

Formation and Development of Tourism Disaster Management Networks: From Preparedness to Response

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Abstract

Building destination resilience and preparing tourism businesses for disasters requires collaboration with emergency management agencies. This study investigates network formation and development during emergencies in Piopiotahi/Milford Sound and Tāhuna/Queenstown, Aotearoa/New Zealand. Using survey and interview data from tourism and emergency management stakeholders, it employs mixed methods Social Network Analysis to explore collaboration drivers and network structural changes. Findings underscore tourism stakeholders' pivotal roles in functions such as intelligence, welfare, and logistics. Communication, formal agreements, and business relations have a significant and positive effect on response collaboration, highlighting the importance of cultivating diverse connections and involving tourism stakeholders in disaster planning. Key structural changes include reduced connections and a more distinct core-periphery structure, indicating increased peripheral actor engagement during response. Understanding these dynamics can help policymakers and emergency managers enhance collaboration strategies, thus improving disaster response outcomes.

Keywords

Natural Hazards, Tourism Destinations, Emergency Management, Collaboration, Social Network Analysis, Multiplexity.

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1. Introduction

Tourist destinations are highly vulnerable to a variety of shocks and stressors, such as natural hazards, global environmental change, political unrest, terrorist attacks, economic downturns, and health epidemics (Chen et al., 2022). These disruptive events damage destination infrastructure and reputation, compromise tourists' safety, and require additional investments for emergency and post-disaster recovery (Brown et al., 2019; Filimonau & De Coteau, 2020). To ensure the sustainability of tourist destinations, it is imperative to implement preventive policies, disaster risk reduction measures, and resilience-building efforts to reduce their vulnerability to crises and disasters (Becken & Khazai, 2017). One effective strategy to assist tourism stakeholders in preparing for and responding to emergencies is the formation of collaborative networks with emergency management agencies (Ritchie & Jiang, 2021).

Collaborative networks play a central role in Tourism Disaster Management (TDM), as they encourage coordination, information sharing and community engagement (Becken et al., 2014; Hu et al., 2022). Through network arrangements, organisations with diverse expertise, knowledge and resources can leverage each other's strengths to provide a coordinated response to emergencies (Kapucu & Garayev, 2012). Responding to a disaster involves not only government agencies and emergency services but also groups from civic society or industry that contribute with their specialised knowledge and skills (Becken & Hughey, 2013). Tourism organisations and businesses, for instance, possess valuable expertise, resources, and communication channels that can support emergency management agencies (Cahyanto et al., 2020). Involving them in disaster planning and response has proven to be a successful strategy (Beirman, 2018; Orchiston, 2012).

Tourism disaster management has traditionally relied on linear, stage-based models that emphasize pre-disaster planning, response, recovery, and resolution (Faulkner, 2001; Ritchie, 2004). While these frameworks offer structure, they often overlook the overlapping, non-linear, and unpredictable nature of real-world crises and disasters (Pennington-Gray, 2018; Prayag, 2018). To address this gap, a shift toward *complex systems thinking* and *network theory* is necessary (Reddy et al., 2020). These approaches account for the dynamic, relational, and adaptive nature of tourism systems, offering a more nuanced understanding of how collaborative networks form, evolve, and respond to disruptions (Fyall et al., 2012; Jiang & Ritchie, 2017). Despite their relevance, complexity and network theories have largely been used as conceptual frameworks rather than applied empirically (Reddy et al., 2020; Ritchie & Jiang, 2021).

In the context of tourism disaster management, scholars have used chaos and complexity theories to understand the effects of crises and disasters on destinations (Scott & Laws, 2005), analyse tourism crisis response strategies (Paraskevas, 2006), propose strategic approaches to tourism disaster management (Ritchie, 2008) and study tourism destination development and management during crises and disasters (Reddy et al., 2020). Social networks have mainly been explored in the context of social capital (Chowdhury et al. 2019), tourism response and recovery strategies (Orchiston & Higham, 2016), and crisis communication and marketing (Campiranon & Scott, 2014). These studies identify social networks as key indicators of community resilience and recognise their importance for disaster risk reduction, response and recovery.

However, it remains unclear how collaborative networks form and change during disaster response, specifically the linkages between different types of collaborative relations (Hu et al., 2022). Understanding how networks are designed, function, and develop during the disaster management cycle ensures better outcomes when activated during emergencies (Kapucu & Demiroz, 2017).

This study addresses these gaps by examining how tourism and emergency management disaster response networks form and evolve, using a novel mixed methods Social Network Analysis to investigate collaboration drivers and network structural changes. It addresses the following research questions:

- (i) *“How do structural characteristics and patterns of collaborative networks change from the preparedness to the response phase?”*
- (ii) *“What are the interdependencies between different types of collaborative relations, and how do they influence disaster response collaboration?”*

The analysis focuses on two destinations in Aotearoa / New Zealand (New Zealand hereafter) that are highly exposed to disaster risk because of their proximity to the Alpine Fault (Howarth et al., 2021; Orchiston, 2012). The findings highlight challenges faced by nature-based and similar tourism destinations, offering insights applicable to tourism management. By integrating tourism and emergency management perspectives, our research advocates for a collaborative approach that bridges these disciplines emphasizing their shared goal of reducing risk and enhancing resilience.

This research demonstrates how the tourism industry can actively contribute to the Sustainable Development Goals (SDGs) by enhancing disaster resilience through collaboration between tourism stakeholders and emergency management agencies. Investing in and implementing preparedness measures in the tourism sector can mitigate disaster risks, reducing potential loss of life and property, which supports SDG 11 (Sustainable Cities and Communities). Additionally, by protecting livelihoods and ensuring the continuity of tourism operations during and after crises, this research highlights the sector’s role in promoting SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure). The focus on collaborative networks also reinforces the importance of SDG 17 (Partnerships for the Goals), demonstrating how TDM networks can serve as a platform for mobilising diverse stakeholders and resources to address emergencies. By aligning with the SDGs, this study provides practical insights for reducing disaster impacts and fostering long-term sustainability in tourism-reliant regions.

2. Literature Review

2.1. Collaborative Networks in Tourism Disaster Management

Disaster management involves the organisation, planning, and implementation of measures to prepare for, respond to, and recover from disasters (United Nations Office for Disaster Risk Reduction [UNDRR], n.d.). It encompasses four phases: Prevention (or Reduction), Preparedness (or Readiness), Response, and Recovery (Granville et al., 2016). Prevention focuses on risk mitigation through regulations and measures, preparedness is about developing

individual and organisational response capacities, response involves actions to save lives and protect property during disasters, and recovery includes efforts to restore affected communities (UNDRR, n.d.). A disaster is defined as a serious disruption to a community or society caused by hazardous events, resulting in human, material, economic, and environmental losses and impacts (UNDRR, n.d.). While disaster management is generally the responsibility of international and national systems (Becken & Hughey, 2013), the Sendai Framework for Disaster Risk Reduction (2015-2030) emphasizes the need for active participation by various stakeholders, including the tourism sector.

Tourism organisations and businesses play a critical role across the emergency management cycle due to their local expertise, communication channels, evacuation and sheltering capacities, and contributions to economic recovery (Chan et al., 2019; Nguyen et al., 2017). During prevention and preparedness, Destination Management Organisations (DMOs) coordinate between tourism stakeholders and emergency agencies (Cahyanto et al., 2020), and support tourism businesses with disaster preparedness (Granville et al., 2016). During the response, DMOs assist in crisis communication and act as intermediaries with emergency services and the public (Blackman et al., 2011). Other tourism sectors, such as accommodation and food and beverage, can also provide useful services to EMOs, including emergency generators, shelter and food supplies (Nguyen et al., 2017). Through collaboration and learning, tourism businesses can gain access to the knowledge, resources, and training provided by emergency management agencies (Cahyanto et al., 2020). Overall, partnerships in TDM are critical to minimizing disasters' impacts on destinations (Becken et al., 2014).

2.2. Drivers of Inter-organisational Disaster Response Collaboration

Given the importance of inter-organisational collaboration in tourism, studies have increasingly explored motivations, influencing factors and strategies for effective TDM collaboration (Filimonau & De Coteau, 2020; Jiang & Ritchie, 2017; Nguyen et al., 2017). In the emergency management literature, Hu et al. (2022) identify five key factors shaping network formation and development: (i) organisational factors, (ii) contextual factors, (iii) inter-organisational relationships, (iv) structural effects, and (v) homophily effects. Organisational factors refer to attributes such as an organisation's size and age that can influence its likelihood to collaborate (Siciliano & Wukich, 2017). Contextual factors, including policies, disaster type and scale, also play a role (Hu et al., 2022). For example, the CDEM Act 2002 in New Zealand encourages coordination across multiple agencies (Becken & Hughey, 2013). Additionally, inter-organisational relationships, including the presence of multiple ties (i.e. multiplexity), prior relationships, trust and social capital, can all foster the creation of coordination ties in emergency management (Kapucu & Garayev, 2012; Kapucu & Hu, 2016). Finally, organisations involved in disaster response are more likely to collaborate with well-connected actors or those with similar attributes, such as sector, size, or regional affiliation (Yeo, 2018; Jung et al., 2019).

In addition, previous studies in tourism disaster management have highlighted specific driving factors for collaboration. For instance, the need for assistance in implementing disaster preparedness measures motivated tourism stakeholders to collaborate with emergency management during the Tuhoku 2011 earthquake in Matsushima, Japan (Nguyen et al., 2017).

In the case of Cyclone Marcia in Australia, Jiang & Ritchie (2017) found collaboration was mainly driven by resource sharing and relationship building, and influenced by past experience and relationships. Their research showed that organisations tend to form relationships with others whom they have previously interacted and built trust with. During the response to the cyclone, stakeholders collaborated to share information, capabilities, expert knowledge and financial support. Other factors influencing collaboration included the nature of necessity, leadership, lack of resources and knowledge, personalities and attitudes (Jiang & Ritchie, 2017).

None of the factors identified by Hu et al. (2022) concerning network formation and development have been explored in the context of TDM. To date, the focus has been on stakeholders' perspectives on collaboration, analysed predominantly through qualitative methods and theoretical frameworks such as stakeholder collaboration theory, life-cycle theory, and collaborative planning theory (Chan et al., 2019; Muskat et al., 2015; Nguyen et al., 2017; Rahmafritia et al., 2021). Although these methods and theories offer insights into managerial decision-making and collaborative arrangements, they fall short in capturing the dynamic nature of relationships (Fyall et al., 2012). To fully understand the complexity of tourism and disasters, different approaches and methods are required (Baggio, 2017; Varda, 2017). Adopting concepts and techniques from emergency management network studies can provide better insights into TDM network formation. Specifically, focusing on inter-organisational relationships (Hu et al., 2022) and multiple ties, as previous relationships influence collaboration dynamics (Jiang & Ritchie, 2017).

2.3.Social Network Analysis and Multiplexity to study Network Formation and Development

Analysing different types of relations and how they interact is key to understanding the tourism system (Baggio & Baggio, 2020). Social Network Analysis (SNA) provides a set of techniques to define and quantify these relations (Scott & Laws, 2005). A social network is a set of nodes (also called actors) that are tied by one or more types of edges (also called ties) (Wasserman & Faust, 1994). Networks can be represented as adjacency matrices whose elements indicate the presence or absence of edges between pairs of nodes, thereby facilitating the assessment of various system characteristics (Baggio & Baggio, 2020). Mathematical metrics are employed to examine the network at local, intermediate, and global scales (Baggio & Baggio, 2020). SNA can reveal important network properties such as centrality (the prominence of nodes within the network), clustering (the formation of tightly connected groups), and bridging (the connections between different groups) (Fyall et al., 2012).

Given its potential, SNA has been used in tourism research to explore destination topology and dynamics, dissemination of knowledge, and patterns of visitor flows (Baggio, 2017; Casanueva et al., 2016). It has also found application in emergency management research to identify key actors, evaluate the strength and quality of inter-organisational relations, delineate their configurations and trends, and assess their effects (Hu et al., 2022). In tourism disaster management, the network approach has been employed to understand disaster impacts on destinations (Scott et al., 2008), study the 2011 Christchurch Earthquake response and recovery networks (Becken et al., 2014), analyse the structural changes in local tourism networks (Jeon

& Yang, 2021), investigate the role of social networks in fostering organisational resilience (Pham et al., 2021), and explore intergovernmental collaboration dynamics post-disaster (Wu et al., 2021).

While SNA has been applied in general disaster research, it has not been used to empirically map and analyse the collaborative networks at the tourism–emergency interface. Only two studies have specifically addressed inter-organisational collaboration, focusing on changes in tourism business networks (Becken et al., 2014) and intergovernmental collaboration (Wu et al., 2021) before and after disasters. Among these, only Wu et al. (2021) conducted a detailed structural analysis using various measurements including density, average distance, and structural holes. Becken et al. (2014), while offering insights into stakeholder network changes post-earthquake, lack specific network measures, and their low response rate raises concerns about the reliability of their network study. Furthermore, neither Wu et al. (2021) nor Becken et al. (2014) explicitly focus on collaboration between emergency management and tourism stakeholders, nor provide detailed network measures. Empirical research that thoroughly examines the actual network structure of tourism disaster management collaborative networks, and how they form and change from disaster preparedness to response is lacking.

Exploring the structure and dynamics of inter-organisational collaboration requires a focus on relationship patterns (Hu et al., 2022). In tourism disaster management collaboration, network theory can help understand stakeholder interconnections and their impact on preparedness, response, and recovery. Social Network Analysis can assist in identifying influential actors, highlighting opportunities to enhance disaster management (Becken et al., 2014). Analysing resource flows helps identify critical hubs and routes for optimising resource allocation (Wu et al., 2021). SNA also simplifies and visualizes complex relationships, fostering stakeholder collaboration and integration (Scott & Laws, 2005). Understanding stakeholders' network positions may encourage isolated actors to engage and central ones to lead (Hu et al., 2022). Ultimately, increased awareness of information exchange between tourism and emergency management entities can boost participation in disaster planning (Jiang & Ritchie, 2017). Thus, SNA offers a valuable framework for examining collaboration practices in tourism disaster management.

Multiplex relations should be studied together, as one type of relation can enable or support others (Hu et al., 2022). For instance, findings from a study exploring multiplexity in emergency management suggest that collaboration during disaster preparedness influences the formation of collaboration during disaster response (Kapucu & Hu, 2016). Research on tourism networks also highlights strong connections between different interactions or activities (Cehan et al., 2021; Czernek-Marszałek, 2018). Analysing relationships between network variables requires statistical or predictive methods (Varda, 2017), but few tourism studies have used approaches like correlations, regressions, or other nonparametric statistical tests (Buffa et al., 2019; Cehan et al., 2021; Ying et al., 2015). Past research has explored relations among TDM stakeholders, including sharing information, capabilities, expertise, and financial support (Blackman et al., 2011; Jiang & Ritchie, 2017). However, no TDM studies have analysed the interdependencies between these relations to understand what influences disaster networks in tourist destinations.

This research addresses these gaps by investigating how tourism disaster management networks form and change during disaster response, through the perspectives of representatives from both the tourism and emergency management sectors. Survey and interview data are used to address the following research questions: (i) What are the interdependencies between different types of collaborative relations and how do they influence disaster response collaboration? and (ii) How do structural characteristics and patterns of collaborative networks change from the preparedness to the response phase? Focusing on stakeholders' experiences of past disasters in New Zealand, this study adopts an interdisciplinary approach, integrating concepts and methods from tourism and emergency management studies to provide insights aimed at improving collaboration in tourism disaster management.

3. Materials and Methods

3.1. Research Design

Guided by the pragmatism paradigm, we adopted mixed-methods Social Network Analysis to examine inter-organisational collaborative networks (Morgan, 2014). Combining qualitative and quantitative methods allowed us to address subjective interpretations of collaboration alongside measurable network properties (Creswell & Plano-Clark, 2017). Initial interviews explored stakeholders' understanding of collaboration, identifying five collaborative relations (acquaintance, communication, resource sharing, business relations, formal agreements) and two disaster events (Fiordland floods and COVID-19 lockdown) as the research context. These findings informed the survey design. During results interpretation, qualitative data explained and contextualised quantitative results (Hollstein, 2014), as detailed in Figure 1. A sequential exploratory design was appropriate, as collaborative networks in tourism disaster management remain underexplored. Examining network formation and development together streamlined data collection, as stakeholders were interviewed once, covering both dimensions (see Appendix 1).

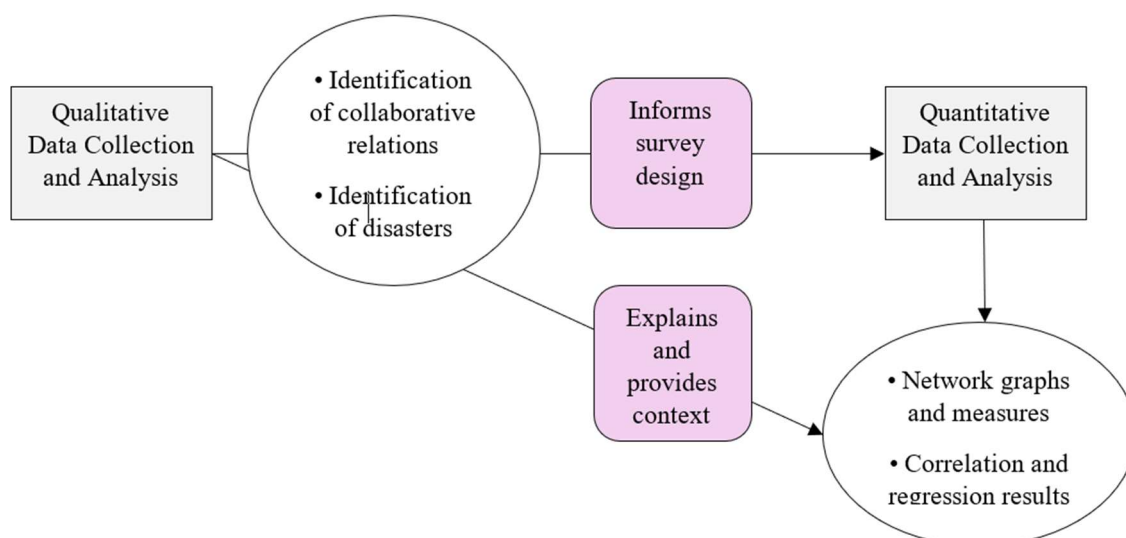
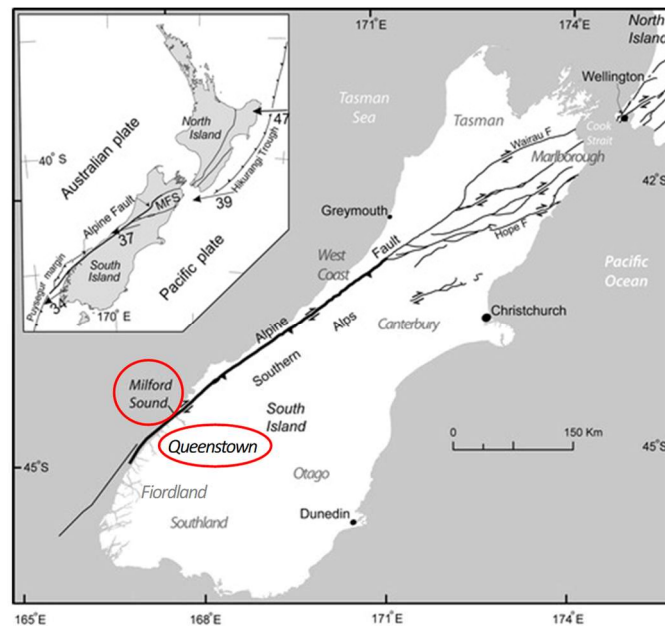


Figure 1. Integration of mixed methods

3.2. Research Setting

The research focused on two top tourist destinations in Aotearoa/New Zealand's (hereafter New Zealand) Te Waipounamu/South Island: Tāhuna / Queenstown (Queenstown hereafter) and Piopiotahi / Milford Sound (Milford Sound hereafter). In 2019, these destinations, home to approximately 29,000 permanent residents, welcomed 1,688,125 international tourists (Statistics New Zealand [Stats NZ], n.d.) drawn by their stunning natural landscapes and outdoor activities such as bungy jumping, boat cruises, scenic flights, skiing, kayaking, and hiking. Tourism in Queenstown is managed by Destination Queenstown, the Regional Tourism Organisation (RTO) responsible for marketing and destination management. Milford Sound tourism is promoted by two RTOs: Visit Southland, which markets the broader Southland region, and Visit Fiordland, focusing on Fiordland specifically. As Milford Sound lies within Fiordland National Park, it is managed by the Department of Conservation (DOC), which aims to balance tourism with environmental preservation. Milford Sound Tourism Limited operates key visitor services and infrastructure, including the harbour, terminal, parking, accommodations, and waste management.

Milford Sound and Queenstown are highly exposed to disaster risk due to their remote locations and proximity to the Alpine Fault, which marks the boundary between the Australian and Pacific tectonic plates (Figure 2). The Alpine Fault has a long history of generating major earthquakes (MW > 8) (Orchiston et al., 2018), including the 1717 event, which caused severe ground shaking and numerous landslides (De Pascale & Langridge, 2012). Based on its paleoseismic record, the Fault has a 75% probability of producing a large earthquake within the next 50 years (Howarth et al., 2021). Such an event would have nationwide effects, including significant casualties, severe infrastructure damage across the South Island, and widespread social and economic disruptions extending to Wellington and the lower North Island (Orchiston et al., 2018). Both Milford Sound and Queenstown face high exposure to damaging ground shaking and secondary hazards such as liquefaction, lake tsunamis, and landslides. These could severely damage infrastructure, disrupt transport networks, and hinder the movement of people, goods, and services (Orchiston et al., 2018; Emergency Management Southland [EMS], 2018). In such a scenario, both locations are likely to be isolated, with many tourists unaware of the local risks and emergency management arrangements (EMS, 2017). Local communities, including the tourism sector, would bear primary responsibility for the initial response, including ensuring the safety and welfare of tourists (EMS, 2017).



Source: Orchiston et al. (2018)

Figure 2. Major active faults of the South Island focusing on the Alpine Fault

Civil Defence Emergency Management (CDEM) Groups are regional bodies in New Zealand that coordinate disaster preparedness, response, and recovery. Comprising local authorities, emergency services, government agencies, and lifeline utilities, CDEM Groups develop emergency management plans, allocate resources, and provide public information to reduce the impact of emergencies on communities. To prepare for managing a major disaster response in Milford Sound and Queenstown, the Southland and Otago CDEM Groups have established the Fiordland Hazard Working Group (FHWG) and the Tourism Operator Responders of Queenstown (TORQUE) Group. These groups bring together emergency management agencies, lifeline utilities, local authorities, tourism businesses, and government departments to plan and prepare for disaster events. They include organisations ranging from small owner-operators to larger entities with fewer than 100 employees. Environment Southland, the regional council managing Southland's natural resources and environmental planning, oversees FHWG through Emergency Management Southland. Destination Queenstown manages TORQUE with support from Emergency Management Otago. Currently, FHWG has 22 affiliated organisations, and TORQUE has 19, with membership open to additional stakeholders. FHWG focuses on promoting awareness of Fiordland's risks and enhancing response capabilities (EMS, 2017), while TORQUE supports Emergency Management Otago and the Queenstown Lakes District Council in mitigating disaster impacts and fostering stakeholder collaboration (anonymous, personal communication, November 10, 2021). Both groups meet regularly for updates, training, joint exercises, and workshops to enhance disaster preparedness.

This study considered two recent disaster events and how the FHWG and TORQUE groups responded to them. The Fiordland floods and the Covid-19 lockdown in 2020 were selected as the research context because interviewees identified them as important events that involved most members of the respective networks. In February 2020, Milford Sound was hit by an

extreme weather event that caused extensive flooding and isolated the Milford township. Consequently, 380 individuals, including 195 tourists, were stranded for several days ((National Institute of Water and Atmospheric Research Ltd [NIWA], n.d.), while 100 hikers remained stuck in huts along popular walking tracks. In response, a regional State of Emergency was declared, prompting the largest aerial evacuation operation ever undertaken in New Zealand. One month later, New Zealand entered a level 4 lockdown to prevent the spread of the coronavirus Covid-19. Queenstown's heavy reliance on international visitors resulted in major social and economic impacts throughout the pandemic (Yeoman et al., 2022). During the pandemic, TORQUE's role shifted from supporting Emergency Management following a major disruption to serving as a platform for members to connect, share information, and access support. When the immediate emergency passed, the TORQUE group returned to its original purpose.

The widespread and prolonged disruptions to the Queenstown tourism sector caused by the pandemic are comparable in scale and impact to natural hazard events like flooding. COVID-19 tested the TORQUE group's capacity to adapt to crises, similarly to what would be required during a major event like the Alpine Fault earthquake. Including COVID-19 alongside the floods provides a broader understanding of how TDM collaborative networks function effectively under different types of emergencies, enhancing this study's contribution.

According to Veal's (2011) criteria of 'illustration, typicality, and pragmatism', Milford Sound and Queenstown constitute appropriate study sites for three key reasons. Firstly, they demonstrate the importance of establishing partnerships between the emergency management and tourism sectors to enhance disaster preparedness. Secondly, they serve as examples of nature-based tourist destinations that are highly exposed to disaster risks (Orchiston, 2012). Lastly, these two regions are closely interconnected, with Queenstown acting as the gateway to Milford Sound. Since collaboration between the two regions is essential in the event of a disaster, it is necessary to examine them together. Rather than aiming for comparison, this study examines two destinations to capture both consistent patterns and context-specific differences in TDM network formation and development, offering a more robust and nuanced understanding than a single case study could provide.

3.3.Data Collection

3.3.1. Interviews

An interview program was developed to examine how actors connect during disaster preparedness and response (Appendix 1), emphasizing their practices, interactions, and communication patterns within diverse contexts (Hollstein, 2014). The interviews aimed to identify collaborative relations in TDM, isolate two disaster events, and provide context for network graphs and statistical analyses. Participants were asked to define collaboration, identify types of collaboration in practice, and describe their collaborative partners (Scott, 2017). Subsequent questions explored how relationships formed, the contextual factors shaping them, and instances where the group benefited the community or destination (Becken et al., 2014; Tyler & Kapucu, 2021; Varda, 2017).

Between 6 October 2021 and 10 March 2022, semi-structured interviews were conducted face-to-face with FHWG and TORQUE members, including emergency management officers,

tourism managers, local government officials, and lifeline representatives. Participants were selected using positional and relational strategies (Knoke & Yang, 2020), and identified through meeting minutes, institutional agreements, and nominations based on connections. Of 45 representatives from 37 organisations (FHWG n=22; TORQUE n=15) invited, 31 agreed to participate. One interview was lost due to a corrupted audio recording, and another participant withdrew from the study after the interview, resulting in 29 interviews (FHWG n=16; TORQUE n=13) for analysis. Each interview lasted about an hour and was recorded via Zoom, phone, or digital recorder.

The pandemic's ongoing impact on the New Zealand tourism sector (Yeoman et al., 2022) caused some changes in group composition during the study. New organisations joined the groups, while others left after the interviews were conducted, resulting in different numbers of research participants across the two methods. To manage these changes effectively, continuous communication with the group leaders was maintained to update the list of members and ensure appropriate representatives were identified.

3.3.2. Surveys

From 30 May to 20 September 2022, data on network structures and collaborative relations were collected through an in-person survey. Respondents were drawn from updated member lists provided by the group leaders, with all 41 organisations affiliated with FHWG and TORQUE invited via email. Two reminders were sent, with an additional follow-up for organisations deemed crucial based on interview data. Two participants expressed their inability to participate due to work commitments. In total, 24 responses were collected (FHWG n=16; TORQUE n=8), equating to a total response rate of 58%. Surveys, a standard method for collecting network data in social research (Scott, 2017), were used here to examine smaller whole networks rather than generalising findings to a larger population. This approach aligns with other studies in emergency management and tourism (Granville et al., 2016; Nguyen et al., 2017; Pålsson et al., 2018), focusing on identifying patterns and lessons from case studies.

To collect social network data, we used roster lists, which are complete lists of the network actors (Scott, 2017). For each organisation on the list, respondents were asked to identify the members they collaborate with during the preparedness phase and select all the categories that best describe their relations with that organisation (Appendix 2). These included (1) acquaintance, (2) information provision, (3) information reception, (4) resource provision, (5) resource reception, (6) business relations, and (7) formal agreements. In addition, each respondent was asked to identify the organisations with whom they collaborated during the response to the Fiordland floods (for FHWG members) or Covid-19 (for TORQUE members). Collaboration was defined as:

'Working with' relationships i.e., any formal or informal social interactions aimed at managing issues related to tourism disaster management. This includes sharing information, exchanging resources, planning and preparing, and coordinating response, and it can be defined by a formal agreement or not.

Up to three important actors missing from the list could be added. To reduce the potential bias of uninformed responses, a separate 'Not applicable/don't know' choice was also available

(Granville et al., 2016). In addition to the network data, we also collected attribute data, which included information about the organisation's sector (public, private, other), its type (for-profit, not-for-profit, other), and its group identification (emergency management, tourism, other). A summary table of the survey questions and references is presented in Table 1.

Table 1. Summary of survey questions and informing literature

Topic	Question type	References
ABOUT YOUR ORGANISATION		
Q1 Name of the organisation	Open-ended	Raisi (2019)
Q2 Organisation sector (public/private/other)	Closed-ended	Raisi (2019)
Q3 Organisation type (for-profit/not-for-profit/other)	Closed-ended	Raisi (2019)
Q4 Organisation field (EM/tourism/other)	Closed-ended	
Q5 Organisation group (FHWG/TORQUE)	Closed-ended	
PREPAREDNESS NETWORK		
Q7 Presence/absence of ties	Roster list	Varda (2017)
Strength and stability of the relationship	3-point Likert scale	
Q8a Categories of relationship	Multiple choice	Hanneman & Riddle (2005)
Other type of relationship	Open-ended	
Q8b Length of the relationship	Closed (grouped)	Raisi (2019)
RESPONSE NETWORK		
Q9 Presence/absence of ties	Y/N/NA	Wyss et al. (2015)
Q9a (for FHWG) CIMS functions	Multiple choice	
Reason for interaction	Open-ended	
Q9b (for TORQUE) Reason for interaction	Open-ended	

3.4. Data Analysis

Three different methodological approaches were used to analyse the data, which are outlined in Figure 3.

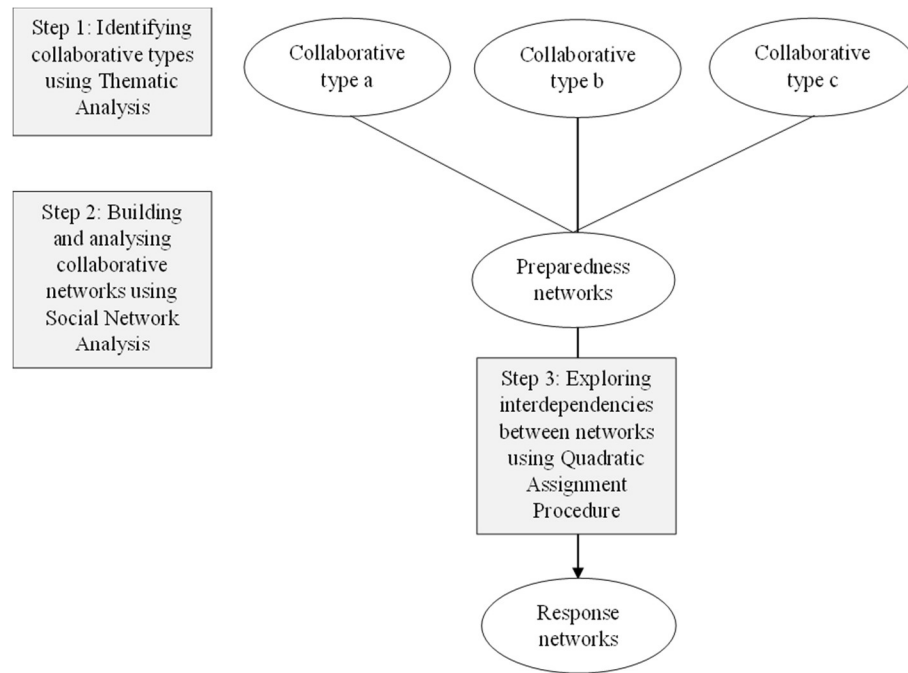


Figure 3. Steps of the data analysis process

3.4.1. Thematic Analysis

The interviews were fully transcribed using Otter AI, with transcripts checked for clarity before being uploaded to NVivo 12 Plus for analysis (QSR International, 2019). Following the six Reflexive Thematic Analysis phases (Braun & Clarke, 2006, 2021), we familiarised ourselves with the data, systematically coded text into descriptive categories, and collated codes into initial themes. Themes were refined, non-relevant ones were removed, and supporting quotes were selected. Finally, we discussed the themes and addressed research questions during the results-writing stage. The coding process led to the identification of five distinct types of collaboration, which were then utilised in the quantitative phase of the study. The thematic analysis is further described in Danzi et al. (2024).

Ethical approval for Category B research was obtained from the University of REDACTED Ethics Committee (Ethics approval number D21/246). Information sheets and consent forms outlined confidentiality measures, clarifying that while personal identification was possible, no personal information would be disclosed. Respondents could choose whether to disclose their organisation's name, with generic names used for those who declined. Unique identifiers were assigned to respondents, categorised as emergency management or tourism businesses, with numerical codes indicating interview sequence and group affiliation ('F' for FHWG, 'T' for TORQUE; Table 2), based on classifications from the Emergency Management Act 2002, the National CDEM Plan 2015, and Ministry of Business, Innovation and Employment [MBIE] (n.d.) (Table 3). Data confidentiality was maintained, with access restricted to researchers, and participants retained the right to withdraw until the analysis phase. Feedback was provided to participants per Knoke & Yang (2020), and interviewees reviewed their transcripts for corrections, which were incorporated before the analysis.

Table 2. Summary of interview participants and organisations from FHWG and TORQUE

Interview code	FHWG	Interview code	TORQUE
ACT1-F	Large Tourism Enterprise	ACT1-T	Indigenous Māori tourism operator
ACT2-F	Cruise Tour Operator		
ACT3-F	Southern Discoveries	ACT2-T	RealNZ
ACT4-F	Southern Lakes Helicopter	ACT3-T	RealNZ
ES1-F	Emergency Management Southland	ACT4-T	Skyline Queenstown
ES2-F		ES1-T	Emergency Management Otago
ES3-F	Emergency Management Southland		
	Fire and Emergency New Zealand Southland	ES2-T	Emergency Management Otago
ES4-F			Emergency Management Otago
GO1-F	Emergency Health Provider	ES3-T	Police Queenstown
GO2-F	Department of Conservation		
LA1-F	Department of Conservation	ES4-T	Queenstown Lakes District Council
LA2-F	Environment Southland	LA1-T	Queenstown Lakes District Council
LU1-F	Southland District Council		
	NZ Transport Agency Milford Road alliance	LA2-T	Destination Queenstown
LU2-F			Regional Tourism Organisation
RTO1-F	Agency for waterways safety	RTO1-T	
RTO2-F	Visit Southland	RTO2-T	Otago Local Advisory Committee
	Regional Tourism Organisation		
		WS1-T	

Table 3. Categories of emergency management and tourism organisations

Tourism organisations	Label
Accommodation	ACC
Activities/Attractions	ACT
Regional Tourism Organisation	RTO
Other tourism product and service	OTH
Emergency Management organisations	Label

Emergency service	ES
Government department or agency	GO
Lifeline utility	LU
Local authority	LA
Welfare service	WS

3.4.2. Descriptive Social Network Analysis

After collecting the social network data, we organised it into node lists and edge lists, which contain all the actors and their connections. In the edge list, each row represents a pair of nodes that share a tie (Borgatti et al., 2013). To facilitate the analysis, we merged links related to information provision and reception into a ‘communication’ edge list, while those related to resource provision and reception were combined into a ‘resource sharing’ edge list. We then constructed a preparedness collaboration network and a response collaboration network for each group, using the software packages Gephi (Bastian et al., 2009) and UCINET (Borgatti et al., 2002) to analyse and visualise the networks. In the absence of a well-established theory to study the dynamic nature of emergency management networks (Varda, 2017), we used summaries of traditional static network metrics, tracking changes over time from preparedness to response (Hu et al., 2021; Wu et al., 2021), and investigated the changing roles of key actors (Kapucu & Hu, 2016). The set of measures used to discuss the results is described in Table 4. The robustness of the core-periphery fit was tested by running the algorithm several times until agreement between the results was found (Borgatti & Everett, 1999). A total of 32 organisations from FHWG and 29 from TORQUE were included in the network study (Appendix 3).

Table 4. Descriptions of key metrics

Network metric	Description
Average degree	Average number of ties for each node (Borgatti et al., 2013).
Density	Expresses the “overall level of connectedness in a network” (Scott, 2017, p.81). It is calculated as the ratio of the number of existing ties compared with the maximum possible number of ties.
Core-periphery fit (categorical)	Indicates the correlation between the observed network against an idealised core–periphery network and simultaneously identifies which actors belong in the core and which belong in the periphery (Borgatti & Everett, 1999).
Centrality	Centrality measures identify the most important actors in the network (Scott, 2017). The four main centrality measures are: - Degree centrality: The number of edges directly connected to a node (Scott, 2017).

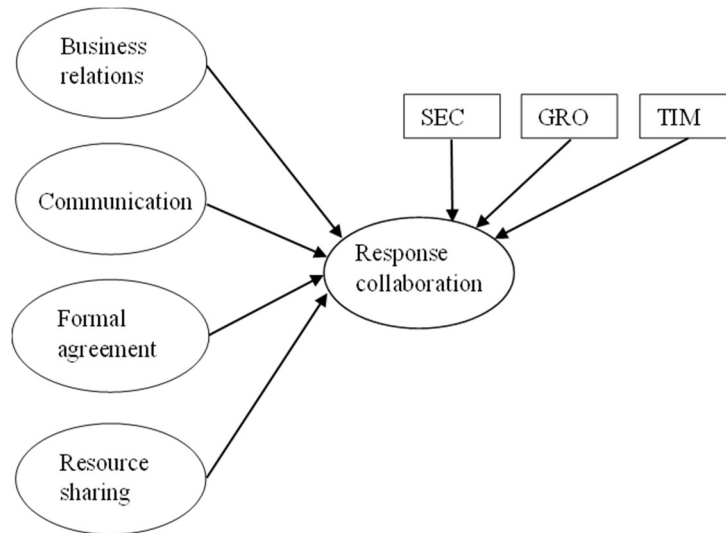
-
- Closeness centrality: The average distance of a given node to all other nodes in the network (Scott, 2017).
 - Betweenness centrality: Measures the extent to which a node connects pairs of other nodes (Scott, 2017).
 - Eigenvector centrality: “is proportional to the sum of centralities of the other actors to whom it is connected” (Knoke & Yang, 2020, p.64). A link to a well-connected node is more important than a link to a node with low centrality.
-

3.4.3. *Inferential Social Network Analysis*

To explore interdependencies between networks, we used the Quadratic Assignment Procedure (QAP). QAP is a nonparametric method commonly used by SNA researchers to study the relationship between network matrices (Buffa et al., 2019; Liu et al., 2017). The procedure works by randomly and repeatedly permuting matrices of the same set of actors and estimating their standard error to test for the significance of the association (Hanneman & Riddle, 2005). Unlike conventional statistical methods, QAP does not assume independence of observations, which makes it appropriate to analyse relational data (Hanneman & Riddle, 2005). Using UCINET 6.0 (Borgatti et al., 2002), we ran correlations and Multiple regression Quadratic Assignment Procedure (MR-QAP) via Double Dekker Semi-Partialling, which is robust to network autocorrelation, spuriousness, and skewness in the data (Dekker et al., 2007).

In our model (Figure 4), collaboration during disaster response is the dependent variable. Four types of inter-organisational collaborative relations identified from the interviews are the independent variables: (i) business relations, (ii) communication, (iii) formal agreements, and (iv) resource sharing (Table 5). The ‘acquaintance’ relation was excluded as it underpins all other relations (e.g., communication requires acquaintance). Control variables include ‘group type’ (emergency management, tourism, other) (GRO), ‘sector type’ (public, private, other) (SEC) and ‘years in business’ (1-15, 16-35, >36) (TIM). To prepare for MR-QAP analysis (Borgatti et al., 2013), all variables were converted into square $N \times N$ matrices, assigning ‘1’ for same-type dyads (e.g. public-public) and ‘0’ otherwise (e.g. public-private). After symmetrising matrices, we conducted pairwise correlations across eight networks per group and ran MR-QAP to examine the influence of different types of collaborative relations on response collaboration networks. The goal of this exploratory study was not to test hypotheses but rather to advance network analysis in TDM by investigating the mechanisms behind network formation.

Figure 4. Conceptual map for the QAP regression



Note: SEC = Sector type; GRO = Group type; TIM = Years in business

Table 5. Descriptions of independent variables

Variable	Description
Business relations	Professional contacts, including management, administrative or transactional work, funding, training, and health and safety.
Communication	Sharing of information regarding risks and hazards, planning and preparedness, organisations resources and limitations.
Formal agreements	Relations based on written documents including service agreements, management agreements, concessions, permits, and laws.
Resource sharing	Sharing of tangible and intangible resources such as helicopters, accommodation facilities, advanced first aid, and medical skills.

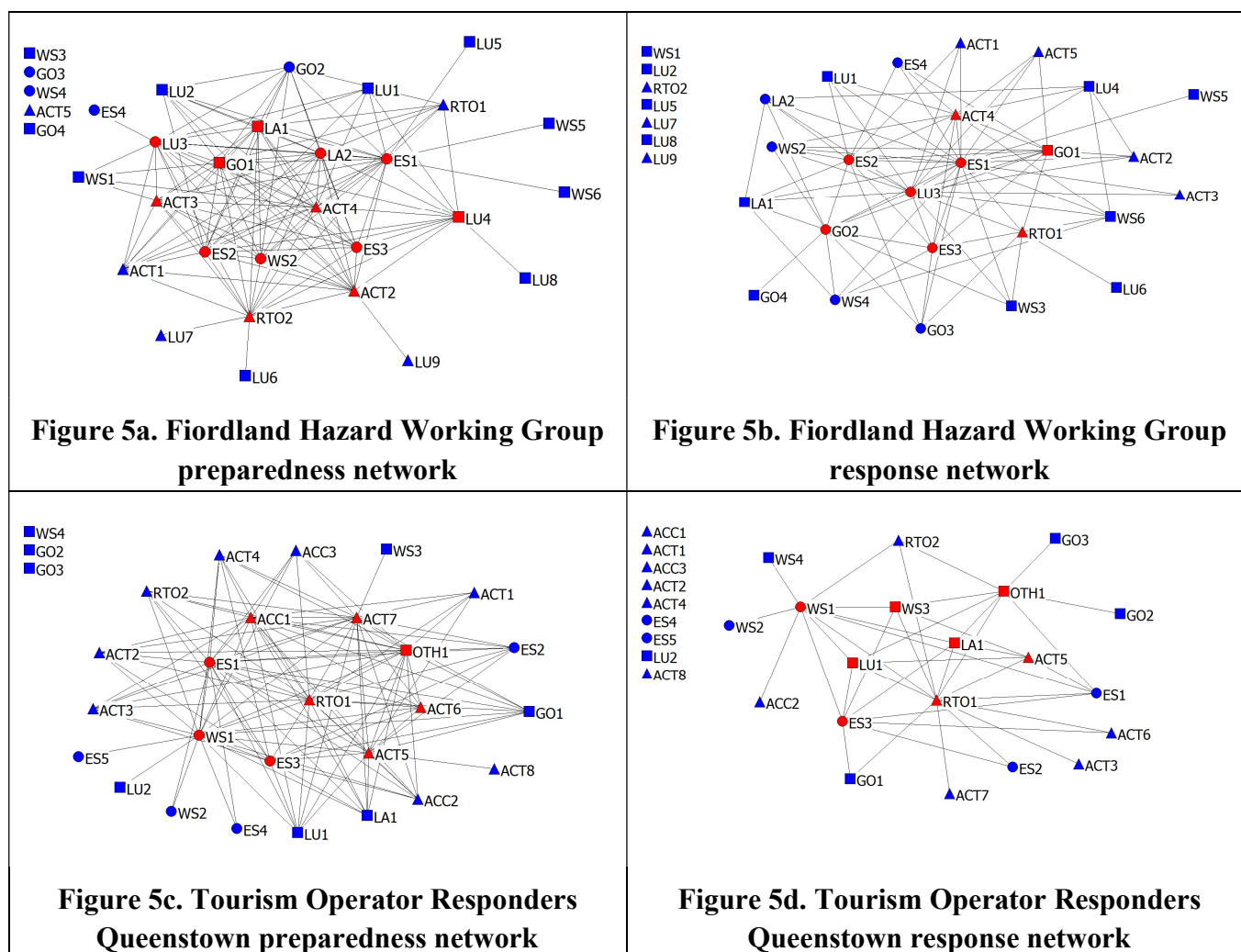
4. Results

This section begins with a discussion of the descriptive statistics and structural characteristics of disaster response networks, comparing them to their preparedness counterparts. We then explore the relationships between different collaborative networks and disaster response networks, using interview data to contextualise the quantitative findings. The unique characteristics of our study sites - peripheral location, small size, and distinct community practices - offer valuable insights into TDM collaboration. While acknowledging limitations in statistical generalisability, we believe the findings can inform nature-based destinations with similar features.

4.1. Changes in Network Characteristics and Patterns

The collaborative networks of FHWG and TORQUE can be visualised as undirected graphs. Figure 5 presents the network graphs for the FHWG preparedness network (Figure 5a), FHWG response network (Figure 5b), TORQUE preparedness network (Figure 5c), and TORQUE

response network (Figure 5d). Nodes represent individual organisations, coded by their emergency management or tourism business category (see Table 3). Links between the nodes represent collaborative relations. In the upper left side of the graphs are the isolated actors.



Note: Node colour represents core-peripherality: core members are red, peripheral members are blue. Node shape represents the organisations' group: circles are emergency management agencies, triangles are tourism organisations, squares are other types (To understand the colour descriptions in the caption of this figure, please consult the online version of this article).

Figure 5. Network graphs for FHWG and TORQUE preparedness and response networks

Table 6 presents a summary of the networks' properties. Both networks experienced a decrease in the number of nodes and edges from the preparedness to the response phase. This decline can be attributed to the involvement of fewer actors during the response, possibly due to their differing roles, the relevance of their skills/resources, or limited availability, as suggested by interview data. For example, one interviewee explained: *"in response, we're only really going to deal with the ones that are either affected by a disaster or emergency, or the solution to a disaster and emergency, because that's the most efficient way to work"* (ES2-F). Another one

said: “*At the moment, they’re just trying to survive themselves as a [tourism] business, let alone work on those peripheral matters, like emergency management*” (ES1-T).

Table 6. Networks Global Properties (isolates excluded)

Network	Nodes	Edges	Density	Avg. degree	Core-Periphery fit (correlation)
FHWG					
Preparedness network	27	169	0.48	12.52	0.89
Response network	25	108	0.36	8.64	0.81
TORQUE					
Preparedness network	26	132	0.41	10.15	0.95
Response network	20	43	0.23	4.3	0.81

Network density and average degree declined during the response phase, reflecting reduced stakeholder connectivity and willingness to collaborate. This trend was particularly pronounced in TORQUE, where some tourism businesses adopted a “*survival*” mode (RTO1-T), avoiding collaboration, while others had to “*either shut down or make staff redundant*” (LA1-T) due to Covid-19’s economic impact. However, some organisations intensified collaboration, notably Queenstown Lakes District Council, Emergency Management Otago and the Regional Tourism Organisations, which formed a “*Business Recovery Group to provide coordinated information and support to address the welfare emergency*” (ES1-T). TORQUE meetings increased from quarterly to weekly during the emergency’s acute phase: “*we would meet (...) up to weekly via Zoom, just to understand what was happening out there through each of our companies*” (RTO1-T).

Collaboration between tourism and emergency management organisations responding to the Covid-19 pandemic served two key purposes. First, it facilitated information sharing, as illustrated by: “*the TORQUE group itself - was utilised last year during Covid as a way to communicate and talk to all the operators, and share, I guess, information around both what was happening for the Covid response, but, most importantly, to offer support to one another; a forum through which people could talk about the challenges and the difficulties they were facing*” (LA1-T). Second, it addressed the welfare of foreign nationals working in tourism and hospitality, facilitated coordinating communications and organising repatriation flights. Tourism businesses acted as a “*conduit*” (RTO1-T), relaying Emergency Management Otago’s support information to migrant communities.

The high core-periphery fit values (all >0.80) indicate that the network structure follows a core-periphery model, with central, highly connected nodes forming the core and less connected, more isolated nodes in the periphery (Borgatti & Everett, 1999). This structure is more pronounced during preparedness than response, suggesting peripheral members become more active during the response, often linked to the core by brokers bridging otherwise disconnected members (Nowell et al., 2018). For instance, RTOs facilitate connections with tourism

businesses, even more so during disaster response: *“When we had the flood, we had to coordinate to get planes coming in and landing, and helicopters. Emergency Management coordinated it, but then we had to know arrival times and numbers because we were connecting with the accommodation”* (RTO1-F). Other tourism businesses also played critical roles, particularly in intelligence, logistics, and welfare. Visitor Information Centres and the Department of Conservation provided Emergency Management Southland with data on visitor numbers and locations, and conveyed information to tourists regarding road closures or power outages. Large tourism operators contributed by supplying helicopters for evacuations, buses for relocation, and accommodations for displaced individuals. One interviewee noted: *“the efficient coordination of that evacuation, using the helicopters and the communication systems that the tourism operators had in place, was really impressive”* (LA1-T).

Participants were found to collaborate to enhance the effectiveness of disaster response, in accordance with previous literature (Jiang & Ritchie, 2017; Nguyen et al., 2017). By working together and sharing resources, organisations can avoid duplication of effort and optimise the utilisation of resources (Kapucu & Garayev, 2012; Provan & Lemaire, 2012). This collaborative approach is particularly crucial in nature-based destinations such as Milford Sound and Queenstown, where access to emergency services and resources is limited. Here, *“the civil defence, the day-to-day civil defence framework, is far too small to deal with any emergency at scale: there’s not enough people. So, we have to leverage operators, suppliers, contractors, ...”* (WS1-T). Tourism organisations and businesses, in particular, can support emergency management agencies (Blackman et al., 2011; Cahyanto et al., 2020). This is because *“they’re in the business of moving people and the logistics, and feeding people, and housing people. They’ve got the skills, the resources, and the know-how”* (ES3-T).

During the floods, tourism operators were able to set aside competition and unite to ensure tourists’ safety. As one interviewee stated, *“When it came to the disaster, and when we were talking disaster around the table, they were all on the same page...Absolutely no commercial gain”* (ES2-F). Another participant remarked, *“Where competition just disappears, everybody comes together for the common cause”* (RTO2-F). Likewise, TORQUE members prioritised the well-being of the affected communities: *“We had to quickly work out what is the best way to manage our visitors and keep our people safe, and it developed over time”* (RTO2-T). However, the Covid-19 issues were less about saving people’s lives and securing property, but rather, *“ensuring their long-term wellness; their sense of comfort in being in a place where they’re going to be looked after”* (LA2-T).

The core-periphery structure highlights several central actors, with notable shifts between preparedness and response phases. In the FHWG network, Visit Southland (RTO1) and Emergency Management public service department (GO2) transition from the periphery (Figure 5a) to the core (Figure 5b). Visit Southland played a key role by providing visitor information to emergency services and arranging accommodation for stranded visitors and emergency personnel:

“The I-Site, we just made sure they were in direct contact with Emergency Management Southland, so they could pass on the right information; that was one thing. We would send out comms. So again, from emergency management or councils if there

was a road shut, or there were going to be power cuts, we would use our communication networks, social media, or whatever other digital to get that through to people” (RTO1-F).

Emergency Management public service department coordinated the response under its statutory role outlined in the CDEM Act 2002. Additionally, previously inactive actors - such as Iwi (Māori tribal group) (WS3), the New Zealand Defence Force (GO3), and a humanitarian organisation (WS4) - became involved, providing accommodation and welfare for stranded tourists.

Similarly, TORQUE’s core-periphery structure undergoes significant changes. Queenstown Lakes District Council (QLDC) (LA1), Southern District Health Board (SDHB) (WS3), and Queenstown Airport (LU1) emerged as core actors during the Covid-19 response. QLDC coordinated the response as the territorial authority, SDHB provided health-related support, and Queenstown Airport facilitated flight schedules to repatriate foreign tourism workers confined in Queenstown. Other changes include a tripling of isolated actors - primarily accommodation or attraction businesses - and the integration of new actors such as Immigration New Zealand (GO2), MBIE (GO3), and Queenstown and Wanaka Medical Centres (WS4) into the response network.

Individual centrality measures complement the understanding of actors’ roles and behaviours during disaster response. To identify the central actors, we calculated an importance index as the geometric mean of the normalised set of the most common centrality measures in SNA (Mariani & Baggio, 2020): degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality (see Table 4 for descriptions). The 10 most important organisations in the networks are displayed in Tables 7 and 8. The explanations of these rankings provided in the following paragraphs are drawn from interview data.

Table 7. Important organisations in the Fiordland Hazard Working Group response network

Rank	Organisation ID	Importance index	Classification	Sector
1	4	0.79	Emergency Management Southland	Public
2	11	0.44	NZ Transport Agency Milford Road Alliance	Public
3	10	0.38	Emergency Management public service department	Public
4	6	0.35	Southland Fire and Emergency New Zealand	Public
5	3	0.30	Department of Conservation	Public
6	7	0.28	Visit Southland	Private
7	15	0.26	Southern Lakes Helicopter	Public
8	12	0.15	Police	Public
9	22	0.12		

10	5	0.12	New Zealand Defence Force Environment Southland	Public
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Table 8. Important organisations in the Tourism Operator Responders Queenstown response network

Rank	Organisation ID	Importance index	Classification	Sector
1	3	0.77	Destination Queenstown	Public
2	12	0.56	Otago Local Advisory Committee	Public
3	6	0.46	Flying Squad Communications	Private
4	19	0.31	New Zealand Police Queenstown	Public
5	4	0.21	Emergency Management Otago	Public
6	13	0.21	Queenstown Airport	Public
7	14	0.21	Queenstown Lakes District Council	Public
8	22	0.21	Southern District Health Board	Public
9	17	0.17	Skyline Enterprises	Private
10	9	0.13	Lake Wanaka Tourism	Public

In the FHWG response network, Emergency Management Southland is the most important actor, leading and coordinating the response according to New Zealand's Coordinated Incident Management System (CIMS). This role is emphasized in interviews: *"Everything went through Emergency Management Southland. So, the chain of command was really clear"* (RTO1-F). Next, the New Zealand Transport Agency Milford Road Alliance, which managed access to Milford Sound and provided updates on road conditions: *"you know, the initial event we had to (...) securing the road, making sure that it's closed and we aren't sending more people in. After that (...) liaising directly with the tourism operators with schedules"* (LU1-F). Other important actors include the Department of Conservation, which oversaw operations in Fiordland National Park, and Southern Lakes Helicopter, which planned and executed the evacuation of tourists: *"people were being pulled off and dragged off the track; helicoptered out of the Great Walks"* (GO1-F).

In the TORQUE response network, Destination Queenstown is the most important actor, chairing the group, organising meetings, and serving as a vital link between emergency management and tourism organisations: *"Destination Queenstown chairs that [TORQUE]. So they have the reach into other [tourism] organisations (...) And they're a great assistance in terms of getting our message out to everyone that we need to"* (ES3-T). A welfare service and a communication company rank as the second and third most significant organisations, actively collaborating with both tourism and emergency management sectors. The Police also played a

critical role by providing key information to enhance law and order understanding and patrolling communities to enforce isolation rules. Other important actors include Emergency Management Otago and Queenstown Lakes District Council, both instrumental in coordinating the response and disseminating information on wellbeing, forecasting, and support services.

4.2. Interdependencies between Collaboration Networks

Pearson's correlation results (Table 9 and Table 10) indicate positive and significant relationships between Acquaintance, Business, Communication, Formal agreements, and Resource sharing with Response collaboration. In contrast, correlations between node attributes and Response Collaboration are weaker and not significant ($p > .05$). However, control variables show some correlation among themselves and with certain independent variables. For instance, Group similarity and Sector similarity are correlated, as emergency management agencies are typically public entities, whereas tourism organisations are predominantly private. A similar distinction is that emergency management collaboration relies on institutional connections and legal mandates, whereas tourism collaboration is driven by relationships and communication (Beritelli, 2011), which explains the correlation between Group similarity and Formal agreements (Table 10). This is evidenced by this quote:

“There are groups where there's definitely a formal collaboration, where we actually meet formally and they're actually mandated to work with or collaborate with emergency management. (...) the lifelines; utilities, so roading, electricity, telecommunication, rail. And then there's the tourism sector who aren't statutorily obligated to work with us” (ES1-T).

Moreover, in TORQUE, business relations and resource sharing are more common within the same group and sector, respectively. Additionally, a correlation exists between Years in business and belonging to the same group and sector, likely due to the stability of public organisations (mainly Emergency Management) compared to the volatility of private businesses (mainly tourism). As one interviewee explained: *“for the major operations, police, FENZ, civil defence: those are fairly well established, and people in roles. The tourism ones are less so, because they come and go” (LU1-F).*

Table 9. Results of QAP correlations between pairs of social networks in FHWG

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Response (1)							
Business (2)	0.399**						
Communication (3)	0.442**	0.718**					
Formal agreements (4)	0.394**	0.689**	0.604**				
Resource sharing (5)	0.291**	0.517**	0.579**	0.593**			
Group similarity (6)	0.020	0.070	0.024	0.082	0.029		
Sector similarity (7)	0.116	0.070	0.078	0.104	0.029	0.140*	
Same years in business (8)	-0.041	0.014	-0.021	-0.059	-0.010	-0.025	-0.015

Note: Calculations obtained with UCINET based on 50,000 permutations.

*p < .05. **p < .001

Table 10. Results of QAP correlations between pairs of social networks in TORQUE

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Response (1)							
Business (2)	0.468**						
Communication (3)	0.402**	0.660**					
Formal agreements (4)	0.285**	0.623**	0.699**				
Resource sharing (5)	0.325**	0.669**	0.519**	0.398**			
Group similarity (6)	0.030	0.179**	0.040	0.142*	0.048		
Sector similarity (7)	-0.072	0.031	0.006	0.006	0.110*	0.442**	
Same years in business (8)	-0.014	-0.039	0.014	-0.082	-0.006	-0.025*	0.005*

Note: Calculations obtained with UCINET based on 50,000 permutations.

*p < .05. **p < .001

To examine the influence of various relationship types in response networks, we conducted regression analyses (Tables 11 and 12). The results revealed that Communication is a key determinant for Response collaboration in both FHWG ($\beta = 0.285$; $p < .001$) and TORQUE ($\beta = 0.227$; $p < .05$). Furthermore, Formal agreements positively influence Response collaboration in FHWG ($\beta = 0.165$; $p < .05$), while Business relations emerge as the strongest predictor for TORQUE ($\beta = 0.393$; $p < .001$). These differences can be attributed to variations in group composition, disaster type, and response strategies. FHWG, composed primarily of emergency management agencies, relied on CIMS functions and formal agreements during the flood response: *“The functions that everybody learned about in the CIMS type courses, the functions of sharing information during the hazard group meetings, all of those small initiatives contributed to a greater good”* (ACT1-F). Conversely, TORQUE, comprising mostly tourism organisations, collaborated informally within the sector during the Covid-19 response.

Table 12. Results of MR-QAP for FHWG

	Standardised coefficient	Std. error
Business relations	0.088	0.075
Communication	0.285**	0.072
Formal agreements	0.165*	0.087
Resource sharing	-0.018	0.077

Group similarity	-0.017	0.031
Sector similarity	0.073	0.052
Same years in business	-0.260	0.029
R-Square (model fit)	0.230	
R-Square (adjusted)	0.219	
N of Obs	496	

Note: Calculations obtained with UCINET based on 50,000 permutations. Dependent variable: disaster response network.

*p < .05. **p < .001

Table 13. Results of MR-QAP for TORQUE

	Standardised coefficient	Std. error
Business relations	0.393**	0.074
Communication	0.227*	0.060
Formal agreements	-0.121	0.062
Resource sharing	0.003	0.080
Group similarity	0.006	0.035
Sector similarity	-0.088	0.032
Same years in business	-0.012	0.028
R-Square (model fit)	0.248	
R-Square (adjusted)	0.235	
N of Obs	406	

Note: Calculations obtained with UCINET based on 50,000 permutations. Dependent variable: disaster response network.

*p < .05. **p < .001

The models account for 23% and 25% variance in the disaster response collaboration networks of FHWG and TORQUE respectively. Lower R-squared values are common in tourism social network studies where relationships between variables are influenced by numerous factors (Buffa et al., 2019; Liu et al., 2017). In this case, the absence of trust measurement - a key factor in disaster response - partly explains the relatively low R-squared values. For instance, the Incident Controller overseeing the flood response relied on a major tourism operator in Milford

due to established trust: *“because we had a relationship with the controller, and he knew and trusted us and we had good systems in place, he basically green-lighted the entire evacuation using Real Journeys as the conduit for that entire evacuation”* (WS1-T). Additionally, organisational changes between the preparedness and response phases may have contributed to some missing data. Despite these limitations, the findings provide valuable evidence that communication, formal agreements, and business relations are critical for inter-organisational collaboration during disaster response. This supports the assumption that disaster response networks are shaped by multiplexity (Hu et al., 2022) and aligns with prior research showing that organisations in TDM tend to collaborate with those they have previously interacted with and trust (Jiang & Ritchie, 2017).

5. Discussion and Conclusion

5.1.Theoretical Implications

This study addresses the research gap in understanding the formation and evolution of TDM collaborative networks by integrating emergency management perspectives, examining stakeholders’ real-world experiences during past disasters, and using SNA techniques to analyse network structural changes and the role of multiple ties in disaster response collaboration. Theoretically, it enhances understanding of how tourism and disaster management networks develop and adapt throughout the disaster management cycle. By employing qualitative and quantitative methods, this research explores stakeholders’ motivations for collaboration and analyses interdependencies between collaboration types. Unlike previous studies, it expands the range of participants by fully incorporating emergency management perspectives, offering practical insights from real cases of TDM collaboration.

Our analysis reveals that from preparedness to response, networks contract in size but develop a more engaged periphery, with roles and relationships shifting to meet the demands of the emergency. Furthermore, we found that interdependencies between collaborative relations significantly influence response collaboration; specifically, pre-existing communication, formal agreements, and business relations are strong predictors of an effective collaborative response network. This highlights the importance of viewing collaboration as a multi-layered, interdependent process rather than a uniform or linear one.

This study makes two important contributions to theory. First, it contributes to network theory by providing empirical evidence on the role of multiplex ties in shaping disaster response collaboration. Second, the study advances the application of complexity science in tourism disaster management by demonstrating features of self-organisation and emergent core–periphery shifts in network structure. These contributions offer empirical support for a complexity-informed understanding of TDM networks, which recognises disaster management as a dynamic and relational process rather than a fixed sequence of stages. This responds to recent calls for moving beyond purely conceptual applications of network and complexity theories in tourism (Reddy et al., 2020; Ritchie & Jiang, 2021), and provides an alternative analytical lens grounded in empirical evidence.

5.1.1. Drivers of Collaboration and the Role of Collaborative Networks

Firstly, findings underscore the necessity of collective efforts and interagency collaboration in addressing complex challenges posed by disasters, as demonstrated during the Fiordland Floods and Covid-19 response. Disasters are inherently complex and cannot be managed by a single agency or individual (Kapucu & Demiroz, 2017). This is particularly valid for nature-based destinations with limited access to resources and emergency services. The remoteness of these communities often requires them to independently address immediate disasters, with tourism organisations and businesses stepping in as first responders. This research highlights their critical role in providing accommodation, welfare support, logistics management, and intelligence during emergencies.

Previous research emphasised the gap between tourism and emergency management stakeholders' expectations, objectives, and priorities (Hystad & Keller, 2008; Morakabati et al., 2017). While recognising these disparities, our study has found that collaboration during the Fiordland floods and Covid-19 response was driven by shared interests and goals. During the disasters, tourism stakeholders set aside competition, united for a common cause, and adapted their strategies accordingly. Furthermore, prior relationships and trust played a crucial role in shaping collaboration dynamics and role allocation, underscoring the importance of fostering strong inter-organisational connections to enhance coordination and decision-making.

In this context, local preparedness groups are instrumental in establishing and sustaining collaborative networks in TDM, as demonstrated in this study. During the Fiordland Floods and the COVID-19 pandemic, emergency services led the response, but the tourism sector played a pivotal role by providing immediate resources, welfare support, evacuation logistics, up-to-date information, and media facilitation. This strong collaboration was facilitated by pre-existing networks and preparedness efforts led by FHWG and TORQUE. By fostering trust, promoting strategic planning, and facilitating communication and leadership, these groups provided a consistent platform for stakeholder engagement, ensuring effective disaster responses. These findings contrast with other international studies that report unsuccessful collaboration in TDM (Chan et al., 2021; Filimonau & de Coteau, 2020; Rahmafritia et al., 2021). For instance, Chan et al. (2021) identified poor information sharing and cross-sector communication in Hokkaido, Japan, which hindered stakeholder coordination during the 2018 Hokkaido Eastern Iburi earthquake. Similarly, Rahmafritia et al. (2021) found that fragmented institutional systems, misalignment between local and national agencies, and insufficient continuity in disaster management programs impeded coordination in Indonesia.

Differences in disaster collaboration outcomes between Japan, Indonesia, and New Zealand can be attributed to New Zealand's distinctive emergency management framework and the characteristics of its small, closely connected communities. The CDEM Act 2002 and the National Disaster Resilience Strategy 2019 promote a whole-of-society approach, encouraging collaboration among government, civil society, and the private sector. This framework fosters a culture of inclusivity and preparedness, promoting regular stakeholder engagement through coordinated planning and training. Recent disaster events involving tourists, such as the 2019 Whakaari / White Island volcano eruption, have further heightened awareness of tourist safety and the need for comprehensive risk assessments, emergency plans, and cross-sector collaboration. Additionally, the geographic isolation and small size of communities like Milford Sound and Queenstown enhance their ability to collaborate effectively. In these rural regions,

where populations are tightly knit and social relations are strong, TDM stakeholders often know each other personally, facilitating trust and communication. This contrasts with the larger, more populous regions examined by Chan et al. (2021) and Rahmafitria et al. (2021), where institutional silos and limited stakeholder alignment present significant challenges. While New Zealand's context is unique, our research provides valuable insights for other nature-based destinations with similar characteristics that require robust disaster preparedness. Overall, this study highlights how collaborative networks in TDM, fostered through formalised local disaster preparedness groups, contribute to successful disaster responses by fostering trust and enabling information and resource sharing.

5.1.2. Structural Changes of Collaborative Networks in Tourism Disaster Management

Secondly, our research provides insights into the structural changes of collaborative networks from preparedness to response, thus contributing new knowledge to the field of tourism disaster management networks. We built a collaboration network for each group and analysed network density, average degree, core-periphery and actors' centrality. Our findings revealed a decrease in the number of connections and actors from preparedness to response. This aligns with prior studies comparing post-disaster and 'normal' networks and is unsurprising, as systems are often less efficient, and organisational circumstances vary widely after a disaster (Becken et al., 2014). Further, the level of distribution in a core-periphery structure is more pronounced during preparedness, with peripheral actors becoming more active during response. Changes in core and periphery roles and the emergence of new actors underscore the influence of disaster type and magnitude on network structures: organisations collaborate with different organisations for different reasons compared to the preparedness phase. This aligns with the established concept in emergency management social network studies, which acknowledges that the nature of the disaster determines the specific actors involved in disaster management (Hu et al., 2022). Finally, centrality analysis highlights the critical role of DMOs as intermediaries in TDM networks, particularly during disaster response. This reinforces earlier research advocating a shift in DMOs' focus from destination marketing to strategic leadership, with a focus on facilitating connections and promoting disaster preparedness in tourism (Blackman et al., 2011; Hystad & Keller, 2008). While emergency management agencies hold primary responsibility for disaster management, this research provides clear evidence that tourism stakeholders have a crucial role, particularly in functions such as intelligence, welfare, and logistics.

5.2. Methodological and Practical Implications

Methodologically, this study has integrated concepts and methodologies from social network studies in emergency management with tourism insights, bridging the gap between these fields. By challenging the traditional focus on tourism alone, it offers a more holistic view of tourism disaster management collaboration. The analysis of how TDM networks form and change during emergencies underscores the value of Social Network Analysis and mixed methods in understanding complex systems like tourism (Mariani & Baggio, 2020). Visualisations, quantitative measures, and the regression model helped understand network changes and collaboration drivers, while qualitative data provided context and explanation. This approach moves beyond descriptive analysis, employing QAP correlations and regression to examine

relational linkages, distinguishing this work from earlier studies focused on pre- and post-disaster structural changes (Becken et al., 2014; Jeon & Yang, 2021; Wu et al., 2021).

Using inferential network analysis techniques, we explored mechanisms underlying disaster response network formation by establishing causal links between different types of relations. Business relations, communication, formal agreements, and resource sharing all correlated with collaboration during disaster response. These findings build on prior research on factors driving collaboration (Jiang & Ritchie, 2017; Nguyen et al., 2017) and emphasize the value of multiple ties in fostering collaboration in emergency management (Kapucu & Hu, 2016). Given the benefits of multiplexity for collaboration, managers should foster a culture that promotes the establishment of diverse relations with partners. Communication, formal agreements, and business relations were particularly influential in driving disaster response collaboration, underscoring the need to involve tourism stakeholders in disaster planning (Becken & Hughey, 2013; Jiang & Ritchie, 2017) and develop effective communication practices.

Policymakers should consider allocating additional funding to empower emergency management groups, enabling them to dedicate time and resources to building connections with sector groups, including tourism. This may involve developing policies and frameworks that promote collaboration between emergency management and the tourism sector, ensuring active participation of tourism businesses in disaster management. Enforcement strategies, such as mandating emergency management training for tourism organisations, could be considered (Cahyanto et al., 2020). Mechanisms to fund local initiatives such as hazard groups and resilience hubs could be established to support long-term community preparedness. Tourism stakeholders are encouraged to learn emergency responders' systems and language through training in CIMS or equivalent systems elsewhere. Investments in robust communication channels and information-sharing systems could further mitigate inter-agency communication challenges and enhance emergency network performance.

Additionally, given the importance of pre-existing relationships and trust in network formation and development, practitioners should focus on building and maintaining strong connections across organisations. This can be achieved through means like sharing information, conducting joint training sessions, or formalising commitments with Memoranda of Understandings (MOUs). Furthermore, practitioners should consider variables such as disaster type, community size, and geographic isolation when forming and developing networks. Understanding these elements allows for tailoring collaboration strategies and initiatives to specific contexts, enhancing success rates.

5.3.Limitations and Future Research Agenda

While this study has made significant theoretical, methodological and empirical contributions, it is essential to acknowledge its limitations, which highlight areas for future research. Our population size only supported an indicative statistical analysis of interdependencies, so expanding to larger populations and multiple destinations could improve generalisability. Additionally, this study focused on changes in TDM collaborative networks from preparedness to response, leaving room for studies including the recovery phase. Given the importance of collaborative networks for effective disaster response, further research is needed on the factors influencing network performance and strategies to sustain connections. Despite these

limitations and unique case-specific contexts, our research offers valuable insights for nature-based destinations that share similar features and need to be adequately prepared if or when the need for disaster response arises.

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Appendix 1. Interview protocol

Background questions

Q1. Can you tell me about your role in the organisation? How long have you been working there?

Exploration of networks

FHWG *Q2a.* When there is a hazardous event, how important is it for you to think/prioritise tourists and their safety? And if this is a priority, how do you go about it/who do you work with on tourism management issues?

TORQUE *Q2b.* Why should we be concerned about hazards? How important is emergency management for Queenstown Lakes District? And if this is a priority, how do you go about it/who do you work with on emergency management issues?

➔ *Network boundary specification*

Q3. What does collaboration look like in tourism disaster management?

Q4. What do you think collaboration involves? / Which types of collaboration can you identify in practice?

Q5. How much collaboration is happening before an event, and how much happens during the response? How does it change?

➔ *Network content specification*

Network practices and effects

Q6. Please describe how your collaborative relations have emerged. What are the contexts and goals of the relations?

Q7. Can you please further describe your collaborations? Which organisations are of particular importance and why?

➔ To understand individual perceptions, subjective meaning, and frameworks of relevance. How and why contextual factors influence the networks.

Q8. Can you give me an example of when the group has been of value to the community/destination?

Q9. How important is the objective of _____ (name of the group) to your own organisation? How much time do you dedicate to it in your day-to-day business schedule?

Q10. How are connections maintained in the absence of disasters (*network sustainability*)? What happens when someone important leaves the network?

Q11. Whom would you like to interact with, but haven't been able to reach? Why would you like to connect with them? (*desired network*) Are there opportunities to bring in new members to the group? If so, how do you go about it? What about the healthcare sector? Any other?

After the interview

Great, this was the last question. Have you got any additional comments to make? Or anything else you'd like to say? Thank you very much for your time.

Appendix 2. Survey structure

SECTION 1: About your organisation

What's the name of your organisation?

Is your organisation...(select what applies)

- ☐ Public
- ☐ Private
- ☐ Other

Is your organisation...(select what applies)

- ☐ For-profit
- ☐ Not-for-profit
- ☐ Other

Please indicate the group with which you identify as an organisation.

**Note that for the terms marked in blue, additional context has been provided to further explain their meaning. These explanations can be obtained by hovering your cursor over the text.*

- ☐ Emergency Management
- ☐ Tourism
- ☐ Other

Please specify the network your organisation belongs to. Select the one your representation as a member best applies.

- ☐ Fiordland Hazard Working Group
- ☐ Tourism Operator Responders Queenstown (TORQUE)

SECTION 2: Network sustainability

Please indicate your level of agreement with the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Our organisation maintains relationships with other organisations with a role in disaster preparedness and response	☐	☐	☐	☐	☐
In the absence of disasters, our organisation sustains relationships with other organisations	☐	☐	☐	☐	☐
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
In the absence of disasters, our organisation is involved in collaborative practices with organisations we collaborate with during disaster response	☐	☐	☐	☐	☐
Critical relationships among organisations involved in Tourism Emergency Management should be formalized (through policies, plans, or MOUs) so that they are sustainable over time	☐	☐	☐	☐	☐

SECTION 3: Preparedness network

Considering the Tourism Emergency Management space, how strong and stable is the relationship between your organisation and each of the organisations on the list?

Please select "No relationship / Not applicable / Don't know" when appropriate.

Please also add any organisation that is not on the list.

**Note that for the terms marked in blue, additional context has been provided to further explain their meaning. These explanations can be obtained by hovering your cursor over the text.*

	Strong			Stable				
	Weak	Somewhat strong	Strong	Unstable	Somewhat stable	Stable	No relationship	Not applicable / Don't know
Organisations names	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐
Other 1 (please specify)	☐	☐	☐	☐	☐	☐	☐	☐
Other 2 (please specify)	☐	☐	☐	☐	☐	☐	☐	☐
Other 3 (please specify)	☐	☐	☐	☐	☐	☐	☐	☐

Please indicate what categories best describe your organisation's relationship with each organisation (select all that apply) and how long your organisation has been working with them.

	Type of the relationship									Length of the relationship			
	We know each other	We provide information to this organisation	We receive information from this organisation	We provide resources (financial, technological...) to this organisation	We receive resources (financial, technological...) from this organisation	We have a day-to-day business relationship	There is a formal agreement (legislation or MOU)	Other type of relationship (please specify)		Less than one year	1-5 years	6-10 years	More than 11 years
Organ. names	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	
Conservation	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	
Other 1	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	
Other 2	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	
Other 3	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	☐	

SECTION 4: Response network

(Continuation of the survey for FHWG members)

All the organizations on the attached list were identified as actors involved in the response phase for the **Fiordland February 2020 floods**. Please indicate which organisations you worked with during the response, and what was the reason for the interaction.

Feel free to add any relevant organisations that have not been listed.

**Note that for the terms marked in blue, additional context has been provided to further explain their meaning. These explanations can be obtained by hovering your cursor over the text.*

	Worked with			CIMS function (if known)										Reason for interaction
	Yes	No	Not applicable	Control	Safety	Intelligence	Planning	Operations	Logistics	Public Information Management	Welfare	Recovery		
Organisations names	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Other 1 (please specify)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Other 2 (please specify)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Other 3 (please specify)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

(Continuation of the survey for TORQUE members)

Please indicate which organisations you worked with **during the level 4 lockdown** that New Zealand entered **from 25 March 2020 to 27 April 2020** to prevent the spread of the **COVID-19 virus**. Please indicate also the reason for the interaction.

Feel free to add any relevant organisations that have not been listed.

	Worked with			Reason for interaction
	Yes	No	Not applicable	
Organisations names	☐	☐	☐	
	☐	☐	☐	
	☐	☐	☐	
Other 1 (please specify)	☐	☐	☐	
Other 2 (please specify)	☐	☐	☐	
Other 3 (please specify)	☐	☐	☐	

SECTION 5: Confidence level

Overall, how confident are you that the system you are operating in is working well?

- ☐ Not at all confident
 - ☐ Slightly confident
 - ☐ Moderately confident
 - ☐ Very confident
 - ☐ Extremely confident
-

Please use the text box provided below if you would like to leave any further comments.

Thank you very much for your time spent completing this survey!

Are you interested in receiving a copy of the results?

- ☐ Yes
- ☐ No

Appendix 3. List of organisations included in the network study

Table 1. Fiordland Working Hazard Group (FHWG)

Id	Label	Full name	Sector	Type	Group
1	LU1	Airways Corporation	PUB	FP	OTH
2	WS1	Findex	PRI	FP	OTH
3	GO1	Department of Conservation	PUB	NFP	OTH
4	ES1	Emergency Management Southland	PUB	NFP	EM
5	LA1	Environment Southland	PUB	FP	OTH
6	ES2	Southland Fire and Emergency New Zealand	PUB	NFP	EM
7	RTO1	Visit Southland	PUB	NFP	TOU
8	LU2	Meridian Energy	OTH	OTH	OTH
9	ACT1	Large Tourism Enterprise	OTH	OTH	TOU
10	GO2	Emergency Management public service department	PUB	NFP	EM
11	LU3	NZ Transport Agency Milford Road Alliance	PUB	NFP	EM
12	ES3	Police	PUB	NFP	EM
13	ACT2	RealNZ	PRI	FP	TOU
14	ACT3	Southern Discoveries	PRI	FP	TOU
15	ACT4	Southern Lakes Helicopter	PRI	FP	TOU
16	LA2	Southland District Council	PUB	OTH	EM
17	WS2	Emergency Health Provider	PUB	NFP	EM
18	LU4	Te Anau - Manapouri Airport	PUB	OTH	OTH
19	RTO2	Regional Tourism Organisation	PUB	NFP	TOU
20	WS3	Iwi	OTH	OTH	OTH
21	ES4	LandSAR Te Anau	PUB	NFP	EM
22	GO3	New Zealand Defence Force	PUB	NFP	EM
23	WS4	Humanitarian organisation	PUB	NFP	EM
24	ACT5	Ultimate Hikes	PRI	FP	TOU
25	WS5	Southern District Health Board	PUB	NFP	OTH
26	WS6	Te Anau Community Board	OTH	OTH	OTH

27	LU5	Agency for waterways safety	PUB	NFP	OTH
28	LU6	Invercargill Airport	PUB	OTH	OTH
29	LU7	Milford Sound Airport	PUB	OTH	TOU
30	GO4	Ministry for Primary Industries	PUB	NFP	OTH
31	LU8	Civil aviation authority	PUB	NFP	OTH
32	LU9	Te Anau Helicopter	PRI	FP	TOU

Table 2. Tourism Operator Responders of Queenstown (TORQUE)

Id	Label	Full name	Sector	Type	Group
1	ACC1	BYATA/Adventure Hostels	PRI	FP	TOU
2	GO1	Department of Conservation	PUB	NFP	OTH
3	RTO1	Destination Queenstown	OTH	NFP	TOU
4	ES1	Emergency Management Otago	PUB	NFP	EM
5	ES2	Fire and Emergency New Zealand	PUB	NFP	EM
6	OTH1	Flying Squad Communications	PRI	FP	OTH
7	ACC2	Hotel sector TIA/Copthorne	PRI	FP	TOU
8	ACT1	IFLY Indoor Skydiving Queenstown	PRI	FP	TOU
9	RTO2	Regional Tourism Organisation	PUB	NFP	TOU
10	ACC3	MANZ/Highview Apartments	PRI	FP	TOU
11	ACT2	Indigenous Māori tourism operator	PRI	FP	TOU
12	WS1	Otago Local Advisory Committee	PUB	NFP	EM
13	LU1	Queenstown Airport	PUB	NFP	OTH
14	LA1	Queenstown Lakes District Council	PUB	NFP	OTH
15	ACT3	RealNZ	PRI	FP	TOU
16	ACT4	Southern Discoveries	PRI	FP	TOU
17	ACT5	Skyline Enterprises	PRI	FP	TOU
18	ACT6	Trojan Holdings Limited	PRI	FP	TOU
19	ES3	New Zealand Police Queenstown	PUB	NFP	EM
20	ES4	Search and Rescue Queenstown	PUB	NFP	EM
21	WS2	Emergency Health Provider	PUB	NFP	EM
22	WS3	Southland District Health Board	PUB	NFP	OTH

23	WS4	Queenstown and Wanaka Medical Centre	PUB	NFP	OTH
24	ES5	Coast Guard Queenstown	PUB	NFP	EM
25	LU2	Queenstown Airport Corporation	PUB	NFP	OTH
26	ACT7	AJ Hackett Bungy NZ	PRI	FP	TOU
27	ACT8	G Force paragliding	PRI	FP	TOU
28	GO2	Immigration New Zealand	PUB	NFP	OTH
29	GO3	Ministry of Business, Innovation and Employment	PUB	NFP	OTH