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A climate change vulnerability assessment methodology for coastal tourism

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Coastal and marine environments are among the most popular areas for outdoor recreation and tourism. Coastal areas have also been identified as the most vulnerable to climate change, for example as a result of extreme events and sea-level rise. It will be increasingly important for coastal tourism destination managers to understand their vulnerability to climatic changes and to devise appropriate adaptation. This paper presents a five-step vulnerability assessment methodology for tourism in coastal areas. The five steps include (1) system analysis, (2) identification of activity and hazard sub-systems, (3) vulnerability assessments for the different sub-systems at risk, (4) integration for the destination as a whole and scenario analysis and (5) communication. The framework is illustrated by an example of how it might be applied to Fiji. The paper concludes that a consistent methodology, like the one proposed, will facilitate vulnerability assessments in a range of coastal destinations, allow comparison to be made of vulnerabilities across different situations, provide a basis for more research into specific adaptation measures and assist destinations to develop a more sustainable tourism industry.

Keywords: vulnerability assessment methodology; coastal tourism; climate change; adaptation

Introduction

In the past, weather events have generally been associated with natural cycles (e.g. seasons) or local variability against the background of a constant climate (Abegg, König, Bürki, & Elsasser, 1997). More recently, with increasing scientific agreement about human influences on the global climate, some weather events are seen as indicators of a changing climate (e.g. Emanuel, 2005). Coastal areas seem particularly vulnerable to climate change impacts as they are exposed to both extreme climate events and sea-level rise (IPCC, 2007). This vulnerability is exacerbated by the accumulation of multiple stressors and increasing man-made pressures such as rising population and development (Nicholls et al., 2007).

Coastal and marine environments are also very important tourist destinations, with hundreds of millions of people visiting coasts and participating in some kind of marine activity (Orams, 1999). According to Hall (2001, p. 602),

> . . . coastal tourism embraces the full range of tourism, leisure, and recreationally oriented activities that take place in the coastal zone and the offshore coastal waters. These include coastal tourism development (accommodation, restaurants, food industry, and second homes) and the infrastructure supporting coastal development (e.g. retail businesses, marinas, and activity suppliers).

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The intensity and diversity of coastal tourism seems to be continuously growing (Hall, 2001; Kenchington, 1993; Miller, 1993; Orams, 1999, 2007). For example the European Union estimates that about 60% of trips within Europe with at least four overnight stays take place by the seaside; climate and scenery are the predominant motives for choosing the holiday destination (Leidner, 2004).

Most of the recreational activities in coastal and marine environments are dependent on weather and climate conditions (Scott et al., 2008). In some cases, weather even determines or limits tourists' involvement on certain activities (e.g. cancellation of trips due to bad weather conditions), as it impacts directly on comfort or safety of participants. In other cases, climatic events could affect the natural resources that are essential for tourist activities, resulting in a decrease of attractiveness and therefore visitor numbers (Uyarra et al., 2005). For example, during the 3 months after hurricane Gilbert hit Cancun in 1988 approximately US$87 million were lost in income from tourism (Aguirre, 1991), and even after the event tourists were reluctant to return, thus exacerbating the negative effects (Davenport & Davenport, 2006). With a few exceptions (e.g. Becken, 2005; Perry, 2006; Raksakulthai, 2003), however, the consequences of climate change on coastal tourism have not been explored in detail so far (Amelung, Moreno, & Scott, 2008).

Over the year 2007, climate change media coverage increased substantially and the tourism sector received increasing attention, in part due to the meeting organized by the United Nations World Tourism Organization (UNWTO) in Davos, Switzerland. This meeting highlighted the importance of climate as a tourism resource and the sensitivity of tourism activities to weather conditions and climate change sensitivity, which is manifesting itself already (Scott et al., 2008). Climate change might trigger the occurrence of a tourism industry crisis in many destinations (e.g. decrease in tourism numbers, environmental degradation, social disruption), and it is of crucial importance for the sustainability of the tourism sector and the destination as a whole to develop mechanisms to anticipate and minimize the impacts of such crises (de Sausmarez, 2007; Meheux & Parker, 2006). Tourism managers are now likely to be aware that climate change might affect their business and there is an increasing need to discuss and implement adaptation measures. However, there are very few, if any, detailed assessments or tools that allow decision-makers and managers to address climate change proactively and develop the necessary adaptation to the potential changes (e.g. "early warning systems"; "beach nourishment"). This paper, therefore, provides a methodology for assessing the vulnerability of tourism in coastal areas. More specifically, the proposed methodology assists stakeholders in the identification of key vulnerability components (sensitivity, exposure and adaptation measures) and it also provides an opportunity for a systematic comparison of vulnerability across different situations and destinations to ensure a sustainable tourism development.

The paper is organized as follows: Section 2 introduces the concept of vulnerability in the context of this research and describes the components of the vulnerability assessment methodology. The application of the methodology is illustrated in Section 3, using coastal tourism in the Mamanuca Islands (Fiji) as a case study. Section 4 discusses the results and validity issues of the proposed methodology and Section 5 draws overall conclusions and explores next steps.

Developing a methodology for tourism vulnerability assessments

Background on vulnerability

The concept of vulnerability was originally applied in geography and risk-hazard studies (Füssel, 2007; Kasperson, Kasperson, Turner, Hsieh, & Schiller, 2003; Turner et al., 2003),

but its use has been extended to fields such as ecology, health or food systems (Füssel, 2007). The vulnerability concept is now also widely used in climate change science (Adger, 2006). The IPCC defined it as

> . . . the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. (McCarthy, Canziani, Leary, Dokken, & White, 2001, Glossary)

It has been noted by Luers, Lobell, Sklar, Addams, and Matson (2003) that some vulnerability assessments in the past (e.g. Ribot, 1995) were quite narrow in focus (e.g. isolated impacts on the natural and biophysical elements in a system), but more recent advances recognized the need to consider the combined effect in so-called *coupled human-environment systems* (Füssel, 2007; Polsky, Neff, & Yarnal, 2007; Schröter, Polsky, & Patt, 2005; Turner et al., 2003). Such vulnerability assessments are often place-based (Cutter, 1996, p. 536), although Luers et al. (2003) argued that the key focus of vulnerability assessments should be on selected variables of concern and specific sets of stressors rather than particular locations per se. Schröter et al. (2005) suggested that vulnerability assessments should (1) be derived from multiple disciplines and stakeholder participation, (2) be place-specific, (3) consider multiple interacting stresses, (4) take into account differential adaptive capacity and (5) be prospective as well as historical. To assist implementation of such assessments, the authors proposed an eight-step method; informing stakeholders about adaptation options is an integral component in each step.

Building on the above eight-step methodology, Polsky et al. (2007) developed the vulnerability scoping diagram (VSD) as a tool for visualization and comparison between different vulnerability assessments. The diagram is composed of three layers: the innermost layer relates to the dimensions of vulnerability, namely exposure, sensitivity and adaptive capacity. The next layer specifies the components of each vulnerability dimensions, i.e. the "abstract characteristics" that typify the dimensions (Polsky et al., 2007, p. 478). These depend on the particular vulnerability situation in question. Finally, the outermost layer shows the indicators that are used to measure the components.

In an attempt to summarize the various conceptualisations and terminologies of vulnerability to climate change, Füssel (2007) concludes that the concept of "vulnerability" should usefully be applied in reference to particular *vulnerable situations*. The following six dimensions are central to describe such a situation:

- the *system* of analysis, e.g. the tourism sector, a tourism destination;
- the *attribute of concern*, e.g. tourism infrastructures, coral reef;
- the *hazard* or potential event that might damage or affect the system of analysis and the particular attribute of concern, e.g. sea-level rise or extreme events;
- the *temporal reference*, either the point of time or time period of interest (current vs. future vs. dynamic);
- the *sphere*, which distinguishes internal (i.e. from within the system of analysis), external (i.e. outside the system in question, but impacting upon the system) or cross-scale (both internal and external) vulnerability factors and;
- the *knowledge domain*, which includes socio-economic, biophysical or integrated factors.

This section provided an overview of vulnerability research for the purpose of this specific research on coastal tourism. Extensive reviews on the history, interpretations, methods and application of the concept can be found in Adger (2006), Füssel and Klein

(2006), Nicholls (1995) and O'Brien, Eriksen, Schjolden, and Nygaard (2004) among others. Adger (2006) concluded that the challenge of vulnerability assessment consists in the development of credible measures that allow for the inclusion of different perceptions of risk and vulnerability, dynamics of the systems, aspects of governance and the wider political economy that take into consideration the multiple scales that are relevant for climate change impacts.

A methodology for assessing tourism's vulnerability

Tourism systems have been identified as complex systems (Miller & Twining-Ward, 2005), and the interaction between tourism and the climate systems adds another layer of complexity (Becken & Hay, 2007). A tourist destination comprises a variety of stakeholders or agents, including tourism businesses, public sector organizations, community groups and non-governmental organizations (NGOs). Moreover, the destination is characterized by different settings, both natural and cultural, a broad range of infrastructure and the kinds of activities that different types of tourists might engage in. Tourist destinations are excellent examples of human-environment coupled systems (Füssel, 2007; Polsky et al., 2007; Schröter et al., 2005; Turner et al., 2003).

The quantification of vulnerability to climate change requires consistent and structured methodologies (Adger, 2006). The proposed five-step methodology seeks to address this requirement for assessing coastal tourism's vulnerability to climate change (Figure 1). The proposed steps are sequential in principle but circular if appropriate. All steps rely on the input of both quantitative data and qualitative (expert and stakeholder) input.

Step 1 is concerned with the coastal tourism system in question. Given the complexity of tourist destinations, it is paramount to understand the system as thoroughly as possible and describe its key features, including relationships between its components and feedback loops, and other dynamics. In this step, the geographic, social and institutional scope of the study area is clearly defined, main stakeholders are identified and involved in the process (Schröter et al., 2005) and relevant tourism activities are described and prioritized according to their relevance. Following Füssel's line of thought it is not only important to understand the *system*, but also the *attributes of concern*. In a tourism context, attributes could be the ongoing sustainability of key tourism activities, such as diving or water sports. Step 1 also includes an analysis of existing management plans and relevant policies, such as environmental impact assessments (Ramjeawon & Beedassy, 2004), as well as other institutional arrangements for environmental management.

Step 2 analyses potential climate hazards and makes an explicit link between tourism activities and hazards. This requires a tailoring of existing climate information (e.g. outputs from climate models) to the specific needs of tourism stakeholders. To this end, the tourist destination will be disaggregated into a number of coupled activity-hazard sub-systems or, in Füssel's language, *vulnerability situations*. An example of an activity-hazard sub-system is coastal ecotourism's (activity) dependence on biodiversity that might be influenced by changing temperatures (hazard). The sub-system would then be referred to as ecotourism-temperature. The different sub-systems might operate at different scales. In this step, a selection of the sub-systems to be analyzed is undertaken in collaboration with stakeholders.

Step 3 builds on the earlier two steps as it involves identification of key vulnerability components and quantitative indicators to measure them. Different tools could be used to facilitate the identification and visualization of vulnerability components. The vulnerability scoping diagram developed by Polsky et al. (2007) is useful to organize the multiple

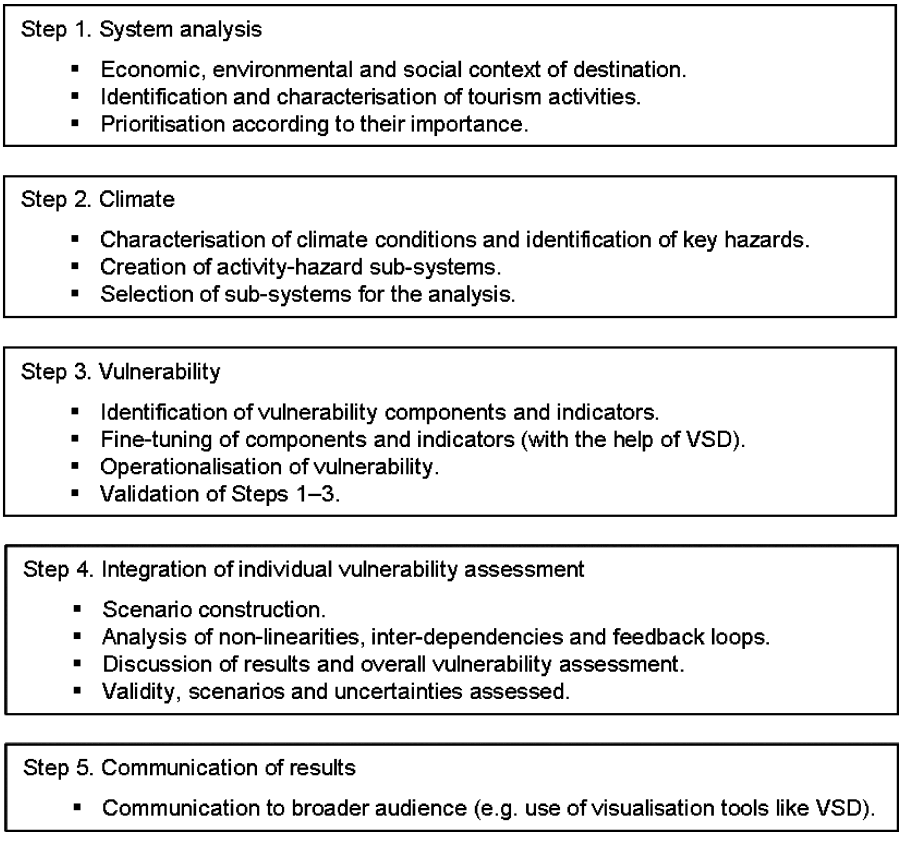

Figure 1. Overview of the five-step tourism vulnerability assessment methodology.

components and indicators for each activity-hazard sub-system, check them for completeness and validate them in consultation with stakeholders.

Indicators will assist decision-makers to assess vulnerable components each within exposure, sensitivity and adaptive capacity. Importantly, these indicators are also used to monitor these components over time, assess their stability and susceptibility to disturbance and eventually track changes in vulnerability (de Sausmarez, 2007; Miller & Twining-Ward, 2005). Indicators are typically of a quantitative nature and they may involve intensive data gathering. While the practice of measurement through indicators seeks to be as objective as possible, the interpretation of the indicators could be highly subjective and depend on the values and perceptions of those involved in the assessment process (Adger, 2006; de la Vega-Leinert et al., 2008). For example, it will be necessary to determine a "threshold of risk, danger or harm" (Adger, 2006, p. 276) associated with some indicators and/or the system as a whole. A common practice in many impact and vulnerability assessments is the use of semi-quantitative approaches. These often involve scoring methods, where each indicator is divided into categories (e.g. low, medium and high) and a numerical score is assigned to each of these categories, a process which is usually carried out with inputs from stakeholders (Brooks, Adger, & Kelly, 2005; de la Vega-Leinert et al., 2008; IFRC, 2007; Yamada, Nunn, Mimura, Machida, & Yamamoto, 1995).

Step 4 assesses the overall climate change impact on the destination. Scenario analysis could be employed in order to project potential future vulnerabilities, address relevant variables and development patterns and to explore different adaptation options and possible unexpected shocks affecting the system. This is, in fact, not a linear process, but a dynamic step in which stakeholders define development patterns and other elements that might determine or influence future vulnerability (e.g. different adaptation options). To this end, stakeholders will have to discuss the totality of individual assessments and weigh them against specified criteria. This decision-making process is subjective in nature and depends on the assessment of the stakeholders involved, their attitudes to risk and the goals they attach to tourism, e.g. employment generation, economic development, foreign exchange contribution, nature conservation or social equity. A multi-criteria analysis tool in which actors assess different measures based on their personal perspectives and values can contribute in the consensus-building process between different stakeholders (Belle & Bramwell, 2005; Brown et al., 2001). In this process, it is also important to take into account system attributes, such as non-linearity (e.g. the potential for surprises), interdependencies and feedback loops. Engaging stakeholders also allows for validation of the methodology and the derived sets of vulnerability components and indicators (visualised for example in the VSDs).

Step 5 involves the communication of the results to stakeholders beyond those who were involved in the decision-making process. Involving stakeholders during the assessment as well as afterwards ensures the credibility and acceptability by the different stakeholders (Schröter et al., 2005; Vogel, Moser, Kasperson, & Dabelko, 2007). The aim is to improve the methodology and also facilitate its application to other contexts and regions and as a result maximise the learning for each specific assessment.

Application to Fiji

Fiji is the largest tourist destination in the South Pacific. Tourism has typically been linked to marine environments (beach and diving) with more than 60% of tourists engaging in swimming and snorkelling and 12% participating in scuba diving (Becken, 2004). The Mamanuca Islands are an important tourist destination in the Fijian archipelago (Figure 2). Yet, they are likely to be highly vulnerable to climate change. In the following, the vulnerability assessment methodology presented in the previous section is applied to the situation of the Mamanuca Islands. The desktop assessment is based on the authors' previous work in Fiji, which included interviews with key stakeholders from the public sector and NGOs (undertaken in two different projects in 2004 and 2006), a survey among tourists ($n = 373$) and a survey of accommodation providers[1] ($n = 25$) (Becken, 2004, 2005; Fiji Ministry of Tourism, 2006). During this process, stakeholder engagement was not difficult as they had a strong interest in the issue; the process was set up as a participatory one and the key was to ensure that the different voices were represented and heard. This related to various levels of government, industry, communities and NGOs. A combination of personal and group meetings was found to be fruitful. The earlier work provided sufficient information and knowledge about the local conditions and stakeholders' views on climate change to test the proposed methodology.

Step 1: The Mamanuca Islands lie west of Viti Levu (main island). The island group counted about 88,341 visitor nights in 2005 (17.3% of all nights in Fiji) and tourism is an extremely important income and job generator (GRM International, 2007). The Mamanuca Islands offer 808 guest rooms in 23, mostly up-market, accommodation properties. As for the rest of Fiji, key activities undertaken by tourists are relaxing on the beach, swimming,

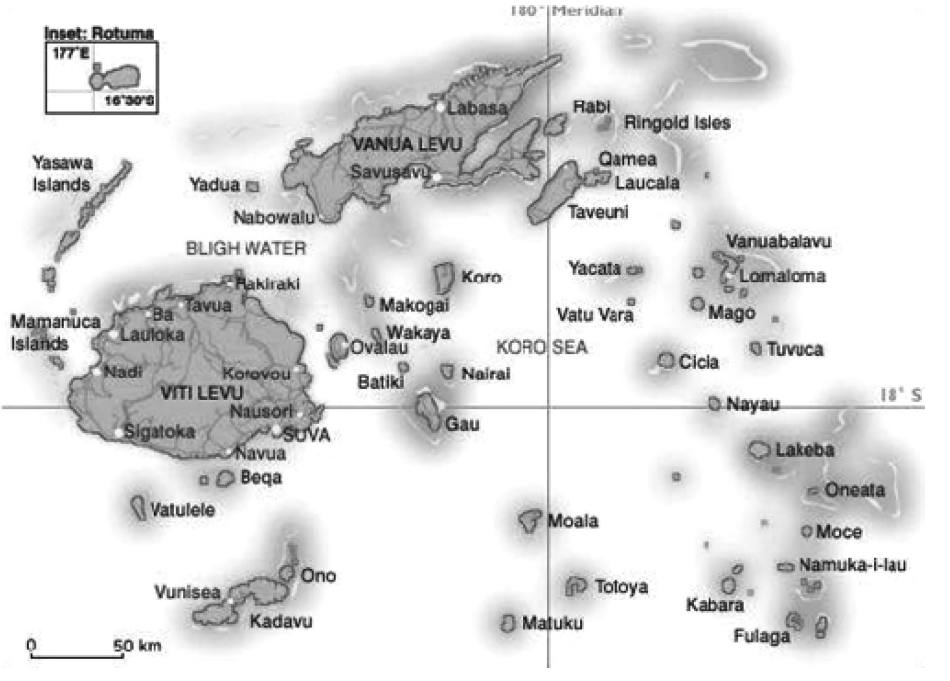

Figure 2. Map of Fiji showing the Mamanuca Islands to the West of Viti Levu (the islands of Ono-i-Lau and Vatoa from the Southern Lau group are not represented in this map). Source: Fiji Visitor Bureau, 2004.

snorkelling and diving. Increasingly, tourists participate in ecotourism and cultural village tours. Relevant management plans and policies should be explored in this step although they are not presented here, as the purpose is to develop the methodology and illustrate the principles.

Step 2: Fiji's climate is oceanic tropical, with a dry season from May to October and a wet season from November to April. The wet season – which includes the holiday peak season around Christmas – is also the cyclone season. Rainfall patterns are determined by the southeastern trade winds, resulting in a wet east and dry west (including the Mamanucas). The El Niño Southern Oscillation affects Fiji as it influences the position of the Southern Pacific Convection Zone. During El Niño events (about every 7 years), the weather conditions in Fiji are drier and hotter than average (Hay et al., 2003).

The Mamanuca Islands are highly exposed to cyclones, droughts and increasing sea temperatures, which will have an impact on coastal erosion, water shortages and coral bleaching among others (Fiji Meteorological Service, 2006). In 2000, a massive coral-bleaching event led to the damage of substantial parts of the coral reefs due to high water temperatures (Cumming et al., 2002). The Mamanuca Islands are low-lying atoll islands, and as such are vulnerable to sea-level rise. According to a survey among accommodation operators, tourist resorts face problems with beach erosion and water quality (Becken, 2004). The same group of stakeholders identified cyclones as the most important impacts from climate change to their (often uninsured) businesses. Cyclones also pose a hazard to the local communities and tourists and they destroy natural resources, including beaches and coral reefs. As such cyclones affect the very existence of tourism in this destination and the activity-hazard system of "beach-cyclone" is identified as the most critical one. The risk of

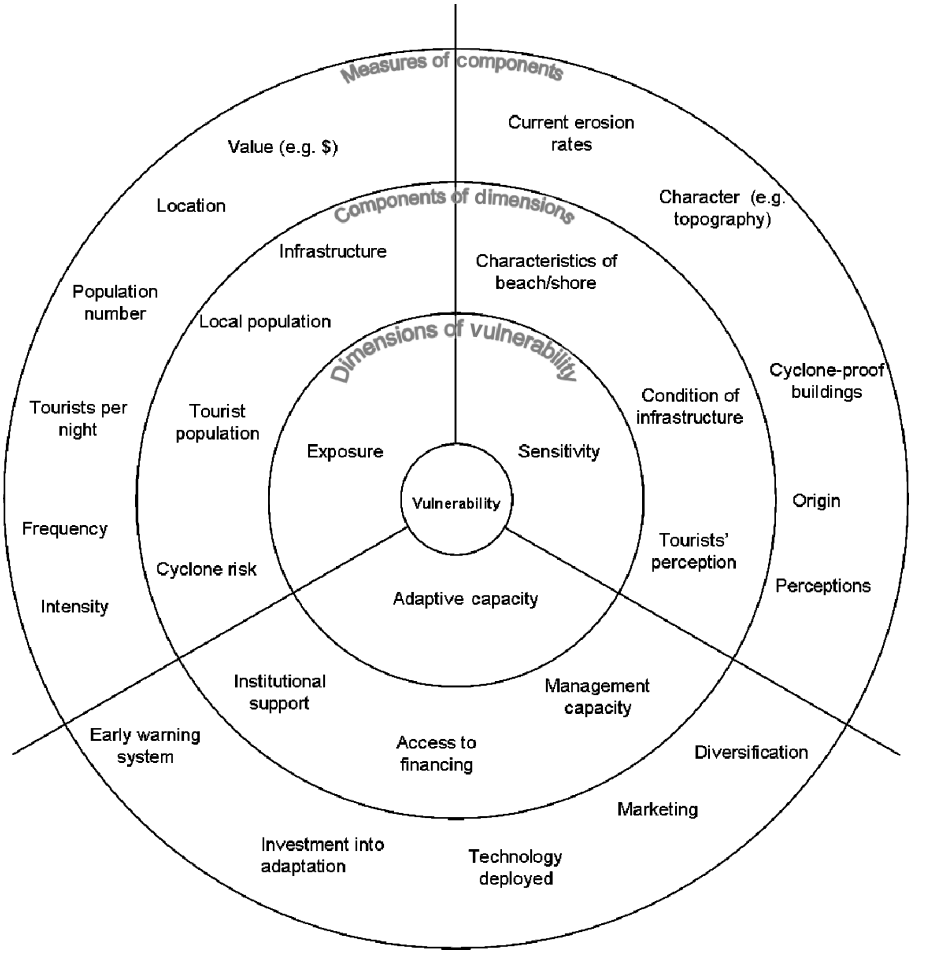

Figure 3. Vulnerability scoping diagram for the "beach-cyclone" sub-system (adapted from Polsky et al., 2007).

coral bleaching and the fact that snorkelling is a major activity, makes "diving/snorkelling–coral bleaching" the second sub-system of analysis. Other activity-hazard systems of interest would be "hotel-water supply" and "ecotourism-biodiversity changes", although they have not been included in this assessment. The particular circumstances for each vulnerability situation depend on the particular island in question.

Step 3: The identified vulnerability components of both sub-systems in the Mamanuca Islands are shown in Figures 3 and 4. The VSD (Polsky et al., 2007) is used here for visualization purposes. For the "beach-cyclone" sub-system, components describing the exposure include, for example, the "statistical risk of cyclones" and the "tourist population" and "infrastructure" that might be affected by a cyclone. Potential measures for exposure to cyclones could relate to the "intensity" of the storms or the return periods, based on historic data and trend analyzes (Fiji Meteorological Service, 2006). Tourist population could be measured as the number of tourists on an island for each night during the cyclone season. The exposure of tourist infrastructure could be estimated in the form of capital "value" and/or "location" (e.g. distance from the high-tide mark).

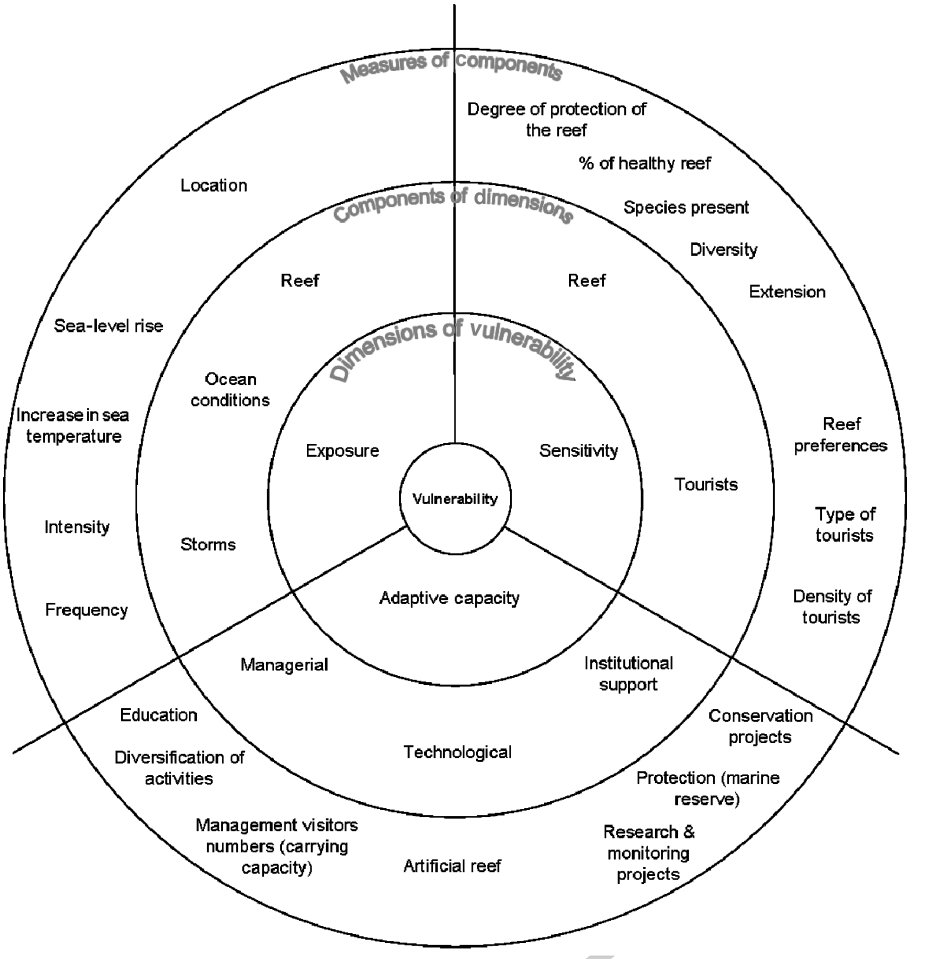

Figure 4. Vulnerability scoping diagram for the "snorkelling-coral bleaching" sub-system (adapted from Polsky et al., 2007).

Sensitivity is described through the following components: the particular "characteristics of the beach and shoreline", the "perception of tourists", and the condition of the infrastructure. The sensitivity of the beach/shoreline to cyclones can be measured by "current erosion rates" (e.g. in millimetre per year), a parameter that is highly dependent on the geomorphologic coastal characteristics (i.e. different coastal types – because of variables such as hard/soft rocks or beach materials and profiles – possess different sensitivity to erosion) (Eurosion, 2004). Other parameters could be useful as well, such as topography and bathymetry or integrity of vegetation. "Tourists' perception" could be captured in surveys, for example the proportion of tourists that are concerned about being caught in a cyclone. The condition of the infrastructure could be measured as the proportion of "cyclone-proof buildings". In addition, an indicator could measure insured capital versus uninsured.

Finally, adaptive response is captured by components such as "management capacity", "access to financing" and "institutional support". Indicators to assess these components include, for example, the number of islands/resorts that are part of an early "warning system" or the dollars invested into adaptation measures and technology, such as the use

Table 1. Summary of vulnerability components of the two activity-hazard sub-systems analysed in Mamanuca Islands.

Activity-hazard	Exposure	Sensitivity	Adaptive capacity	Overall vulnerability
1. Beach cyclones	High	Very high	Moderate	Moderate
2. Snorkelling – coral bleaching	High	High	Low	High

of hard and soft structures for protection. Management strategies like "diversification" of activities and "marketing" campaigns could contribute to a reduction in the dependency on beach tourism and therefore less vulnerability in case of beach damage.

Similarly, the vulnerability components for the "snorkelling–coral bleaching" can be described briefly. Main determinants of the exposure include the "reef location", "ocean conditions" and "storminess" as key drivers of coral bleaching. Reef characteristics, such as "number of species present" or "diversity", influence the extent to which the reef is sensitive to the changing conditions. "Tourists preferences and knowledge" about the reef and their pressure are also part of the sensitivity dimension. Finally, the capacity to adapt is described, for example, by "managerial", "technological" and "institutional" components like the possibilities of creating "artificial reefs" and protection measures through "visitors management" and establishment of "marine protected areas" to improve the resilience of the reef system.

For the assessment of the indicators that measure the different vulnerability components, a scoring system should be developed in collaboration with stakeholders, and building on existing knowledge and data. For the Mamanuca example, and based on expert knowledge and existing literature, the result of such scoring would provide an assessment of the degree of vulnerability for each sub-system as reflected in Table 1. The overall vulnerability is not the mean of the three components as different weights can be applied to each of them (i.e. adaptive capacity plays a fundamental role in defining the final vulnerability as it determines to a great extent the magnitude of the impacts). This assessment is speculative at this stage and has not been derived with stakeholder input.

A key component of any vulnerability assessment is the identification of potential adaptation options that are both feasible and practical (Smit & Wandel, 2006). These adaptation strategies should not only aim at the reduction of impacts but also explore new possibilities brought about by climate change taking into consideration the triple-bottom line of economic, social and environmental aspects. Communities have been dealing with adaptation to coastal change for decades. In the case of Fiji, protection of the shoreline, mainly by seawalls, started after 1960, probably as a reaction to population pressure and coastal erosion. These and other structures were created mainly based on available materials and not guided by any expertise, making the maintenance of such structures expensive and complicated for the communities (Mimura & Nunn, 1997). This provides a good example of how sustainable tourism planning strategies, supported by tools like the vulnerability methodology presented here, are needed and could assist tourism stakeholders to proactively adapt to climate change impacts.

Steps 4 and 5: The analysis of each activity-hazard sub-system would provide an identification of the main components of vulnerability as reflected in the above VSDs, as well as a measure of the degree and severity of the vulnerability. This would allow identification of the dimensions that contribute most to vulnerability, i.e. a high exposure, high sensitivity or lack of adaptive capacity for each sub-system. When making an overall assessment, stakeholders would explore a number of scenarios and assess how future developments and unexpected shocks could influence the sub-systems' vulnerabilities. Non-linearities

and feedback mechanisms between the different sub-systems could also be included. For example, an increase of coral bleaching due to warmer water temperatures and storm impacts will lead to a reduction in the coastal protection and therefore a magnification of the effect of cyclones in beach erosion (Pacific Islands Climate Change Assistance Programme, 2005). Stakeholders involved in the analysis would therefore prioritize vulnerabilities and the actions that should be taken. Stakeholders in the Mamanuca Islands could include the resort owners and/or managers, community representatives, local or national NGOs (e.g. the Mamanuca Environmental Society), regional bodies (e.g. SOPAC or WWF South Pacific), local councils (Lautoka Council) and national bodies such as the Ministry of Tourism and Environment. The results of the study could then be distributed to interested parties within Fiji or other island destinations.

Discussion

There is a substantial research body on vulnerability to climate change. The IPCC technical guidelines for assessing climate change impacts and adaptations (Carter, Parry, Nishioka, & Harasawa, 1994) have been widely used and are the basis for several national climate change vulnerability assessments. Based on this, the United Nations Environment Programme (UNEP) handbook on methods for climate change impact assessment and adaptation strategies (Feenstra, Burton, Smith, & Tol, 1998) was designed to provide guidance at system or sector level. However, none of the two methodologies addressed the specific requirements of the tourism sector. Recent advances in vulnerability research identified the need of focusing on coupled human-environment systems. Tourism with its high dependency on the natural environment and the involvement of numerous human actors is a very good example of such a system.

This paper developed a five-step methodology for assessing the vulnerability of a coastal tourism destination. The proposed framework recognizes that a tourism destination is a complex system that consists of many different vulnerability situations. Each of these are characterized by different attributes of concern, hazards, stakeholders involved, timeframes considered and adaptive capacities. Also, these vulnerability situations, or activity-hazard sub-systems, are not all equally important for the sustainability and well being of the destination as a whole. Some of the sub-systems will be integral parts of what makes the particular destination, while others are possibly more dispensable. The sub-systems are not independent from each other, but are likely to be interlinked.

This paper argues that the framework provides a useful "scaffold", but it also acknowledges that detailed assessment analyses have to be undertaken across case studies. Some difficulties, and potentially disagreement amongst stakeholders, might arise, for example, when determining which vulnerability components and measures are to be included in the analysis and which dimensions they belong to. In the present example of the Mamanuca Islands, the existence of "early warning systems" was understood as an element that improved the capacity to adapt. However, it could also be seen in the context of sensitivity, where an established and functioning warning system decreases the sensitivity of a particular sub-system. As Polsky et al. (2007) pointed out, exposure, sensitivity and adaptive capacity are not perfectly separable and need to be negotiated depending on the context of analysis.

The proposed vulnerability assessment methodology for coastal tourism has several advantages. As the case study with the two activity-hazard sub-systems from Fiji showed, the approach is able to cover all the tourism activities of interest and relate them to the various dimensions of vulnerability in a structured way. The disaggregating of a destination into multiple activity-hazard sub-systems reduces complexity and thereby allows for an

assessment in manageable steps. This is a novel approach that has been ignored in previous attempts to assess tourism vulnerability to climate change. However, this addition is of high relevance, as climate change vulnerability (including key agents involved) is likely to differ substantially for the different sub-systems.

The proposed five-step framework is able to reflect the dynamic nature of the tourism system by addressing the vulnerability of current activities as well as those planned for the future. Thus, it also lends itself to scenario analysis and vulnerability assessment of specific future states (in the climate or other factors). Moreover, both internal and external factors can be considered in the analysis of vulnerability components. For example, internal factors relate to the destination itself (e.g. whether it is located within a hurricane zone or not), whereas external factors relate to pressures that occur outside the system, for example the activities of competing destinations.

The methodology explicitly integrates stakeholders into the process in each step and recognizes that the ultimate outcome of the assessment (including adaptation measures put in place) is the result of stakeholder decision-making. This is subjective in nature and the result will reflect the priorities and expectations that stakeholders attach to tourism. As such, the framework is highly reliable and more likely to lead to a successful implementation of adaptation measures. Moreover, this stakeholder dialogue adds credibility and improves the social relevance of the assessment (Brooks et al., 2005; de la Vega-Leinert et al., 2008). The present framework can also be easily distributed and applied in a wide range of settings, even beyond coastal tourism, playing an important role in raising awareness in other destinations.

Finally, the validity of the methodology will be determined by its capacity to improve the understanding of vulnerability of the particular destination (short term), and, to the extent that adaptation measures are put in place, to reduce climate change vulnerability (longterm). The short term validity and usefulness of the framework is given by an evaluation of stakeholders' understanding of vulnerability and their satisfaction with the process and the outcome of the assessment. If, as a result of the vulnerability assessment, adaptation measures are implemented (e.g. "beach nourishment", "elevating structures", "cyclone-proof buildings", "early warning systems" etc.), it might be possible to assess the validity by monitoring vulnerability indicators over time and identifying reductions in vulnerability. The implementation of these adaptation measures should be based on stakeholders' dialogue assisted by technical and scientific knowledge (e.g. cost-benefit analysis; sustainability assessments). Destinations that have used the proposed methodology to reduce vulnerability could be compared with similar destinations that have not assessed their vulnerability and implemented adaptation measures.

Conclusion

Recreation in coastal areas has a long tradition and it is still the most important form of tourism. Many destinations depend on coastal tourism for their economic development, especially small island destinations. However, coastal destinations are highly vulnerable to climate change, which exacerbates existing pressures in these, often highly populated, areas. Coastal areas are not only exposed and sensitive to climate change, but in many cases their adaptive capacity is low. This threatens the sustainability of tourism activities not only from an economical point of view, but also socially and environmentally. Knowledge about vulnerability to climate change will therefore play an important role in present and future management strategies of tourism destinations and will help to develop adaptation strategies tailored for the location being studied.

The quantification of vulnerability to climate change requires consistent and structured methodologies. The presented five-step methodology provides a systematic framework for assessing coastal tourism's vulnerability to climate change. An assessment starts with a thorough analysis of the destination, both in terms of its tourism activities and relevant socio-economic parametres (Step 1). Step 2 involves an analysis of potential climate change impacts, and identifies and prioritizes relevant activity-hazard sub-systems. The analysis of vulnerability of each sub-system, based on the three dimensions of exposure, sensitivity and adaptive capacity, takes place in Step 3. Polsky et al.'s (2007) VSD is used in this step to provide a structure for working with stakeholders. Identification of feasible adaptation measures based on principles of sustainable development increases the resilience and preparedness of the system. In Step 4, integrating the various individual analyses assesses the overall vulnerability of the destination. Scenarios can assist in the exploration of future developments. Communication of results is a key to enhance the knowledge about tourism vulnerability (Step 5). Hence, a wide application of this proposed framework would enable climate change adaptation in other coastal destinations.

Two different approaches exist in the application of sustainable development to tourism: those who advocate sustaining tourism in a destination in the long term, and those who advocate tourism as a vehicle for achieving sustainable development, an approach which encompasses much wider goals and priorities (Holden, 2000). Independent of the approach, climate change will threaten destinations putting at risk the continuation of tourism activities and therefore jeopardising the development of those regions which might find in tourism not only a key driving force for their economy, but also an important incentive for social and environmental conservation. The presented methodology addresses the sustainability of the tourism sector, increasing its preparedness for future potential crises triggered by climate change impacts and stimulating the adaptation of destinations and their development in a sustainable way.

Next steps will involve an extensive application of the vulnerability assessment framework to different tourism destinations, including cases in Spain, Australia and New Zealand. This will allow fine-tuning of the methodology and assessing the framework's validity. A wider application of the methodology will be useful for comparing different tourism destinations in relation to their vulnerability and develop a greater understanding of vulnerability hotspots on the world tourism map. Subsequent research should also investigate in more detail potential adaptation measures, including their costs and feasibility.

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Note

1. The example presented here focuses on accommodation providers to illustrate the principle; however, in reality the mix of stakeholders is more diverse and complex, including a wide range of representatives from the public and private sectors and civil society.

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