Resilience, freight mobility and governance: mapping the actors in New Zealand's transport network

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Abstract

Decisions get made every day about how to keep New Zealand's freight moving. They get made about our road, rail, shipping and air infrastructure by people at every level of the transport system, from the politicians deciding the level of funding available, to the infrastructure operator, to the transport user deciding what mode is best to freight goods. As part of the Resilience to Nature's Challenges research programme on governance and infrastructure, we are using the consequences for freight of the November 2016 North Canterbury earthquakes to examine where decisions are being made so we can better understand barriers and opportunities for resilience in how networks are governed.

Piloting an adaptation of Rasmussen's Actor Maps methodology, this paper describes how a map was drawn of the network of actors and their relationships so that it is possible to see connections between institutions, regions, sectors and transport modes. The map of the system was produced initially from analysis of documents, policies and media reports, and then developed iteratively by talking to a range of subject matter experts.

The novel application of the Actor Map methodology in the pilot has been able to shed light on the key player relationships necessary for resilient decision making and where stronger relationships could help. Initial lessons show the need for greater recognition of the multi-level nature of complex systems such as multimodal, inter-regional transport networks to ensure greater effectiveness in response and recovery, as well as preparing for significant disasters. This paper will discuss lessons for New Zealand, and discuss potential approaches to enhance resilience governance of networks.

1. Introduction

Keeping freight and people moving around New Zealand is a constant challenge. We are faced with transport infrastructure which needs to work, despite being laid out across an environment which is in itself mobile, as our mountains make their inexorable way to the sea, and tectonic plates re-arrange the land. Adding to the challenge, New Zealand's transport (or more broadly speaking, mobility) network comprises a range of interdependent modes, including road, rail, shipping and air, provided by a range of public and private institutions.

Reggiani et al (2015) used functionality as a way of describing the resilience and robustness of a mobility network. That is, can goods and people continue to reliably move around the network with limited disruption (Money et al., 2017)? Achieving such functionality following a significant disaster can be achieved through adaptive capacity within the network in various ways, for example, through route shifts as well as modal shifts (Cox et al., 2011).

The vulnerability of New Zealand's network to natural hazards is well known. As far back as the nineteenth century, natural hazards played an instrumental role in decisions about whether to put rail along the coast or inland route (Broad, 2013). The repeated closures of the Manawatu Gorge road have consequences for freight operations (Imran et al., 2014) and decreased accessibility (through longer travel time to services and facilities) across the region and beyond (MacRae et al., 2015). As well as historical examples, the future potential for significant network-level disruption has also been well discussed. And well before recent events, the vulnerability of the Kaikoura transport corridor to natural hazards was long recognized (Clydesdale, 2000).

Working towards a more resilient network involves many decision-makers, and in recent years, changing institutional arrangements. The late twentieth century saw a shift away from centralized funding and operational model of transport towards increasing competition and contestability between modes, with different investment models now driving infrastructure decisions (Castalia Strategic Advisors, 2015). Money et al (2017) described the network as a complex system including the infrastructure itself, government (local and central), businesses and organizations, and the wider community. Treating significant distributed infrastructure (such as regional transport corridors) as a complex system is increasingly being recognized as valuable where decisions are made across geographies, jurisdictions, organizations, relationships (formal and informal) (Öberg et al., 2016) and multiple levels (Rijke et al., 2013).

The operation of New Zealand's mobility system has been brought into sharp relief by the network-level consequences of the November 2016 earthquake. The M_w 7.8 North Canterbury earthquake struck just after midnight on 14th November 2016 and was centered 15 km from Culverden, North Canterbury at a depth of 15 km. It was followed by multiple aftershocks and generated a tsunami in the North Canterbury area (GeoNet, 2016).

The earthquake caused significant damage to road, rail and port infrastructure, impacting extensively on the mobility of freight and people between and within the North and South Islands. The main routes between Christchurch and Picton (the port for rail and vehicle ferries) was closed and a detour put in place, extending the travel distance by 250 km and severely straining roads, bridges and services on alternative routes (Stevenson, et al., 2017). Wellington's port and Kaikoura's marina both sustained considerable damage, limiting capacity. Freight-related impacts include increased uncertainty and travel costs for businesses reliant on goods being moved through the area, freight and transport operators themselves, and communities living on both on the coastal route and detours.

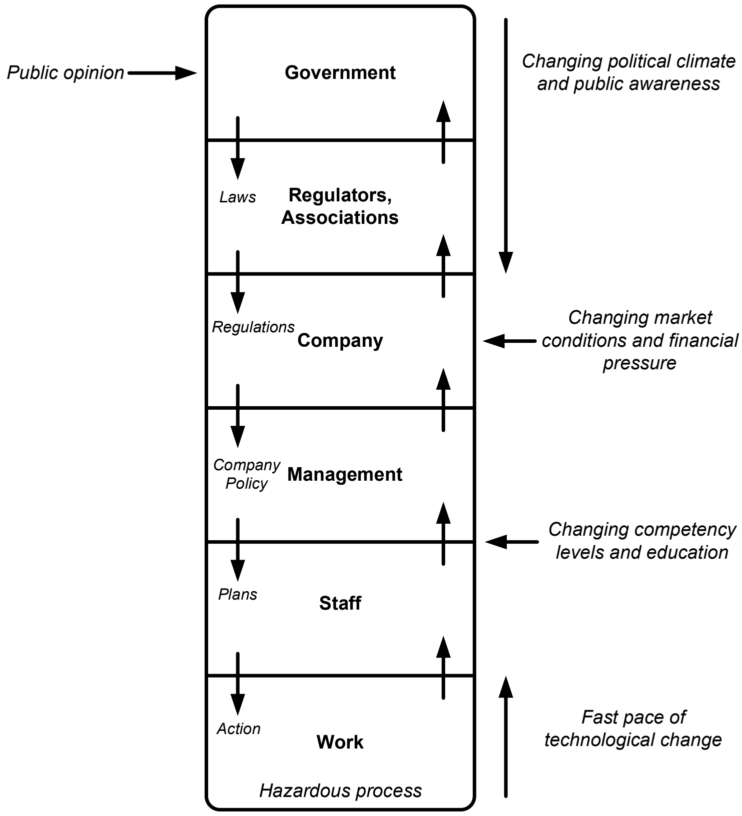
Decisions about the response and recovery of the network have been made rapidly. Within the Resilience to Nature's Challenges research programme, we use the opportunity provided by the earthquakes and its impact on freight to trial systems methodology for describing the governance arrangements around New Zealand's mobility network.

1.1. Creating a system-based perspective of the transport infrastructure network

Systems such as transport infrastructure networks are considered dynamic rather than static, with inputs and relationships between components constantly changing and evolving. A useful way to think about the transport network in New Zealand is to see it as a complex sociotechnical system with humans (e.g. politicians, business owners, vehicle operators) as well as technology (e.g. vehicles, roading, rail lines, bridges). In such systems, elements are interdependent, both affecting and being affected by each other and no element can be considered in isolation (Klein, 2014) (Carden & Salmon, 2016; Cilliers, 1998). The effectiveness of the system is seen as an emergent property of the interacting elements across the system (Robertson et al., 2015). The impacts of these interactions propagate up and down the system levels, meaning governance decisions have an influence across all levels of the network. Hence, it is necessary to consider the actors within the context of the system as a whole, rather than examining the impact of any particular actors in isolation.

In this study, we used Rasmussen's (1997) Risk Management Framework (Figure 1) as the underlying systems framework through which to examine the mobility network. This framework describes systems as the interaction between factors across six systems levels: government; regulatory bodies and associations; company management; technical and operational management; staff; and work. According to Rasmussen (1997), resilience is an emergent property of these interacting systems.

Figure 1. Rasmussen's Risk Management Framework (adapted from Rasmussen, 1997)



The framework has a number of associated methodologies, including the development of Actor Maps. The maps plot the actors (groups, agencies and people who make and or influence decisions) in the event, along with their interactions, across the same systems levels. These associated methodologies have been applied to the analysis of complex sociotechnical systems in many different domains, including led outdoor activities (Salmon et al., 2010), space travel (Johnson & Muniz de Almeida, 2008), public health (Vicente & Christoffersen, 2006) and transportation (Salmon, Lenné, Walker, Stanton, & Filtness, 2014; Young, Salmon, & Cornelissen, 2013). Examples of the types of actors that could be included at each level from the perspective of New Zealand's Mobility network are included in Table 1.

Table 1. Framework levels adapted for the NZ Mobility system and examples of actors at each level

Levels of Mobility and Transportation System	**Examples**
Government policy and budgeting	Politicians, Ministries, National Crisis Management Centre, NZTA, Martine NZ, etc..
Regulatory bodies, associations, advocates, advisors	Road Transportation Forum, Federated Farmers, Beef and Lamb NZ, Dairy NZ, etc…
Local area government, company management, planning and budgeting	Local Govt Politicians, Councilors, Rail, road, shipping companies, fuel companies, engineering consultants, health organisations, Lifelines, etc
Technical and operational management	CDEM local controller, Regional /local recovery managers, Contractors, Utility coordinators, Road Network Management Alliance, etc.
Physical processes and actor activities	Seismologists, structural engineers, company drivers/pilots/skippers, farmers/producers, retailers, consumers etc.
Equipment and surroundings	State highways, regional roads, ports, farms, factories, goods, construction materials/equipment, websites, radio etc.

To date, there has been limited use of the methodology to explore governance in distributed infrastructure-related systems. In this study, we piloted the use of Actor Maps to describe the institutional setting of the rural transport system in the Canterbury and West Coast regions of New Zealand and the range of governance actors involved in the recovery of freight mobility following the Kaikoura Earthquake event. The purpose of the pilot was to determine whether Actor Maps could be used post-earthquake to provide a clear visual representation of the system, including actors and interactions at all level of the framework, in a way that could allow identification of gaps in the network and therefore potential 'intervention points'. This specific event was used as a leverage point from which understanding about the mobility network more generally could be developed.

2. Method

The Actor Map construction process itself was designed to enable and enhance discussion of the mobility system, with the aim of identifying opportunities for improvement. The Actor Map development process was iterative, involving two development phases; initial construction: Media and document analysis; and extension and enhancement: Expert analysis.

2.1. Initial construction: Media and document analysis

Actors were initially identified through references in online, television, radio and print media. Among others, Radio New Zealand National and Stuff.co.nz 24/7 Earthquake Coverage provided extensive and detailed content. The media analysis approach was taken for two reasons. Firstly, attempting to extract information from transport infrastructure experts was both impractical and unethical given the huge pressures they were faced with during the response and early recovery stages. Secondly, we saw value in capturing rich and diverse information from multiple sources during a dynamic and evolving situation, rather than waiting for official post-event enquiries and reviews.

Identified Actors were then positioned at the appropriate systems level as per the Actor Map methodology (listed in the left column of Table 1.). Any interactions between Actors were captured using an Excel matrix in which every pair of Actors for which there was evidence of interaction, both within and across systems levels, in the data was indicated with a 1. The identified interactions are indicated by connectors between actors.

Acknowledging the potential biases of media reports, an iterative approach was then applied using subject matter experts to extend and validate the Actor Map.

2.2. Extension and enhancement: Expert analysis

2.2.1. Participants

Six subject matter experts reviewed the Actors map iterations individually and five more did so as part of a webinar. The experts were all significantly experienced in their fields of expertise (10+ years), which included mobility and transportation resilience engineering, transportation planning, natural hazard resilience planning, emergency response and transport infrastructure engineering.

2.2.2. Procedure

The draft of the Actor Map and explanation of the process was initially sent to two mobility resilience engineering experts, who reviewed the Actors, adding/removing them as necessary and identifying the relationships they felt were key to a resilient recovery. They also identified interactions/relationships that they felt could be key but could be stronger or more effective in some way. The feedback from the experts was obtained in interviews with members of the research team, using the Actor maps as props that both the team member and expert could draw on. The interviews always took place at minimum a few days after the Actor Maps initially being sent so that the experts had sufficient time to review them prior to discussions.

Based on the feedback from experts, the Actor Map was updated and sent to two further transportation and emergency response experts for review. Their additional feedback was incorporated and the next iteration of the Actor Map was presented to a further five subject matter experts via Webinar. The ensuing discussion and insights were recorded and incorporated into the next iteration. This was then sent to two more subject matter experts, followed by another two.

2.2.3. Analysis

A summary Actor Map was produced consolidating the key actors, relationships and relationship gaps as determined by selection by multiple experts and through the discussions this selection process with the participants generated.

3. Results

3.1. **Map development**

The iterative process used to construct the Actor Map meant that the format of the Actor Map itself evolved over the course of the study. Several major structural changes took place between several of the iterations. The key changes included:

1. the updating of the level names to better reflect the mobility system levels (between iterations 1 and 2);
2. the division of the Actor Map into response and recovery columns and an overlapping section (between iterations 2 and 3);
3. the division of the Actor Map into a 'Venn diagram' format with response, recovery and preparation (or preparedness in Disaster Risk Reduction terms) columns and overlaps (between iterations 4 and 5).

3.2. **Actors and interactions**

In total, 132 actors were identified. The disaster phase with which the greatest number of actors were identified as being involved was the recovery phase, followed by the response phase. No actors were identified as being involved only with the preparation phase. The systems level in which the greatest number of actors were identified was the Government, policy and budgeting level, followed by Local area government, company management, planning and budgeting and Infrastructure. The break down for each disaster phase and systems level is provided in Table 2.

Figure 2. Actor Map following extension and enhancement phase

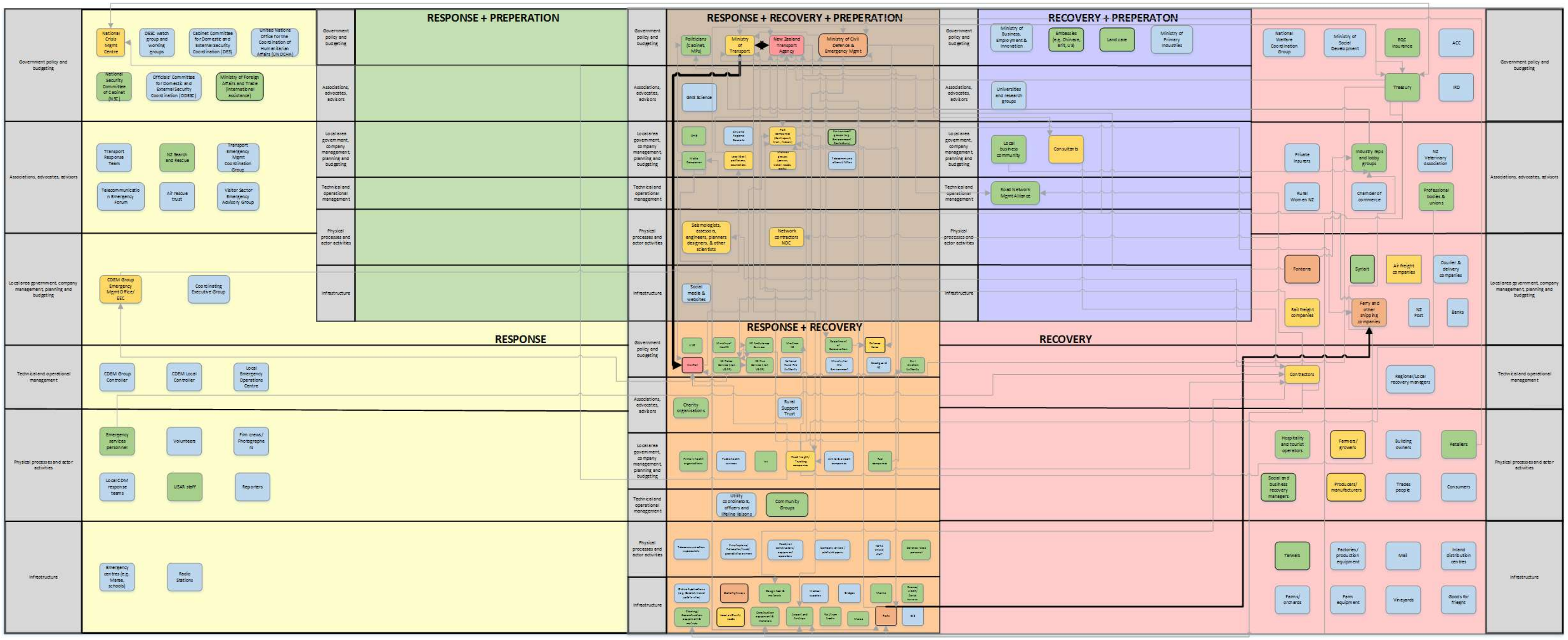


Table 2. Number of actors identified as involved in freight mobility disaster resilience by disaster phase and system level

Disaster Phase	TOTAL	Government policy and budgeting	Associations, advocates, advisors	Local area government, company management, planning and budgeting	Technical and operational management	Physical processes and actor activities	Infrastructure
Preparation	**0**	0	0	0	0	0	0
Response	**26**	7	6	2	3	6	2
Recovery	**38**	6	6	8	2	8	8
Response + Preparation	**21**	0	0	0	0	6	15
Recovery + Preparation	**8**	4	1	2	1	0	0
Response + Recovery	**23**	13	2	6	2	0	0
Preparation + Response + Recovery	**16**	4	1	8	0	2	1
TOTAL	**132**	**34**	**16**	**26**	**8**	**22**	**26**

The identified actors and their interactions both within and across the different phases and systems levels, are shown in Figure 2. For ease of understanding, actors are also listed in Table 3. In this table, colour represents perceived visibility within the system: actors identified by all experts are highlighted in pink, by 3 or more experts in orange, by two in yellow, by one in green, and by the research team as part of the initial actor map in blue. Only two actors were identified by all experts: the New Zealand Transport Agency and KiwiRail. Five more were identified by the majority of experts: the Ministry of Civil Defence and Emergency; Fonterra: Ferries and other shipping companies; State Highways and Ports. Eighteen more actors were identified by two or more experts, and 44 by one expert. Overall, 69 actors of the 132 identified initially were identified as key by the subject matter experts.

Table 3: Actors and their interactions by system level, time stage, and level of visibility

LEVEL	TIME	ACTOR
Government policy and budgeting	Response	National Crisis Management Centre
		DESC watch group and working groups
		National Security Committee of Cabinet (NSC)
		Cabinet Committee for Domestic and External Security Coordination (DES)
		Officials' Committee for Domestic and External Security Coordination (ODESC)
		United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA)
		Ministry of Foreign Affairs and Trade (international assistance)
	Response + Recovery	LINZ
		Ministry of Health
		KiwiRail
		NZ Police Service (incl. USAR)
		NZ Fire Service (incl. USAR)
		National Rural Fire Authority
		Ministry for the Environment
		Maritime NZ
		Department of Conservation
		Coastguard NZ
		Defence Force
		NZ Ambulance service
		Civil Aviation Authority
	Recovery	National Welfare Coordination Group
		Ministry of Social Development
		EQC Insurance
		Treasury
		ACC
		IRD
	Response + Preparation	N/A
	Recovery + Preparation	Ministry of Business, Employment & Innovation
		Ministry of Primary Industries
		Embassies
		Landcare Research
	Preparation	N/A
	Response + Recovery + Preparation	Politicians (Cabinet, MPs)
		Ministry of Transport
		New Zealand Transport Agency
		Ministry of Civil Defence & Emergency Mgmt

LEVEL	TIME	ACTOR
Associations, advocates, advisors	Response	Transport Response Team
		Telecommunication Emergency Forum
		NZ Search and Rescue
		Air rescue trust
		Transport Emergency Mgmt Coordination Group
		Visitor Sector Emergency Advisory Group
	Response + Recovery	Charity organisations
		Rural Support Trust
	Recovery	Rural Women NZ
		Private Insurers
		Chamber of commerce
		Industry reps and lobby groups
		Professional bodies & unions
		NZ Veterinary Association
	Response + Preparation	N/A
	Recovery + Preparation	Universities and research groups
	Preparation	N/A
	Response + Recovery + Preparation	GNS Science
Local area government, company management, planning and budgeting	Response	CDEM Group Emergency Mgmt Office/EEC
		Coordinating Executive Group
	Response + Recovery	Primary health organisations
		Public health services
		Road freight/Trucking companies
		Iwi
		Airline & airport companies
		Fuel companies
	Recovery	Fonterra
		Synlait
		Air freight companies
		Rail freight companies
		Courier & delivery companies
		Ferry and other shipping companies
		NZ Post
		Banks
	Response + Preparation	N/A
	Recovery + Preparation	Local business community
		Consultants
	Preparation	N/A
	Response + Recovery + Preparation	DHB
		Media Companies
		City and Regional Councils
		Local Govt politicians, councillors
		Port companies (Centreport, Marl., Nelson)
		Telecommunications Utilities
		Lifelines groups (power, water, roads, ports)
		Regional environmental groups

LEVEL	TIME	ACTOR
Technical and operational management	Response	CDEM Group Controller
		CDEM Local Controller
		Local Emergency Operations Centre
	Response + Recovery	Utility coordinators, officers and lifeline liaisons
		Community Groups
	Recovery	Contractors
		Regional/Local recovery managers
	Response + Preparation	N/A
	Recovery + Preparation	Road Network Mgmt Alliance
	Preparation	N/A
	Response + Recovery + Preparation	N/A
Physical processes and actor activities	Response	Emergency services personnel
		Local CDM response teams
		Volunteers
		USAR staff
		Film crews/Photographers
		Reporters
	Response + Recovery	Telecommunications specialists
		Private plane/helicopter/truck/geared ship owners
		Company drivers/pilots/skippers
		Road/rail construction/equipment operators
		Defence force personal
		NZTA onsite staff
	Recovery	Hospitality and tourist operators
		Trades people
		Social and business recovery managers
		Farmers/growers
		Producers/manufacturers
		Building owners
		Consumers
		Retailers
	Response + Preparation	N/A
	Recovery + Preparation	N/A
	Preparation	N/A
	Response + Recovery + Preparation	Seismologists, assessors, engineers, planners, designers, & other scientists
		Network contractors NOC
Infrastructure	Response	Emergency centres (e.g. Marae, schools)
		Radio Stations
	Response + Recovery	Online Applications (e.g. Geonet, travel update sites)
		State highways
		Clearing/deconstruction equipment & martials
		Local authority roads
		Design tool & materials
		Construction equipment & materials
		Medical supplies
		Airport and Airstrips
		Bridges
		Rail/tram tracks
		Marina
		Ports
		Drones/LIDAR/Aerial surveys
		Marae
		GIS

LEVEL	TIME	ACTOR
	Recovery	Farms/orchards
		Farm equipment
		Factories/production equipment
		Vineyards
		Mail
		Goods for freight
		Inland distribution centres
		Tankers
	Response + Preparation	N/A
	Recovery + Preparation	N/A
	Preparation	N/A
	Response + Recovery + Preparation	Social media & websites

The interactions and relationships between actors identified by the subject matter experts are illustrated in Figure 2 with connector arrows. In total, the experts identified 65 separate key interactions. Only three of these were identified by different experts on multiple occasions. The relationship between the Transport Agency and the Ministry of Transport was identified as key by three different experts, as was the relationship between the Transport Agency and KiwiRail. The relationship between the ports and the ferries and other shipping companies was identified as key by two different experts.

The subject matter experts also gave feedback on the relationships/interactions they felt were key but were not currently sufficiently effective to enhance resilience. The main themes that came out of these discussions were:

- A lack of interactions and mechanisms that allow an understanding at a governance level of all the equipment held by consultancies across the country.
- A general lack of lessons learnt mechanisms that allow transference of knowledge both up and down the systems levels
- Inefficient coordination structures for tsunami response.
- Local authorities not currently seen as playing a large role in network.

The identified opportunities and lessons from the Actor Map are discussed in the following section.

4. Discussion

Applying the Actor Map method to New Zealand's transport infrastructure following November 2016's damaging earthquakes has exposed the highly complex network of key actors involved in transport mobility resilience, involving a large number of both actors and relationships at multiple levels, as seen in other complex infrastructure systems (Rijke et al., 2013). That such a broad range of factors and relationships were identified as key by a relatively small group of subject matter experts, with limited overlap between participants, further underlies the complexity of the network, with experts reflecting on the system from different perspectives. The process used by the Actor Map method helped reveal the systemic nature of the network to experts, helping them query wider actors and interactions (or absences) within the system, rather than be limited to those with whom they have direct experiences. This highlights the importance of including a range of experts with diverse specialties and locations in any group tackling transport mobility or other complex sociotechnical systems threatened in disasters.

4.1. Key actors

The Actor Map establishes the key role the two government agencies responsible for land transport infrastructure—New Zealand Transport Agency and KiwiRail—play in allowing a resilient response to disaster to emerge from the system. The Transport Agency in particular, interacts and/or influences with the greatest number of other actors on the map. Decisions and actions by the Transport Agency therefore have the potential to impact widely across the largest number of other actors, from within the government level all the way to the infrastructure level. The Actor Map also emphasises the key role the Ministry of Transport has in the coordination and of these two agencies and hence the governance of the system response overall. Given these findings, there is scope for the Ministry to strengthen this role by establishing themselves as the allocator of key funding and the voice of Ministers and the Government's approach more generally.

Cox (2011) regarded the adaptive capacity to shift modes as an indicator of a complex system. While New Zealand's mobility network is regarded as fragmented (Castalia Strategic Advisors, 2015; Davies et al., 2016), in the short term it has largely been able to adapt by increasing freight levels on the road network in response to disrupted rail and Wellington port infrastructure, at least to retain function. As well as highlighting the importance of land based transport agencies, the Actor Map also reveals the value of taking a multimodal approach to the resilience of the network (Cox et al., 2011; Öberg et al., 2016) as it highlights the key nexus between land and sea based freight—ports and ferry/shipping companies. While merchant shipping has reduced in importance to freight mobility in preceding years, and appears to have received minimal attention in relation to network resilience (Davies et al., 2016), the Actor Map demonstrates the value placed on having multiple modes by experts. They saw shipping across the whole country as playing an important part in maintaining freight mobility in the event of extensive road and rail damage, both in terms of immediate capacity to keep freight moving but also to relieve pressure on existing road networks. Port infrastructure and its ability to cope with additional load, as well as be itself resilient to potential damage, must be considered as an important part of preparing for future events. Ferry and shipping companies, perhaps represented through Maritime New Zealand, were seen as equal partners in future discussions of transport resilience and freight movement. Land-based freight companies may want to look to developing their relationships with shipping companies and incorporating multimodal solutions into their organisational resilience planning.

While the Actor Map was ostensibly used to highlight important, useful interactions, the high number of interactions identified by single sources highlights a contrary issue: Over-interaction between Actors can be as detrimental as under-interaction. When interactions are ad hoc and prioritisation not clearly defined, confusion can develop between Actors with competing agendas. The involvement of many Actors (e.g. telecoms, utilities) is contingent on other responders (e.g. road clearing, emergency responders) who need to work as effectively and efficiently as possible. Effective management of the prioritisation of agency responses (potentially by the Ministry of Transport as discussed above) may reduce inefficiencies caused by over-interaction.

4.2. Future governance opportunities

The subject matter experts used the development and enhancement of the Actor Map to identify gaps in the network. These were then used as indications of key governance opportunities for development. Two key themes came across in these discussions. The first, an absence of lesson learned mechanisms about infrastructure networks at a national level was seen to hamper future preparedness efforts and, hence resilience to future events. Preparedness in the network is more apparent for the response stage; however, lack of a cohesive, all-encompassing evaluation for overall network resilience post-disaster means reduces the focus on examining and/or following following alternative processes and looking at what these could require in advance. New Zealand's lack of discussion and policy around planned retreat is a pertinent example of this (International Federation of the Red Cross and

Red Crescent Societies, 2014). The challenge to creating measures for network resilience, and for complexity faced to valuing them (Money et al., 2017) may explain the lack of lessons learned. Without adequate measures, obtaining funding for business cases examining alternative solutions in the wake of lessons learned can be challenging. Future research could investigate the governance mechanisms that need to be put in place to encourage the in-depth research and creative problem solving necessary to learn from and evolve from past events to remain resilient in the future.

The second key theme for future investigation is the position of actors whose roles are less visible, such as local authorities within the network. Much of the response and recovery burden will fall on the local and regional councils in the impacted areas. In New Zealand, many have small rate payer bases, limited experience, and sometimes more importantly, the capacity to manage the situation and therefore depend on the support of consultants, contractors and other agencies. Central government support for local authorities post-event can clearly play a crucial role here, providing resources and guidance and/or oversight around competing priorities and efficient response and recovery efforts. The findings highlight to need to consider actors at multiple levels in the governance of a network (Rijke et al., 2013) if we are to understand the drivers for effective response and recovery of a network. In trans-European transportation network context, Oberg et al (2016) recommended corridor forums as a poly-lateral governance tool bringing together modes, organisations and jurisdictions towards a common goal of planning and preparing for resilience. Such a forum could help address New Zealand's challenges of needing to make multi-level decisions but with no current mandate to ensure multiple state and non-state entities work together.

4.3. Developing Actor maps as an infrastructure governance tool

It is important to acknowledge that the ability of various actors to have influence across the system differs according to the degree of power imbued in each of them. Our Actor Map does not examine actors in relation to their power differential. However, the methodology's originator encouraged its adaptation to specific systems and contexts (Rasmussen, 1997). Given the degree of complexity already introduced by incorporating disaster phases in to the Actor Map produced in the study, additional complexity was considered a hindrance to usability, but power differential could be incorporated in future examinations of the mobility system using the Actor Map methodology. Likewise, Actor Maps could be structured towards Actors' desired outputs or time scales.

Given that the purpose of this study was exploratory we were restricted to a relatively small number of experts. Nevertheless, the pilot demonstrated the utility of the method for revealing the systemic nature of the network by, a) focusing expert attention on multiple levels and aspects of the network and disaster risk reduction stages, and b) engaging efficiently with targeted expertise and institutions to provide rapid insights relatively soon after a significant event. Next steps include reviewing the map by extending 'expertise' to those within key institutions themselves, such as endusers (including communities affected by the network damage, freight consumers) as well as local and central government authorities.

5. Conclusion

Since November 14, 2016, keeping New Zealand's freight moving across our severely earthquake-damaged and compromised infrastructure has involved many decisions. Rasmussen's Actor Map methodology (Rasmussen, 1997) has revealed the range of Actors making decisions before during and after the event, showing the complexity of relationships within the system. By using initial media reports and subject matter experts we were able to rapidly describe the system, and extend our understanding of governance, resilience and infrastructure beyond the response and recovery phases to include preparedness. The process of developing the map raises further questions about the opportunities provided by such events to act as a circuit breaker to a less than resilient status quo, and prompt thinking about how we can facilitate system-level overview where Actors can have joint perspectives about how to best invest in, design and operate a resilient mobility network that keeps freight moving.

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