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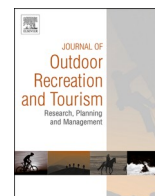
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## Research Article

# Tourism-related economic loss and damage from the North Island weather events on New Zealand conservation land and waters

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## ABSTRACT

Extreme weather events are causing increasing levels of loss and damage, including to natural assets and associated nature-based tourism economies. This article provides estimates of the economic impacts on public conservation lands and waters in New Zealand's North Island from the flooding events of Cyclone Hale and Cyclone Gabrielle in early 2023. Losses and damage are estimated in four buckets: regional tourism GDP losses from cancelled visitor bookings at Department of Conservation accommodation facilities; lost business revenue of companies operating in protected areas; lost value of government-managed visitor assets; and regional tourism GDP losses from estimated reductions in visitor numbers at three iconic protected area sites. The research also attributes a proportion of these losses to climate change, assisting learning and future planning for New Zealand's conservation agency.

## Management implications

The quantification of different types of economic impacts from an extreme weather event on conservation-related tourism in New Zealand will help the Department of Conservation plan future asset management (including potential retreat), risk management (including visitor safety), and business partnership management (with those businesses that operate as concessionaries on protected area land and waters). The next step for the Department is to overlay future climate risk projections with its asset (hut, tracks, other infrastructure) system to identify multi-hazard hot spots. Demarking some areas may have to be one consequence. This requires stakeholder consultation; already underway in some regions.

## 1. Introduction

The year 2023 was characterised by heatwaves, wildfires, unprecedented sea surface temperatures, record low levels of Antarctic Sea ice and widespread destruction from extreme weather (King et al., 2023; WMO, 2023). The science of attributing extreme weather events to climate change reveals that 62 of the 77 extreme weather events that occurred during the period 2015–17 carried significant human influence (CarbonBrief, 2023). Increasing climate risks raises questions about how

to measure impacts and how to minimise loss and damage (L&D) in the future. The issue of economic and non-economic L&D from extreme weather events (Mechler et al., 2019) has been formally recognised in 2015 at the United Nations Conference of Parties (COP21) in Paris. Countries have agreed to report L&D under the Paris Agreement's transparency framework since 2018 (Bahinipati & Gupta, 2022), and significant funding has been pledged at COP28 in Dubai in 2023 (Gayle & Evans, 2023).

Climate change-related risks to assets and livelihoods are increasingly pertinent to tourism, both in developing and developed countries (TPCC, 2023). New Zealand, a popular tourist destination in the Pacific, experienced severe weather events in early 2023, when three major events led to large-scale flooding, wind damage and landslides in the North Island. The government declared a State of National Emergency from 14 February to March 14, 2023. This article focuses on assessing the direct economic impacts of these North Island Weather Events (NIWE) due to closed or destroyed protected area assets, assessed from the perspective of the Department of Conservation (DOC). DOC, a government agency in charge of protecting New Zealand's natural and cultural heritage, manages public conservation land and waters (PCLW). Protected areas are key generators of revenue (Balmford et al., 2015; Majewski, 2024), including in New Zealand, where 53% of the close to four million international tourists in 2019 visited one or more national

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parks (Department of Conservation, 2022). Current and future climate change impacts are likely to alter existing patterns of visitation, operating costs, and safety requirements.

This article presents a replicable methodology tailored for parks agency policymakers of how to assess the direct and immediate economic impacts of an extreme weather event on tourism. The focus here is on disaster damage which “is ‘nearly equivalent’ to the concept of direct economic loss” (Frame et al., 2020, p. 784). The purpose of this research is to inform future planning and climate change adaptation for those involved in managing nature-based tourism assets.

## 2. Literature review

The increase in extreme weather events compounds with an increase in the number of settlements in exposed areas and an accumulation of valuable assets in these areas, leading to growing economic damage (Kron et al., 2019; Mechler et al., 2019), including for tourism (TPCC, 2023). Despite these observable trends, an agreed definition of L&D is still lacking. The United Nations Framework Convention on Climate Change includes both sudden-onset and slow-onset events but focuses on the ‘residual impacts’ that occur over and above climate adaptation measures (Warner & van der Geest, 2013). Elsewhere, research on post-disaster assessment considered loss to represent the negative impact on production of goods and services due to an event, and damage as the monetary value of infrastructure and assets that experienced devastation (Bahinipati & Gupta, 2022). Other studies defined loss as irreversible or irreparable deviation of people from the place and way of living that they value (health, safety, sense of belonging), whereas damage implies that reparation or restoration is possible (Bhowmick et al., 2021).

Research on the impacts of climate change on natural area tourism has typically focused on visitor perceptions and changes to travel patterns (Prettenhaler et al., 2022; Soboll et al., 2012), or the impacts on natural resources (e.g. Cheablam & Shrestha, 2015). Researchers have also investigated weather-related disasters and tourism, for example infrastructure damage from flooding in South African national parks (Dube et al., 2023). Elsewhere, the case study of Taiwan Maolin National Scenic Area highlighted the extent of economic damage caused by the loss of 700,000 visitors after typhoon Morakot (Liu, 2014). The authors quantified the direct impact of reduced visitors and developed an econometric demand model that allowed estimation of projected loss of income due to foregone growth. The direct damage caused to shared accommodation in Florida was estimated by Chen et al. (2021) using damage curves for wind and storm surge, alongside indirect impacts of lost income.

Tourism in New Zealand inherently depends on the integrity and safety of natural environments, with climate change posing a significant risk to a business-as-usual approach to tourism management (Higham et al. 2023; Hughey & Becken, 2014). Disruptions and concerns over visitor safety from extreme events have led to New Zealand tourism organisations working more closely with regional disaster risk-management networks (Becken & Hughey, 2013). Research on L&D incurred on nature tourism or tourism-critical infrastructure due to specific events, however, is lacking to date. Addressing this gap is important given that New Zealand’s iconic landscapes and scenery remain the key drivers for potential visitors (Tourism New Zealand, 2023). DOC is an integral part of the tourism economy, managing 13 national parks and 44 marine reserves. DOC cannot charge visitors for access, but it can charge for the use of accommodation facilities (967 back-country huts and 331 campsites). DOC also charges fees for authorising businesses to operate as concessionaires to conduct tourism activities on DOC-managed land. These fees are set at ‘reasonable’ levels to “foster the use of natural and historic resources for recreation [and] allow their use for tourism” in accordance with the Conservation Act 1987; Parliamentary Counsel Office, 2003, pp. 25, 44). DOC’s facilities and businesses on PCLW generate economic activity that can be

disrupted by disasters with direct impacts for regional economies.

Many of DOC’s assets are exposed to climate risks, and an Adaptation Action Plan has been developed to better guide decision-making (Department of Conservation, 2020). Weather events are already impacting operations; for example, one extreme 30-h rainfall event in March 2019 at Aoraki Mount Cook village flooded huts, destroyed a walking track and washed out an access bridge. The NIWE events, however, were of a much larger scale, both meteorologically and in terms of their spatial expanse. First, Cyclone Hale (originating from the Gulf of Carpentaria north of Australia) crossed New Zealand on the January 10, 2023 as an extra-tropical cyclone with impacts in Auckland and the Coromandel Peninsula. On the 27 January, Auckland received 245 mm of rainfall in 24 h, significantly exceeding the existing 24-h rainfall record of 161 mm set in 1985 (New Zealand Infrastructure Commission, 2023). Four people lost their lives and major infrastructure and housing damage was observed. Thirdly, Cyclone Gabrielle formed close to the Solomon Islands, eventually reaching New Zealand on the 12 of February. Reaching extreme wind speeds and extremely high levels of precipitation, exceeding 20 mm/h for more than 6 h in several locations; the imprint of climate change on this event has been demonstrated scientifically (World Weather Attribution, 2023). The Gabrielle weather system led to widespread devastation, particularly on the east coast in Hawke’s Bay and eleven people lost their lives.

As a result of NIWE, DOC’s visitor assets suffered significant damage (Fig. 1). Damaged properties included buildings, signage, tracks, car-parks and boardwalks. Around 42% of DOC’s sites in the affected regions were found to require repairs or full asset replacements. Some affected sites with cultural heritage and biodiversity values had not yet been assessed at that time. These extreme weather events also closed main roads and infrastructure that prevented visitors accessing these regions. This research note estimates several types of direct economic loss and damage resulting from the NIWE.

## 3. Methodology

The methodology represents a situational assessment of replaceable economic loss and value of visitor assets destroyed on PCLW based on internal work undertaken in DOC in April 2023<sup>1</sup>. It is in line with the macroeconomic approach taken by the New Zealand Treasury, and it also follows recommendation by Stats NZ (2023) for quantifying economic losses from flooding and cyclones. A regional perspective is taken (Soboll et al., 2012), and attribution to ‘bottom up’ impact data follows similar principles to Frame et al. (2020) study of the economic costs from droughts and floods during 2007–17 in New Zealand. This study compiled direct economic loss measures in four buckets (Fig. 2). The focus was on quantifying the initial negative economic impacts based on the cancelled visitor bookings at DOC’s accommodation (1), loss in concessionaires’ business revenue (2) and the lost value in DOC’s assets (3). In addition, case studies of the impacts at three iconic sites were undertaken (4). The positive economic impact from the repair and rebuild work over the coming years was not estimated given the uncertainties of funding, DOC’s decisions where to rebuild and not rebuild across its damaged visitor network, and the timing and pace of this process. Intangible L&D, for example related to irreversible loss of natural or cultural heritage, was not included but should be considered in future research (Bhowmick et al., 2021).

### 3.1. Loss in regional tourism GDP due to cancelled bookings

The direct economic tourism impacts derived from DOC’s facilities

<sup>1</sup> The economic assessment assumed that the damages would impact visitor flows for all of 2023. DOC closed more than 500 sites for safety reasons because of NIWE. As of 30 June 2023, 14 assets were written-off, 122 were impaired, and some were yet to be assessed.

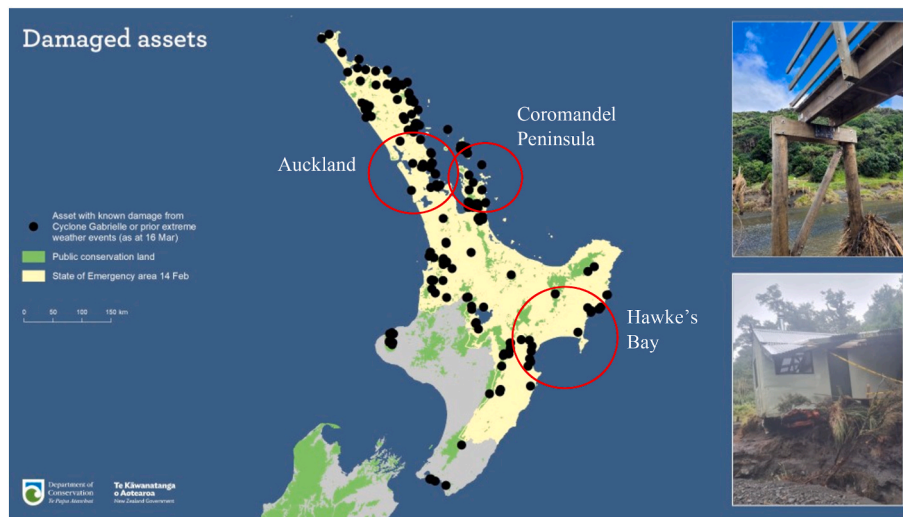


Fig. 1. Damaged DOC visitor sites in New Zealand's North Island (mid-March 2023), key impacted areas highlighted with a red circle. Photos: Te Henga Bridge and Leon Kinvig Hut, Ruahine Forest Park (Source: DOC).

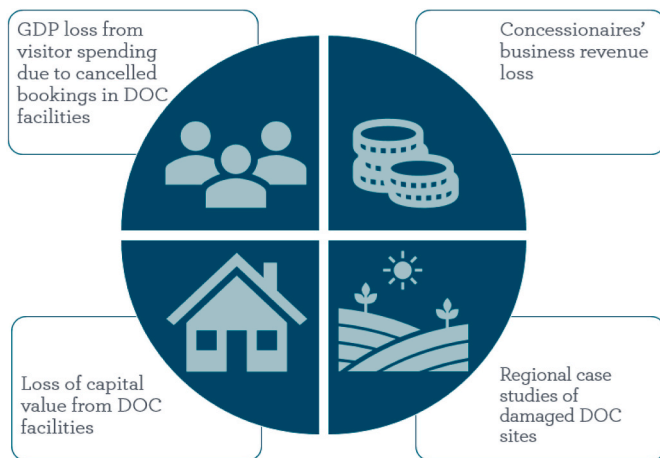


Fig. 2. Key measures of estimated economic impacts for four buckets.

are a function of the volume and level of regional visitor spending, assuming that DOC sites are the main reason for visitors to come to this region. Hence, the first bucket of direct economic losses to the NIWE-affected regions were based on cancelled bookings for DOC's accommodation, the estimated reductions in visitor numbers and expenditure, and loss in regional tourism GDP. Historic dollar values are inflation adjusted to 2023.

- **Step 1: Cancelled DOC bookings.** The booking system (Table 1) showed that 41% of accommodation bookings were cancelled during the state of emergency period.
- **Step 2: Reduced numbers.** First, the number of visitors was estimated from the cancelled bookings by assuming a 36% uplift in demand. The ratio of people per booking was informed by actual numbers in the booking system between July 2022 and January 2023. There is no reason to assume that this twelve-month period displays a non-representative ratio. In addition, it was assumed that there were a further 20% of visitors for non-bookable facilities. The total number of booked and unbooked visitors who would have come to the regions in the absence of NIWE was estimated at around 18,000 visitors. At a 41% cancellation rate, the reduction in total visitors was 7000 visitors. Second, the region-specific proportions of total cancelled bookings were applied to the total reduction in visitor

Table 1  
Active and cancelled bookings (Source: DOC Booking Services).

Region	Active bookings	Cancelled bookings	Grand Total	Number of cancelled bookings	Proportion per region of total cancelled bookings
Auckland	52%	48%	100%	194	12%
Bay of Plenty	76%	24%	100%	157	10%
Coromandel	40%	60%	100%	523	32%
East Coast	45%	55%	100%	11	1%
Hawke's Bay	50%	50%	100%	5	0%
Northland	56%	44%	100%	622	38%
Waikato	82%	18%	100%	58	4%
Wairarapa	82%	18%	100%	66	4%
<b>Grand Total</b>	<b>59%</b>	<b>41%</b>	<b>100%</b>	<b>1636</b>	<b>100%</b>

Source: DOC Booking system

numbers to estimate the regional loss of visitors (Table 2 in section 4). This assumed that booking cancellations were in response to NIWE.

- **Step 3: Determining loss in expenditure.** The loss in tourism expenditure from cancellations for each impacted region was based on multiplying numbers of the average tourism expenditures per visitor in that impacted region for the New Zealand business year starting in March 2019 and ending in February 2020 (i.e. before COVID-19 arrived in the country) provided by the Ministry of Business, Innovation and Employment (MBIE, 2020) and the reduced number of visitors for that region. The CPI inflation between 2020Q1 and 2023Q1 was applied to update the average expenditure per visitor to 2022/23 prices.
- **Step 4: Determining loss in regional tourism GDP (direct value added).** Losses were estimated by applying the shares of tourism GDP (direct value added) in total tourism expenditure in 2019/20 to the estimated losses in visitor expenditures in the respective regions. The tourism GDP data for the regions were sourced from Infometrics (2022) and the total tourism expenditure data came from MBIE's Monthly Regional Tourism Expenditure (MBIE, 2020). For two regions (East Coast and Hawke's Bay), it was necessary to apply the average tourism GDP share for New Zealand (Stats, 2022), as regional shares were unavailable.

**Table 2**  
Estimated loss in tourism expenditure and tourism GDP from cancelled DOC accommodation bookings.

Region	Cancelled visitor numbers <sup>a</sup>	Average tourism expenditure per visitor (Amount in \$) <sup>b</sup>	Tourism expenditure loss (Amount in \$ million)	Tourism GDP/Tourism Expenditure ratio <sup>c</sup>	Tourism GDP loss (Amount in \$ million)
Auckland	850	984	0.84	0.67	0.56
Bay of Plenty	688	354	0.24	0.79	0.19
Coromandel	2291	121	0.28	0.31	0.09
East Coast	48	275	0.01	0.39	0.01
Hawke's Bay	22	445	0.01	0.39	0.00
Northland	2725	561	1.53	0.45	0.69
Waikato	254	209	0.05	0.35	0.02
Wairarapa	289	196	0.06	0.32	0.02
<b>Totals (gross)</b>	<b>7168</b>		<b>3.02</b>		<b>1.57</b>

<sup>a</sup> Source: DOC, Booking Services (March 2023).

<sup>b</sup> Ratio of total tourism expenditure and total number of visitors. Total tourism expenditure is based on MBIE's Monthly Regional Tourism Expenditure (2019/20 March-February) and CPI inflation (2020Q1-2023Q1). Total number of visitors is sourced from MBIE's MURPE data.

<sup>c</sup> Ratio of Tourism Direct Value Added (TDVA) and total tourism expenditure. TDVA is sourced from Infometrics for all the regions except East Coast and Hawke's Bay. In absence of TDVA data for East Coast and Hawke's Bay, this ratio was assumed to be the average ratio of TDVA and Total Tourism Expenditure for New Zealand sourced from Stats NZ's Tourism Satellite Accounts.

Source: DOC Booking system

### 3.2. Loss in concessionaires' business revenue

Around 800 of DOC's concessionaires were impacted by NIWE, with the top three most affected industries being accommodation, guiding and attractions/tours. Concession fees bear a close relationship to business revenues where the fees are set as percentages of their sales revenue. The methodology for the second bucket of concessionaire losses followed two steps: first, identifying reduced concession fee amounts from invoices made available from DOC's permissions team; and second, deducting an estimated loss in business revenue assuming three concession fee rate scenarios, namely 2%, 3.5% and 5% of the company's revenue (actual concession agreements are confidential).

### 3.3. Loss of DOC capital value

DOC assets in the region suffered minor, moderate and major damage. The third bucket of total lost asset value was estimated at NZ\$5 million, based on the lost net book value (NBV) (write-offs) of the assets suffering moderate and significant damages. This was informed by DOC's accounting data of its register of fixed capital assets. As many damaged assets were already old, the estimated lost book value understated the support they had been providing to the regional economies. The replacement value for restoring the assets to support pre-disaster levels of visitor activities is expected to be much higher, but was not used in this analysis.

### 3.4. Case studies

Case studies were conducted for three iconic DOC sites that were significantly impacted by Cyclone Gabrielle – Cathedral Cove, Te Henga Walkway and Mount Mania. These sites are major drawcards for visitors to the region.

- *Step 1: Reductions in visitor numbers.* DOC uses activity counters to understand where, when and how often people are visiting sites. A 50% drop in visitor numbers was assumed at each of the three sites relative to the visitor numbers for the last available year for the regions of those sites. The 50% reduction reflected an assumption that the lost access to these important attractions meant that half the visitors would not come to the region. A sensitivity analysis of a 30% reduction and a 70% reduction was also undertaken to examine the range of GDP loss of a drop in visitor numbers for the three sites. A substitution effect, whereby other regions in New Zealand might have benefited, was not modelled.

- *Steps 2 and 3: Determining loss in expenditure and regional tourism GDP.* These steps mirror Steps 2 and 3 of the first bucket. The share of tourism direct value added in expenditure for the three regions was applied to estimate the tourism GDP loss.

Finally, and to determine what part of the economic L&D was attributable to human-induced climate change, a 30% attribution factor was applied to all economic estimates of the effect of NIWE (Frame et al., 2020). The attribution factor for Cyclone Gabrielle was estimated by a group of scientists and published by World Weather Attribution (2023).

## 4. Results

This section presents the economic impact of NIWE for the four buckets shown in Fig. 2. Table 2 shows the losses that arose from cancelled visitation of DOC's accommodation facilities. Lost tourism expenditure of NZ\$3.0 million lead to a reduction of NZ\$1.6 million in direct tourism GDP for the impacted regions. The biggest impact was observed in Northland (NZ\$0.69 million loss in GDP) although Auckland also suffered a notable reduction (NZ\$0.56 million), mainly due to the high average visitor expenditure in the region.

The reduced income for DOC from lost concession fees was NZ\$1.4 million, but the derived loss to business revenue (the second bucket) in the impacted regions was much larger. For the three concession bands, it was estimated that the loss was NZ\$28 million, NZ\$40 million or NZ\$69 million. The private sector losses in revenue were also far larger than the losses from the third bucket, namely impacts on DOC's tourism assets in the region, which were estimated to be NZ\$5 million. The replacement value for the damaged assets is expected to be much larger than lost book value after assets are restored to support normal visitor activity levels. Finally, the fourth bucket of impacted iconic visitor attractions results in additional loss of tourism GDP, in the order of NZ\$21 million. More specifically, the negative impact on the region's tourism GDP at Cathedral Cove was a loss of 3.0% (NZ\$4.7 million), in addition to losses at Te Henga Walkway of 0.5% (NZ\$1.4 million) and Mount Mania of 1.1% (NZ\$5.3 million). Table 3 summarises the findings under the four buckets and applies the 30% climate change attribution factor.

## 5. Concluding discussion

Climate change is increasingly becoming a major concern for tourism destinations, including those involved in managing natural assets such as protected area agencies. The 2023 extreme weather events in New Zealand's North Island caused widespread impacts on peoples' lives and severely affected tourism. Focusing on overall economic losses, the New

**Table 3**

Estimates of the L&D due to NIWE and human-induced climate change attribution.

	Economic estimates of the loss and damage (Amount in \$ million)	30% attribution to human induced impact of climate change (Amount in \$ million)
Loss in regional tourism GDP due to booking cancellations	1.6	0.5
Loss in business revenue of concessionaires	28–69	8.4–20.7
Loss in DOC's Net Book Value of assets	5.0	1.5
Case studies (loss in regional tourism GDP)		
(i) Cathedral Cove <sup>a</sup>	4.7	1.4
Range <sup>b</sup>	(2.8–6.6)	(0.8–2.0)
(ii) Te Henga Walkway <sup>a</sup>	11.4	3.4
Range <sup>b</sup>	(6.8–16.0)	(2.1–4.8)
(iii) Mount Manaia	5.3	1.6
Range <sup>b</sup>	(3.2–7.4)	(1.0–2.2)

<sup>a</sup> Show estimated impacts of a 50% fall in visitor numbers.

<sup>b</sup> The ranges show the outer limits of 30% and 70% fall in visitor numbers.

Zealand Treasury (2023) estimated that economic output was reduced by NZ\$400–600 million (driven mainly by loss of agricultural and horticultural crops) in the first half of 2023. In addition, total damages to physical assets were estimated to be NZ\$9–14.5 billion, and average persistent annual output losses due to loss of assets (such as orchards) was put at around NZ\$100 million per annum. The tourism-related L&D had not been addressed by Treasury, and this research note provides an attempt to estimate economic loss and damage from the perspective of cancelled bookings and visits to nature-based attractions. This is important because nature-based tourism is an integral part of New Zealand's economy and society, but mounting disruptions from extreme weather events are beginning to pose significant challenges, including higher costs, compromised service delivery and safety concerns (Becken & Wilson, 2016; Brunton, 2023).

This work highlighted that economic loss from reduced visitor bookings, lost regional tourism GDP, decreased business revenue for concessionaires and lost net book value in DOC assets amounted to between NZ\$65–97 million. Applying the human-induced attribution factor revealed that the climate change-related losses for tourism were in the order of NZ\$17–29 million. The biggest loss was incurred by private sector companies that offer activities in conservation land, reinforcing the role of protected areas in generating economic income and (regional) development through positive ripple effects (Balmford et al., 2015). The numbers highlight the (economic) dependence of tourism businesses on functioning and safe protected area infrastructure and access and the challenge that public sector faces to maintain these with limited budget but mounting operational costs. The increasing impact of climate change on natural attractions themselves and resulting need to adapt all parts of the associated management system, has been demonstrated by research undertaken by New South Wales National Parks (Australia) (Jacobs et al., 2016, pp. 17–29) and confirmed in this work. Future work should assess additional losses to intangible values, including impacts on threatened ecosystems and species and implications for tourism attractiveness. The growing body of research, including this New Zealand case study, raises questions about how significant L&D might be in the future, and whether park agencies are prepared, including to deal with perhaps unrecoverable losses.

The inter-connectedness of climate change, biodiversity, and natural area tourism is increasingly recognised (Dube & Nhamo, 2020), including the impact of weather-related disasters (Liu, 2014). Translating this knowledge into practical management action is a necessary next step. This analysis provides useful information to DOC for its future adaptation planning. It is also pertinent to the wider tourism industry and its exposure to climate risk. Practical implications relate to the

careful consideration of the types of structures being built in natural areas, the need to budget accordingly (i.e. with future climatic impacts accounted for) and an understanding of event return times to prepare for the possibility of retreating from highly exposed areas. Capacity building to better understand climate risks might be necessary both within the public and private sectors. All measures require consultation with the wider community, indigenous partners and the tourism industry.

Finally, and in conclusion, quantified evidence of economic L&D as presented in this research may aid awareness raising efforts, not only in New Zealand, but in other destinations that maintain infrastructure and systems to connect people with nature. Doing so in a cost-efficient and resilient way will be increasingly challenging.

### CRedit authorship contribution statement

**Dhritidyuti Bose:** Writing – review & editing, Visualization, Project administration, Methodology, Formal analysis. **Susanne Becken:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

### Declaration of competing interest

The authors declare that they have no known competing interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

The data that has been used is confidential.

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