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Factors affecting the speed and quality of post disaster recovery and resilience

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Abstract

This chapter pulls together insights about post-disaster resilience and recovery from a comparison of 10 recent earthquake disasters. Recovery is a complex process that starts immediately after a disaster. In simple terms it involves a return to 'normality'. But recovery is not only about speed; the quality of reconstruction and the idea of 'building back better' are also important.

To better understand which factors may affect the speed of recovery, data from the 10 earthquake events are analysed in terms of 3 exogenous factors that are given, and 5 sets of endogenous factors that are within the control of decision-makers and planners – authority, decision-making, planning, finance and science.

The somewhat surprising finding is that there appears to be little relation between speed of recovery and the exogenous factors of size of impact, population demographics and economic factors.   However, there is a clear relationship between the standard of post-disaster management decision-making and both the speed (R^2=0.56) and quality of recovery (R^2=0.90). The relationship between post-disaster decision-making and the quality of recovery in terms of whether crucial aspects of the society and economy are 'built back better' is striking.

Keywords

disaster recovery, resilience, earthquakes, recovery speed, build back better

Introduction

This chapter pulls together insights about post-disaster resilience and recovery from a comparison of 10 recent earthquake disasters. It is aimed at people in earthquake engineering who may have focused on understanding hazards or mitigating their impact but who would like to know more about long-term recovery after a disaster. The chapter analyses the effect of 8 factors on both the speed and quality of recovery.

Resilience

The word resilience derives from the Latin word *resiliens* meaning to rebound. In engineering, resilience is defined as a measure of how easily a material returns to its original shape after elastic deformation (Hollnagel et al, 2006; Oxford Dictionary of Construction, Surveying and Civil Engineering, 2013). In ecology Holling (1973) defined resilience as the capacity to absorb shock and linked resilience to the idea of systemic stability. The concept of resilience has been used extensively in disaster research (Tierney, 1997; Comfort, 1999; Petak, 2002; Bruneau et al., 2003). Zolli and Healy (2012, p 7) define resilience as "the critical ability to anticipate change, heal when damaged, to reorganize … to maintain core purpose, even under radically changed circumstances". Resilience encompasses a society's level of preparedness to confront or deal with a disaster and its ability to recover quickly and successfully (Alexander, 2013). The UNISDR (2004, p 16) in their global review of disaster reduction initiatives define resilience as "the capacity of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions". Bruneau et al. (2003) define seismic resilience as the ability of a system to reduce the chances of a shock, to absorb such a shock if it occurs and to recover quickly after a shock. They argue that a resilient system is one that shows reduced failure probabilities, reduced consequences from failures, in terms of lives lost, damage, and negative economic and social consequences, and reduced time to recovery (restoration of a specific system or set of systems to their "normal" level of functional performance).

Recovery

Recovery is a complex process that starts immediately after a disaster. Recovery is defined in this chapter as "the act or process of returning to a normal state after a period of difficulty" (Merriam-Webster). Most (lay) people think about disaster recovery as a return to normality although this raises the question of what is 'normal'. The 'normal' may not be a return to the status before the event; in fact this may be undesirable. Quarantelli (1999) suggests that the word recovery implies an attempt to bring the post-disaster situation to some level of acceptability. Bruneau et al. (2003) include restoration of the system to its normal level of performance in their definition of recovery. This conception of recovery as a return to 'normality' is the one used in this chapter. But recovery is not only about speed; the quality of reconstruction and the idea of 'building back better' are also important.

To try to better understand which factors may affect the speed of recovery, data from the 10 earthquake events are analysed in terms of exogenous factors, i.e. those factors that are given and are outside the control of decision-makers and planners, and endogenous factors, i.e. those factors that are amenable to decision-making. The following are the factors considered in this chapter.

Exogenous factors

1 **Size** of the disaster: people displaced, deaths, economic loss

2 **Demography**: age profile of population, birth rate

3 **Economy**: regional and national annual growth in GDP

Endogenous factors

4 **Authority**, leadership and governance

5 **Decision-making** and window of opportunity

6 **Planning**: repair or rebuild; master planning urban environment

7 **Finance**: resourcing recovery and reconstruction

8 **Science** and engineering: informing decision-making with evidence

Methodology

The author has studied recovery in 10 places affected by earthquakes (See Table 1). This chapter analyses these case studies in terms of the 8 exogenous and endogenous factors listed above. Although the disasters are all earthquake-related many of the insights would apply to recovery after other types of natural disaster, including tropical cyclones, floods and volcanic eruptions.

Table 1. Data from 10 major earthquakes

Country	Name	Year	Date	Mw	Displaced	Deaths	Loss US$ bn	Size
USA	Northridge	1994	Jan-17	6.7	125,000	61	44	0.1
Iran	Bam	2003	Dec-26	6.6	75,000	26,271	1.5	82
Thailand	Indian Ocean	2004	Dec-26	9.2	1,690,000	276,025	14	3,979
Pakistan	Kashmir	2005	Oct-08	7.6	3,500,000	100,000	2.3	1,313
China	Wenchuan	2008	May-12	8.0	1,940,000	90,000	75	1,393
Italy	L'Aquila	2009	Apr-06	5.8	67,000	309	16	0.7
Chile	Maule	2010	Feb-27	8.8	800,000	550	30	45
New Zealand	Christchurch	2011	Feb-22	6.3	25,000	185	16	39
Japan	Tohoku	2011	Mar-11	9.0	130,927	18,499	235	5,502
Turkey	Van	2011	Oct-23	7.1	50,000	604	1	0.4

Table 1 provides a comparison of the scale of the disaster in different countries. Size is measured by the formula: Size = deaths * (economic loss / GDP). (Dacy and Kunreuther, 1969; Padli et al, 2010; Suppasri et al, 2016)

Data collection

Five types of data collection method were used in a complementary way to provide both quantifiable and qualitative data and to improve the reliability of the evidence (See Figure 1). The methodology of measuring recovery and resilience is reported in more detail in Platt (2016).

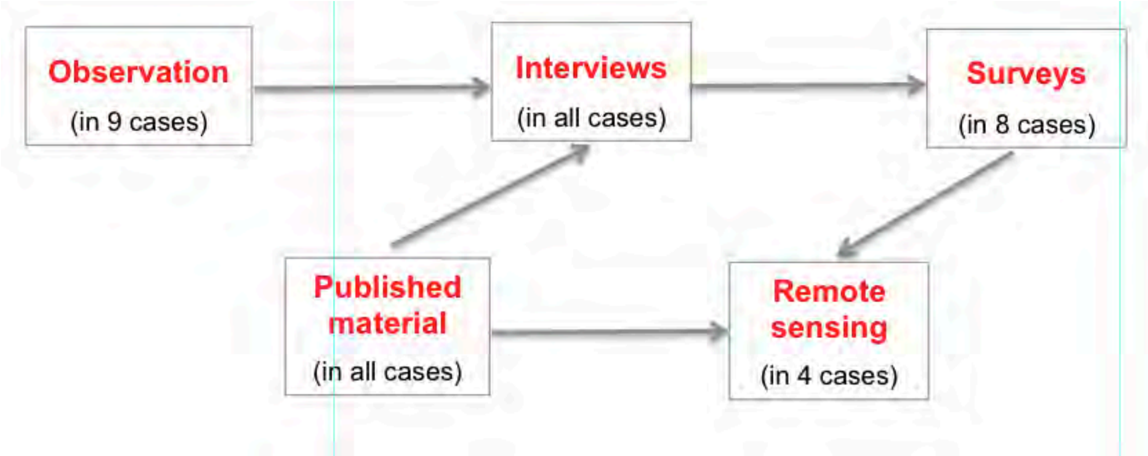

Figure 1. Data collection methodology

Remote sensing: Manual and semi-automatic analysis of satellite imagery was used to provide accurately quantifiable measures of recovery of relatively small sample areas in Pakistan, Thailand, China and Turkey. Twelve indices of recovery were identified covering transport, housing, shelter, services, environment and livelihoods (Platt et al., 2016a). However, the satellite imagery analysis was partial. The analysis covered only part of the affected area for specific snapshots over the first two years of recovery.

Interviews: Semi-structured interviews and focus groups were conducted with decision-makers, planners, stakeholders and residents. Typically 30 key informants were interviewed in each location and about half of them attended a focus group workshop to explore issues in greater detail. Their perceptions and opinions formed the basis of the meta decision analysis reported below. No specialised software was used but interview quotes were coded into a thematic framework using a standard ethnographic procedure (See Appendix A).

Surveys: Household surveys of a small sample of residents were used in 6 of the 10 disaster locations (Chile, Japan, New Zealand, Pakistan, Thailand and Turkey) to collect data about the timing and quality of recovery plus many other qualitative aspects of the process (See Appendix B). Household surveys of 50 households chosen randomly were used to collect data about the timing of recovery. People were asked by what percentage different aspects of society (access, debris clearance, environmental recovery, schooling, healthcare, mains water and livelihoods) had recovered at given intervals after the disaster. Other resilience factors such as governance, leadership, planning, science and construction were derived in part from published sources and in part from the interviews.

Analysis of published material: As much use as possible was made of reports, statistical data and documents produced by government departments and international agencies. This helped provide base line data on population, housing and economic activities and was used to validate the extent and timing of various aspects of recovery, for example school and health provision. There was, however, limited data about rehousing, business continuity, funding recovery and regional GDP. Published sources also provided data about the impact of the disaster in terms of deaths, displaced persons and economic loss, and pre-disaster resilience attributes, for example demography, economic production and socio-economic factors such as equity and education. It would have been most helpful to have obtained published data about the timing of recovery, for example about population movements, housing and the local economy, but it was extremely difficult to get any useful information.

Measuring the speed and quality of recovery

Speed of recovery was measured using key informant interviews in every case as well as satellite imagery analysis in Pakistan, Thailand, Turkey, Italy, China and New Zealand. The timings reported by key informants were compared to that from remote sensing and was found to correlate closely (Platt et al. 2016a).

Five indicators were used to calculate a single measure of the speed of recovery, 'a return to normality', based on the time taken to return and comply with all the conditions listed in Table 2. Recovery quality was assessed using data from interviews, field observations and published material. Five indicators were used (see Table 3) to calculate a measure of quality of recovery based on the concept of "building back better" (Kim and Olshansky, 2015). Each indicator was assessed on a 5-point scale in terms of whether the recovered state was worse, the same or better than the pre-disaster state and the scores were summed to give a single measure of the quality of recovery in each country. This was a similar approach to that adopted by Burton (2012 p 3) in research that aimed at measuring the multi-dimensional nature of disaster resilience; "what set of indicators provide the best comparative assessment of disaster resilience and to what extent do these predict disaster recovery".

Table 2. Indicators of speed and quality of recovery

(Reduced set of indicators devised by the author to measure speed and quality of recover)

SPEED INDICATORS		QUALITY INDICATORS
Access	fully restored	Scale 1-5
Temporary housing	completely cleared	Safety
Permanent housing	≥90% displaced rehoused	Amenity
Schooling	≥90% children in school	Ecology
Livelihoods	≥90% back in work	Housing
Power	fully restored	Local economy
Time taken for all above conditions to be met		Recovery quality = sum of indicator scores

Table 3. Assessment of speed and quality of recovery

	USA Northridge 1994	Iran Bam 2003	Thailand Indian Ocean 2004	Pakistan Kashmir 2005	China Wenchuan 2008	Italy L'Aquila 2009	Chile Maule 2010	NZ Christ-church 2011	Japan Tohoku 2011	Turkey Van 2011
Speed (years to recover)										
Access restored	<1	1	1	1	<1	<1	<1	<1	<1	<1
Temp housing cleared	<1	4	2	4	<1	>7	2	<1	5	<1
Rehousing	2	8	2	10	2	>7	4	5	9	2
Schooling	<1	2	<1	2	<1	<1	<1	<1	<1	<1
Restore livelihoods	1	20	3	4	1	>7	2	1	5	5
Speed (years to restore to normality)	2	25	5	15	5	20	5	10	12	5
Quality (score 1-5)										
Safety	4	3	3	1	4	4	4	5	5	4
Amenity	3	1	2	2	1	1	4	2	2	2
Ecology	3	2	2	2	1	3	4	4	4	2
Housing	3	2	2	1	2	1	5	3	2	3
Local economy	3	1	4	2	5	1	4	3	2	3
Quality (% of possible maximum score)	64%	36%	52%	32%	52%	40%	84%	68%	60%	56%

Note to Table 3

Table 3 synthesises a great deal of research. The measure of **speed** of recovery is based on field observation, key informant surveys and published data, together with satellite imagery analysis in a small subset of cases (Pakistan, Thailand, Turkey, China, Italy and New Zealand). The detailed data of speed of recovery in months for 12-13 indicators has been reduced to 5 indicators and is given in years.

The assessment of **quality** is also based on field study, key informant interviews and published information. The scoring, however, is subjective and was done by the author. A 5-point scale was used to assess whether the recovered state was much worse, worse, the same, better or much better than the pre-disaster state. The scores were summed and normalised to percentages to give a single measure of the quality of recovery in each country.

Exogenous factors

1 Size of the disaster

There is evidence from historic disasters of a directly proportional relationship between the number of fatalities and the years it takes to recover (Kates and Pijawka, 1977). Figure 2 plots their data, separating pre and post 20th Century disasters to reflect the enormous strides in pre-disaster mitigation and preparedness and in post-disaster health care and disease control. The graphs show a strong correlation between the number of fatalities and the time to recover (R^2 = 0.83 and 0.91).

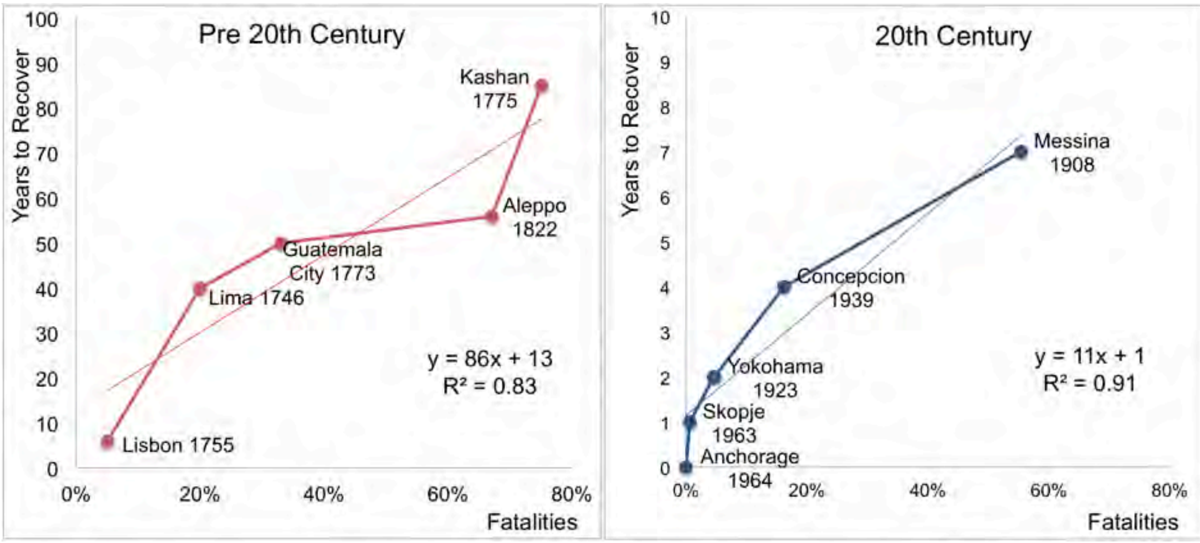

Figure 2. Fatalities and speed of recovery after historic disasters (Source: Kates and Pijawka, 1977)
(Note the vertical scale of the Pre 20th Century is 10 times larger than that of the 20th Century data.)

For the 10 case study events analysed here, there is an obvious relationship between the magnitude of the event and its impact as indicated by the trend lines for deaths and economic loss in Figure 3. However, the relationship is not that strong (R^2 ranges from 0.22 to 0.33). Other factors, including the economic wealth of the country, the condition of its building stock and the level of preparedness, affect how ‘robust’ a place is in terms of its capacity to resist an earthquake. Four disasters had significantly high deaths tolls: Indian Ocean Tsunami 2004, Wenchuan Earthquake 2008, Kashmir Earthquake 2005 and the Bam Earthquake 2003. In three of these disasters the main cause was poor building construction. Three disasters had significantly high economic losses: Tohoku 2011, Wenchuan 2008 and Northridge 1994.

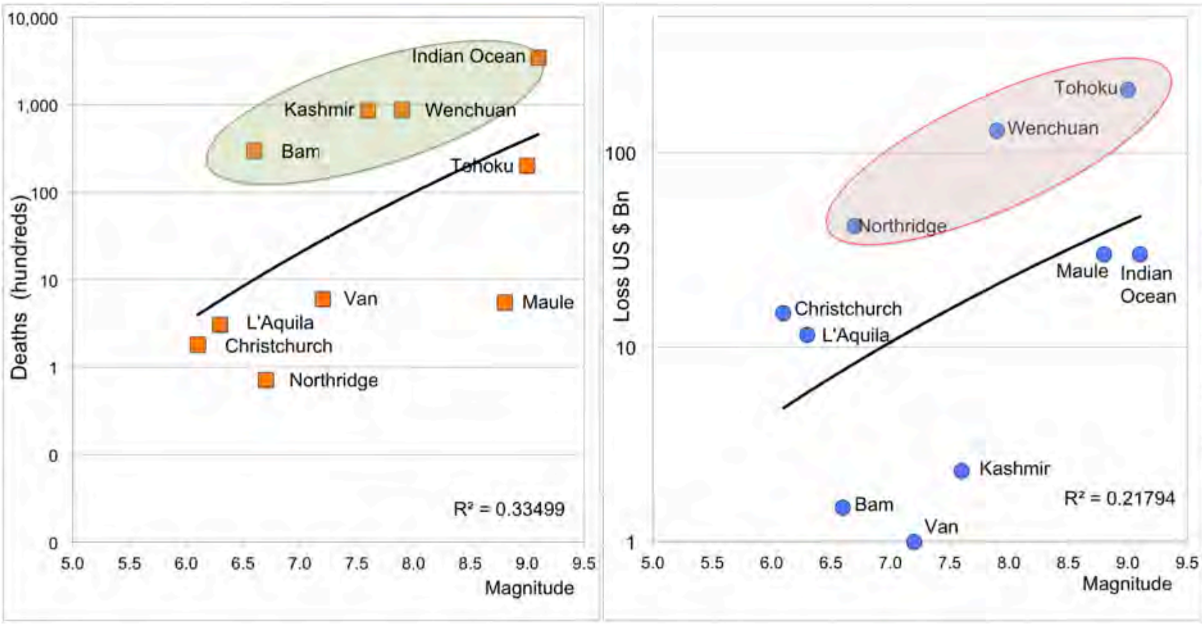

Figure 3. Impact of events in terms of deaths and economic loss (axes logarithmic)

The question is does this mean recovery is slower after larger events with bigger impacts? Kates and Pijawka (1977) argued that for historic earthquakes the speed of recovery was principally related to the magnitude of the damage (Figure 2). This makes intuitive sense, but does the relationship still hold for current disasters? Surprisingly there is little evidence from these 10 events that the speed of recovery is related to the magnitude of the event or the size of its impact (see Figure 4 left hand graph). Therefore other factors must account for the wide variation in recovery times. Kates (1977) acknowledged that other factors, including the prevailing pre-disaster economic and demographic trends, the resources available for recovery and the quality of leadership, planning and organization are also important and stated that exceptional performance could reduce recovery time by as much as half. This chapter therefore seeks to measure the effect of these other factors mentioned by Kates on both the timing and quality of recovery.

2 Demography and 3 Economy

Two other exogenous variables to be considered are demography and economy. It might be expected that a country with a dynamic population, i.e. a high population growth rate, would recover quicker. It might also be expected that a wealthier country with a buoyant economy would have more resources to aid recovery. Finally a country with a more equitable division of wealth might also be expected to recover more quickly since a large proportion of the funds for recovery come from individual families and local communities. The 10 countries have widely differing demographic and economic profiles, and differing levels of equality. Are these differences reflected in recovery rates? Table 4 presents the data to test this.

Table 4. Speed of recovery against population growth, economic growth and equality

Name	Year	Av Annual Pop. Growth 2010-15	Av Annual GDP Growth 2010-15	Equality (GINI Index) 2015	Resilience	Return to 'normality' years
Northridge, USA	1994	0.9	4	0.41	1.5	2
Bam, Iran	2003	1.0	7	0.38	2.7	25
Indian Ocean	2004	1.1	6	0.39	2.6	5
Kashmir, Pakistan	2005	1.8	9	0.3	4.9	15
Wenchuan, China	2008	0.4	9	0.37	1.3	5
L'Aquila, Italy	2009	0.2	-6	0.35	-0.4	20
Maule, Chile	2010	0.9	6	0.51	2.8	5
Christchurch, NZ	2011	1.0	1	0.33	0.3	10
Tohoku, Japan	2011	-0.1	-5	0.32	0.2	12
Van, Turkey	2011	1.1	8	0.39	3.4	5

Sources: Population growth rate: United Nations, Department of Economic and Social Affairs, Population Division

GDP growth: World Bank http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

GINI Index http://data.worldbank.org/indicator/SI.POV.GINI

There is, however, no relationship between the speed of recovery and any of the demographic and economic indicators (See Table 5).

Table 5. Effect of exogenous factors on the speed of recovery

Exogenous Factor	R2
Deaths + missing	0.046
Economic loss US$bn	0.042
Loss/GDP	0.001
Total national population (year of disaster)	0.083
Population growth (av. annual)	0.002
Total national GDP (year of disaster	0.086
GDP growth (av. annual)	0.093
Regional GDP (year of disaster)	0.179
GINI equality index	0.196

It is possible that the exogenous variables interact to produce a combined effect. To test this the three indicators of average annual population growth, annual GDP growth and the GINI equality index can be combined into a single measure of 'societal resilience', where

$$R = P * E * G$$

(R = Resilience; P = Population Growth; E = Economic GDP Growth; G = GINI index)

Figure 4 shows surprisingly that there appears to be no relation between speed of recovery and either size of impact of the disaster or the combined resilience index of demographic and economic factors.

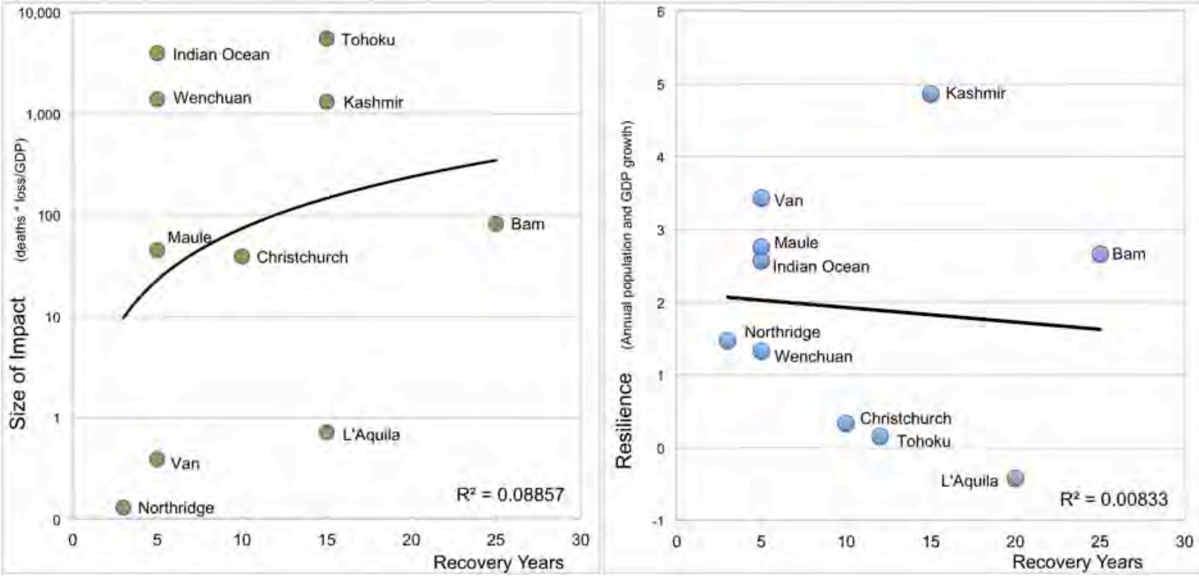

Figure 4. Effect of exogenous factors on the speed of recovery
Size of impact is measured by the formula: Size = deaths * (loss / GDP). (Dacy and Kunreuther, 1969; Padli et al, 2010; Suppasri et al, 2016.
Resilience is measured by the formula: Resilience = Annual Population Growth 2010-15 * Annual GDP Growth 2010-15 * GINI Index of Equality 2015 (Sources: see Table 3)

Endogenous factors

The following five sets of endogenous factors are considered:

- Authority, leadership and governance
- Decision-making and window of opportunity
- Planning: repair or rebuild; master planning urban environment
- Finance: resourcing recovery and reconstruction
- Science and engineering: informing decision-making

4 Authority, leadership and governance

Governance is defined in this chapter as the extent to which control and decisions about recovery are “top-down” and centralised or “bottom-up” and delegated to regional and local authorities with a degree of community consultation and involvement. In 5 of the 10 countries (China, Iran, Pakistan, Thailand and Turkey) there is a top-down governance structure. There are, however, differences of detail.

In Pakistan governance is conducted through military institutions and government departments. Turkey also has a centralised top-down structure with little tradition of community involvement. Van is far to the east, away from the centres of power in Ankara and Istanbul, and local involvement of stakeholders was hampered by political tensions of the Kurdish separatist movement. Decisions about reconstruction were taken by AFAD, the

Prime Minister's Office for Disaster Management, and Toki, the Government Housing Agency. Interviews with personnel in AFAD revealed that geologists made planning decisions in Van on the basis of distance from a known fault and whether the land was government-owned; there was no public consultation (Platt and Durmaz, 2016). Iran, Thailand and China have similar top-down governance structures.

In Italy decision-making was initially top-down, but after the first phase there was a lack of coordination between regional, provincial and municipal authorities. The many people who spoke at the Forum organised by the OECD (OECD, 2012) and Groningen University (Brezzi and McCann, 2012) on recovery in L'Aquila, attended by the author of this chapter, related how the national, regional, provincial and municipal authorities had failed to cooperate effectively, with each accusing the other of being the cause of delay. This judgement is supported by Alexander (2010) and Daziel (2012). Nor was there any genuine community involvement and consultation, even with local architects, engineers or academics. Leadership after the L'Aquila earthquake might be characterised by chaos and failure of government.

In contrast, governance in the USA, Japan, New Zealand and Chile was more balanced with delegation of authority to regional and local government and with stakeholder involvement and community consultation. In Chile the government appointed a national coordinator to develop a reconstruction plan. The plan was based on the premise that "the State is unable to reconstruct everything or even control the process of recovery centrally from Santiago. With the support of the state, it is the responsibility of each region, town council and community to develop its own plans" (MINVU 2010 p. 108; English translation MINVU 2013 p. 2). This meant that authority was delegated to the regional government.

The distinctive aspect about recovery in Chile, however, was the quality of the participation process that involved the community in decision-making and kept them informed about progress (See Figure 5). The architects who were master planning recovery in the eighteen coastal settlements visited their areas at least once a week, briefing residents groups and business people and walking the streets to monitor progress and meet residents. Maps, sketches and plans were used throughout this process to communicate ideas and get feedback. The main objective was to get business up and running again. So restaurants and fish processing plants operated in temporary structures while permanent accommodation was planned and built.

Figure 5. Architect Carolina Arriagada at weekly briefing to a residents association and resulting master plan for Tubul, Chile

KEY: 1 health centre; 2 school; 3 police; 4 fire brigade; 5 wetland park; 6 housing (266); 7 main street; 8 waterfront; 9 info centre; 10 park; 11 cycleway; 12 port infrastructure; 13 new road; 14 evacuation assembly.

Similarly in Japan after the Tohoku disaster in 2011, the central government took control providing the resources and setting the agenda, and the regional and municipal authorities interpreted this policy and implemented plans. There is also a legal obligation in Japan to consult members of the community. But there are cultural differences between Chile and Japan that impacted the speed and quality of recovery. The political structure in Japan is more strongly centralised and the national government maintains a closer oversight over the prefectures, cities and other local government institutions so there is much less delegation of decision-making (Sorensen, 2004). Public consultation in Japan was therefore more formalised, less inclusive and gave priority to a smaller section of opinion.

In New Zealand the Canterbury Earthquake Authority (CERA) and Christchurch City Council (2011) made efforts to involve citizens in the debate about the future of the city. CERA conducted community workshops and public consultation on the Recovery Strategy for Greater Christchurch (CERA, 2011). The City Council planning department's focus was on re-planning the central business district and it ran the "Share an Idea" campaign that involved residents through an interactive website and an exhibition attended by over 10,000 people (Carlton, 2013). However, despite these initiatives, more power lay with the Minister for Canterbury Earthquake Recovery and CERA than with the city council or local citizens and stakeholders.

There were considerable differences in which authority was responsible for recovery decision-making i.e. whether existing ministries and local government are in charge or a special dedicated organisation is in control. Typically the creation of a dedicated body needs special legislation. In 6 of the 10 case studies (China, Iran, New Zealand, Pakistan, Thailand and Turkey) authority was vested in a special body.

The Government of Pakistan established the Earthquake Reconstruction and Rehabilitation Authority (ERRA) on October 24, 2005, two weeks after the disaster, to control all aspects of relief and recovery and to “convert adversity into opportunity” by “building back better” (GFDRR, 2014 p. 4). In coordinating the various organisations involved, ERRA adopted the UN cluster approach that grouped humanitarian organisations into specific areas of responsibility, for example health and water/sanitation (United Nations, 2005). The early performance of clusters in Pakistan was uneven, responsibilities not clearly defined and some clusters struggled until government departments were involved, but it provided a framework for coordination in a chaotic operational environment (Hidalgo, 2007).

In New Zealand the local authorities, Christchurch City Council and Waimakakiri District Council were initially in charge after the September 2010 earthquake. This changed after the second more devastating earthquake the following February 2011. Two weeks after the February quake the Government passed the Canterbury Earthquake Recovery Act 2011 granting extraordinary powers to the Canterbury Earthquake Recovery Authority (CERA) as a department of government. Instead of working to strengthen the City Council, CERA took over its core recovery functions and the City Council was, initially, side-lined. However, despite the tensions, CERA and the municipal authorities cooperated and power gradually reverted to the City Council. In January 2015, CERA was downgraded from a department to an agency within the Department of the Prime Minister.

After the disaster in Tohoku in 2011, the Japanese government immediately sought to broaden the recovery strategy by setting up an advisory council. Within two months the council issued “seven principles for the reconstruction framework”, that became the basis for the government guidelines that were decided by the National Policy Unit three months after the disaster (Government of Japan, 2012). The new governmental Reconstruction Agency, reporting to the Cabinet, was established in February 2012. Its aim was to plan and coordinate all national reconstruction policies and measures and to support the efforts of afflicted local governments by serving as a ‘one-stop shop’. The role of the central government was therefore to provide guidelines for reconstruction and support in terms of finance, human resources and know-how but the main administrative actors were the municipalities.

In Chile the central government recognised it would be unable to reconstruct everything or even control the process, and national coordination was limited to defining the scale of the problem and allocating resources. Planning and implementation was the responsibility of regional government and specialist teams of experts. What distinguished recovery in Chile was the community consultation and the desire from the bottom up to rebuild as quickly as possible but also to build back better (Platt and So, 2016).

5 Decision-making and the 'window of opportunity'

Societal resilience, the level of preparedness and rapid and successful recovery depend, to a large extent, on good decisions (Coles and Zhuang, 2011).

If official agencies do not act quickly, many victims will begin to rebuild where and how they choose. Although speed is necessary, it is also vital to take the time to plan post-disaster reconstruction. Planning can create opportunities to improve land use and infrastructure, enhance safety, promote good design, involve citizens in decision-making, and find cost-effective solutions. If planning takes too long, though, it will be ineffective. Alexander (2013b) cautions that reconstruction that occurs very rapidly should be treated with suspicion, for it implies that there has been a failure to consult adequately with interested parties. Time is not limitless, however. The worst cases, he suggests, are either those in which planners ride roughshod over local interests or those in which a conflict of interest leads to stalemate. Many of these problems can be mitigated by pre-disaster planning that sets out general principles and policies that can be updated after the disaster.

Reactive policies are understandable in the context of the urgent policy needs in post-disaster situations (Ingram et al, 2006). Relief has to be rapid and short-term recovery efforts must aim to minimise the time needed to rehouse people safely and to re-establish livelihoods. During this 'transitional' phase it is critical that communities are informed about longer-term plans in order to reduce anxiety and frustration. Long-term recovery policies require comprehensive, site-based assessments of risk and vulnerability and effective consultation with stakeholders. Long-term multi-sector strategic planning can facilitate the sustainable management of resources, supply livelihood support, strengthen infrastructure, improve urban planning and design, extend insurance, and enhance disaster preparedness at the national, regional, and community level.

The 'window of opportunity' for effecting radical change and for accomplishing post-disaster improvements is narrow, in many cases lasting for just 18–36 months after a disaster (Birkmann et al., 2010). Although there is little research on this topic, Comerio (1998) suggests that basic functions should be restored within two years to ensure successful recovery. This window of opportunity varies from one country to another, not so much because it is an inherent quality of disaster recovery, but rather because it is a product of a particular country's political climate. Having to deal with a crisis moves issues higher up a government's policy agenda (Kingdom, 1995). In time, other pressing problems divert attention.

Turkey and Japan represent extremes in this regard. In Turkey, following the Van earthquake in October 2011, the window of opportunity was extremely limited in duration and extent. Post-disaster planning by the Disaster and Emergency Management Presidency (AFAD) and the various government ministries adhered to strict protocols with well-defined criteria and there were a small number of decision-makers and little stakeholder or community involvement. The window of opportunity to do things better may have been open for six months at most.

In Japan, following the Tohoku earthquake in March 2011, there was, by contrast, a massive concerted effort by many sections of society to come to terms with the issues and to devise safer solutions. Despite the efforts of the national government to speed up the process by providing resources and imposing deadlines, the effect was to delay reconstruction. The window of opportunity was still, to an extent, open five years after the event.

In Chile, meanwhile, following the Maule earthquake in February 2010, the window of opportunity was open for about 18–24 months, during which architects seconded from the University of Bío Bío by the regional government worked on master plans for the disaster-affected coastal communities and planners from the Ministry of Transport in Santiago devised a new master plan for Concepción, the capital of the Bío Bío Region (Platt, 2012a). Subsequently, the planners who had been seconded to special teams went back to their old jobs and the government's priorities shifted with the change of government from Sebastián Piñera's centre-right Alliance for Chile to former President Michelle Bachelet's centre-left New Majority party in December 2013 (Meyer, 2014).

Figure 6 shows the results of an attempt to estimate this window of opportunity for 12 countries (in terms of recovery and the number of months after the event). The estimates are based on fieldwork interviews in 10 of the 12 countries and an intense search of published sources. None of the papers and reports specifies this time period, but, in most cases, inferences can be drawn from how long policy committees consulted and when final plans were published.

Figure 6. The window of opportunity

Sources: various reports and papers were used to estimate these times, but the following represent the main sources: Chile: Platt (2012a); Sandoval and Gonzalez (2015); China: Huang, Zhou, and Wei (2014); Haiti: Fan (2013); India: Thiruppugazh (2001); Iran: Omidvar, Zafari, and Derakhshan (2010); Italy: OECD (2013); Japan: Matanle (2011); New Zealand: Toomey (2015); Pakistan: Kirk (2008); Thailand: Srivichai, Supharatid, and Imamura (2007); Turkey: Turan (2012); United States: Wu and Lindell (2004).

6 Planning: repair or rebuild; master planning urban environment

Reconstruction after an earthquake is a complex process entailing economic, political, and social issues as well as geotechnical considerations. Public awareness of the risk is high, and the issue is accorded high priority on political agendas (Scholl, 1986). It is therefore an opportunity to change how things are done – to 'build back better' (Gunewadena and Schuller, 2008). Opportunities exist in the aftermath of earthquakes to enhance hazard mitigation (Birkmann et al., 2010). However, experience shows that current hazard response and mitigation practices often sustain communities as they are, and merely perpetuate the disaster damage cycle rather than address the root causes of the problems (Graham, 1999). There is a natural tendency among survivors to want to restore their lives and communities to normal as quickly as possible (Scholl, 1986), putting pressure on the authorities and inhibiting mitigation strategies and long-term planning. Nevertheless, most communities do become safer and less vulnerable to earthquakes as a result of post-disaster reconstruction (Haas et al., 1977; Rubin et al., 1985).

Speed or safety

Decisions about whether the emphasis should be on rapid reconstruction or on increased safety and 'building back better' are perhaps the most critical of post disaster meta-decisions (Kim and Olshansky, 2015). The key question facing the authorities is whether they should aim to reinstate livelihoods and rebuild homes as quickly as possible or is the crisis an opportunity to change – to increase safety, to strengthen the economy and to improve the urban environment. Speed of reconstruction was exceptionally fast in two of the studied countries, China and Turkey, where a large proportion of displaced families were rehoused within two years and infrastructure and livelihoods were restored (Miao, 2010; Dunford and Li, 2011).

In Italy after the L'Aquila earthquake in 2009 the main issue was the slow recovery of the local economy. Most of the historic buildings were safeguarded with an exoskeleton of scaffolding; however, it may take years to repair them (See Figure 5). Meanwhile, much of the city centre of L'Aquila was closed. Although the main priorities of residents were repair and reconstruction of their homes, reconstruction of the historic centre and re-establishing employment (OECD, 2012), rebuilding was on the outskirts of the town (Alexander, 2010; EEFIT, 2013). In 2016, the centre of L'Aquila city was still partially closed and the university, the main economic driver in the region, was operating in temporary rented accommodation. Instead of repairing existing homes the government built 12,000 new homes in 19 new settlements 15 kilometres from the old city centre (Alexander, 2010). Although these were built within 8 months of the disaster they were built without consulting local opinion and are not where people want to live.

In Chile there was pressure from the residents to rebuild homes, restore facilities and get the economy moving, but there was also a desire on the part of the authorities to develop new urban plans that would improve these communities and make them safer. Master planning of the 18 coastal settlements affected by the disaster was completed within 10 months by a team of architects and planners seconded from the University of Bio-Bio. The aim of these master plans was to restart business, rehouse residents and to improve safety. This involved relocating critical facilities, a setback for buildings of 50-80 metres from the beach and constructing new sea defences, including tree planting and a promenade forming a sea wall. The teams also produced designs for tsunami-resistant housing (Platt, 2012a).

In Japan, after the 2011 Tohoku earthquake, the government's top priorities were also economic revival and safety. In contrast to Chile, however, these two aims seemed to be at odds and were causing delay. The safety imperative in Japan meant that ways of life and people's relationship to the sea had to change and this was painful and caused dissent. Up to 9 metre high tsunami protection levees were built, homes were moved to higher ground along the fiord-like Rias Coast, and on the Sendai Plain, where there are no natural hills, housing was concentrated on raised platforms. By law the authorities had to consult people and it is in the nature of Japanese society to try to reach consensus rationally (Heath, 1995;

Kopp, 2012). This takes time, which undermined the possibility of recovery in places that were already in economic and demographic decline.

In Turkey the imperative was speed, particularly to rehouse people in permanent housing. Transitional container shelters were provided within 3 months and 35 camps comprising 30,000 containers and 175,000 inhabitants were established in Van and Erçis (Basbuğ et al, 2015). The containers were smaller than those provided in Japan and housed bigger families, but people didn't have to stay in them nearly as long as people did in Japan. The author visited Van 10 months after the earthquake while temporary camps were in operation. The author visited again 18 months after the disaster and the camps were nearly all empty. Within 15 months, the Ministry for Housing Development (TOKI) had built 10,000 dwellings in Van, and 5,000 in Erçis (Figure 7). This rate of reconstruction is unprecedented (Platt and So, 2016).

Figure 7. New TOKI housing (photo by author taken on landing at the airport in Van 10 months after the disaster

Construction – repair or rebuild

Unless the decision is to relocate the whole city or settlement, people need to decide whether to repair or rebuild after a disaster. Two case study countries – Iran and China – opted for complete rebuilding. The remaining countries opted for a mixed strategy.

In New Zealand there was a feeling amongst engineers that some decisions to demolish were unjustified and that demolition was driven by the high level of insurance penetration and by a conservative approach to safety (Lynch, 2012). The engineers the author interviewed at Canterbury University in Christchurch and GNS Science in Wellington confirmed this. One of the key issues was that few cities hit by recent earthquakes had suffered such a high intensity of aftershocks and this had influenced decisions about reinsuring buildings in Christchurch (Merkin, 2012; Watson, 2012).

The main policy outlined in the Christchurch City Council's Central City Plan was for a more compact, low-rise, greener city centre, in which building heights would be strictly controlled (Christchurch City Council, 2011). City centre businesses were relocated to the periphery. The City Council was also engaged in a debate about saving historic buildings, the most heated concerned the Anglican Cathedral (Interviews; Burdon, 2015). Christchurch was unusual for the quality of its Gothic Revival public buildings and the city's Victorian and Edwardian character (Lochhead, 2012). A serious architectural loss was the collapse of the Canterbury Provincial Council Chamber (1865), a remarkable colonial example of High Victorian Gothic by the local architect, Benjamin Mountfort (New Zealand Historic Places Trust, 2012). This example from New Zealand, an advanced country that values its historic buildings, illustrates the importance of decisions about repair or demolition and how, unless these issues have been debated and decided in advance there is a risk that irreplaceable cultural heritage will be lost for lack of adequate protection during the period of aftershocks.

Emergency legislation removed all statutory protection for heritage buildings and over 150 listed heritage buildings were demolished in Christchurch. In contrast in L'Aquila, over 3,000 medieval buildings were damaged, many as badly as those in Christchurch, but were subsequently supported with scaffolding (Comune di L'Aquila, 2011). Over half of the city centre of Christchurch was demolished, many historic buildings were lost and extensive areas of residential land were taken out of use. There is clearly a tension between a desire to conserve the familiar and repair damage, usually the preferred option of residents, and the ambition to make safer and 'build back better', often led by government. Balancing these competing goals is one of the main aims of meta decision-making.

In Pakistan, after the earthquake in 2005, the federal government directed the Housing Ministry to upgrade building codes to match international standards and in March 2006, the Ministry, in collaboration with National Engineering Services Pakistan Limited (NESPAK) drafted new building codes. But in the years following the release of the codes there was evidence that few people had followed recommended construction practice. The high cost of standard building materials, especially steel and cement, the lack of understanding about sound concrete construction and the lack of adequate site supervision meant that reconstruction was not as safe as supposed.

Master planning

An aspect of the wider question about speed and safety is whether homes and activities should be reconstructed in the same place or relocated to safer areas. Relocation is generally considered as a last resort because of land ownership issues and public opposition (Gonzalez, 2012). Although the policy decision to relocate is taken at high levels, detailed implementation involves local land-use planning decisions about which built-up land should be abandoned and new green-field or agricultural land be taken into use.

In Christchurch, in neighbourhoods bordering the lower River Avon and along the River Waimakariri in Kaiapoi to the north, there was widespread liquefaction (Quigley et al., 2012; Ballegooya et al., 2014). The water table raised nearer the surface and the crustal thickness was reduced and less able to support the weight of built structures. Severe widespread liquefaction affected many of the Christchurch suburbs, especially Avonside, Avondale, and Bexley, and its central business district. This meant a loss of large areas of the city. Approximately 20,000 houses were seriously affected by liquefaction, out of which between 6,000-7,500 were damaged beyond economic repair and were abandoned (Cubrinovski et al., 2012). Buried pipe networks suffered extensive damage and the wastewater system was particularly affected resulting in loss of service to large areas (MacAskill, 2016). Extensive areas along the lower River Avon and around the estuary and coastal zones, and in the town of Kaiapoi, were deemed as unsuitable for rebuilding, and the government 'bought' the affected properties, and cleared the land. Complete neighbourhoods and some communities were displaced (Swaffield, 2013).

In Pakistan, after the 2005 earthquake, the plan was to relocate the city of Balakot, which had been almost completely destroyed, to a safer location 23 kilometres south towards Mansehra (Ismail, 2012). Yet when the author visited the town nine months after the disaster new inhabitants had already migrated to the site of the original town because of its strategically important location and had set up businesses and were building homes. For various reasons, including costs, land ownership, poor governance and corruption, plans for the new town were not realised (Asad, 2014). Owners of the land that was designated for the new city refusing to leave their land and a failure to involve the local community in the plans were other reasons for the failure of the project (Shafique and Warren, 2015).

7 Finance: resourcing recovery and reconstruction

Financing recovery is about providing the resources for business continuity and reconstruction. This involves decisions about whether businesses should fend for themselves or receive support, whether individual households or the state should rebuild homes, and whether government should try to control resource allocation and prices or leave demand and supply to market forces. In part these decisions depend on sovereign wealth and insurance penetration.

All the countries studied, with the possible exception of Iran, prioritised business continuity and some gave significant amounts of assistance to help business continue. In Chile, Japan and New Zealand the local government financed the construction of temporary shops and restaurants and these became local tourist attractions (see Figure 8).

Figure 8. Temporary shops and restaurants: Dichato Chile, Kesennuma Japan, Christchurch New Zealand

Insurance penetration ranged from near 100% in New Zealand to virtually zero in Pakistan. Chile was somewhere between these extremes. Nevertheless insurance played a role in Chile in facilitating recovery and reconstruction (Franco and Siembieda, 2010) even though insurance penetration was low (30% of the residential properties in the capital Santiago and 10% elsewhere, and about 60% for commercial and industrial properties throughout the country).

In New Zealand less than 0.5% of all damaged dwellings were uninsured and most non-residential buildings in the CBD were fully insured. The government insurance scheme will pay losses of more than NZ$7 billion and private insurers will pay upwards of a further NZ$10 billion towards the cost of rebuilding Christchurch. The Government expected to spend an additional $8.5 billion. One of the more difficult issues was that authorities were keen to have buildings seismically strengthened, but there was a question about who paid for the enhanced performance.

In terms of housing, most reconstruction in China was done by the state and a proportion of new homes were also built by the state in Japan, Turkey and Italy (OECD, 2012). In contrast, in Pakistan, to ensure that homes were rebuilt the way people wanted, the policy was for people to self-build on the same plot with government advice about safer construction and grants for reconstruction (Bajwa, 2007). It was hoped that this approach would more adequately match people’s needs, but the financial assistance was insufficient, the technical advice was unclear and people lacked understanding of safe construction practice.

Various authors have pointed out the problem of what has come to be known as ‘welfare dependence’. Sandoval and Voss (2016) describe how this was a problem after the volcanic eruption in Chaitén, Chile, in May 2008. They describe how a lack of control over the benefits may have produced a ‘welfare dependency’ in which people were reliant on government benefits for more than two years. The author of this paper observed a similar phenomenon in Thailand after the Indian Ocean tsunami of 2008. Survivors in Ban Nam Khem, the town studied by the author, received aid for over two years. The unprecedented level of international aid and compensation resulted in fishermen receiving two or three boats and families being given two houses. This excess attracted migrants and produced an unhelpful indolence amongst some. Similar patterns were reported in Indonesia and India (Régnier et al. 2008).

8 Science and engineering: informing decision-making

There have been major advances in our scientific understanding of natural hazards, in quantifying vulnerability, exposure and risk and in engineering solutions to mitigate damage. This knowledge, particularly its application in building codes and enforcement, has dramatically reduced the casualty rates in developed countries. Better disaster preparedness, early warnings and evacuation, immediate response and international relief have also had a positive impact. Fatalities, however, in very large disasters, such as Tohoku 2011, and in less developed countries such as Haiti, Pakistan and Nepal are still unacceptably large. Damage and economic losses are also huge and can impose severe strains even on developed economies like Japan. Nevertheless, the widening application of scientific knowledge and engineering expertise means that things are steadily improving.

New Zealand was perhaps the most impressive of the case studies in terms of the engineering and science that went into understanding the earthquakes and resultant damage and the development of clear guidance. In particular, a simple system of zoning land was devised according to the future risk of liquefaction and the type of foundation required. For example, Tonkin & Taylor, a firm of consulting engineers collated all the survey data, insurance claims and other information into a GIS that it made available to all the players (Platt, 2012b).

Worldwide there has been less progress in terms of understanding recovery and providing the information decision makers need to manage reconstruction. One area in which the author has personal experience is in the use of remote sensing to monitor recovery (Van Westen, 2000; Brown and Blaschke; 2010; Platt et al., 2011; Bello and Aina, 2014). There have been big strides recently in the use of data collected from satellite and airborne sensors to map hazards, assess post-earthquake damage, manage humanitarian and financial assistance and plan and monitor long-term recovery. The most useful application in the disaster management field is to estimate the vulnerability of buildings to earthquake and tsunami risk (Geiß et al, 2013; Geiß et al., 2014, Mück et al., 2013; Wurm et al., 2015).

However, the take up of this technology by disaster management practitioners and planners is disappointing.

Two types of information needs

The Nobel prize-winning economist Kahneman (2012) suggested that we have two ways of thinking. Fast thinking involves intuition and instinctive behaviour while slow thinking demands deliberation and rational analysis. The people charged with disaster management have to make choices fast using experience, instinct and following established protocols. They find it difficult to think about using the kind of information research scientists are able to provide. Moats et al. (2008) describe how, after major disasters, leaders are required to make high consequence decisions with incomplete or inaccurate information, ill-defined goals, and the pressures of time and a constantly changing situation by drawing on their training and experience. They posit scenario planning as a way that managers can understand better their environments so as to avoid disastrous events and to put in place efficient and effective plans for coping if disaster should strike. Bradfield et al. (2005) say public policy makers are increasingly using scenarios to involve multiple agencies and stakeholders in policy decisions, enabling joined-up analysis and creating an accommodation platform to assist policy implementation.

As part of the EU project Framework to integrate Space-based and in-situ sENSing for dynamicvUlnerability and recovery Monitoring (SENSUM) the author devised a scenario planning game to better understand the information needs of disaster management decision-makers (See Figure 9; Platt et al., 2014). The game aimed to explore how information is needed at different stages in the recovery process and to address the question of why the take-up of new data technology, specifically remote sensing based maps, is slower than one might have expected. In the disaster management field, this approach has been applied in 'ShakeOut' preparedness exercises and drills (William Spangle Associates, 1994; Wein and Rose, 2011) and civil defence exercises (Bradfield et al., 2005). Of particular interest, Chermack (2004) analyses decision failure by isolating three key issues that affect dynamic decision-making in situations similar to that found in disaster management: bounded rationality, exogenous variables and friction.

Figure 9. Disaster recovery scenario planning game with disaster managers and reconstruction planners in Kyrgyzstan/Tajikistan (left) and Turkey (right)

Although the scenario planning game worked remarkably well, disaster managers in both countries had difficulty in transferring information needs into requests for data products. At the time we put this down to the pace of the disaster event forcing decision makers to follow standard protocols. We assumed that with more familiarity with GIS and remote sensing, information products would be more widely adopted. However, Kahneman's thesis of Thinking Fast, Thinking Slow suggests that the problem is more fundamental. The need to respond quickly means that disaster managers use intuitive System 1 thinking almost exclusively and may not be able to use the kind of information scientists are able to provide currently.

Two types of people needed for disaster management and recovery planning

This analysis suggests that Governments need to authorise two teams to respond to disasters: one, the usual civil defence team managing relief and immediate recovery who are good at System 1 thinking and the other who are good at both System 1 and System 2 thinking, planning long-term physical, social and economic recovery. The second team might have a few key people from civil defence who would provide liaison but would lead and comprise people seconded on merit for eighteen months to two years from academia, industry and the civil service.

Disaster management and the speed and quality of recovery

The preceding 5 endogenous factors can be used to construct an index of post-disaster management and recovery planning where each factor is scored between 0–4 on a 5-point subjective scale. It should be stressed that although the data used to construct this index is based on careful study of the available evidence, the assessments are subjective and based on the considered opinion of the author alone (see Table 5).

Table 5. Disaster management indicators and the speed and quality of recovery

Name	Governance	Decision-making	Build Back Better	Finance	Science Information	Normalised	SPEED	QUALITY
Northridge, USA	3	3	2	2	3	65	3	64%
Bam, Iran	1	1	1	1	2	30	25	36%
Indian Ocean	1	2	1	3	2	45	5	52%
Kashmir, Pakistan	2	1	1	1	1	30	15	32%
Wenchuan, China	2	2	2	2	3	55	5	52%
L'Aquila, Italy	1	0	1	1	2	25	20	40%
Maule, Chile	4	3	3	3	2	75	5	84%
Christchurch, NZ	2	2	2	3	4	70	10	68%
Tohoku, Japan	2	2	2	3	3	60	12	60%
Van, Turkey	2	3	2	2	1	50	5	56%

Figure 10 shows that there is a clear relationship between the standard of post disaster management decision-making (as assessed by the author) and both the speed (R^2=0.56) and quality of recovery (R^2=0.90). The relationship between post-disaster decision-making and the quality of recovery in terms of whether crucial aspects of the society and economy improve i.e. are 'built back better' is striking, although perhaps unsurprising.

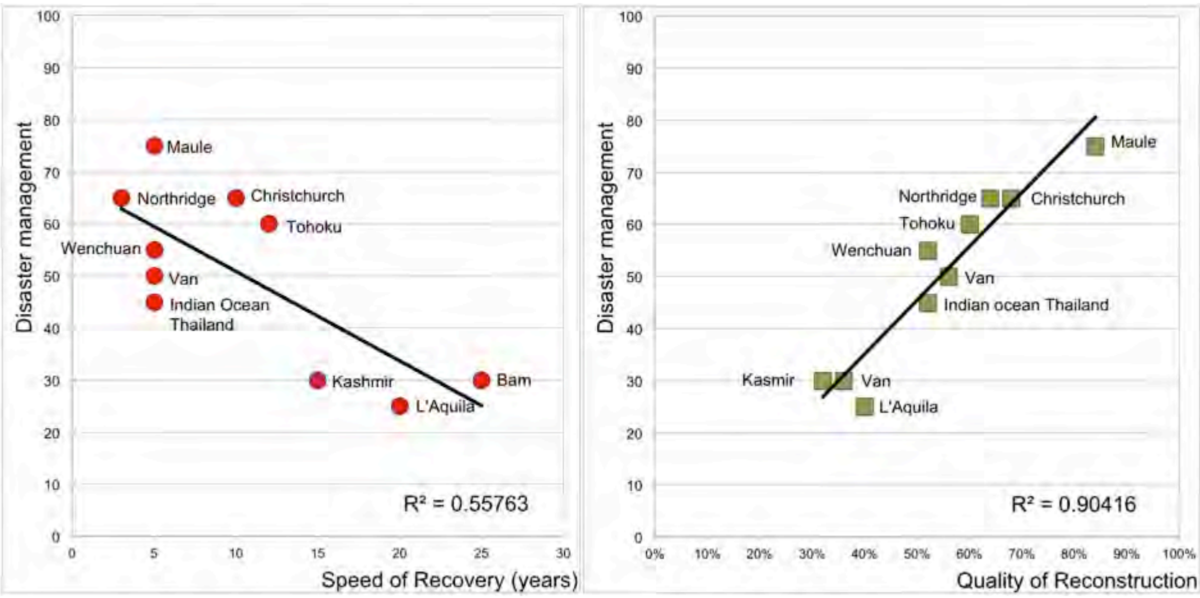

Figure 10. Disaster management and the speed and quality of recovery
Note the data plotted is an assessment of disaster management and the speed and quality of recovery for specific earthquakes, for example L'Aquila 2009, rather than an assessment of disaster management in general for all events in that country.

Discussion

Disaster resilience is widely assumed to be determined by how well a society resists the impact of a disaster event and by how quickly it recovers. But speed is not everything and that as well as 'returning to normality', 'building back better' is also important in assessing recovery since it increases resilience to future disasters.

It has been widely assumed by many people, including the author of this paper, that both exogenous and endogenous factors play a part in determining the speed and quality of recovery (for example Rubin and Barbee, 1985). The finding that none of the exogenous factors considered in this analysis has an effect on the speed of recovery sounds counter-intuitive. Common sense suggests that Japan is taking longer to recover than Turkey or the USA because the events were quite different in size of impact. One might assume that Pakistan is taking longer to recover than China because its economy is much weaker.

A possible explanation for this lack of relationship is that there are interactions between population and economic variables. The analysis, therefore, combined measures of population growth, GDP growth and the GINI index of equality to derive a simple index of societal resilience. This single index of societal resilience also had little effect. We know, however, that societal resilience is much more complex than population and economic dynamics. Various authors have argued that 'social capital' is important in building community resilience (for example Cutter, Burton, and Emrich, 2010; Aldrich, 2012) and others have talked about the adaptive capacity of families, communties and societies to respond to crises (for example Dovers and Handmere 1992; Kleina et al. 2003). This is a rich area for further research, not least to determine to what extent social capital and adaptive capacity are exogenous and therefore fixed, and to what extent they can be encouraged and developed in advance of disasters.

Before concluding it is important to question the reliability and replicability of the method of analysis adopted here. The author has studied recovery after more than a dozen disasters, 10 of which are reported here. This has afforded him a broad understanding of the issues involved in post-disaster recovery. However, the data used in the analysis is in part subjective. Although the assessments are based on evidence from field studies, remote sensing analysis, interviews and published data, there is the possibility of subjective bias.

There is also a danger of treating variables as independent when they are possibly inter-related. This is especially true of the relationship between the assessment of post-disaster management and the quality of outcomes. Post-disaster management was assessed in terms of the five exogenous factors: governance, decision-making, build back better, finance and science and information. Conceptually these are different from changes in the quality of housing, amenity etc. The author was aware of this risk and made efforts to differentiate the assessments. Nevertheless, there is a possibility that an assessment of governance and policies of building back better, for example, are confounded with the quality of recovery. In other words one is judging the standard of disaster management by the quality of recovery outcomes.

Next steps

The factors affecting the speed and quality of recovery would seem to be a promising area for further research. The reliability findings from this limited study of 10 cases would be improved with events from more countries. It would also be useful to study other earthquakes in the same countries to see if the variation in speed and quality varied as much within the same country as it does between countries.

In terms exogenous and endogenous factors it would be interesting to see if the frequency of earthquakes within a country has any effect. One might expect that in countries where earthquakes are frequent, national and local government and businesses and households would be better prepared, more resilient and recover faster than in places where earthquakes occur infrequently.

Conclusion

Disaster recovery is a huge subject for investigation. It applies to all sectors of society: housing, transport, infrastructure, industry, environment etc. and covers many aspects of human behaviour, from individual wellbeing to the macro-economy of whole regions. Our understanding of the issues ranges from the scientific to the intuitive and initiatives taken encompass professionally engineered solutions and spontaneous community action.

Governments seem unable to learn lessons from previous disasters in other countries. In part this is because of the relative infrequency of major disasters and a lack of direct experience amongst the key players. But it is also a product of the extreme time pressure on decision-makers from the public and press to be seen to be 'doing something'. It is perhaps not surprising then that progress in understanding and managing recovery has been relatively slow.

This chapter has explored to what extent pre-existing resilience (exogenous factors) and post-event response (endogenous factors) determine the speed and quality of disaster recovery. Careful analysis of the evidence from 10 recent earthquake related disasters tentatively suggests that exogenous factors – the magnitude of the event, population dynamics, the wealth of the nation and the state of the economy – play a smaller role in determining outcomes than has hitherto been supposed. Endogenous variables, i.e. the decisions, policies and choices governments and societies make, seem to have a greater effect on recovery outcomes than has perhaps been supposed.

The critical factors in determining speed and quality of recovery would seem, therefore, to be within the control of government decision-makers, recovery planners and local communities.

The evidence suggests that the quality of decision-making determines the difference between the post-disaster performance of different countries rather than the size of the impact of disaster or pre-existing demographic and economic conditions. If substantiated by other research this would be a significant breakthrough in our understanding of resilience and post-disaster recovery.

In conclusion, the key issues for governments and decision makers in hazard prone countries are:

1 Authority

Governments need to decide who is in charge of recovery and prepare the necessary legislation to assign this responsibility. They need to ensure that they form the most competent teams of people to manage the process of recovery (i.e. people good at System 2 long-term strategic thinking). And as far as possible, they need to involve local residents and business people in decision-making.

2 Decision-making

National, regional and local governments need to improve their preparedness, in terms of rehearsing critical decisions before an event.

3 Build back better

Every effort needs to be made to find ways of building back better both in terms of building structures but also urban planning and economic development.

4 Finance

Governments need to know where the money is coming from to finance reconstruction and to develop procedures for getting this money to the grass roots as quickly as possible.

5 Science and engineering

Decisions about reconstruction need to apply science to inform decision-making and engineering and construction know-how to build back better.

Above all, the people charged with managing recovery need to learn lessons from previous disasters, both in the same country and in other places. This is not happening nearly enough at the moment. Nevertheless, the idea that exogenous variables are more significant than endogenous is literally empowering. It means that recovery outcomes after major disasters are in our own hands and we can decide how to recover quicker and build back better.

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Appendix A. Interview questions

Personal: You and your involvement with a particular earthquake

1. What is your role or experience in disasters?
2. What relations do you have with local or central government?
3. What event do you have experience of? How big an event? Casualties, fatalities?

The Event: impact of the earthquake – Preparedness phase

4. Amount of damage – residential, commercial, infrastructure?
5. How well prepared were you physically, economically and in terms of organisation?
6. In what way was the economy affected?
7. How has society or social organization been affected?

Meta decisions: Strategic decisions made at high level by central government

8. Who was in charge – the existing authorities or a special dedicated body?
9. Was new legislation passed or were new authorities created?
10. Was the emphasis on speed or on community involvement and building back better?
11. Was the aim to reinstate what had been lost or was it an opportunity to change?
12. How far was the Government involved in recovery?
13. What proportion of resources went on relief and what on long-term recovery?

Operational Emergency Management Decisions – Relief and response phase

14. How did central, regional and local government respond?
15. Who coordinated relief and made operational decisions?
16. Could information be provided quickly enough to influence decision-making?
17. How many people were displaced and how many needed temporary shelter?
18. Where were transitional shelters located? Did this affect permanent housing?
19. Who provided temporary units, of what size, material etc?
20. What essential public services were disrupted?
21. What proportion of people were insured?
22. How badly were water, sanitation and food supplies affected?
23. Which access roads were blocked and needed clearing?
24. Where were public services located? Health, schools etc?

Planning Decisions – Recovery and reconstruction phase

25. Who was in charge of recovery and reconstruction?
26. Has the urban planning process changed to manage post-earthquake recovery?
27. How is policy developed and by whom?
28. Who does land use, transport or economic development planning?
29. Was there an urban or regional plan? Was there an economic development plan?
30. What other organisations were involved? Scientific institutes, universities?
31. What scientific, land use or census information was used?
32. How is policy and action coordinated between national regional and local authorities?
33. Is recovery and reconstruction monitored?
34. How is information used to guide the planning process?
35. What stage is recovery at? How long do you think it will take?
36. What is the impact of demographic change and migration?
37. How were people helped or compensated? Insurance? Government assistance?
38. How resilient is the community and to what extent can family networks drive recovery
39. How were displaced people rehoused? Who decided about resettlement?
40. How is housing need or demand assessed?
41. How is speedy recovery balanced against deliberation?
42. What cultural issues are involved in recovery and reconstruction?
43. Are local residents involved in decision-making, for example where to rebuild?
44. Is anyone working on plans to improve the city? What new projects are planned?

Long-terms Decisions – Future mitigation

45. In what ways is the country/city better prepared for another disaster?
46. Have any previous built up areas been defined as too hazardous to rebuild?
47. Has critcial infrastructure and essential services been relocated?
48. Have building design codes changed?
49. How effective is inspection to ensure buildings are repaired properly?
50. Were lessons learnt and has the public perception of risk been improved?

Appendix B. Disaster recovery survey

Disaster Recovery Survey

This survey aims to understand recovery after earthquakes. The survey is being conducted by Cambridge Architectural Research (www.cardltd.com) and the data will be used only as part of an international scientific study.

1. About you

Your profession or job

____

(Your relation to the disaster area)

- ◯ I live in Van
- ◯ I work/study in Van
- ◯ I am not based in Van but I study or work on Van
- ◯ Other

2. As of today, have the following recovered or been provided?

Permanent Housing (return to repaired or new homes)

◯ yes ◯ no ◯ partial ◯ don't know

Economy (workers back to work and jobs, commerce, industry, agriculture get back to normal)

◯ yes ◯ no ◯ partial ◯ don't know

Earthquake Safety (preparedness against future earthquake, feeling of safety)

◯ yes ◯ no ◯ partial ◯ don't know

Infrastructure (bridges, roads, power, water, sewage, telecommunications)

◯ yes ◯ no ◯ partial ◯ don't know

Non-domestic buildings: Commercial, religious, private sector, govermental buildings, schools, hospitals

◯ yes ◯ no ◯ partial ◯ don't know

3. How long did it take or will it take to restore the following?

Permanent Housing (return to repaired or new homes)

◯ less than 6 months ◯ 6-12 months ◯ 1-2 years ◯ 3-4 years ◯ 5-6 years
◯ more than 5 years

Economy (workers back to work and jobs, commerce, industry, agriculture get back to normal)

◯ less than 6 months ◯ 6-12 months ◯ 1-2 years ◯ 3-4 years ◯ 5-6 years
◯ more than 5 years

Earthquake Safety (preparedness against future earthquake, feeling of safety)

◯ less than 6 months ◯ 6-12 months ◯ 1-2 years ◯ 3-4 years ◯ 5-6 years
◯ more than 5 years

Infrastructure (bridges, roads, power, water, sewage, telecommunications)

◯ less than 6 months ◯ 6-12 months ◯ 1-2 years ◯ 3-4 years ◯ 5-6 years
◯ more than 5 years

Non-domestic buildings: Commercial, religious, private sector, govermental buildings, schools, hospitals

◯ less than 6 months ◯ 6-12 months ◯ 1-2 years ◯ 3-4 years ◯ 5-6 years
◯ more than 5 years

4. How has the "quality" of the following changed comparing to pre-earthquake?

Permanent Housing (return to repaired or new homes)

◯ much worse ◯ worse ◯ same ◯ better ◯ much better

Economy (workers back to work and jobs, commerce, industry, agriculture get back to normal)

◯ much worse ◯ worse ◯ same ◯ better ◯ much better

Earthquake Safety (preparedness against future earthquake, feeling of safety)

◯ much worse ◯ worse ◯ same ◯ better ◯ much better

Infrastructure (bridges, roads, power, water, sewage, telecommunications)

◯ much worse ◯ worse ◯ same ◯ better ◯ much better

Non-domestic buildings: Commercial, religious, private sector, govermental buildings, schools, hospitals

◯ much worse ◯ worse ◯ same ◯ better ◯ much better

6. Is there anything you would like to add? Many thanks for completing the survey.

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