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Harmonising climate change adaptation and mitigation: The case of tourist resorts in Fiji

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Abstract

Tourism in island states is vulnerable to climate change because it may result in detrimental changes in relation to extreme events, sea level rise, transport and communication interruption. This study analyses adaptation to climate change by tourist resorts in Fiji, as well as their potential to reduce climate change through reductions in carbon dioxide emissions. Interviews, site visitations, and an accommodation survey were undertaken. Many operators already prepare for climate-related events and therefore adapt to potential impacts resulting from climate change. Reducing emissions is not important to operators; however, decreasing energy costs for economic reasons is practised. Recommendations for further initiatives are made and synergies between the adaptation and mitigation approaches are explored.

Keywords: Tourism; Climate change; Mitigation; Adaptation; Resorts

1. Introduction

Fiji is the largest tourism destination in the South Pacific but international arrivals have fluctuated over the last 5 years because of a series of detrimental events, such as the political coup in Fiji in 2000, the terrorist attack in the United States on 11 September 2001, the Bali attack in 2002, and Severe Acute Respiratory Syndrome outbreaks in Asia in 2003. These events have shown that tourism in Fiji is vulnerable to both internal and external events. Tourism is also vulnerable to natural hazards and disasters, such as earthquakes, tsunamis, floods, droughts, and cyclones. Climate change plays an important role in disaster management, because it is likely to affect Fiji through sea level rise and storm surge, changing temperature and precipitation patterns, and extreme weather events. As in other developing countries, this vulnerability is aggravated by limited institutional capacity, non-availability of technologies, ill-enforced regulatory frameworks, and lack of financing (B. Challenger, Presentation at the IPCC Outreach Workshop on Mitigation, September 23–24, 2002). Climate change has to be seen in a multi-stress context of wider environmental, social, and political changes and pressures (Wilbanks, 2003).

While the wider climate change debate has until recently mainly focused on mitigation (Burton et al., 2002; Wilbanks, 2003; Nicholls and Lowe, 2004), the sparse research specifically dealing with tourism and climate change has largely concentrated on tourism's vulnerability and adaptation to climate change (e.g., Elsasser and Buerki, 2002; Scott, 2003; Scott et al., 2003). Both the tourism industry and researchers have identified a threat to tourism resulting from climate change, especially in alpine areas, small island states, and developing countries (World Tourism Organisation, 2003). Climate change is also likely to affect global tourist flows as a result of the changing attractiveness of both destinations and countries of origin (Hamilton et al., 2005). Despite an inherent interest in 'protecting' the tourism industry, there is increasing awareness that tourism is an important contributor to climate change through its consumption of fossil fuels and resulting greenhouse gas emissions (Becken, 2002; Gössling, 2002). The wider literature on climate change now

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emphasises that neither adaptation nor mitigation should be implemented independently, but that an integrated framework for sustainable development should be envisaged (IPCC, 2001; Nicholls and Lowe, 2004). In the same way, research on climate change and tourism will benefit from taking into account the multiple interactions between climate, tourism, and the wider environment (Dubois, 2003; Viner and Amelung, 2003).

This study seeks to enhance understanding of climate change issues associated with tourism from both adaptation and mitigation perspectives, and explores synergies between the two responses. A localised approach is taken (as suggested by Wilbanks (2003)), with the research being confined geographically to the main tourist destinations in Fiji (Viti Levu, the main island, and the Mamanuca Islands). Moreover, this study concentrates on the accommodation sector as the core component of the tourism product in Fiji. The paper is based, in part, on a more comprehensive report on climate change and tourism in Fiji (Becken, 2004).

1.1. State of tourism in Fiji

In 2002, about 400,000 tourists visited Fiji with an average length of stay of 8 days. Despite adverse political events nationally and internationally, tourism in Fiji has grown over the last years (Fig. 1) and is forecast to grow at an average rate of 6.2% per year between 2004 and 2014 (Campbell, 2004). In 2002, most tourists came from Australia (31%), New Zealand (17%), the United States (15%) and the United Kingdom (11%). While most visitors come for 'rest and relaxation' typically linked to beach environments (Ministry of Tourism, 2003), current marketing campaigns aim to shift the image away from pure beach promotion to a wider experience. Also, there are attempts to attract more tourists from long-haul markets, for example from the USA and Europe, in addition to the traditional markets of Australia and New Zealand (Ayala, 1995; S. Toganivalu, Manager, Fiji Visitors Bureau, pers. comm.).

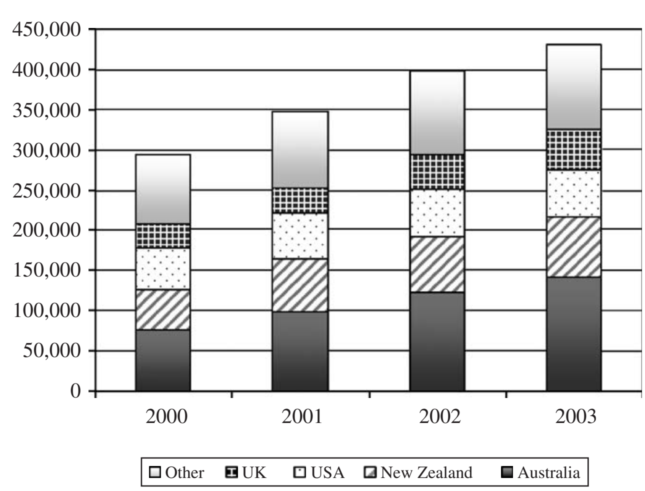

Fig. 1. International visitor arrivals to Fiji between 2000 and 2003.

Tourism is increasingly important to the national and local economies. In 1998, tourism earned F$568 million in foreign exchange, while sugar only earned F$244 million (Narayan, 2000). The decline of the sugar industry (Narayan and Prasad, 2003) has resulted in heightened expectations from tourism as the main export industry (Levett and McNally, 2003). In 1999, tourism directly and indirectly contributed 29.5% to GDP and 37.0% to exports (Word Travel and Tourism Council, 2001). A major problem of tourism in Fiji, however, is its economic leakage; about 60% of tourists' expenditure is estimated to leak out of the country (Levett and McNally, 2003).

Several attempts have been made to improve the environmental performance of Fiji's tourism industry, including projects related to energy efficiency and renewable energy sources, and environmentally friendly resort construction (Aalbersberg et al., 2003). Nevertheless, the overall focus of the Government is on increasing visitor numbers, retaining tourist dollars, and encouraging further development (Narayan and Prasad, 2003). The Fiji Tourism Development Plan 1998–2005 (Ministry of Tourism, 1998) recommended a 'Step Change', with a substantial number of new developments, mainly in the already developed areas of the Coral Coast and the Mamanuca Islands. Levett and McNally (2003) assessed the sustainability of this Tourism Development Plan and concluded that it contains some useful suggestions for reducing tourism's environmental impacts. However, the authors expressed concern that the large scale of the envisaged development could exceed carrying capacities and 'tip the balance' towards irreversible effects on the environment. While there exist policy frameworks that regulate tourism development (e.g., Environmental Impact Assessment), few of them are implemented and work in practice.

1.2. Vulnerability of tourism in Fiji to climate change

Several studies on climate change, climate variability and vulnerability, and impact assessments have been undertaken in the South Pacific (e.g., Hay et al., 2003) and in Fiji specifically (Nunn et al., 1994; Feresi et al., 2000; World Bank, 2000). Projected temperature increases are somewhat lower for Fiji than for the global average of 0.1 °C per decade (IPCC, 2001), being in the order of 0.7–0.9 °C per 1.0 °C increase in temperature globally (Feresi et al., 2000; Salinger, 2000). Sea level rise in Fiji may be in the order of 23–43 cm in 2050, and up to 1.03 m in 2100 (World Bank, 2000). Trends in climate change and sea level rise due to global warming have to be seen against other variations caused by existing natural variability, prevailing winds, earth crustal movements, and wave action.

Most of Fiji's population (about 90%; Feresi et al., 2000) and infrastructure (e.g., towns, airports, resorts) are currently located on coastal and low-lying areas and, therefore, are potentially affected by inundation and other damage to coastal systems. However, in contrast to atoll islands (e.g., the Maldives or Kiribas), the higher Fiji islands such as Viti Levu offer some room to shift activities inland under a long-term scenario of sea level rise. Climate-related risks in coastal areas pose a risk for existing capital and could also be a major impediment to further investment and capital, in particular when insurance premiums are high or exclude cover for damage resulting from climate-related impacts. Other problems associated with rising sea levels, besides inundation, include flooding, intrusion of salt water into groundwater and rivers, and drainage problems (Feresi et al., 2000).

Coastal retreat and erosion resulting from changing wind patterns and strength, changes in shoreline features (e.g., groynes and sea walls), and sea level variability and sea level rise are major problems, as they affect tourism building stocks and beaches. Coastal retreat over the last decades in Fiji may be in the order of 15–20 m in certain locations (Mimura and Nunn, 1994, in Feresi et al., 2000). Low-lying atolls could be completely lost as a result of sea level rise. In addition, major damage to existing coastal ecosystems is expected as a result of climate change (World Bank, 2000). Coastal ecosystems are already under pressure from overexploitation, pollution (from sewage, toxic substances, and nutrients), deforestation, infrastructure development, loss of mangroves,[1] conversion into agricultural land, and coral mining (Feresi et al., 2000). The cumulative effect of these non-climate-related impacts reduces the ability to cope with sea level rise and other adverse consequences of climate change.

There is great uncertainty about how climate change might affect the frequency and nature of extreme events, such as cyclones and floods. Climate models suggest, however, that the average intensity and possibly the frequency of cyclones may increase. Currently, on average, there are 1.28 cyclones per year in Fiji (Feresi et al., 2000). Cyclone-related risks for tourism include loss of quality holiday time, disrupted transport, cancelled flights, stranded passengers, destroyed tourism infrastructure and overall damage to Fiji's image as a safe and attractive destination. The greatest damage is often associated with storm surges—large masses of water pushed onshore by tropical cyclones and potentially aggravated by astronomical tides. Under global warming conditions the risk of storm surges is increased as a result of higher sea levels and changes in cyclone characteristics (McInnes et al., 2000).

Climate change entails changes in precipitation patterns with wide implications for soil moisture and water availability, and as a result agricultural production and water supply for households and tourism. Current climate models provide ambiguous projections regarding precipitation in Fiji, although there is some indication that heavy rainfall events might increase while total rainfall might decrease (Hay et al., 2003). It is also possible that droughts may become more frequent, which would require water management measures to reduce the need for freshwater. Currently, loss from leakage from water pipes in Fiji is greater than potential decreases in water availability due to climate change (World Bank, 2000).

Coral reefs are among the most threatened ecosystems in Fiji. Reefs have several functions: they are important for biodiversity, provide habitat for fish, buffer against waves and erosion, and provide carbonate sand for beaches (Hoegh-Guldberg et al., 2000). The optimal ambient temperature for coral is 25–29 °C and they are extremely sensitive to sudden changes in their environment. When corals are under stress, they expel the algae (dinoflagellates) that symbiotically supply them with oxygen or food, resulting in 'bleaching'. Corals are already under stress from factors such as high nutrient content, turbidity and sedimentation, overfishing, destructive fishing methods, changed water chemistry and physical damage, and an increase in sea level. Some corals can grow at the same rate upwards as sea levels rise; however, these types of corals are not common in the Pacific, where existing coral species are characterised by lateral rather than vertical growth (Nunn, 2000). An ecological shift in coral composition would be required in the Pacific to compensate for rising sea levels. Stress thresholds that result in bleaching events will become very frequent in islands of the South Pacific between 2010 and 2070, and it is likely that in the next 20–50 years corals as dominant organisms on reefs will disappear (Hoegh-Guldberg et al., 2000). Destruction of a substantial proportion of the coral reefs means that one of the major pull factors for tourists to Fiji could disappear (see also Cesar et al., 2003).

Other climate change impacts include health issues, such as the more frequent occurrence of cholera and dengue fever, and biotoxin poisoning, risks to food and energy supply (based on fuel import via a supply chain from Singapore, Australia and New Zealand; Hay et al., 2003), and, as a result of all of the above, significant socio-economic impacts. Tourists' personal health and safety may be at risk in the case of extreme weather events. Tourism might also be affected indirectly, for example as a result of climate-related impacts on food production.

2. Methods

Tourism in Fiji is largely resort-based and therefore the accommodation sector is the prominent tourism sub-sector (about 70% of total expenditure is on accommodation; Ministry of Tourism, 2003). Tourists spend most of their time at a resort, and most of tourists' resource consumption (e.g., water and energy) takes place at the resort level (for a full analysis of both accommodation and transport energy use, refer to Becken, 2004). For the above reasons, it was considered appropriate to focus this analysis on the accommodation sub-sector.

[1]Mangroves are paramount in protecting the shore, filtering runoff, trapping sediment, and providing habitat for fish (World Bank, 2000).

Data were collected from three sources: stakeholder and expert interviews, tourist operator interviews, and an accommodation survey. The stakeholder and expert interviews ($N = 14$) were informal and notes were taken. The results and background information obtained informed the accommodation survey and industry interviews ($N = 9$). The private-sector interviews were conducted at the resorts and included site visits. Interviews were semi-structured and designed to enhance or confirm knowledge gained in the accommodation survey. The interviews covered the operators' attitudes towards climate change, and adaptation and mitigation measures in place. All the interviews were undertaken between 15 April and 1 May and 23 August and 3 September 2004.

The accommodation survey was designed as a mail-back survey and was sent out on 23 April 2004. The questionnaire sought information on energy consumption, climate change mitigation and adaptation measures, and environmental management. The survey was undertaken with the support of the Department of Energy and the Ministry of Tourism. The questionnaire was posted to all tourism accommodation providers in Suva, the Coral Coast, the Mamanuca Islands, and Nadi ($N = 116$), together with a prepaid envelope for sending the survey back. The addresses of the businesses were taken from the 'Explore Fiji' brochure (March 2004) published by the Fiji Visitor Bureau on a monthly basis, and available to tourists free of charge. It is possible that this list of businesses is not comprehensive, but it covers the majority of providers and constitutes information that is easily available to tourists themselves.

Two weeks after the accommodation survey was sent out, follow-up calls were undertaken. Some businesses claimed they had not received the survey forms, and the questionnaire was resent by fax or email. The same procedure was repeated after another week. Twenty-five accommodation providers replied to the survey, which represents a response rate of 21.6% (Table 1). Two of the respondents were also among the operators interviewed. Unfortunately, the responses do not represent the true geographical dispersion of tourism. Resorts based on the Coral Coast are under-represented with only three accommodation providers sending back the survey. The Mamanuca Islands showed the highest response rate. This may be related to a possibly greater environmental awareness and involvement of these businesses as reflected in the existence of the Mamanuca Environment Society with 11 islands and 28 members. Overall, it is possible that the accommodation survey is biased towards businesses that are more interested in and aware of climate change, which may have aided their willingness to reply. Because of its small sample size, the accommodation survey has to be seen as indicative rather than truly representative. The same applies to the calculation of energy consumption rates, which give a rough estimate of what might be the average energy use of accommodation businesses in Fiji.

The adaptation part of the accommodation survey is analysed descriptively, and relevant information obtained in stakeholder and manager interviews is added where appropriate. Analysis of the energy consumption part of the survey involved some calculations to derive energy benchmarks and CO_2 emissions. The data provided by respondents was in original units (e.g., kWh, litres, kilograms) or dollar terms (F$), and conversion factors were applied to estimate energy usage in megajoules (MJ) and CO_2 emissions in kilograms (Baines, 1993). Carbon dioxide emissions associated with electricity provided in Viti Levu through the main grid had to be estimated based on the information that about 24.5% of electricity is based on thermal generation, with the remainder being either hydropower or generated by burning bagasse from sugarcane, both of which were considered carbon neutral. No data were available on the ratio of fossil fuel input to electricity output for Fiji thermal power plants from which emission factors could be calculated. For this reason a New Zealand figure of 624 g of CO_2/kWh electricity consumed (i.e., including transmission losses) was used (New Zealand Ministry of Commerce, 1995); in the knowledge that this figure might differ for the Fijian context. The emission factors for diesel and gas as used in this study were 68.7 and 60.4 g CO_2/MJ, respectively.

The following sections discuss, in turn, adaptation of the tourism accommodation sector to climate change, its CO_2 emissions and mitigation measures, and the barriers to implementing either adaptation or mitigation measures.

3. Climate change vulnerability and adaptation measures

3.1. Existing impacts

Tourism stakeholders and operators recognised environmental factors, such as healthy reefs and clear water, as essential for tourism in Fiji. Operators surveyed were aware of potential climate-change-related impacts, such as

Table 1
Overview on responses to the accommodation survey

	Suva/Pacific Harbour	Coral Coast	Nadi	Mamanuca Islands
Resort	4	2	2	7
Motel/Hotel	1	1	2	–
Budget accommodation	1	–	4	1
Total, response rate in brackets	6 (18.2%)	3 (12.5%)	8 (19.5%)	8 (44.4%)

cyclones (32%), the loss of coral reefs (32%), and heavy rain events or flooding (20%). Some also related polluted water or the growth of seaweed to rising water temperatures and therefore climate change. Rising sea levels were only mentioned by three businesses, two of which are based in the low-lying Mamanuca Islands. Most accommodation businesses had experienced at least one of the climate-related impacts shown in Table 2. The most commonly identified impacts were erosion problems, water availability, and the disruption of supply chains (e.g., electricity). These disruptions are possibly unrelated to climate change. Several resorts had been affected by coral bleaching and suffered damage to their property as a result of cyclones or other climate-related events.

Eight businesses reported that they were not impacted by any of the factors listed. Five of those are located in the Mamanuca Islands, which are comparatively vulnerable to climate change because of the risk of cyclones, sea level rise, poor water quality, dying corals, and limited water availability. This apparent contradiction suggests the need for further research to find out whether the resorts in question have not been affected or whether they are well adapted to climate variability. Another possibility is that there is a general lack of awareness of climate change impacts and managers do not necessarily relate the problems that they may be facing to climate change.

Twelve out of the 25 accommodation businesses have insurance cover against damage from climate-related events; most policies being for cyclones while some include floods or sea surge as well. Insurance cover against cyclones is expensive, but critical given the extent of damage in the case of a cyclone hitting the resort, and premiums can be reduced substantially by implementing risk-mitigating procedures (J. Rice, Manager, Shangri-La's Fijian Resort, pers. comm.).

3.2. Adaptation

Adaptation measures by accommodation providers can be usefully categorised into those measures that require some form of construction (to protect against cyclones, hot temperatures, and drought) and those that entail changes in management or behaviour, either by staff or tourists. Tourist accommodation is increasingly built in a cyclone-proof way (Table 3); however, managers interviewed pointed out that the risk of a cyclone constitutes a natural part of running a tourism business in Fiji. One resort manager commented that it is very costly to retrofit existing structures, and it is often easier to consider climate-related issues when developing new areas or extending existing resorts.

The construction of new resorts continues to focus on coastal areas in high development zones (Short, 2004). To prevent damage from storm surge and sea level rise, facilities are built at least 2.6 m above mean sea level (S. Huggett, Architects Pacific, pers. comm.). One interviewee (S. McGree, Fiji Meteorological Service) commented that rather than generalising a minimum height it is more useful to consider the specific geographic situation of a development site, for example the bathymetry and the topography.

The interviews and site visits showed that resorts commonly adapt to erosion and the risk of storm surge by constructing seawalls, as well as by planting trees, mainly coconut palms or mangroves (Table 3). Seawalls and other hard structures often cause erosion elsewhere, and further erosion protection measures are necessary as a result of this (Raksakulthai, 2003; A. Gorton, Manager, Sonaisali Resort, pers. comm.); especially when the construction does not take into account latest knowledge or technologies (Prof. B. Aalbersberg, Institute of Applied Science, University of the South Pacific, pers. comm.). The loss of sand as a result of cyclones, changing wind patterns

Table 3
Adaptation measures in place

	Frequency (out of 25)
Construction-based	
Adequate building structures	20
Own water storage	19
Replanting trees/mangroves	18
Pollution control	17
Self-sufficient for energy supply	13
Setting back structures	12
Behaviour-based	
Guest education	18
Reef protection	17
Evacuation plan	13
Offering more indoor activities	10

Table 2
Climate-related impacts previously experienced

	Frequency (out of 25)	Comments by respondents
Shoreline/beach erosion	9	Banks on edge of property/beach give way
Reduced water availability	9	In recent drought
Interrupted supply chain (e.g., food, energy)	8	Power cuts
Coral bleaching	8	Noticed by tourists, snorkelling affected
Damage to property	5	From sea surge
Sea level rise	3	–
Increased storm frequency and intensity	3	Maintenance of gardens

and sea level rise is a major problem, especially on low sandy islands such as Beachcomber Island (T. Boa, Manager, Beachcomber Island, pers. comm.). Despite knowledge about the importance of mangroves for shore protection, large areas are still cut down to provide space for further development. The resulting sedimentation puts considerable pressure on coral reefs (D. Walker, Project Manager, Mamanuca Environment Society, pers. comm.).

Some resorts have measures in place to store and conserve water where possible. For example, the mulching of garden waste and layering of shredded paper, cardboard or coconut shells are measures that keep the soil moist and reduce the need for irrigation, one of the major demands for water consumption in a tourist resort. Some resorts use recycled or grey water for irrigation, hold grey water reservoirs for firefighting, and operate toilets with saltwater or recycled water for flushing. There are also technological solutions for water-conserving showers and toilets (e.g., dual flush). A major problem that undermines water conservation measures is leakage. Unknown but potentially substantial quantities of freshwater leak into the sea. More remote islands have the option of a desalination plant, with costs being only slightly higher than shipping water to the island (B. Herriman, Engineer, Beachcomber Island, pers. comm.). Rainwater collection is possible, but this adaptation measure is problematic in that considerable space is required for water storage. Underground tanks are a solution for newly designed resorts.

Reefs that are not already under pressure from pollution and sedimentation are more likely to cope with increases in water temperature than stressed reefs. Hence, pollution control is an important adaptation measure to protect the coral reefs around tourist resorts. Typically, resorts and local communities have septic tanks, and treatment systems that go beyond these simple tanks require considerable investment both in terms of capital and ongoing maintenance. Cost may be prohibitive for smaller accommodation providers, although there exist small and cost-efficient systems (e.g., sand-filters) that can cope with small amounts of sewage. Potential conflicts exist when a tourist resort invests in a sewage treatment plant, but the neighbouring community keeps polluting the water on which the resort's tourist activities are based.

The coral reefs were usually the largest concern of tourism operators when it came to changing their own or tourists' behaviour. Most of the managers or public-sector stakeholders interviewed expressed concern about the condition of at least some of the coral reefs, although climate change and the resulting increase in sea surface temperatures were not necessarily seen as major factors. Rather, protecting the reefs was associated with avoiding physical damage, pollution, sedimentation, and freshwater influx. Resort-based boat operators are instructed not to anchor on reefs but only on designated buoys, and some resorts have given up activities such as reef walking or allow it only in designated areas. Tourists are informed about appropriate behaviour (e.g., no touch, no take) while snorkelling or diving in order to avoid damage to the corals.

About half of the businesses surveyed have evacuation plans in place. Less than half reported they offer indoor activities as an alternative in poor weather conditions.

4. Tourism's contribution to climate change

4.1. Greenhouse gas emissions from tourist accommodation

Tourist accommodation uses a wide range of energy sources, with electricity either generated from hydropower (Viti Levu, 52% of respondents) or by using a diesel generator (Mamanuca Islands or other remote areas, 60% of respondents) being the most important in terms of energy used. Petrol or diesel for business vehicles is used by 68% of respondents, and 20% use petrol or diesel for other purposes. Liquefied petroleum gas is used by most businesses (84%), mainly for cooking, hot water, or in the laundry. Ten out of 25 businesses use some form of renewable energy sources, most of which are hot water systems or solar lights.

Energy consumption and resulting greenhouse gas emissions vary widely for different accommodation businesses. There are two factors, however, that seem to have a major influence on energy consumption and CO_2 emissions, namely the standard of accommodation (resort, motel/hotel, and budget accommodation) (Table 4) and geographical location (mainland Viti Levu versus the Mamanuca Islands) (Table 5). On a per-visitor-night basis, motels, hotels, and budget accommodation consume considerably less than tourist resorts. This is not surprising given the different levels of service provided (Becken et al., 2001). Most resorts maintain extensive outdoor and indoor areas, including swimming pools, diving centres, bars, restaurants, and other entertainment facilities. Moreover, resorts usually offer air conditioning in common areas as well as in tourists' rooms or apartments. Budget accommodation usually operates shared facilities and has ceiling fans rather than air conditioning.

Tourist accommodation in the Mamanuca Islands is approximately 2–3 times as carbon-intensive as that based in Viti Levu (36 kg CO_2 per visitor-night compared with 14 kg, Table 5). The main reason for this lies in electricity generation, which is much less carbon-intensive in Viti Levu due to the high proportion of renewable energy sources (hydro and bagasse) compared with diesel generation on islands with its inherent inefficiency (about 65–70% of energy input is lost during the process of generation). Moreover, resorts on remote islands operate more or less self-sufficiently, and therefore have additional energy requirements (e.g., sewage treatment, freezing rubbish[2]).

[2]Freezing rubbish stops development of unpleasant odour as a result of decomposition of organic waste. This practice allows island resorts to store their rubbish for several days until shipped from the island to the

Table 4
Average energy use and CO_2 emissions for different types of accommodation

	Number of respondents	Visitor nights	Total energy use (GJ)	Energy use per visitor-night (MJ)	CO_2 total (tonnes)	CO_2 per visitor-night (kg)
Resort	15 (14[a])	18,800	6684	443	391	27
Motel/Hotel	4 (3[a])	21,700	790	34	40	2
Budget	3 (2[a])	6600	515	61	22	4

Notes:
[a]Only 14, 3 and 2 businesses provided visitor numbers necessary to derive per capita energy data.

- 1 gigajoule (GJ) equals 1000 megajoules (MJ).
- Only 14, 3 and 2 businesses provided visitor numbers necessary to derive per capita energy data.
- Assumptions for calculating energy use: the average cost of electricity from the main grid in Viti Levu was assumed to be 22.09 c/kWh (www.fdoe.gov.fj). Diesel purchased in bulk was approximated to cost 80 c /l, and diesel/petrol used for vehicles $1/l (A. Gonelevu, Department of Energy and B. Herriman, Engineer Beachcomber Island, pers. comm.). Costs for LPG vary but were averaged as $1.50/l (information obtained from Fiji Bluegas).
- The energy content of diesel is 38.1 MJ/l, and for LPG 26.5 MJ/litre or 49.5 MJ/kg (Baines, 1993).

Table 5
CO_2 emissions for tourist accommodation by geographical location

	Number of respondents	CO_2 total (tonnes)	CO_2 per visitor-night (kg)	Visitor-nights
Viti Levu	15 (13[a])	238	14	18,000
Mamanuca Islands	7 (6[a])	465	36	17,800

[a]Only 13 and 6 businesses provided visitor numbers necessary to derive per capita energy data.

Transport energy use is also high given that not only do tourists have to be transported to and from the resort, but so also do food supplies, energy (diesel and gas), water and other devices required for operating the resort.

The data presented in Tables 4 and 5 are subject to uncertainty because of (i) possible errors in reporting on part of the respondent, (ii) unintentional under-reporting (e.g., diesel for boats; services contracted to other companies), (iii) missing data (e.g., three businesses reported gas use but did not provide an estimate of their consumption), (iv) other unknown sources of error. For these reasons, the benchmarks provided could be interpreted as *minimum* estimates of energy use and CO_2 emissions. However, the means presented in Table 5 are also biased towards resorts on more remote islands (higher response rate), which could result in higher estimates of energy use and carbon intensity. It is not possible to quantify those contrasting effects. Notwithstanding those limitations, no other data on energy use in accommodation businesses in Fiji exist and these benchmarks provide a starting point for further analyses. These figures are also in the same range as accommodation energy use derived for other countries (Becken et al., 2001).

It is possible to obtain a rough estimate of energy use and CO_2 emissions associated with tourist accommodation through extrapolating the above results for the whole of Fiji. The total number of visitor nights spent in Fiji was 2,891,295 in 2002 (Ministry of Tourism, 2003), whereby 82% of visitor-nights were spent in hotels, 13% in backpacker/budget accommodation, with the remainder of nights being spent in motels, on boats or in other forms of commercial and non-commercial accommodation. For the purpose of this extrapolation it is assumed that the category 'hotel' in the Ministry of Tourism's IVS is equivalent to 'resort' as shown in Table 5, the backpacker category is the same as budget accommodation, and the remaining categories are aggregated into the motel category. With this breakdown, the total energy use due to tourist accommodation was calculated to be 1,078,373,475 (MJ per annum (or 1078 terajoules (TJ)), which is equivalent to a contribution to national energy use of about 6.5% (Department of Energy, 2003). In terms of CO_2, the accommodation industry emits roughly 68,219 t per annum (Department of Environment, no date). Since no recent data are available for national CO_2 emissions, the accommodation sector's contribution to these emissions is not calculated, but it would be at least in the same order as the 6.5% derived for energy use. These estimates have to be seen as approximations only.

4.2. Mitigation measures

Energy is a major cost driver for the operation of a tourism accommodation business, especially when energy

(*footnote continued*)
mainland where waste is further treated (e.g. incinerated) or deposited in a landfill.

is derived from fossil fuels either for transport or electricity generation. The operation of diesel generators is costly, because of inefficiencies, transportation costs (diesel shipment), maintenance, and salaries for powerhouse staff. Thus, managers have an economic interest in keeping electricity consumption low. The crux with diesel generators, however, is that once a generator is purchased, the optimum range of electricity generation is determined at about 80% of the maximum performance. If as a result of electricity conservation the generator runs below this range, the diesel is not combusted completely, which ultimately reduces the lifetime of the generator (B. Herriman, pers. comm.). To overcome this problem, one business reported that they switch to a smaller generator at night-time. However, purchasing a smaller generator is often not an alternative because of high capital costs. For these reasons some managers see little incentive in conserving energy below a certain performance of their generator (H. Sykes, Resort Consultant, pers. comm.).

Nine out of the 25 businesses in the survey did not name any measures in place for reducing energy consumption. Those managers who reported measures showed various levels of knowledge and commitment, identifying air conditioning, cooling, and the laundry as major drivers of energy use. Some budget resorts have no air conditioning or only use it at night, which keeps energy costs low and reduces the need for a high-capacity generator. Adequate building materials and structures and planting trees for shade help minimise the need for air conditioning.

Reducing the consumption of hot water (laundry and showers) and reducing the water temperature are other saving measures (e.g., some budget accommodation only provide cold showers). Other energy-use-reduction measures reported in the accommodation survey centred on lighting, including 'energy-efficient light bulbs', 'sensor lighting in the garden', 'solar panel lights' and 'room keys used to operate lights in each room'. The interviews revealed that not all managers are convinced that energy-efficient bulbs are a good option, because they are expensive and do not last, as a result of fluctuating power supply from generators. In the case of smaller islands the energy costs of shipping are substantial, and managers seek to maximise load factors by combining passenger vessels with transporting food, waste, or water. One business reported that they reduce the number of shopping trips to save fuel.

Little seems to be done in terms of guest education, and as one resort manager pointed out, 'tourists are not here to worry about air conditioning' (E. Vuki Tavai, Human Resources Manager, Treasure Island, pers. comm.). Some managers try to educate their staff, but this proves very difficult and requires a lot of reinforcement and supervision (e.g., in the area of recycling). As noted by the Fiji Visitor Bureau (S. Toganivalu, pers. comm.), the number of resorts that are active in this regard is limited.

A number of accommodation businesses operate solar hot water systems; however, photovoltaic systems are less common. The monthly average solar radiation is about 15 MJ/m^2 and day (Department of Energy, 2003), which makes solar energy relatively cost-effective, especially on islands that rely on diesel generation. Some of the interviewees believed that the use of solar energy, especially photovoltaic, is not economical (especially when technology has to be imported); and this misconception was identified as a major barrier by the Department of Environment (I. Neitoga, pers. comm.). The installation of 1-kW rooftop solar cells for electricity generation could be an effective way to supply tourist bungalows with sufficient electricity for lighting and small appliances. Such photovoltaic systems have the advantage that they are silent (as opposed to diesel generators), reliable, require little maintenance, have low operating costs and are easy to install (United Nations Environment Programme (UNEP), 2003). However, they may be vulnerable to storm damage and salt deposit.

Mini hydropower schemes are less relevant for coastal resorts, but could be an option for tourism ventures operated in inland communities (referred to as ecotourism operators by the Fiji Ministry of Tourism and Visitor Bureau). The capital costs are very high, however, and consequently the uptake is minimal (A. Gonelevu, Department of Energy, pers. comm.). The Department of Energy currently assesses potential sites for mini hydropower schemes, and it is also exploring potential for geothermal electricity generation on Vanua Levu, the second largest island of Fiji. Wind energy is not widely used in Fiji, but the Coral Coast, Mamanuca Islands, and Sonasavu are promising locations for wind-powered generation (A. Gonelevu, pers. comm.). Wind energy systems are available at different scales, ranging from small 1-kW ones to 100–700 kW schemes (medium scale), or even larger ones (UNEP, 2003). Tourist resorts would need small- to medium-scale wind systems if they want to meet their whole electricity demand by wind power. Small islands are unlikely to erect wind turbines because of lack of space and noise pollution (B. Herriman, pers. comm.). Resorts on larger areas are in a better position to pursue wind energy (A. Gorton, pers. comm.). No renewable energy sources are currently seriously discussed for transport, although one resort looked into wind-driven boats, and there are explorations into replacing fossil fuel with biofuel, for example derived from coconut (copra) oil (SOPAC, 2004).

4.3. Barriers to climate change adaptation or mitigation

There are several barriers to climate change adaptation and mitigation within the tourism industry in Fiji, most importantly a lack of data to fully assess the situation. Few data exist that allow assessment of the vulnerability of tourism as a whole and specific tourism infrastructure in particular, and already-existing climate-change-related impacts. Similarly, in terms of mitigation, neither the energy nor the greenhouse gas statistics are good enough to identify major users and end uses, based on which strategies could be developed for reducing emissions at least cost. The lack of data is both a result of Government simply not having collected the required information and of the industry not supplying data when asked, for example by the Department of Energy for their energy statistics (A. Gonelevu, pers. comm.).

Possibly, because of this lack of data, little has been done to raise awareness and understanding of how climate change and tourism interact, and what could be undertaken to mitigate negative effects both in terms of adaptation and mitigation ('lack of knowledge' was identified by most respondents in the accommodation survey, Table 6). Some respondents seemed to confuse climate change with other environmental (e.g., waste management) or cultural problems (e.g., land use problems), or where not able to understand causes and effects of climate change. More than half of the respondents noted that they would be interested in further information on the topic.

A lack of financial resources was commonly mentioned in the interviews and the survey as another major barrier to being active in terms of climate change adaptation or mitigation. This is true not only for the private sector but also for the public sector, which lacks funding for undertaking studies or measures such as developing hazard maps or a risk management plan. Environmental management was sometimes perceived as being too expensive for small businesses, especially when it involves new technologies which may have to be imported at great cost. For some imports it is possible to get some tax exemption (e.g., renewable energy technology), but no clear guidelines exist at this stage (A. Gonelevu, pers. comm.).

The 'lack of government incentives' was identified as one barrier to implementing climate-change-related measures in the accommodation industry and needs to be addressed. Along similar lines, interviewees noted that the legislatory framework that exists would be sufficient if enforced, but a major problem is that regulations are often not put into practice, nor are they monitored (e.g., Environmental Impact Assessment, building codes). Lack of capacity was another barrier identified in both the survey and the interviews. Several operators commented on how difficult it was to recruit and also to keep qualified staff. Another issue was a lack of willingness on the part of qualified personnel to share their expertise and experience with potential successors.

5. Discussion

Tourism in Fiji is highly vulnerable to climate-change-related hazards such as cyclones, storm surge and flooding, sea level rise, erosion, transport and communication interruption, and temporarily reduced water availability. Another major concern for the tourism industry is the degradation of natural systems, such as coral reefs and forest ecosystems, further aggravated by climate change. Most commonly, tourism businesses are impacted upon in the form of physical damage from a cyclone or storm surge, erosion, and coral bleaching. Despite the high risk associated with tourist facilities built on the waterfront, most new developments focus on coastal areas, and it is also still common practice to cut down mangrove forests, which would serve as a natural protection against various climate-related impacts.

Tourist accommodation providers adapt to climatic conditions that may affect their business, and in doing so they are also prepared for impacts that may result from a changing climate. Typically, operators focus on relatively concrete and foreseeable high-risk impacts, such as cyclones and storm surges, for example by cyclone-proofing their structures and erecting seawalls. A number of accommodation providers have insurance cover against cyclones and storm surges. Generally, it seems that the risk of accumulative impacts or more abstract impacts are less recognised and addressed. Pollution control, sewage treatment, and water management are examples of this. The vulnerability to extreme climate-related events can be reduced when climate change adaptation is integrated in the development process from the earliest stages (Jones, 2003). The exact location of the development, as well as the design (e.g., building materials, orientation, structures) and landscaping can help reduce vulnerability. There is also some opportunity to harmonise tourism development at locations that are less vulnerable to climate change (e.g.,

Table 6
Barriers to implementing climate change mitigation or adaptation

Barriers	Yes (frequency)	No (frequency)
Lack of knowledge	14	10
Lack of incentives by Government	13	11
Lack of finance	12	12
Lack of skilled staff	10	14
Lack of technological solutions	10	14
Lack of adequate legislation that requires compliance	9	15
Lack of recognition on the part of customers	9	15
Lack of time	8	16
Customer expectations that counteract specific measures	4	20
No need for any measures	4	20

Note: One business did not answer this question ($N = 24$).

inland areas in Viti Levu) with current attempts of diversifying Fiji's tourism product, especially in relation to 'ecotourism'. Ayala (1995), for example, proposed that new and unique tourism products could be developed in the Fijian hinterland on elevated areas, by using the Japanese concept of 'shakkei' (borrowed landscape), where hotel layout, garden landscaping and scenery are integrated into an overall experience of an ecosystem that differs from the typical panorama of a beachfront.

Energy use and greenhouse gas emissions are not major environmental concerns of tourism operators, although from an operational point of view energy is recognised as an important driver of costs. Energy use and CO_2 emissions in tourist accommodation are substantial (between 34.2 and 443.0 MJ or 1.6 kg CO_2 and 28.1 kg CO_2 per visitor-night). Staying on island resorts is about 2–3 times as carbon-intensive as staying on the mainland Viti Levu. Altogether, the accommodation sector consumes about 1078 TJ per annum and emits 68,219 t of CO_2. This is equivalent to a contribution of about 6.5% of national energy use (Department of Energy, 2003).

A number of greenhouse gas mitigation measures are in place (e.g., adapting generator sizes, switching off lights, energy-efficient light bulbs, and solar hot water). However, with few exceptions, initiatives are not systematically explored and implemented, but seem to be piecemeal and ad hoc. While there is a huge potential for solar energy and wind-generated power (especially on the Coral Coast, the Mamanuca Islands, and Sonasavu), these technologies are taken up slowly, inhibited by lack of knowledge, capital, capacity and government incentives. Often, the energy demand of a single tourist resort is too small to justify investment in a wind turbine.

The policy focus and interests of resort operators in Fiji are development-driven, although there is a strong recognition of the concept of sustainable development. Climate change is mainly seen from the perspective of tourism's vulnerability and adaptation. Mitigation seems to be less pressing, although in the medium term increasing greenhouse gas emissions (e.g., as a result of increasing tourist arrivals) could undermine Fiji's credibility in international negotiations on climate change. The above order of Government and industry priorities has to be recognised when trying to implement any climate-change-related measures. Wilbanks (2003) suggested that climate change be integrated into wider sustainable development by first identifying the key local problems and then linking those to climate change.

In the case of tourism in Fiji, these major local problems are: land use issues, an aged accommodation stock, lack of new capital and investment, restricted air capacity, dependency on air travel, economic leakage, a lack of a unique selling point, environmental degradation, and political instability (Narayan, 2000; Levett and McNally, 2003). Wider environmental problems that need to be considered are pollution, deforestation, and overexploitation of resources. Measures that have the potential to address the above issues in addition to climate change offer no-regret solutions (Hay et al., 2003) and are therefore more likely to be funded (e.g., by donor agencies) and taken up by local agencies, stakeholders, and industry members. Adopting wider environmental management practices, for example, addresses climate change adaptation and mitigation, and also has the potential of providing a 'unique selling point' for Fiji as a sustainable tourist destination. Developing small-scale technologies for solar or wind energy on the more remote islands would also help reduce the dependency on imported fossil fuel and economic leakage.

A good example of combining climate change adaptation and mitigation is reforestation. Trees reduce vulnerability to cyclones, improve microclimates, and enhance landscapes used for tourist activities. Moreover, trees function as carbon sinks, although Dang et al. (2003) note that those species preferred for adaptive measures (e.g., erosion control or watershed management) are not necessarily the ones most suited for carbon sequestration. Beg et al. (2002, p. 139) recommend that forest protection or plantation should be done 'under the umbrella of adaptation policies, given the controversial aspects of including it under mitigation options, such as the Clean Development Mechanism' (p. 139). Notwithstanding this, there is some potential to include forest sinks in carbon trading schemes, whereby carbon emitters (e.g., tourist resorts) purchase carbon credits from landowners who restore forest on (marginal) land (e.g., see EBEX21, www.ebex21.co.nz). In Fiji, such a scheme would need to address land rights issues, which may be difficult to solve in the near future (H. Sykes, pers. comm.). Despite some possible practical difficulties, the option of forest carbon sinks should be explored further, especially when seeking to offset emissions associated with tourists' travel to and from Fiji (Hart et al., 2004). In 2002, tourists' international air travel (one-way) to Fiji consumed about 5500 TJ of energy, and this resulted in CO_2 emissions of about 384,000 t (for more detail, see Becken, 2004).

Recognising co-benefits of climate change measures is as important as avoiding counteracting effects; for example, heavier use of air conditioning leads to increasing greenhouse gas emissions, or the relocation of sand adds to local environmental impacts (Table 7). Future work would need to take into account technological and economic aspects, as well as the expected amount of reduced or increased greenhouse gas emissions (Dang et al., 2003).

6. Conclusions

There is currently no common strategy to address interactions between climate change and tourism in Fiji, nor is there a sector-wide industry association that could promote any climate-change-related initiatives. However, there are isolated examples among industry members that reveal a high understanding and advanced use of technology and management to address climatically unfavourable

Table 7
Adaptation measures for tourism on tropical islands and their positive or negative ancillary effects

Adaptation	Impact on mitigation	Impact on environmental management	Economic aspect
Tree planting	Reduces net CO_2 emissions through carbon sinks	Benefits biodiversity, water management, soils	Could be included in a carbon-trading scheme
Water conservation	Reduces energy costs for supplying water	Positive in areas where water is limited	Saves costs, especially when water is shipped to islands
Renewable energy sources	Reduces CO_2 emissions	Overall, less polluting than fossil fuels	Potentially saves costs; reduces dependency on fuel imports
Using natural building materials (e.g., wood)	Smaller carbon footprint for locally produced materials	Depends on sustainability of plantations	Stimulates local forestry sector
Reducing water pollution	Possibly increased energy use for sewage treatment	Positive for coral reefs and marine life	Maintains resource basis for tourism earnings
Marine sanctuaries/coral reef protection	Neutral	Positive for marine biodiversity	Maintains resource basis for tourism earnings
Rainwater collection	Saves transport energy for supplying water	Possibly interrupts the natural water cycle	Saves costs in the long term
Guest education	Neutral	Increases awareness	Risk of deterring tourists
Setting back building structures	Neutral	Positive when structures built away from beachfront	Positive if maintenance costs are reduced
Diversifying markets	Positive if new markets are more eco-efficient ($ spent /kg CO_2)	Depends on the environmental impact of new markets	Positive if new markets are high-yield
Weather-proofing tourist activities	Depends on the type of activities	Depends on the type of activities	Potential for high-yield alternative and income for local communities
Water desalinisation	High energy costs	Takes pressure off freshwater resources	Expensive
Increasing air conditioning	Increases CO_2 emissions	Air pollution in the case of diesel generation	Expensive
Beach nourishment	Energy use for mining and transportation	Disturbs ecosystems	Expensive
Reducing beach erosion with seawalls	Neutral	Disturbs natural currents and causes erosion elsewhere	Expensive, requires ongoing maintenance

conditions. Those operators are also best prepared for increased risks resulting from climate change. Also, a number of operators engage in wider environmental management, energy conservation, and therefore climate change mitigation, although the greenhouse gas emission aspect is rarely the reason for the mitigating measures undertaken.

Overall, there is a need for tourism-specific information on what climate change is, how it will affect tourism, and what operators could do to adapt and mitigate. In the medium term it would also be important to include climate change in the curricula of tertiary education for students in the field of tourism, resource management engineering and architecture. Since the scope and costs for many adaptation and mitigation measures are largely determined by the design of tourist facilities, the incorporation of these aspects into architectural courses is particularly important. Alongside information and education initiatives, the Government could assist businesses in undertaking energy audits, facilitating the implementation of Environmental Management Systems (e.g., Green Globe 21), and providing incentives, for example for the uptake of renewable energy sources.

Climate change could form part of a wider risk management plan for tourism. Such an initiative is currently being discussed between the Ministry of Tourism (M. Malani, pers. comm.) and the Disaster Management Office. A two-level approach could be possible, where guidelines are provided for tourism operators to develop their own risk or disaster management plan at the business level, while Government covers wider issues beyond individual businesses, such as tourism infrastructure and larger evacuation plans. The current attempt by the Fiji Visitor Bureau (S. Tonganivalu, pers. comm.) to diversify the product could be seen as part of national-level risk management, as they attempt to spread risk across different markets (e.g., event tourism, sport tourism, nature tourism) and seasons. Fewer initiatives exist to weather-proof tourism, as suggested for tourism in Phuket, Thailand (Raksakulthai, 2003). Another important step towards implementing a nation-wide risk management strategy for tourism and climate change would be the mapping of all tourism infrastructure, as well as the risk of various hazards in different locations.

The Department of Environment in their climate change policy or the Ministry of Tourism in their risk management plan are best advised to pursue measures that offer win-win situations, namely for adaptation, mitigation, wider environmental management and development. Examples of such measures are reforestation, water conservation, and the use of renewable energy sources. It is recommended that the synergies between adaptation, mitigation, and sustainable development be explored further and that the effects be quantified where possible; i.e., how much carbon can be saved as a result of a particular measure and what costs are involved (Dang et al., 2003). This is even more important given the lack of resources in Fiji, which requires maximising benefits from any implemented measure.

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References

Aalbersberg, W.G.L., Thaman, B., Berno, T., Malani, M., Sykes, H., Watling, D., 2003. Guide to Setting Up Environmentally Sustainable Small Hotels and Resorts. Fiji Integrated Coastal Management Project, Suva.

Ayala, H., 1995. From quality product to eco-product: will Fiji set a precedent? Tourism Management 16(1) 39–47.

Baines, J.T. (Ed.), 1993. New Zealand Energy Information Handbook. Taylor Baines and Associates, Christchurch.

Becken, S., 2002. Analysing international tourist flows to estimate energy use associated with air travel. Journal of Sustainable Tourism 10, 114–131.

Becken, S., 2004. Climate Change and Tourism in Fiji—Integrating Adaptation and Mitigation. Final Report. University of the South Pacific, Suva.

Becken, S., Frampton, C., Simmons, D., 2001. Energy consumption patterns in the accommodation sector—the New Zealand case. Ecological Economics 39, 371–386.

Beg, N., Morlot, J.C., Davidson, O., Afrane-Okesse, Y., Tyani, L., Denton, F., Sokona, Y., Thomas, J.P., Lebre La Rovere, E., Parikh, J.K., Parikh, K., Rahman, A.A., 2002. Linkages between climate change and sustainable development. Climate Policy 2, 129–144.

Burton, I., Huq, S., Lim, B., Pilifosova, O., Schipper, E.L., 2002. From impacts assessment to adaptation priorities: the shaping of adaptation policy. Climate Policy 2, 145–159.

Campbell, J., 2004. Visitor Arrivals—the Next 10 Years. 2004 Fiji Tourism Forum, 22–23 July 2004, Fiji. Available (06/07/05) http://www.bulafiji.com.

Cesar, H., Lauretta, B., Pet-Soede, L., 2003. The economics of worldwide coral reef degradation. Prepared for the World Wildlife Fund for Nature, Netherlands. Available (20 April 2004) at www.panda.org/coral.

Dang, H.H., Michaelowa, A., Tuan, D.D., 2003. Synergy of adaptation and mitigation strategies in the context of sustainable development: the case of Vietnam. Climate Policy 3S1, 81–96.

Department of Energy, 2003. Energy Statistics Yearbook 1993–2000.

Department of Environment, no date. Fiji National Greenhouse Gas Inventory. Base Year 1994.

Dubois, G., 2003. Le changement climatique. Un enjeu émergent pour le tourisme français L'observation du Tourisme 72, 7–10.

Elsasser, H., Buerki, R., 2002. Climate change as a threat to tourism in the Alps. Climate Research 20, 253–257.

Feresi, J., Kenny, G., de Wet, N., Limalevu, L., Bhusan, J., Ratukalou, I. (Eds.), 2000. Climate Change Vulnerability and Adaptation Assessment for Fiji. Fiji Pacific Island Climate Change Assistance Programme, Government of Fiji, Suva, Fiji, and International Global Change Institute, Waikato University, Hamilton, New Zealand.

Gössling, S., 2002. Global environmental consequences of tourism. Global Environmental Change 12, 283–302.

Hamilton, J., Maddison, D., Tol, R., 2005. The effects of climate change on international tourism. Global Environmental Change 15 (3), 253–266.

Hart, P., Becken, S., Turney, I., 2004. Offsetting carbon dioxide emissions from tourism. Abstracts, Second International Workshop on Climate, Tourism and Recreation. Orthodox Academy of Crete, Kolimbari, Greece, 8–11 June 2004.

Hay, J., Mimura, N., Campbell, J., Fifita, S., Koshy, K., McLean, R., Nakalevu, T., Nunn, P., de Wet, N., 2003. Climate variability and change and sea-level rise in the Pacific Islands region. A resource book for policy and decision makers, educators and other stakeholders. South Pacific Regional Environment Programme. Ministry of the Environment, Japan.

Hoegh-Guldberg, O., Hoegh-Guldberg, H., Stout, D.K., Cesar, H., Timmermann, A., 2000. Pacific in Peril. Biological, Economic and Social Impacts of Climate Change on Pacific Coral Reefs. Greenpeace, Sydney, Australia. 72 p. Available (20 April 2004) at http://archive.greenpeace.org/climate/science/reports/GR249-CoralBleaching3.pdf.

IPCC, 2001. Climate Change 2001: Synthesis Report. Summary for Policymakers. Available (1 April 2004) at http://www.ipers.com.c.ch/pub/un/syreng/spm.pdf.

Jones, T., 2003. Impacts of climate change in coastal and marine areas. In: Climate Change and Tourism. Proceedings of the First International Conference on Climate Change and Tourism, Djerba, Tunisia, 9–11 April. World Tourism Organisation, Madrid.

Levett, R., McNally, R., 2003. A Strategic Environmental Assessment of Fiji's Tourism Development Plan. Advisory Group version. A study undertaken for the World Wildlife Fund, Fiji.

McInnes, K.L., Walsh, K.J.E., Pittock, A.B., 2000. Impact of Sea-level Rise and Storm Surges on Coastal Resorts. A report for SCIRO Tourism Research. Available at (7 July 2004) http://www.dar.csiro.au/publications/mcinnes_2000a.pdf.

Ministry of Commerce, 1995. Technical Guidelines for Establishing and Reporting Voluntary Agreements to Reduce Carbon Dioxide Emissions in New Zealand. Second Issue. Wellington, New Zealand.

Ministry of Tourism, 1998. Fiji Tourism Development Plan 1998–2005. Suva, Fiji.

Ministry of Tourism, 2003. Fiji International Visitor Survey 2002. Suva, Fiji.

Narayan, P.K., 2000. Fiji's Tourism Industry: a SWOT analysis. The Journal of Tourism Studies 11 (2), 15–24.

Narayan, P.K., Prasad, B.C., 2003. Fiji's sugar, tourism and garment industries: A survey of performance, problems and potentials. Fijian Studies 1 (1). Available (15 November 2003) at www.fijianstudies.org/dload/cover_page.pdf.

Nicholls, R.J., Lowe, J.A., 2004. Benefits of mitigation of climate change for coastal areas. Global Environmental Change 14 (3), 229–244.

Nunn, P., 2000. Sea-level changes and their effects on tropical Pacific Island environments: the next hundred years. In: Linking Science and Policy. Pacific Islands Conference on Climate Change, Climate Variability and Sea Level Rise, Rarotonga, Cook Islands, 3–7 April 2000, pp. 59–62.

Nunn, P., Favuvu, A.D., Aalbersberg, W., Mimura, N., Yamada, K., 1994. Assessment of coastal vulnerability and resilience to sea-level rise and climate change. Case study: Yasawa Islands, Fiji. Phase 2: Development of Methodology. South Pacific Regional Environment Programme.

Raksakulthai, V., 2003. Climate Change Impacts and Adaptation for Tourism in Phuket, Thailand. Asian Disaster Preparedness Centre Pathumthani, Thailand.

Salinger, M.J., 2000. Climate Shifts in the South Pacific. In: Linking Science and Policy, Pacific Islands Conference on Climate Change, Climate Variability and Sea Level Rise, Rarotonga, Cook Islands, 3–7 April 2000, pp. 67–72

Scott, D., 2003. Climate change and tourism and the mountain regions of North America. In: Climate Change and Tourism, Proceedings of the first International Conferenc on Climate Change and Tourism, Djerba, Tunisia, 9–11 April. World Tourism Organisation, Madrid.

Scott, D., McBoyle, G., Mills, B., 2003. Climate change and the skiing industry in Southern Ontario (Canada): exploring the importance of snowmaking as a technical adaptation. Climate Research 23, 171–181.

Short, D., 2004. Hotel developments in the Fiji Islands. In: MacLellan, L.R. et al. (Eds.). Proceedings of Tourism: State of the Art II, 27–30 June 2004, Glasgow, UK.

SOPAC, 2004. Copra Oil for Power Generation and for Transportation. Project description. Available (25 July 2004) at http://www.sopac.org/tiki/tiki-index.php?page = Energy + Projects + COPRA.

United Nations Environment Programme, 2003. Switched On. Renewable Energy Opportunities for the Tourism Industry. UNEP, Paris.

Viner, D., Amelung, B., 2003. Climate Change, the Environment and Tourism: The Interactions. In: Proceedings of the ESF-LESC Workshop, Milan 4–6 June. eCLAT, Climatic Research Unit, Norwich, UK. 63 p.

Wilbanks, T.J., 2003. Integrating climate change and sustainable development in a place-based context. Climate Policy 3S1, 147–154.

World Bank, 2000. Cities, Seas and Storms. Managing Change in Pacific Island Economies. Volume I Summary Report. World Bank, Washington, DC, USA.

World Tourism Organisation, 2003. Climate Change and Tourism. In: Proceedings of the First International Conference on Climate Change and Tourism. Djerba, Tunisia, 9–11 April 2003. Madrid, Spain.

World Travel and Tourism Council, 2001. Tourism Satellite Accounting Research. Estimates and Forecasts for Government and Industry. WTTC, London.