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REPORT

Applying a Comprehensive Contextual Climate Change Vulnerability Framework to New Zealand's Tourism Industry

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Abstract Conceptualisations of 'vulnerability' vary amongst scholarly communities, contributing to a wide variety of applications. Research investigating vulnerability to climate change has often excluded non-climatic changes which may contribute to degrees of vulnerability perceived or experienced. This paper introduces a comprehensive contextual vulnerability framework which incorporates physical, social, economic and political factors which could amplify or reduce vulnerability. The framework is applied to New Zealand's tourism industry to explore its value in interpreting a complex, human-natural environment system with multiple competing vulnerabilities. The comprehensive contextual framework can inform government policy and industry decision making, integrating understandings of climate change within the broader context of internal and external social, physical, economic, and institutional stressors.

Keywords Vulnerability · Climate change · Global climate change · New Zealand · Tourism · Comprehensive contextual vulnerability framework · Vulnerability frameworks

INTRODUCTION

The social, cultural, political, and economic impacts of climate change are wide ranging in scale and scope. The physical manifestations of climate change have been identified as average global temperature increases, reductions in snow and ice, global mean sea-level rise, and changes to some climate extreme (among a wide variety of additional climatic changes) (IPCC 2013). Different geographical locations, industries, and communities will be impacted upon by these climate change impacts in various ways and to various degrees. In response, climate change vulnerability assessments have set about addressing who and where will be the most vulnerable, in order to enact proactive adaptive responses. Vulnerability to climate change is framed in different ways, often related to specific epistemic communities (Füssel 2007; Schneiderbauer et al. 2013). Due to the wide-ranging impacts of climate change, vulnerability research encapsulates numerous academic traditions (Adger 2006). Conceptualizations of vulnerability have been employed as analytical tools to explore resilience, marginality, susceptibility, adaptability, fragility, risk, exposure, sensitivity, and coping capacity (Liverman 1990; Adger 2006; Füssel and Klein 2006), and it depicts concepts of "possible loss, damage, and impact; of threat, risk and stress; of uncertainty and insecurity, of a lack of power and control…" (Klein 2009. p. 285). More important than the *existence* of different conceptualizations of vulnerability is the effect that these framings have on the questions asked, knowledge produced, and policy responses prioritized (O'Brien et al. 2007).

Climate change should be viewed in a multi-stress context, interacting with a range of natural- and human-environment changes and pressures (Wilbanks 2003). With this in mind, a ''single-stressor-single-outcome'' approach to vulnerability will clearly not capture the whole state of affairs (Eakin and Luers 2006). This paper seeks to enhance understandings of climate change vulnerability within its wider physical, social, economic, and political context. It will introduce a *comprehensive* contextual vulnerability framework, which is born from the outcome and contextual frames of vulnerability previously proposed by O'Brien et al. (2007) to present a way of conceptualizing climate change vulnerability situated in wide-ranging physical, social, cultural, environmental, political, and economic discourses. The example of New Zealand's

tourism industry is employed to discuss and examine the validity of this framework for application to a variety of case studies.

FRAMING VULNERABILITY

Vulnerability research emerged as a pathway to draw together impacts and adaptation (Malone and Engle 2011). The vulnerability concept couples human and natural systems (Polsky et al. 2007), and research in this area explores the exposure, sensitivity, and adaptability of these systems to threats, such as climate change. As a result, vulnerability has been employed as a key organizing concept for wide-ranging research in this field (Glaas et al. 2010; Malone & Engle 2011; Holsten and Kropp 2012; Schneiderbauer et al. 2013). This research has explored vulnerability on a range of scales, from local (Glaas et al. 2010) to regional (Malone and Engle 2011; Holsten and Kropp 2012; Schneiderbauer et al. 2013) to national contexts (Klein 2009; Fazey et al. 2010). Likewise, the concept of vulnerability has been applied to wide-ranging industry (Moreno and Becken 2009) and social contexts (Fazey et al. 2010). Indeed, sectoral vulnerability assessments have dominated climate change research in this field, while integrated and transferable approaches to vulnerability, as presented in this paper, are less common (Holsten and Kropp 2012).

In recent years, developments in theoretical and scientific frames for vulnerability research have proliferated (Schneiderbauer et al. 2013). There are a broad range of perspectives through which vulnerability can be viewed; it is beyond the scope of this paper to thoroughly review all, and, therefore, readers are referred to Eakin and Luers (2006) and McLaughlin and Dietz (2008) for comprehensive reviews. Instead, this paper will review a range of approaches from deterministic (geocentric) to political economy (anthropocentric) which incorporate a breadth of associated research methods and application (Füssel 2007).

A deterministic or ''biophysical'' (McLaughlin and Dietz 2008) approach to vulnerability focuses on learning about the physical impacts of natural hazards (Füssel and Klein 2006; Eakin and Luers 2006). In terms of research methods, this approach relies on modeling and measurement techniques. This has been a dominant approach to climate change vulnerability research (Pelling 2001; McLaughlin and Dietz 2008). However, this perspective neglects the factors—social, economic, and political—which shape vulnerability as well as overlooking coping strategies enacted by individual and corporate actors (McLaughlin and Dietz 2008).

An alternative lens is provided through the mechanistic engineering approach to vulnerability (Füssel 2007) which proposes that technology and innovation can reduce vulnerability, often through technical adaptations. The inclusion of adaptation into vulnerability assessments is widely advocated (Scott et al. 2003; O'Brien et al. 2007) with reliance on technological responses often critiqued for maintaining business as usual patterns of behavior and decision making. In particular, overly technocratic responses stimulated the emergence of more anthropocentric vulnerability research traditions (Eakin and Luers 2006, Hewitt 1983), which differs from earlier approaches by analyzing social and economic processes along with causation and social difference (Eakin and Luers 2006).

The first attempt to integrate both climatic and societal stressors into a vulnerability model came from Kates (1985), with the intention of addressing the underlying processes which contribute to vulnerability whether biophysical or socio-cultural. Of these anthropocentric traditions, the human ecology approach argues for greater social engagement and consideration for human behaviors and perceptions (Füssel 2007). Whether individuals, communities, and industries perceive themselves to be vulnerable to climate change will impact upon funding regimes, policy approaches, and local-level mitigative and adaptive behaviors. This was further developed by the political economy approach which questions who is the most vulnerable to environmental risks and hazards, and why. Thus, it is the disproportionate vulnerability of certain social groups relating to marginalization and underdevelopment which is the focus of the political economy approach.

An outcome vulnerability framing has been hegemonic for social and economic climate change research (O'Brien et al. 2007). This linear approach to conceptualizing vulnerability focuses on impacts (exposure) and responses (adaptations) and has also been referred to as end-point (Kelly and Adger 2000; Füssel 2007) and as the ''impact model'' (Kates 1985). It considers vulnerability to be the residual output after any measures to reduce the impact have been taken, and, therefore, relies on adaptation (and adaptive capacity) to moderate the impact. This framing has traditionally excluded the social aspects of vulnerability, focusing instead on the biophysical manifestations of the hazard. As such, vulnerability is framed as a singular event, or group of events which can be represented as monetary costs, mortality rates, and ecosystem damage (O'Brien et al. 2007). As climate change has become an increasingly socialized issue (Hopkins 2013a), it has become apparent that the biophysical impacts need to be considered in light of the social, economic, and political conditions.

O'Brien et al.'s (2007) conceptualization of ''contextual vulnerability'' challenges the dominance of the outcome framing of climate change vulnerability. It is concerned with a human-security perspective of climate change vulnerability specifically focusing on the unequal impacts

climate change will have on individuals and societies, and it interprets vulnerability as a current inability to withstand external changes including, but not limited to, climate change. Thus, the contextual framework identifies a range of social, physical, technological, and structural stressors. This approach posits that through a focus on present-day vulnerabilities and stressors, vulnerability to future climate change will also be addressed (Burton et al. 2002; O'Brien et al. 2007).

The continued salience of dichotomies in vulnerability research—for example the anthropocentric and geocentric approaches mentioned above—has been used to explain the ongoing difficulty in bringing together social and environmental variables (McLaughlin and Dietz 2008). The present research attempts to address this problem by unifying the various approaches to understanding climate change vulnerability in order to create a *comprehensive* climate change vulnerability framework.

MATERIALS AND METHODS

A *Comprehensive* Contextual Vulnerability Framework

This paper will be structured around the *comprehensive* contextual vulnerability framework (Fig. 1). This framework focuses on drawing together the many different ways of framing and understanding climate change vulnerability, so as to gain a comprehensive, multi-disciplinary understanding of climate change vulnerability for application to specific study areas including organizations, industries, and communities. Significantly, it explores the direct (physical) impacts as well as the indirect (social and policy) impacts, including both internal and external stressors. This framework was developed to represent the many competing aspects of climate change vulnerability which can be overlooked. Within the model, the (social, biophysical, economic, and political) phases are not contained, but exist (both temporally and spatially) on an overlapping continuum. There is significant interplay and interaction between the aspects of this framework, represented by the removal of lines and boundaries between the sections. Moreover, this framework does not endeavor to measure vulnerability in specific contexts, rather it provides a snapshot of the complex interplay of dynamic factors, at a particular point of time. Scalability is a particular feature of this framework, whereby (A) could be an individual, an organization, a community, or a country, and the internal and external factors will shift accordingly. In the case of the present research, the framework is applied on a national scale, while incorporating global and local dimensions.

As a three-dimensional framework, this conceptualization is working through analytical, external, and internal categorizations or ''vulnerability factors'' (Füssel 2007). The analytical factors are broad categorizations of themes which are spatially and temporally dispersed and influence the existence of vulnerability at different scales. The terms ''external and internal factors'' are used in line with Turner et al. (2003) to "distinguish the external stressors that a system is exposed to from the internal factors that determine their impacts on that system" (Füssel 2007, p. 157). Likewise, the internal, external, and analytical levels of the framework align with Schneiderbauer's et al. (2013) three-level approach for adaptive capacity, through drawing together the generic and specific factors. The three elements of the framework will now be explored in greater detail.

Analytical Factors (A)

The analytical factors underpinning the *comprehensive* contextual climate change vulnerability framework are: the physical phenomenon of climate change, the social phenomenon of climate change, and broad scale political and economic influences. These four interacting elements frame and provide structure for subsequent external and internal analyses. Adopting terminology from Hulme (2009), the social and physical phenomenons of climate change acknowledge the multiple ways climate change is understood by a variety of factors. In terms of a vulnerability assessment, these perceptions are critical to fully comprehend resultant behaviors. Likewise, broad-scale economic and political factors will influence the landscape in which climate change is embedded. These analytical factors place climate change within a multifaceted and dynamic social, physical, economic, and political context, with the purpose of better understanding the complex range of factors contributing to a vulnerability assessment.

External Factors (B)

In terms of spatial scale, the external factors presented in Fig. 1 (B) relate to a broader scale of analysis yet associated patterns to the internal factors (C). In relation to the social phenomenon of climate change, external factors include norms, world views, and consumptive behaviors. Uniquely, this framework incorporates how social perceptions of climate change vulnerability and discourses of climate change might impact upon vulnerability assessments and behaviors. Thus, it argues that social factors (individuals and communities) external to the case study under examination may contribute to vulnerability. Likewise, the external factors explore the global framing of the

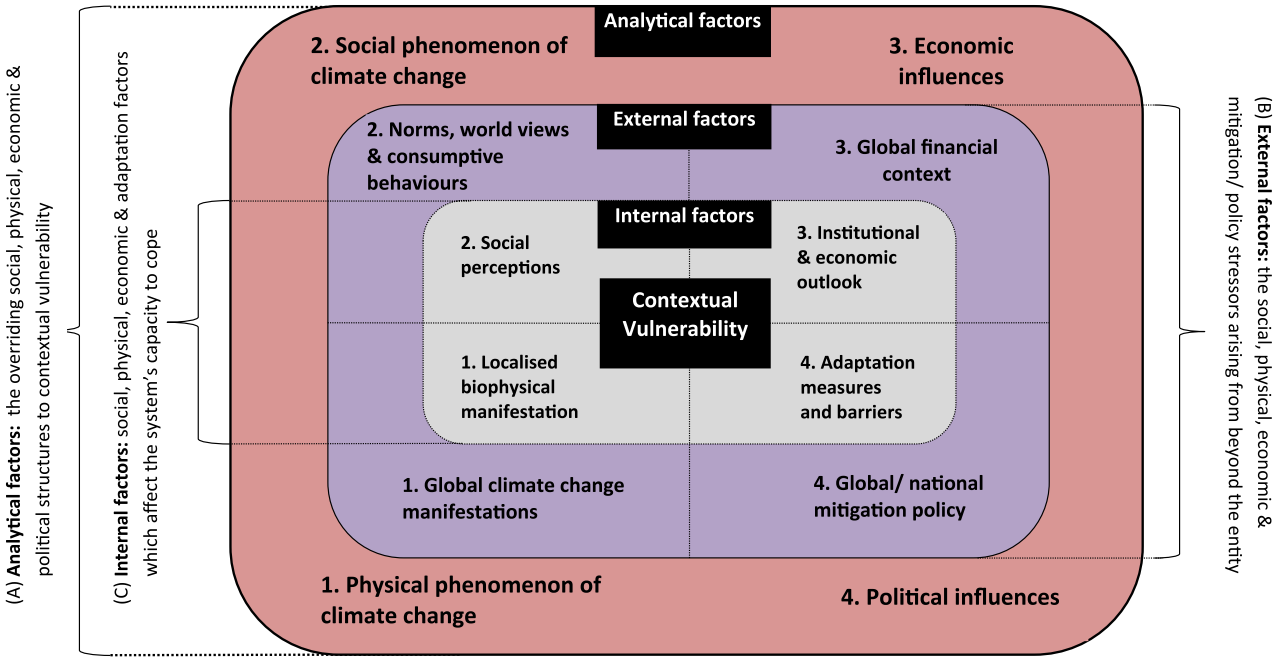

Fig. 1 A *comprehensive* contextual climate change vulnerability framework

bio-physical impacts of climate change and the interplay these may have on the social, economic, and political factors.

Internal Factors (C)

The internal factors depicted in Fig. 1 call for closer attention to the social, biophysical, economic, and institutional conditions of the case study. Thus, it advocates moving beyond physical climatic determinants of vulnerability to consider how a range of contextual conditions could contribute to adaptive capacity, resilience, and vulnerability. Thorough analysis of the localized biophysical conditions of climate change and the related impacts may differ from the way the risk of any climatic variability and change is perceived by social factors. Likewise, adaptive capacity and adaptive action may not correlate due to financial, social, and political influences (O'Brien et al. 2007). The agency of actors to enact adaptive or coping behaviors must be incorporated to accurately represent vulnerability. The economic outlook of the entity may affect adaptive capacity, as the ability to invest in risk-reducing technologies and practices may be reduced. Likewise, an organization with a poor economic outlook may be less concerned by risks associated with climate change due to the ''finite pool of worry'' (Hansen et al. 2004). Thus, each aspect of the ''internal core'' should be viewed as interacting, and the complex interactions *between* the elements require attention.

Adaptations through technical, behavioral, and policy measures are the main method through which vulnerability can be reduced through reducing negative impacts and promoting positive outcomes (Field et al. 2012). The capacity to utilize adaptive strategies is highly location and time sensitive. The type of adaptation promoted, broadly defined as technical, social, and policy, is often contingent on the frame of vulnerability employed through the research. Adaptive capacity, on the other hand, is considered to be intrinsically connected to normative and motivational values, rather than economic development context, as previously thought (Haddad 2005). As adaptation is built into each of the four categories of the framework, it will be discussed within the relevant sections.

The framework presented in Fig. 1 will now be applied to the context of New Zealand's national tourism industry. "Internal Factors (C)" section of the framework (Fig. 1) will be the national scale of New Zealand, with some discussion of regional contexts. "External Factors (B)" section will explore the global context in which New Zealand's tourism industry exists.

Research Methods

The drivers of vulnerability have traditionally been approached through a mix of both qualitative and quantitative research methods (Eakin and Luers 2006). The *comprehensive* contextual vulnerability framework (Fig. 1) pulls together and accommodates a range of data sources to

gain a broad picture of vulnerability for (aspects of) a system. Each portion of Fig. 1 was systematically reviewed in the context of New Zealand's tourism industry. Drawing from secondary data and a comprehensive literature review, the application of the framework to New Zealand's tourism industry demonstrates the way through which vulnerability on varying scales (from global through to local) can be investigated. The four themes within the internal, external, and analytical factors were each approached independently by the author, constructing questions around how, for example, the global financial context, might impact upon the New Zealand tourism industry. This could be replicated with other industries, communities, and ecosystems, although further testing and application are required.

New Zealand

New Zealand is in the south-west Pacific Ocean comprising two main islands: the North Island; and the South Island. New Zealand is a long and narrow country (approximately 35°S–47°S). Located on the boundary of the Pacific and Indo-Australia Plates, New Zealand experiences frequent earthquakes and is home to over 80 volcanoes. Accordingly, New Zealand society has established around a variety of natural risks and vulnerabilities to which it has needed to adapt and build resilience. New Zealand is also characterized by varied topography, in particular the South Island is divided in length by the Southern Alps. This context contributes to varied climatic features; while broadly defined as a maritime climate, the far north of the North Island experiences a sub-tropical climate. Temperature, rainfall, and wind all vary substantially across New Zealand. This can be evidenced by mean annual temperatures which vary from 16 °C in the north to 10 °C in the southern regions and results in distinct regional variations of climate change forecasting (NIWA 2013).

New Zealand's economy is reliant on international trade (The Treasury 2012); agriculture, horticulture, fishing, forestry, and mining all have large contributions to the economy. Inbound, international tourism provided a direct contribution of 3.3% ($6.2 billion) to New Zealand's GDP (Ministry of Business Innovation and Employment 2012), and international tourism expenditure amounts to NZ$9.6 billion (New Zealand Tourism 2013). The tourism industry's importance to New Zealand's economy is forecast to continue, with the Ministry of Business, Innovation, and Employment expecting 3 million visitors a year by 2015—and a domestic population of approximately 4.6 million (Statistics New Zealand 2014). Aviation accounts for 40 % of tourism's overall carbon footprint (Hall et al. 2013), and, therefore, the attraction of New Zealand's natural environment is at odds with the environmentally detrimental effect of long-haul air travel required by most of New Zealand's main tourism markets: Australia (Eastern seaboard is the only medium-haul region), China, United States, United Kingdom, Japan, South Korea, and Germany (Tourism New Zealand 2013). Since New Zealand's tourism industry is highly weather and climate dependent (Becken and Wilson 2013), the impacts of climatic changes need to be better understood.

Consequently, New Zealand's tourism industry was selected as an important and relevant case study for 4 reasons:

(1) New Zealand's economic reliance on international tourism markets and extreme long-haul air travel is aligned with other geographically remote countries and small island economies;
(2) The ski industry is the core feature of New Zealand's tourism industry; this economic importance is replicated in many alpine regions;
(3) The diverse climatic features of New Zealand represent a range of climatic vulnerabilities including drought and flooding, thus representing a range of impacts to which the tourism industry (and country more broadly) must cope;
(4) A low domestic population (4.6 million in 2014) which aligns with European and Nordic countries including Ireland, Norway, Finland, and Denmark.

The Complex Tourism System

The tourism industry has been defined as a complex, uncertain, and unpredictable system (Farrell and Twining-Ward 2004; Baggio 2008). However, limited attention has been paid to a whole system approach to tourism. This is "despite the advantages such methods afford for coping with the multidisciplinary environment in which tourism operates" (Farrell and Twining-Ward 2004, p. 278). None less so than the multidisciplinary nature of climate change. The case of New Zealand's tourism industry will be employed in this paper to systematically examine the contextual vulnerability to climate change from physical, social, economic, and political perspectives. It will engage with these issues at a range of spatial scales from global through to local and provide a preliminary attempt to draw together a comprehensive understanding of climate change vulnerability for New Zealand's tourism industry. A national scale analysis important due to the range of industries and vulnerabilities which operate within it, for example, viewing winter tourism without considering summer tourism could depict an asymmetric image of vulnerability. Up to now, single-season vulnerability assessments have been dominant in the literature (Kruse

et al. 2013). Through the application of the *comprehensive* contextual climate change vulnerability framework to the New Zealand tourism industry, a greater understanding of the wide-ranging impacts of climatic and non-climatic factors will be achieved, so as to inform the New Zealand government's tourism and climate change policies and the tourism industry's future management planning.

RESULTS

The Physical Phenomenon of Climate Change

On a global scale (Fig. 1, Sect. A.1), manifestations of climate change have been identified as: sea-level rise, glacier recession, increasing average global temperatures, and increased extreme weather events, among others (IPCC 2007). While these biophysical impacts will produce a wide range of effects (ranging from devastating to positive changes) at specific locations, they will also generate follow-on effects which may create a wide range of climatic and non-climatic changes in New Zealand. New Zealand (Fig. 1, Sect. B.1) is already experiencing some biophysical climate change manifestations (Hennessy et al. 2007): stresses on water supply, reduced seasonal snow cover, and glacier shrinkage to name a few. The mean annual temperature in New Zealand has increased by 0.96 °C from 1910 to 2010 (Wratt et al. N.D.). Projected mean annual temperature change for New Zealand regions for 2040 ranges from 0.6 to 1.3 °C (Wratt and Mullan N.D.), dependent on future scenarios. Manifestations of climate change in New Zealand are, and will continue to be, diverse due to the varied topography and layout of the North and South Islands.

Within New Zealand, the Bay of Plenty, Northland, eastern regions, and the Southern Alps have all been identified as particular vulnerability hotspots (Hennessy et al. 2007). In particular, the Southern Alps is an important region in terms of both hydroelectricity and tourism. As a tourism destination, it attracts year-round visitors due to its popular climate, with dry warm summers and cold snowy winters, enabling a wide range of activities. Physical climatic changes in tourism regions reliant on weather for tourism operations could impact upon tourist flows, activity participation, satisfaction, and safety (Becken and Wilson 2013).

While localized projections suggest negative impacts of climate change for New Zealand's ski industry, research has shown that the biophysical impacts to New Zealand will be less than other regions or countries, including close neighbors, Australia (Hendrikx et al. 2013). This recognizes the importance of considering the contextual factors of any vulnerability assessment. While being examined in isolation, the outcome for New Zealand may appear overly negative. Nevertheless, this has in many ways led to complacency regarding the relative vulnerability of Australia to climate change impacts (Hopkins et al. 2013), and provided a source of optimism, and potential opportunity for New Zealand—particularly in terms of tourism. A particular critique of the outcome framing of vulnerability has been its focus on vulnerability without consideration of the broader context including examinations of relativity (O'Brien et al. 2007); thus, considering the broader context of biophysical impacts of climate change is paramount.

The Social Phenomenon of Climate Change

As a social phenomenon, climate change is individually and collectively constructed through a complex interplay of beliefs, values, attitudes, aspirations, and behaviors (Hulme 2009). Social perceptions will influence vulnerability (both perceived and projected) through driving proactive or reactive, autonomous or planned adaptive behaviors (Smit et al. 2000). It has already been suggested that tourist perceptions of destination scale climate change impacts, as well as travel-related environmental degradation (CO_2 emissions), are likely to play an increasing role in travel decision making (Scott et al. 2008). Research conducted with community members, tourists, and industry stakeholders in New Zealand's ski industry indicated a wide variation of perceptions regarding climate change impacts (Hopkins 2013b) and adaptive responses (Hopkins 2013c). In contrast, the perceptions of international tourists related to international travel to New Zealand indicated that in the European context, behavioral modifications in terms of travel behaviors may occur in short-haul travel first (Higham and Cohen 2010). Consequently, notwithstanding an unforeseen shock to the current transport system (such as a global price on carbon), the desire to undertake extreme long-haul travel to visit New Zealand may continue into the short- to medium-term future.

Embedded norms and practices designed around rights and needs to travel are at odds with greenhouse gas reduction efforts (Hall et al. 2013). Research has indicated a lack of willingness to reduce international, long-haul, travel behaviors (Higham and Cohen 2010; Cohen and Higham 2011). Nevertheless, societal changes including shifting travel and mobility patterns will have implications for tourist demands and could contribute to a greater number of "staycations" (Papatheodorou et al. 2010). The social changes occurring as a result of climate change, and associated economic and political changes, will contribute to the vulnerability of a tourism destination. For New Zealand's ski industry, the relative vulnerability of Australia's ski industry could contribute to an increase in

Australian skiers changing their travel behaviors and thus increasing travel flows to New Zealand for the primary purpose of skiing (Hennessy et al. 2007). However, research has also suggested that a decrease in domestic natural snow in Australia could lead to reduced activity substitution rather than spatial substitutive behaviors (Pickering et al. 2010). Thus, greater understandings of the nuanced social perceptions and behavioral intentions of tourism markets are required to gain a better understanding of potential vulnerabilities for tourism destinations.

Economic Influences

Droughts, floods, and other extreme events can contribute to substantial economic losses (Hennessy et al. 2007). Approximately 10 % of the global GDP is spent on tourism and recreational activities (Berrittella et al. 2006). Global, national, and individual financial positioning will impact upon vulnerability to climate change impacts. Coping with changes and/or external stressors requires flexibility in business practices. Many countries likely to experience climate change first, and most drastically, are small island developing states, often reliant on tourism for economic development (Prideaux and McNamara 2012). These regions often have a lower adaptive capacity due to developing economies and single-industry dominance. Similarly, New Zealand's tourism industry is largely constructed of small businesses, which will be directly affected by climatic events, with potentially less resilience and coping capacity.

While the Australian government explored the impacts of climate change on its economy through the Garnaut Review (Garnaut 2008), and the British government released a report by Nicolas Stern discussing the impacts of climate change on the world economy (Stern 2007), New Zealand is yet to commission a study examining the economic impacts of climate change to the nation. Consequently, there has been a piecemeal approach to understanding the likely climate change impacts from an economic viewpoint.

The Global Financial Crisis (GFC) in 2008/2009 instigated changes in travel and consumption behaviors (Hall 2010; Ritchie et al. 2010). The GFC negatively impacted individual disposable incomes and job security leading to reduced international travel flows (Papatheodorou et al. 2010; Ritchie et al. 2010); this contributed to local-scale economic vulnerability in tourism destinations with low adaptive capacity (in this case a diversity of incoming tourist markets or non-tourism economic activities). This impact was not uniformly distributed; some regions indicated small degrees of impact. While non-climatic events such as the GFC have been shown to decrease public concern for climate change, in terms of tourism flows, they could result in the same outcomes—changing tourism flows and travel behaviors. Nevertheless, many were surprised at the speed at which carbon dioxide emissions returned to their upward trajectory following the initial downturn following the start of the financial crisis.

The capacity to adapt for tourism subsectors will be heavily influenced by social perceptions and financial capacity, particularly in terms of large-scale, technical adaptation which is prevalent in the tourism industry and specifically the ski industry. Snowmaking has been the focus of ski industry adaptation for the past decade, leading to improvements in technology. This response is aligned with Füssel's (2007) mechanistic engineering approach to vulnerability assessments, which focuses on research questions of how technology can reduce the risks associated with climate change. Through this approach, vulnerability is coupled with economic capacity to invest in technical adaptations, thus promoting inequities.

Political Influences

It is important that policy interventions adequately approach the inherently multi-scalar nature of climate change (Turner et al. 2003; Adger 2006). Yet as a result of the complexity of attributing aviation emissions, global aviation CO_2 emissions were not included in the compulsory reduction targets of the Kyoto Protocol (Becken and Hay 2007; Smith and Rodger 2009). Likewise, international aviation has not been explicitly incorporated to post-Kyoto emission reduction negotiations (Hall et al. 2013). In order to address climate change, annual carbon dioxide emissions need to be reduced by between 3 and 6 % (Hansen et al. 2006; Parry et al. 2008; Peeters and Dubois 2010). Tourists contribute 4.4 % of global carbon dioxide emissions (Peeters and Dubois 2010), and emissions are projected to increase at an average annual rate of 3.2%, thus directly contradicting any attempts to reduce emissions. This resulted in Peeters and Dubois concluding that: "Without radical shifts, it seems quite impossible to find a future tourist travel system consistent with the strong CO_2 emissions reductions required to avoid dangerous climate change" (Peeters and Dubois 2010, p. 455). Given the reluctance of individuals to reduce personal mobility, universal climate policy and regulation have been advocated as the best method to foster positive change (Scott et al. 2012).

Due to New Zealand's isolated geographical positioning, and reliance on long-haul air travel for tourist arrivals, a key vulnerability factor is the state of global governance and mitigation policy. New Zealand's Ministry for Tourism (2009, np) acknowledged that: "New Zealand's distance from most key markets makes journey-related greenhouse gas emissions, costs and consumer perceptions key issues

for the sector." Research has been undertaken to explore the perceptions of outbound visitors (from New Zealand) (Becken 2007) and international public perceptions of the extreme long-haul travel required to visit New Zealand (Cohen and Higham 2011) and has indicated contradictions in concern and behaviors. This could denote a requirement for government scale intervention to incorporate aviation emissions into emissions reductions targets. When aviation is included in mitigation policy, New Zealand's inbound and outbound tourism will be impacted. Thus, aviation mitigation policy is increasingly important in terms of international tourism in countries requiring long-haul air travel such as Australia and New Zealand. To date, however, no country has established a strategy to monitor and/or measure tourism-related CO_2 emissions reductions (Scott et al. 2012; Hall et al. 2013).

Policy responses to climate change do not need to be detrimental to New Zealand's economy. Responses which include technical efficiency and modal-shift/length of stay could result in a decrease in CO_2 emissions from tourism. Thus, responding early and positively could allow New Zealand's tourism model to adapt. Already popular with the ''backpacker'' tourist, New Zealand's distance could work as an opportunity. However, this does not account for social (tourist) perceptions of the acceptability of extreme long-haul flight in the coming decades (Cohen and Higham 2011). New Zealand's Tourism Strategy 2010 highlights resource efficiency and carbon neutrality as two priorities for sustainable tourism development (Becken and Hay 2007). Climate change policy could impact upon investment decisions and operator decision making.

DISCUSSION

This paper has identified the complexity of assessing climate change vulnerability for New Zealand's tourism industry due to the range of non-climatic factors, interactions, and feedbacks. Annual emissions arising from tourism are increasing unabated, directly contradicting efforts to address climate change. The tourism industry, along with national governments and international governance systems, needs to explore ways to tackle this paradox, and one such way is including aviation in any policy efforts. This poses a significant risk for countries, like New Zealand, which rely on aviation for exports and tourism. Furthermore, since climate is a significant driver of tourist's destination choice (Gómez Martín 2005), this could have implications for New Zealand's tourism industry due to its reliance on outdoor recreation (Wilson and Becken 2011).

The physical impacts of climate change will demand changes to management practices and supporting policy and regulation. The potential negative effects associated with increased extreme events could damage existing infrastructure, or lead to safety concerns which will require greater regulation from within the industry or from government. In terms of New Zealand's government decision making, it is vital that potential tourist behavioral changes are accounted for in policy and planning. Assumptions around a business as usual status quo could limit the resilience of New Zealand's tourism industry to potential shocks. By developing domestic markets, and further expanding upon Australian markets, New Zealand's tourism industry could proactively prepare for the likelihood of a global climate change mitigation policy and the inclusion of international aviation emissions into a post-Kyoto agreement. Furthermore, changes to tourism-related investments and decision making will require changes to current structures and the flexibility of key tourism industry actors.

There are currently many knowledge gaps concerning the climate change impacts for New Zealand, both in terms of its tourism industry, and in more general terms. Greater attention is required to understand how climate change is likely to impact New Zealand and its vulnerability to direct and indirect climate change impacts. Employing the *comprehensive* contextual vulnerability framework is one way to attempt to understand the complexity of climate change impacts. It can also indicate areas which require further empirical investigation. For New Zealand's tourism industry, it is clear that there are many overlapping issues both directly and indirectly related to climate change which contributes to degrees of vulnerability. Nevertheless, the impacts and vulnerability will be highly site specific.

CONCLUSION

This paper has applied a comprehensive contextual vulnerability framework to the tourism industry of New Zealand. In doing so, it has highlighted the broad range of interrelated issues which could contribute to or mitigate the risks of vulnerability to climate change. While these vulnerabilities are unique to the New Zealand context, based on its geographical, economic, political, and socio-cultural contexts, this framework can be applied to other contexts to rethink vulnerability for some industries or regions. Further, it can be applied to different spatial scales—such as a regional tourism industry—allowing an examination of the internal and external factors which may enforce vulnerabilities or help the region to develop resilience. It is beyond the scope of the current paper to explore these alternative contexts, and expert knowledge on the case study is required in order to adequately represent the context-specific internal, external, and analytical factors.

For example, research by Brouder and Lundmark (2011) exploring perceptions of vulnerability in Northern Sweden reported clear differences in terms of stakeholder perceptions of vulnerability to biophysical impacts. This research would contribute to box (c) 2. Social perceptions of the contextual vulnerability framework (Fig. 1) incorporate understandings of stakeholder willingness and ability to adapt to changes, thereby directly contributing to vulnerability. The community impacts identified by their research might be mitigated by local, regional, or national policy, planning, and/or adaption. Thus, mapping the vulnerability of Northern Sweden with the framework from Fig. 1 may illuminate options and opportunities for this region. The relationship between adaptive capacity and actual adaptive behaviors is not clear nor rational (O'Brien et al. 2007); thus, exploring social perceptions and behavioral intentions can provide a better understanding of the interactions between the four aspects of the framework. While research investigating discrete aspects of this framework is required, the value of the framework is to draw it together as done with the example of New Zealand's tourism industry.

Vulnerability to climate change will not be experienced in a homogenous way. Dominant frames of vulnerability focus on vulnerability as the outcome of impacts after enacting adaptive capacity (O'Brien et al. 2007). Further, there is often a focus on technical adaptation strategies to reduce the associated risks, which can further perpetuate inequalities due to a reliance on economic capacity. This paper has presented a comprehensive and unified approach to exploring climate change vulnerability. Incorporating economic, political, biophysical, and social aspects of climate change, this framework draws together the many nuanced factors contributing to climate change vulnerability. This paper has highlighted the many gaps in understanding the vulnerability of New Zealand's tourism industry to climate change and also the difficulty in operating on a national scale in vulnerability assessments. Individual tourism destinations (such as Queenstown in New Zealand) and industries (such as the ski industry) will experience climate change vulnerability differently and associated with adaptive capacity which is intrinsically linked to economic capacity. To better inform policy, greater focus is required on the range of possible vulnerabilities (climatic and non-climatic) and their interplay. National and international responses to climate change can and will have direct impacts on local-scale tourism operations, and a greater exploration of these prior to the fact is needed to prepare New Zealand for changes ahead. Future research could undertake expert interviews with a range of stakeholders to test the framework.

This paper has reviewed climate change vulnerability research and vulnerability frameworks and presented a comprehensive framework exploring the climatic and non-climatic factors contributing to climate change vulnerability. The structure of this framework allows for a mix of data to be brought together to collectively examine climate change vulnerability for a given system. The application of this framework to the New Zealand tourism industry demonstrates its valuable use to explore complex systems; however, the scalability of the framework lends itself to a wide range of applications. Further research will be required to test this framework in different contexts.

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REFERENCES

Adger, W.N. 2006. Vulnerability. *Global Environmental Change* 16: 268–281.

Baggio, R. 2008. Symptoms of complexity in a tourism system. *Tourism Analysis* 13: 1–20.

Becken, S. 2007. Tourists' perception of international air travel's impact on the global climate and potential climate change policies. *Journal of Sustainable Tourism* 15: 351–368.

Becken, S., and J.E. Hay. 2007. *Tourism and climate change: Risks and opportunities*. Clevedon: Channel View Publications.

Becken, S., and J. Wilson. 2013. The impact of weather on tourist travel. *Tourism Geographies* 13: 1–20.

Berrittella, M., A. Bigano, R. Roson, and R.S. Tol. 2006. A general equilibrium analysis of climate change impacts on tourism. *Tourism Management* 27: 913–924.

Brouder, P., and L. Lundmark. 2011. Climate change in Northern Sweden: Intra-regional perceptions of vulnerability among winter-oriented tourism businesses. *Journal of Sustainable Tourism* 19: 919–933.

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

Cohen, S.A., and J.E.S. Higham. 2011. Eyes wide shut? UK consumer perceptions on aviation climate impacts and travel decisions to New Zealand. *Current Issues in Tourism* 14: 323–335.

Eakin, H., and A.L. Luers. 2006. Assessing the vulnerability of social-environmental systems. *Annual Review of Environment and Resources* 31: 365.

Farrell, B.H., and L. Twining-Ward. 2004. Reconceptualizing tourism. *Annals of Tourism Research* 31: 274–295.

Fazey, I., M. Kesby, A. Evely, I. Latham, D. Wagatora, J.E. Hagasua, M.S. Reed, and M. Christie. 2010. A three-tiered approach to participatory vulnerability assessment in the Solomon Islands. *Global Environmental Change* 20(4): 713–728.

Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.K. Plattner, and S.K. Allen. 2012. *A special report of working groups I and II of the intergovernmental panel on climate change*. Cambridge: Cambridge University Press.

Füssel, H.M. 2007. Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change* 17: 155–167.

Füssel, H.M., and R.J.T. Klein. 2006. Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic Change* 75: 301–329.

Glaas, E., A. Jonsson, M. Hjerpe, and Y. Andersson-Sköld. 2010. Managing climate change vulnerabilities: formal institutions and knowledge use as determinants of adaptive capacity at the local level in Sweden. *Local Environment* 15: 525–539.

Garnaut, R. 2008. Final report [Online]. Retrieved October 11, 2012, from http://www.garnautreview.org.au/index.htm.

Gómez Martín, B.M. 2005. Weather, climate and tourism a geographical perspective. *Annals of Tourism Research* 32: 571–591.

Haddad, B.M. 2005. Ranking the adaptive capacity of nations to climate change when socio-political goals are explicit. *Global Environmental Change* 15: 165–176.

Hall, C.M. 2010. Crisis events in tourism: subjects of crisis in tourism. *Current Issues in Tourism* 13: 401–417.

Hall, C.M., D. Scott, and S. Gössling. 2013. The primacy of climate change for sustainable international tourism. *Sustainable Development* 21: 112–121.

Hansen, J., S. Marx, and E.U. Weber. 2004. *The role of climate perceptions, expectations, and forecasts in farmer decision making: The Argentine Pampas and South Florida*. New York: Cambridge University Press.

Hansen, J., M. Sato, R. Ruedy, K. Lo, D.W. Lea, and M. Medina-Elizade. 2006. Global temperature change. *Proceedings of the National Academy of Sciences of the United States of America* 103: 14288–14293.

Hendrikx, J., C. Zammit, E.O. Hreinsson, and S. Becken. 2013. A comparative assessment of the potential impact of climate change on the ski industry in New Zealand and Australia. *Climatic Change* 119(3–4): 965–978.

Hennessy, K.J., B. Fitzharris, B.C. Bates, N. Harvey, M. Howden, L. Hughes, J. Salinger, and R. Warrick. 2007. Australia and New Zealand. In *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on climate change*, ed. M.L. Parry, O.F. Canziani, J.P. Palutikof, P. van der Linden, and C.E. Hanson. Cambridge: Cambridge University Press.

Hewitt, K. 1983. *Interpretations of calamity*. Boston, MA: Allen & Unwin.

Higham, J.E.S., and S.A. Cohen. 2010. Canary in the coalmine: Norwegian attitudes towards climate change and extreme long-haul air travel to Aotearoa/New Zealand. *Tourism Management* 32: 98–105.

Holsten, A., and J.P. Kropp. 2012. An integrated and transferable climate change vulnerability assessment for regional application. *Natural Hazards* 64: 1977–1999.

Hopkins, D. 2013a. Learning about climate: an exploration of the socialisation of climate change. *Weather, Climate, and Society* 5(4): 381–393.

Hopkins, D. 2013b. The perceived risks of local climate change in Queenstown, New Zealand. *Current Issues in Tourism*. doi:10.1080/13683500.2013.776022.

Hopkins, D. 2013c. The sustainability of climate change adaptation strategies in New Zealand's ski industry: a range of stakeholder perceptions. *Journal of Sustainable Tourism* 22(1): 107–126.

Hopkins, D., J.E.S. Higham, and S. Becken. 2013. Climate change in a regional context: relative vulnerability in the Australasian skier market. *Regional Environmental Change* 13: 449–458.

Hulme, M. 2009. *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge: Cambridge University Press.

IPCC. 2007. *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on climate change*. Cambridge: Cambridge University Press.

IPCC. 2013. Summary for Policymakers. In *Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on climate change*, ed. T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midgley. Cambridge: Cambridge University Press.

Kates, R.W. 1985. The interaction of climate and society. In *Climate impact assessment: Studies of the interaction of climate and society*, ed. R.W. Kates, J.H. Ausubel, and M. Berberian. London: Wiley.

Kelly, P., and W. Adger. 2000. Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change* 47: 325–352.

Klein, R.J.T. 2009. Identifying countries that are particularly vulnerable to the adverse effects of climate change: an academic or a political challenge? *Carbon & Climate Law Review* 3: 284–291.

Kruse, S., M. Stiffler, D. Baumgartner, and M. Pütz. 2013. Chapter 15: vulnerability and adaptation to climate change in the Alpine space: a case study on the adaptive capacity of the tourism sector. In *European Climate Vulnerabilities and Adaptation: A Spatial Planning Perspective*, 1st ed, ed. P. Schmidt-Thomé, and S. Greiving. London: Wiley.

Liverman, D.M. 1990. Vulnerability to global environmental change. In *Understanding global environmental change: The contributions of risk analysis and management*, ed. R.E. Kasperson, K. Dow, D. Golding, and J.X. Kasperson. Worcester, MA: Clark University.

Malone, E.L., and N.L. Engle. 2011. Evaluating regional vulnerability to climate change: purposes and methods. *WIRES Climate Change* 2: 462–474.

McLaughlin, P., and T. Dietz. 2008. Structure, agency and environment: Toward an integrated perspective on vulnerability. *Global Environmental Change* 18: 99–111.

Ministry for Tourism. 2009. Retrieved August 1, 2011, from http://www.tourism.govt.nz/Our-Work/Our-Work-Summary-page/Climate-Change/.

Ministry of Business Innovation and Employment. 2012. Key tourism statistics (Online). Retrieved November 13, 2012, from http://www.med.govt.nz/sectors-industries/tourism/pdf-docs-library/key-tourism-statistics/key-tourism-statistics.pdf.

Moreno, A., and S. Becken. 2009. A climate change vulnerability assessment methodology for coastal tourism. *Journal of Sustainable Tourism* 17: 473–488.

New Zealand Tourism. 2013. About the tourism industry (Online). Retrieved September 27, 2014, from http://www.tourismnewzealand.com/about-the-tourism-industry/.

NIWA. 2013. Overview of New Zealand Climate (Online). Retrieved September 27, 2014, from http://www.niwa.co.nz/education-and-training/schools/resources/climate/overview.

O'Brien, K., S. Eriksen, L.P. Nygaard, and A. Schjolden. 2007. Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy* 7: 73–88.

Papatheodorou, A., J. Rosselló, and H. Xiao. 2010. Global economic crisis and tourism: Consequences and perspectives. *Journal of Travel Research* 49: 39–45.

Parry, M., J. Palutikof, C.E. Hanson, and J. Lowe. 2008. Squaring up to reality. *Nature Reports Climate Change*. doi:10.1038/climate.2008.50.

Peeters, P., and G. Dubois. 2010. Tourism travel under climate change mitigation constraints. *Journal of Transport Geography* 18: 447–457.

Pelling, M. 2001. Natural disasters? In *Social nature: Theory practice, and politics*, ed. N. Castree, and B. Braun, 170–188. Malden, MA: Blackwell Publishing.

Pickering, C.M., J.G. Castley, and M. Burtt. 2010. Skiing less often in a warmer world: Attitudes of tourists to climate change in an Australian ski resort. *Geographical Research* 48: 137–147.

Polsky, C., R. Neff, and B. Yarnal. 2007. Building comparable global change vulnerability assessments: The vulnerability scoping diagram. *Global Environmental Change* 17: 472–485.

Prideaux, B., and K.E. McNamara. 2012. Turning a Global Crisis into a Tourism Opportunity: the Perspective from Tuvalu. *International Journal of Tourism Research* 15(6): 583–594.

Ritchie, J.R.B., C.M.A. Molinar, and D.C. Frechtling. 2010. Impacts of the world recession and economic crisis on tourism: North America. *Journal of Travel Research* 49: 5–15.

Schneiderbauer, S., L. Pedoth, D. Zhang, and M. Zebisch. 2013. Assessing adaptive capacity within regional climate change vulnerability studies—An Alpine example. *Natural Hazards* 67: 1059–1073.

Scott, D., B. Amelung, S. Becken, J.P. Ceron, G. Dubois, S. Gössling, P. Peeters, and M. Simpson. 2008. *Climate change and tourism: Responding to global challenges*. Switzerland: Davos.

Scott, D., C.M. Hall, and S. Gössling. 2012. *Tourism and climate change: Impacts, adaptation and mitigation*. Routledge: Abingdon.

Scott, D., G. McBoyle, and B. Mills. 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.

Smit, B., I. Burton, R.J.T. Klein, and J. Wandel. 2000. An anatomy of adaptation to climate change and variability. *Climatic Change* 45: 223–251.

Smith, I.J., and C.J. Rodger. 2009. Carbon emission offsets for aviation-generated emissions due to international travel to and from New Zealand. *Energy Policy* 37: 3438–3447.

Statistics New Zealand. 2014. Population projection tables. Retrieved March 1, 2014, from http://www.stats.govt.nz/tools_and_services/nzdotstat/population-projections-tables.aspx.

Stern, N.H. 2007. *The economics of climate change: The stern review*. Cambridge: Cambridge University Press.

The Treasury. 2012. New Zealand: Economic and financial overview 2012 (Online). Wellington: The Treasury. Retrieved September 27, 2013, from http://www.treasury.govt.nz/economy/overview/2012/nzefo-12.pdf .

Tourism New Zealand. 2013. Market and Stats: Latest visitor data and tourism market guides (Online). Retrieved September 1, 2013, from http://www.tourismnewzealand.com/markets-and-stats/.

Turner, B.L., R.E. Kasperson, P.A. Matson, J.J. McCarthy, R.W. Corell, L. Christensen, N. Eckley, J.X. Kasperson, A. Luers, and M.L. Martello. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences* 100: 8074–8079.

Wilbanks, T.J. 2003. Integrating climate change and sustainable development in a place-based context. *Climate Policy* 3: S147–S154.

Wilson, J., and S. Becken. 2011. Perceived deficiencies in the provision of climate and weather information for tourism: A New Zealand media analysis. *New Zealand Geographer* 67: 148–160.

Wratt, D. & Mullan, B. (N.D.). Climate change scenarios for New Zealand (Online). Retrieved September 11, 2013, from http://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios.

Wratt, D., Salinger, J., Bell, R., Lorrey, D. & Mullan, B. (N.D.). Past climate variations over New Zealand (Online). NIWA. Retrieved September 11, 2013, from http://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/pastclimate.

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