (2014). Small islands. In V.R. Barros et al. (Eds.) *Climate change 2014: impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1613-1654). Cambridge, UK & New York: Cambridge University Press.

Pacific Community (SPC), Secretariat of the Pacific Regional Environment Programme (SPREP), Pacific Islands Forum Secretariat (PIFS), United Nations Development Programme (UNDP), United Nations Office for Disaster Risk Reduction (UNISDR) and University of the South Pacific (USP) (2016). *Framework for resilient development in the Pacific: an integrated approach to address climate change and disaster risk management* [FRDP] 2017 - 2030. Suva.

Rudiak-Gould, P. (2012). Promiscuous corroboration and climate change translation: a case study from the Marshall Islands. *Global Environmental Change*, 22, 46-54. https://doi.org/10.1016/j.gloenvcha.2011.09.011

Rudiak-Gould, P. (2014). The influence of science communication on indigenous climate change perception: theoretical and practical implications. *Human Ecology*, 42, 75-86. https://doi.org/10.1007/s10745-013-9605-9

Scott-Parker, B., Nunn, P.D., & Mulgrew, K., Hine, D., Marks, A., Mahar, D., & Tiko, L. (2016). Pacific Islanders' understanding of climate change: where do they source information and to what extent do they trust it? *Regional Environmental Change*, 17(4), 1005-1015. https://doi.org/10.1007/s10113-016-1001-8

Shen, S., & Gemenne, F. (2011). Contrasted views on environmental change and migration: the case of Tuvaluan migration to New Zealand. *International Migration*, 49(1), 224-242. https://doi.org/10.1111/j.1468-2435.2010.00635.x

van Aalst, M.K., Cannon, T., & Burton, I. (2008). Community level adaptation to climate change: the potential role of participatory community risk assessment. *Global Environmental Change*, 18, 165-179. https://doi.org/10.1016/j.gloenvcha.2007.06.002

Weber, E. (2014). Environmental change and (im)mobility in the South. In R. Anich, J. Crush, S. Melde, & J.O. Oucho (Eds.) *A new perspective on human mobility in the South* (pp. 119-148). Dodrecht: Springer. https://doi.org/10.1007/978-94-017-9023-9_6

Yamamoto, L., & Esteban, M. (2010). Vanishing island states and sovereignty. *Ocean & Coastal Management*, 53(1), 1-9. https://doi.org/10.1016/j.ocecoaman.2009.10.003