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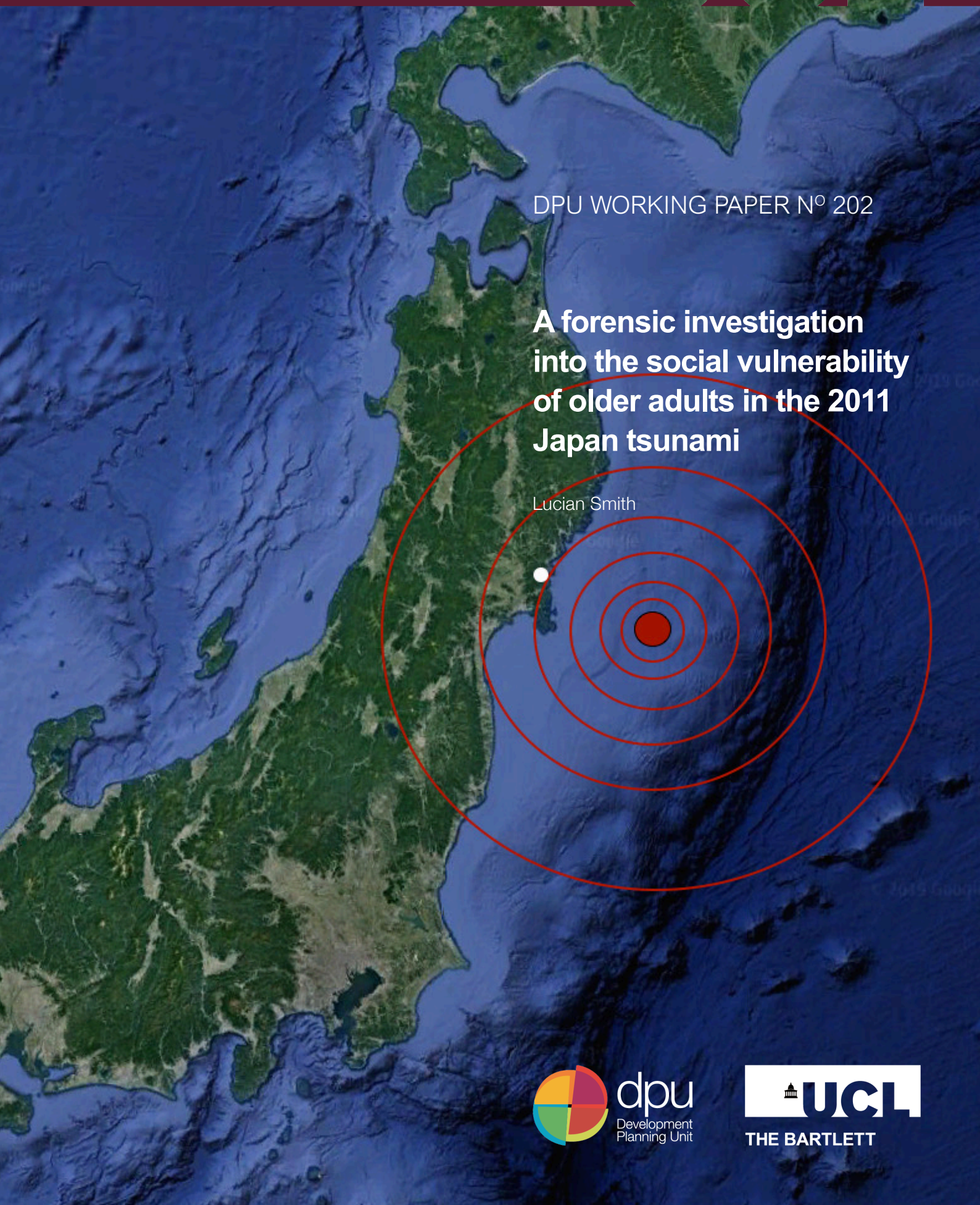

DPU WORKING PAPER Nº 202

A forensic investigation into the social vulnerability of older adults in the 2011 Japan tsunami

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DPU WORKING PAPER NO 202

A forensic investigation into the social vulnerability of older adults in the 2011 Japan tsunami

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Environment and Sustainable Development
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Abstract. Natural hazard-induced disasters are increasing in scale, frequency and intensity around the world. Fearing this trajectory, the Sendai Framework for Disaster Risk Reduction 2015-2030 has called for urgent changes to disaster research, governance, investment and preparedness. At its heart, it lists Priority One as 'understanding disaster risk', demanding more comprehensive, probing and integrated research into the social drivers of disaster to better inform policy and practice, and more effectively abate disaster construction.

Yet, to date, such attempts appear sparse. Vital research gaps remain, even in the most well-documented catastrophe in recent years - the 2011 tsunami in Japan. Here, while distinct social and spatial mortality patterns have been uncovered, researchers have not gone far enough to provide explanations for the differential deaths of older adults, especially in a historically tsunami-prone, yet seemingly well-prepared, coastal area – Sanriku. Crucially, the need to examine the roles of national and local governance and the importance of underlying population dynamics has been widely overlooked.

This paper attempts to address this explanatory gap, adopting, adapting and operationalising a cutting-edge forensic approach to probe the anthropogenic and development-based drivers of older adults' social vulnerability to the tsunami in Minamisanriku town. Ultimately, through implementing and reflecting upon the utility and findings of this adapted framework, this paper demonstrates the analytical necessity, but operational challenges, of pursuing Priority One of the Sendai Framework.

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List of Acronyms

EERI – Earthquake Engineering Research Institute
EWS – Early Warning System
FDMA – Fire and Disaster Management Agency
FORIN – Forensic Investigation of Disasters
ICSU – International Council for Science
IRDR – Integrated Research on Disaster Risk
ISSC – International Social Science Council
JMA – Japan Meteorological Agency
LDP – Liberal Democratic Party
OECD – Organisation for Economic Co-operation and Development
RLA – Retrospective Longitudinal Analysis
SBJ – Statistics Bureau of Japan
SFDRR – Sendai Framework for Disaster Risk Reduction
UNISDR – United Nations International Strategy for Disaster Reduction
WWII – World War II

1. Introduction

Natural hazard-induced disasters are increasing in scale, frequency and intensity around the world (UNISDR, 2018). Fearing this trajectory, the most important international instrument for disaster mitigation, the Sendai Framework for Disaster Risk Reduction 2015–2030[1] (SFDRR), has called for urgent changes to disaster research, governance, investment and preparedness. At its heart, it lists Priority One as 'understanding disaster risk', demanding more comprehensive, probing and integrated research to better inform policy and practice, and more effectively abate disaster construction (UNISDR, 2015). This paper engages with this principal priority, using the most well documented major catastrophe in recent years to show the necessity, but challenges, of better understanding disaster.

The 2011 Tōhoku tsunami was one of the most destructive naturally occurring hazard events of the 21st century. On 11th March 2011, at 14:46 JST, a Mw9.0 earthquake 72km off the shoreline of north eastern Honshu in Japan triggered a tsunami, reaching wave heights of over +20m above sea level as it hit land about 25 minutes later. It devastated coastal settlements across the Tōhoku region, resulting in 19,575 dead, 6,230 injured, 2,577 missing and around 470,000 displaced persons (FDMA, 2017; HelpAge International, 2013).

The disaster generated global headlines of shock and sympathy, portrayed as an overwhelming, unfortunate, and ultimately unstoppable natural tragedy in the most tsunami-prepared country in the world. In its immediate aftermath, media interest fixed primarily on the unprecedented tsunami-induced meltdown of the Fukushima Daiichi Nuclear Power Plant. Meanwhile, research concentrated on the extremeness of the event's geophysical hazards (see Mori, 2012; Goda, 2013; Fraser et al, 2013) and the vast scale of physical damage they inflicted (see EERI, 2011; Yalciner et al, 2011; Takahashi et al, 2011; Suppasri et al, 2013b; Faure Walker, 2013).

Yet, despite this abundance of attention, the human consequences of the tsunami were widely overlooked. Only more recently have they been revisited, and the distinct social and spatial patterns of mortality been revealed across the disaster zone (see Koyama et al, 2012; Nakahara et al, 2013; Aldrich & Sawada, 2015; Yun & Hamada, 2015; Suppasri et al, 2016; Nakasu et al, 2018; Latcharote et al, 2018). Alarmingly, over 57% of all deaths were older adults, over the age of 65 (Nakahara et al, 2013). This rate was magnified in Sanriku, the most historically tsunami-susceptible area in Japan, where a disparately aged population resided.

More than eight years after the tragedy, disaster-devastated Sanriku municipalities have struggled to recover. Throughout this period, the disproportionate burden on older adults has been widely reported (see HelpAge International, 2013; Ando et al, 2017; Naylor et al, 2018). Yet, scholars have delved deeper, isolating underlying issues relating to both recovery governance, and population shrinkage and ageing as key to their situation in slow-recovering towns (see Matanle, 2011; Muramatsu, 2011; Matanle & Rausch, 2011; Cho, 2014; Thiri, 2017). In fact, they have indicated that these trajectories existed long before the 2011 tragedy.

Yet, somehow, at the time of writing this paper, the reasons for older adults' differential disaster mortality, especially in Sanriku, remain unknown. No analysis has probed this, let alone in such depth. While the researchers listed above have importantly eked out the demographic and geographic distribution of deaths in the tsunami, they have failed to take the most vital step: explanation. Sadly, as a consequence of not truly comprehending the disaster and its causes, recovery efforts have created new age-related issues in these towns.

The remaining knowledge gaps surrounding the 2011 event exemplify the importance of pursuing Priority One of the SFDRR. It is clear that disaster construction can only be understood through more ambitious, in-depth investigations, but, frustratingly, such attempts are still sparse today. Therefore, this paper, through the tragedy in Tōhoku, takes on the challenge.

Research Question:

Why did death disproportionately affect older adults in Minamisanriku in the 2011 Tōhoku tsunami?

Research Aims:

1. Illuminate the reasons for older adults' differential disaster deaths in minamisanriku by probing in greater depth than current analyses.

2. Adapt and operationalise a framework and approach at the forefront of disaster causality research, and test its utility for future research and practice.

This paper proceeds as follows:

In Chapter Two, I build upon Chapter One to contextualise this case study and Research Question more thoroughly, by justifying the need for and nature of this investigation, and grounding focus in Minamisanriku, one of the most prepared yet devastated Sanriku towns.

In Chapter Three, I adopt and adapt FORIN, a progressive project at the forefront of disaster causality efforts, promoting more probing research to reveal the development-based, anthropogenic causes of disaster. However, appreciating the need to tailor a more context-sensitive framework, I use insight from Chapter Two to centre a notion of older adults' social vulnerability, and build a risk driver-oriented population dynamics perspective.

In Chapter Four, I outline RLA, a complementary FORIN-recommended approach concerned with the spatial and temporal construction of disaster risk that can best operationalise the framework of Chapter Three, using a longitudinal research design and narrative.

In Chapter Five, I conduct an analysis to dissect the historical construction of older adults' differential disaster deaths in Minamisanriku in the 2011 Tōhoku tsunami. This begins by identifying critical conditions in the proximate, immediate context, before moving beyond the disaster event to contextualise these in far greater depth, with particular attention to: the influence of underlying population drivers; the centrality of the national development pathway; and the decisions, priorities, resources, distribution and responsibilities of national and municipal government actors over space and time.

In Chapter Six, I critically re-engage with the Research Aims to present the findings of my analysis, reflect upon the utility of an adapted FORIN, and extract my investigation's implications for future disaster research and practice, in line with Priority One of the SFDRR.

Ultimately, this paper aims to inspire others to conduct comprehensive forensic disaster research, by demonstrating the urgency to pursue and promote the untapped potential of truly understanding causality for mitigating disasters around the world.

NOTES TO CHAPTER 1

1. The SFDRR is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015. The HFA was conceived to give further impetus to the global work under the International Framework for Action for the International Decade for Natural Disaster Reduction (1989), the Yokohama Strategy for a Safer World (1994), and the International Strategy for Disaster Reduction (1999) (UNISDR, 2015, p.5)

2. Background and context

Here, I advance Chapter One's brief observations on the case study, to more thoroughly contextualise the need for this investigation. After demonstrating the geographic and demographic concentration of disaster mortality in Sanriku, I situate focus on the deaths of older adults in one of its municipalities, Minamisanriku. By outlining how older adults have also borne the burden of recovery problems, and overviewing the breadth and depth of research examining this, I expose the imbalance and insufficiencies of current research into the 2011 disaster. As such, this Chapter not only justifies an investigation into older adults' differential disaster deaths, but also informs its nature.

2.1 Japan and tsunami

Japan is situated in one of the most active earthquake belts on Earth: the Pacific Ring of Fire. Throughout its history, seismic tremors from the subduction of volatile tectonic plates in the Japan Trench have triggered major tsunami that have struck the north-eastern coast of Honshu, especially the Tōhoku region. Prior to the 2011 disaster, the most recent events were in 1960, 1933 and 1896, with the 1896 Meiji Sanriku tsunami being the most devastating, causing over 22,000 deaths (Suppasri et al, 2016).

Japan has long been perceived as the country best prepared to withstand tsunami (Raby et al, 2015). Since 1961, natural hazard preparedness has been propelled through the Disaster Countermeasures Basic Act, permitting the national coordination of and funding for disaster planning right down to municipal level (National Land Agency, 1961; OECD, 2006). Leading up to 2011, advancements were particularly evident in Tōhoku's coastal towns. Firstly, site-specific structural countermeasures, such as breakwaters, seawalls, river gates and control forests, were created as physical buffers for low-lying settlements (Raby et al, 2015). Secondly, softer measures, including evacuation protocols, annual drills and education programmes, helped further public awareness of tsunami threat (Suppasri et al, 2013a). Thirdly, in 2007, the Japan Meteorological Agency (JMA) implemented a state-of-the-art Early Warning System (EWS). This technologically sophisticated system received international praise for its ability to improve evacuation success by rapidly predicting tsunami and disseminating warnings within municipalities via a variety of mediums (Naylor et al, 2018).

2.2 Patterns of death in the 2011 event

Spatial distribution

Sadly, the above mentioned measures did not prevent disaster in 2011. Vast human losses were confined to coastal zones in Fukushima, Iwate and Miyagi prefectures (Figure 2.1), with the highest concentration of deaths along the Sanriku Coast and the Sendai Plain (Figure 2.2), in closest proximity to the earthquake and the tsunami that was triggered (FDMA, 2017). Along the flat terrain of the Sendai Plain, its characteristically larger towns suffered substantial inundation and greater mortality tolls. In comparison, the smaller fishing towns situated in Sanriku's coastal inlets experienced disproportionately high rates of damage and death (Table 1.1) (Latcharote et al, 2018; Nakasu et al, 2018).

Table 1.1: Disaster comparison between the Sanriku Coast and Sendai Plain (SBJ, 2010; GSI, 2011; FDMA, 2017)

	Sendai Plain	Sanriku Coast
Population	1724,571	357,155
Inundated areas (Km2)	375	87
Population in inundated areas	297,613	167,538
Dead or missing	9055	8783
Completely destroyed houses	70,811	33,988
Completely destroyed houses in inundated areas (%)	14.1%	29.6%
Death rate in inundated areas (%)	2.80%	4.55%

Figure 2.1: Prefectures most affected by the 2011 tsunami (Google Earth, adapted by Author, 2019)

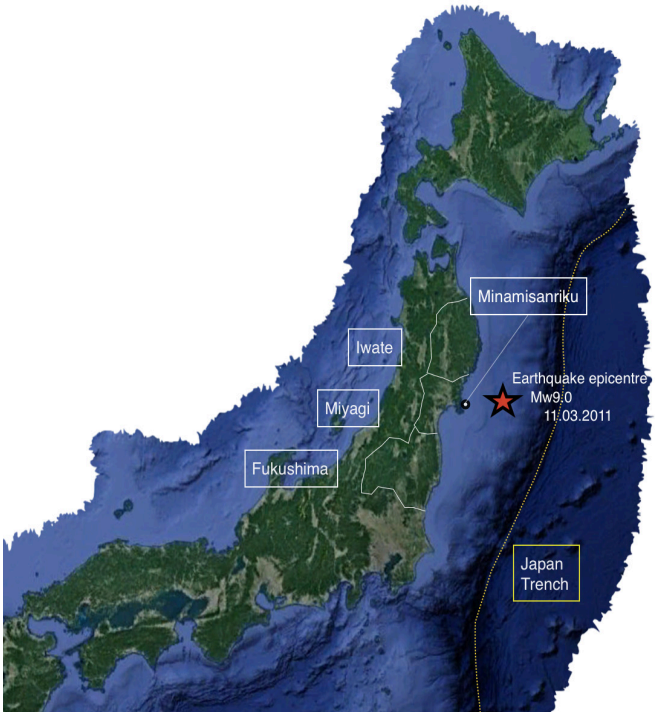
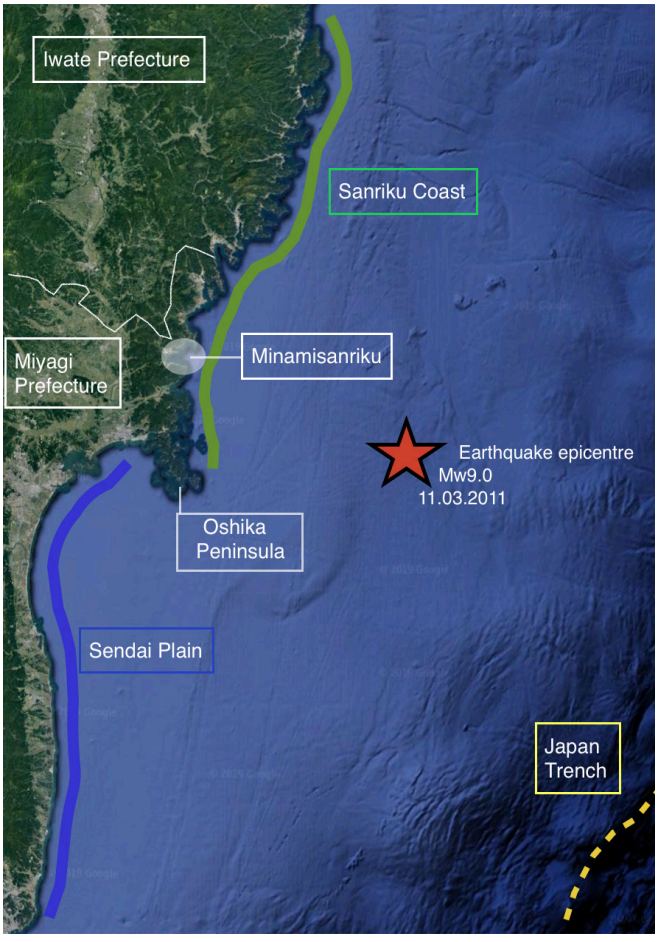


Figure 2.2: Situating Minamisanriku within the disaster zone (Google Earth, adapted by Author, 2019)



Historically, Sanriku towns are the most tsunami-susceptible in Japan, and have been hit by numerous major events, the first dating back to 869 (Suppasri et al, 2013a). Their exposure is commonly attributed to both their proximity to the Japan Trench, and their distinctive topographical characteristics, with V-shaped ria (Figure 2.3) confining residence to low-elevation bays surrounded by steep hillsides, amplifying tsunami size (Fraser et al, 2013; Goda et al, 2013). In contrast, Sendai Plain has remained largely unaffected by tsunami, sheltered by the visually prominent Oshika Peninsula separating these two coastal zones. Before 2011, the last tsunami event recorded there was in 1611 (Suppasri et al, 2013a).

Figure 2.3: Sanriku Coast's ria topography (Google Earth, adapted by Author, 2019)

Social distribution

There has been a growing consensus that age was a major determinant of disaster deaths, especially in Sanriku. Across the disaster zone, 57% of total fatalities were over the age of 65 (Figure 2.4). In contrast, child mortality was lower than in the past three Japanese tsunami events, accounting for just 4% of the death toll (Nakahara et al, 2013). Multiple scholars (see Aldrich & Sawada, 2015; Yun & Hamada, 2015; Latcharote et al, 2018; Nakasu et al, 2018) have attributed the overall higher mortality ratios in Sanriku towns to the greater pre-disaster proportion of older residents there than other areas within the disaster zone. Indeed, in 2010, populations in Sanriku towns consisted of, on average, 32% over the age of 65, whereas this was far lower in the Sendai Plain (24%) (SBJ, 2010; Nakasu et al, 2018).

The significance of other social aspects, such as gender, has been downplayed in numerous regional and municipal analyses (see Sawai, 2012; Koyama et al, 2012; Nakahara et al, 2013; Nakasu et al, 2018); this said, the potential complexities of local death tolls must be appreciated. Indeed, some explorations have demonstrated the importance of gender interacting with age to affect municipal-level mortality (see Nagata et al, 2014); others have illustrated the plight of other social groups, such as Thai migrants or disabled persons, in certain towns (see Tatsuki, 2013; Uekusa, 2017; Pongponrat & Ishii, 2017).

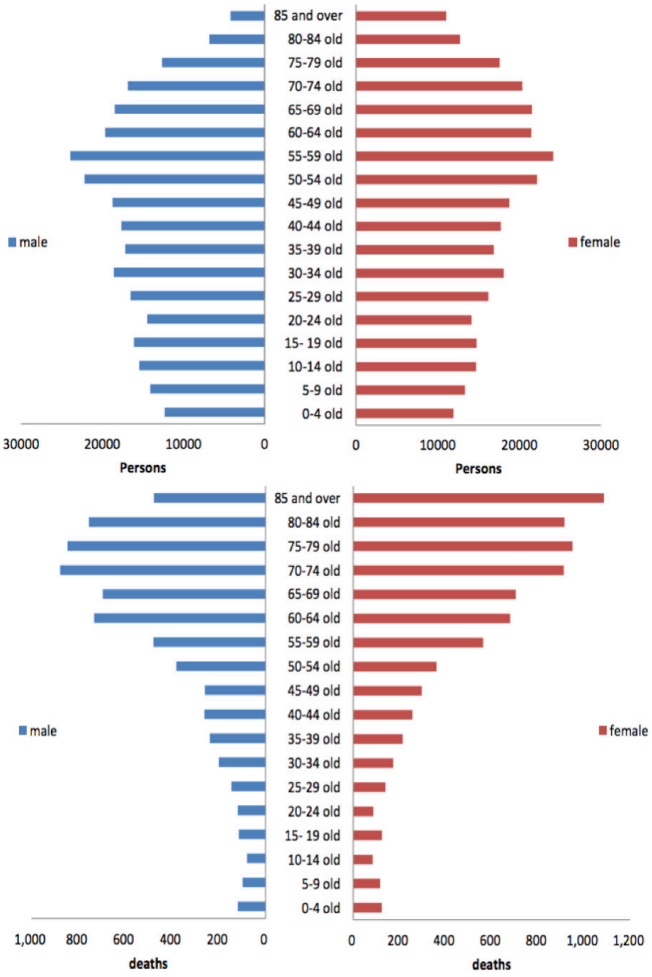


Figure 2.4: Population living in the disaster zone prior to the 2011 event (top) versus the population pyramid of disaster deaths (bottom) (Koyama et al, 2012)

Unfortunately, disaggregated government data at municipal level seems either uncollected or inaccessible. However, local death toll estimates do indicate age as the principal determinant, especially in Sanriku (see Yotsui et al, 2014). Therefore, while appreciating the possible influence of other social aspects, acknowledging older adults as a heterogeneous group over the age of 65 allows us to treat them as a group dominantly defined by age for this investigation.

2.3 Disaster in Minamisanriku

Minamisanriku is an ideal location in which to situate this investigation. Prior to the 2011 tsunami, this small Sanriku coastal town was widely regarded as the most tsunami-prepared in Japan, but it was one of the worst affected.

Minamisanriku is a fishing and agricultural town, situated in a low-lying inlet on the Sanriku Coast. Before the tsunami its population was 17,645, with over 52% living in Shizugawa, the town centre (SBJ, 2010; Minamisanriku Planning Division, 2016). Municipal and public buildings were concentrated here as well. However, residential development also extended 1.5km along the town's three rivers (Fraser et al, 2013).

The municipality was officially configured as part of the 2005 Great Heisei Merger. This government-led initiative saw the creation of larger municipalities across Japan, with the intention to increase the administrative and fiscal power of local authorities (Takahura, 2007). Through this merger process, four districts – Shizugawa, Utatsu, Tokura and Iriya – voluntarily amalgamated to form Minamisanriku (Figure 2.5) (Faure Walker, 2013).

Figure 2.5: Minamisanriku and its districts (Google Earth, adapted by Author, 2019)

Prior to 2011, Minamisanriku had acquired an international reputation for tsunami preparedness (EERI, 2011). This status was based upon its imposing physical countermeasures, notably the impressive river gates (+10m above sea level) and sea walls (+4.6m) that blockaded its rivers and lined Shizugawa Bay. These structural buffers were also complemented by the EWS and evacuation protocols (see Section 2.1). Furthermore, its population was acutely aware of tsunami threat, having suffered 2,480 disaster deaths in 1896, 174 in 1933, and 82 in the most recent 1960 event (Minamisanriku Planning Division, 2016).

However, Minamisanriku endured substantial human loss and physical damage in 2011. An estimated 25 minutes after the earthquake, waves exceeding +12.2m hit the town, reaching recorded heights of +23.9m in Shizugawa (Minamisanriku Planning Division, 2016; Muhari et al, 2012). The tsunami devastated the town centre (Figure 2.6), 60.93% of all residential houses were damaged or destroyed, 9,753 people were displaced, and 831 died (Minamisanriku Planning Division, 2016).

831 deaths from a population of 17,645 may not seem huge considering the tsunami's size. In fact, it could be viewed even more positively when compared with the far higher death toll in the smaller 1986 event, perhaps as a reflection of Minamisanriku's advancements in preparedness since 1960 (Suppasri et al, 2013a). However, downplaying this death toll and its causes is deceptive. Firstly, it neglects the death toll's details, in particular its likely demographic burden on older adults in the town (see Section 2.2). Secondly, it ignores the presence of government-implemented countermeasures and protocols (see Section 2.1) that should have allowed sufficient time for all residents, including older adults, to evacuate safely, but seemingly did not.

Figure 2.6 (top): Destruction of Shizugawa (Schauwecker, Japan-guide.com, 2011)
Figure 2.7 (bottom): Shizugawa's foundations still being laid in October 2018 (Schauwecker, Japan-guide.com, 2018)

2.4 Post-disaster problems

Post-disaster circumstances in Sanriku reinforce the need to better understand older adults' disaster mortality. Hopes for recovery, reconstruction and regeneration were optimistic, bolstered by the actions of national government releasing US$263 billion in aid to affected areas. In early 2012, a Reconstruction Agency was established to coordinate a regional revival strategy of physical rebuilding (2012-15) and industrial revitalisation (2015-20) (Cho, 2014). In Minamisanriku, plans involved elevating Shizugawa by 10m (Minamisanriku Planning Division, 2018). However, in this and other municipalities, recovery has endured significant setbacks, with physical rebuilding ongoing today (Figure 2.7).

Older adults seem to have borne a disproportionate burden of these recovery problems. They comprised a disproportionate number of people displaced to emergency shelters, were found to be more affected by conditions in shelters and temporary accommodation, and formed the majority of tsunami-related hospital admissions and post-event fatalities (HelpAge International, 2013; Faure Walker & Crawford, 2017; Naylor et al, 2018). Their social isolation and psychological wellbeing attracted nationwide concern (Faure Walker, 2013; Matsumoto, 2014; Yokoyama et al, 2014; Lin et al, 2016; Yotsui et al, 2016; Ando et al, 2017).

Their post-disaster situation in these slow-recovering towns has been probed even further. Firstly, a group of researchers (see Matanle, 2011; 2013; Matanle & Rausch, 2011; Muramatsu, 2011; Thiri, 2017) has revealed the linkages between recovery problems and population changes. After the event, youth and working-age out-migration from tsunami-devastated municipalities accelerated, intensifying the burden on older adults, and impairing economic and social recovery. In fact, of all affected towns, Minamisanriku suffered one of the biggest population declines, decreasing from 17,429 inhabitants in 2010 to 13,554 in 2015 (Thiri, 2017; SBJ, 2010; 2015). Secondly, various characteristics of recovery projects have been criticised for creating post-disaster issues, including funding allocations to municipal governments, the extent of citizen participation in planning decisions, and, in particular, the prioritisation of physical and economic aspects of recovery, rather than social and human (Matanle, 2011; Cho, 2014).

In fact, these underlying drivers may also have shaped the Tōhoku disaster mortality patterns. Matanle (2011), Matanle & Rausch (2011), Muramatsu (2011), Kudo et al (2015) and Thiri (2017) all acknowledge that out-migration, shrinkage and ageing in Sanriku towns were evident long before 2011. Similarly, both Matanle (2011) and Cho (2014) argue that there were long-running governance issues in its municipalities and indicate that post-disaster problems were a probable extension of these.

2.5 Research gaps

However, in contrast to the breadth and depth of academic attention to post-disaster circumstances, there remains an explanatory absence into older adults' disaster mortality in 2011. As established in Chapter One, while an increasing number of researchers have helped to uncover particular mortality patterns across the disaster zone, efforts have not gone far enough. These researchers, with the exception of Nagata et al (2014) and Nakasu et al (2018), have largely avoided attempting to produce detailed investigations at municipal level. Instead, analyses have predominantly occurred at a regional level, in particular through comparisons between the Sendai Plain and Sanriku Coast (see Suppasri et al, 2016; Latcharote et al, 2018).

To date, there has been no specialised investigation into the reasons for older adults' differential disaster deaths, let alone one of this depth. From examining the post-disaster context, it is clear that a full range of contributory factors, actors and processes, across multiple spatial and temporal scales, must be considered. This wealth of post-disaster research must be utilised, paying particular attention to the role of population changes and the governance of disaster planning for older adults.

As such, this Chapter has not just contextualised the need for this investigation, grounding it in Minamisanriku, but also produced vital insight to inform the nature of the framework and approach through which it can be conducted.

3. Analytical framework

This Chapter builds upon Chapter Two, to adopt and adapt a framework appropriate for investigating older adults' differential disaster deaths in Minamisanriku. This framework is based upon FORIN, a pioneering project at the forefront of disaster causality research. At the start of this Chapter, I show it to be conceptually and methodologically conducive with this paper's Research Aims. However, by outlining the challenges of using such a broad analytical framework, I argue the need to better tailor it to the context in which it is to be applied. To inform this process, I act upon the limited recommendations in FORIN's guide to research, criticisms of the only published forensic investigation into the 2011 disaster, and the findings of Chapter Two. As such, I centre focus on older adults' social vulnerability, and build a population dynamics perspective, to try to maximise FORIN's suitability for my investigation.

3.1 Forensic Investigation of Disasters (FORIN)

Rationale

The FORIN project is at the forefront of current efforts to understand disaster causality, providing a guide to retrospective, interdisciplinary and in-depth research. It was established in 2010 by the International Council for Science (ICSU) in cooperation with the International Social Science Council (ISSC) and the United Nations International Strategy for Disaster Reduction (UNISDR) as part of the Integrated Research on Disaster Risk (IRDR) programme (IRDR, 2011). A group of scholars led by A. Oliver-Smith, I. Alcántara-Ayala, I. Burton and A. Lavell (2016) (see also Burton, 2010; 2014; 2015; IRDR, 2011; Cutter et al, 2015a) pioneered the project, promoting it as a state-of-the-art alternative for investigating disasters. It emerged from dissatisfaction with contemporary research and practice which, despite growing efforts, have failed to prevent the global increase of natural hazard-induced disasters and losses (Whites, Kates & Burton, 2001; Lavell & Maskrey, 2014). Thus, FORIN is built upon criticisms of these current efforts, observing that:

1. Research into disaster is dominated by disciplinary approaches, and overly concentrated on physical hazards and events and the more immediate causes of loss and damage.
2. Disaster risk management practice is still very much dominated by reaction and response, to the detriment of development-based risk reduction and avoidance interventions.
3. The understanding of risk and disaster is still severely impeded by visions of natural disaster, the dominance of the physical factors affecting risk, and the marginalisation of more fundamental social processes.
4. Disaster should be understood as a social construct, based on the presence of a potentially damaging physical event but seriously and dominantly conditioned by societal priorities, needs, demands, decisions, and practices.

(Oliver-Smith et al, 2016, p.8)

Therefore, FORIN exists to counter the disaster research "deficit" (IRDR, 2011, p.6) that has emerged. This deficit is explicitly illustrated in this case study (see Section 2.5). Moreover, it has informed Priority One of the SFDRR (see Chapter One), the most important international instrument for disaster mitigation (Cutter et al, 2015b). In line with the SFDRR and its principal priority, FORIN promotes efforts to understand disaster causality in far greater depth, to induce more effective research and practice. This, along with its institutional backing, makes FORIN an extremely progressive framework through which to investigate my Research Question.

Conceptual underpinnings

FORIN is grounded in theory advocating the social construction of disaster. This theory emerged in the 1970s as a challenge to the popular hazard-dominated comprehension that deemed disasters as unexpected, extreme and fundamentally natural phenomena. This counter conceptualisation was developed by an expanding group of researchers led by Blaikie et al (1994) and others (see also Wisner et al. 1977; Hewitt, 1983; 1997; Susman et al, 1983; Cutter, 1996; Cutter et al, 2003; Wisner et al, 2003).

A social conceptualisation views disaster as the product of the interaction between people, places and a naturally occurring hazard. However, it directs analytical interest away from the physical event towards the persons and

areas affected. It views a disaster as a social construction, in that the impacts of an event are dominantly conditioned by underlying societal processes, which turn a naturally occurring hazard into disaster for particular groups of people, based on their social and geographic positioning. To this extent, disasters should be comprehended and treated as contextualised, processual and social phenomena (Blaikie et al, 1994; Wisner et al, 2003; Oliver-Smith et al, 2016).

It centers social vulnerability, a complex term which bridges components pertaining to both people (vulnerability) and place (exposure) (Cutter, 1996; Cutter et al, 2003). Vulnerability, for this paper, is understood as the "characteristics of a social group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard" (Wisner et al, 2003, p.11). Meanwhile, exposure refers to their location-based susceptibility to this hazard (Cutter & Finch, 2008). As such, social vulnerability encompasses a wide range of interacting factors over space and time.

This conceptualisation directs analytical importance beneath the conventional scales of analysis, moving beyond the event and site to recognise the underlying drivers of social vulnerability (Wisner, 2017). A generic narrative, taken from Wisner et al (2003) and largely reflected in FORIN, exhibits disaster's construction. Unsafe conditions in the proximate and immediate context are principally influenced by social, political and economic processes in society, or risk drivers. The creation, nature and distribution of these macro drivers derive from the particular socio-economic development pathway in place, or root causes. Thus, the social and spatial distribution of social vulnerability to a natural hazard emerge through this processual and development-based narrative, manifesting in particular mortality patterns in a physical event (Wisner et al, 2003; Oliver-Smith et al, 2016).

Points of departure

Building on this social vulnerability approach and its conceptualisation of disaster, FORIN differentiates itself from the perceived conceptual, methodological and practical shortcomings of these contemporary research efforts.

Firstly, FORIN assumes a "more critical stance" (Oliver-Smith et al, 2016, p.17) towards disaster construction. While employing a narrative similar to Wisner et al (2003), FORIN's authors argue that attention to risk drivers and root causes has not gone far enough. They extend the social conceptualisation to more strongly incorporate anthropogenic aspects. They disaggregate its development-based root causes beyond socio-economic models and ideologies, to instead comprise human decisions, priorities, policies and practices on how resources, including places, are allocated and used, by whom and for whom. As such, FORIN grants greater significance to institutional and governance elements, recognising their importance at national, regional and local levels, in either energising or reducing the drivers and conditions of social vulnerability to a natural hazard (IRDR, 2011; Burton, 2014).

Secondly, FORIN promotes methodological changes to better understand disaster causality. As established, FORIN's authors recognise that research tendencies, including quantitative propensity and disciplinary dominance, have created an explanatory void. However, they also act upon this, encouraging more integrated investigations that involve a variety of different sources and stakeholders, and presenting multiple ways through which researchers can operationalise its framework. For this investigation, the selection of sources and specific approach to be utilised are outlined in Chapter Four.

Thirdly, FORIN exists as much more than an academic framework, with the project holding objectives to improve disaster research, education, practice and policy, all rooted in Priority One of the SFDRR (Cutter et al, 2015b).

Therefore, not only is FORIN extremely appropriate for exploring this paper's Research Question and primary Research Aim to investigate mortality patterns in far greater depth, its novelty and pioneering nature mean that utilising it for this forensic investigation could actually benefit FORIN itself; hence the need for a secondary Research Aim, to reflect upon its wider potential for disaster research and practice through this case study.

3.2 Refining FORIN

Difficulties

Considering the sheer scope of its conceptualisation, FORIN's framework must be adjusted to the context of its application, to ensure a contained and constructive analysis. However, this proves rather problematic. Firstly, Oliver-Smith et al's (2016) research guide provides limited guidance on this, apart from suggesting an observed risk driver as a "pivot" (ibid, p.29) between different analytical scales. Secondly, the novelty of this type of disaster research means there are few attempts upon which to inform this adapted framework - an absence also attributed to the fundamental complexities of exploring social vulnerability (Cutter et al, 2003).

The shortcomings of the only published FORIN-inspired investigation into the 2011 disaster can aid this process. Nakasu et al (2018) examined mortality in Rikuzentakata, another Sanriku town. Their analysis did incorporate the historical development of the town and certain anthropogenic aspects of planning and governance, but they argued: "using only the FORIN approach does not identify the root causes effectively for this case study" (ibid,

p.25). However, they failed to recognise that it was the focal point of their research that had principally limited their success. An undifferentiated focus on all disaster deaths in Rikuzentakata, and failure to follow FORIN's suggestion to centre a specific risk driver, hindered their ability to produce more refined findings.

Learning from these lessons, following the recommendation of Oliver-Smith et al (2016) and using Chapter Two's thorough preliminary contextualisation can all help to adapt FORIN. While FORIN's especial emphasis on disaster governance (see Section 3.1) already seems extremely relevant for this study, the framework must also incorporate:

1. The focus on older adults in Minamisanriku.

2. The role of population dynamics in shaping their differential social vulnerability.

I attempt to construct this more context-sensitive FORIN framework in the subsequent sections.

Older adults' social vulnerability

The need to more accurately comprehend older adults' vulnerability to natural hazard events has been realised by an increasing number of scholars (see Eldar, 1992; Ngo, 2001; 2012; Smith et al, 2009; Cornell et al, 2012; Bodstein et al, 2014; Rhoades et al, 2017). Drawing insight from their work can help my FORIN framework to focus on this social group with greater consideration.

The knowledge gaps surrounding older adults' disaster deaths in the 2011 tsunami define this paper. Yet, this absence is evident beyond this case study alone. Despite age commonly being cited as a main determinant of vulnerability (Cutter et al, 2003), older adults' vulnerability to natural hazards remains a small and underdeveloped field, especially with regard to disaster preparedness (Cornell, 2012). Instead, research efforts remain predominantly concentrated on the post-disaster context, through health-focused perspectives, as explicit in this case study (see Section 2.4) (Ngo, 2001; 2012).

This deficit has allowed assumptions about their vulnerability to proliferate and become reinforced as popularised misconceptions. Old age is often treated as a 'de facto' determinant of everyday heightened social vulnerability, due to the increased likelihood of physiological, social and economic stress (Ngo, 2012). In the context of disaster, it is commonly assumed their vulnerability derives from physiological characteristics associated with ageing that would more likely affect individuals in this social group, such as restricted mobility hindering successful evacuation (Rhoades et al, 2017).

However, narrowly synonymising older adults' social vulnerability to a natural hazard with their physiological frailties is insufficient and misleading. Clearly, as for any other social group, this comprises a far greater breadth and depth of contributory factors that must be considered (Smith et al, 2009). Yet, our uncritical acceptance of older adults' intrinsic vulnerability has obscured the need for this more accurate and balanced understanding (Cornell et al, 2012). As evident in the research surrounding this case study (see Section 2.5), this has been widely overlooked.

Therefore, fully appreciating their social vulnerability to disaster is imperative for this investigation. In particular, contemporary researchers have deemed governance as especially important. For example, Cornell et al (2012) and Bodstein et al (2014) state the need to assess the responsibilities, policies, capacities and practices of national and local governments to provide protection to older adults, both in disaster scenarios and everyday life. This consideration complements FORIN's conceptual point of departure (see Section 3.1) and the suppositions in this study (see Section 2.5).

A population dynamics perspective

As established earlier in this Section, FORIN's founders suggest centring a risk driver as a way to tackle analysis. Chapter Two's findings indicate that historical population changes were influential in constructing older adults' differential social vulnerability in the Sanriku coastal area. Therefore, it appears appropriate to centre population dynamics in this framework.

However, population dynamics seems to be an underdeveloped component in FORIN. Although listed as one of FORIN's four main risk drivers, its definition and elaboration is limited – "population growth, migration and distribution" (Oliver-Smith et al, 2016, p.29). In fact, this brevity is evident throughout the foundational disaster causality research from which FORIN's definition was formed (see Section 3.1).

Subsequently, a group of demography scholars spearheaded by Martine & Schensul (2013) (see also Guzmán et al, 2009; McGranahan, Balk & Anderson, 2007; Balk et al, 2009; Schensul & Dodman, 2013) has criticised its current interpretation and use in vulnerability research. Instead, they argue that population dynamics should be considered a more central analytical component by:

1. Adopting a more nuanced definition of the term as "changes that affect the size, distribution and composition of a human population" (ibid, p.16).

2. Treating it as more than a supplementary macro entity at national and regional levels, by also realising its role in shaping social vulnerability patterns at local levels.

3. Recognising it as compatible with a social conceptualisation of disaster, with population changes defined by development priorities, policies, and their distribution.

(Schensul & Dodman, 2013)

These scholars' progression of population dynamics is situated within climate change adaptation literature. However, overlapping with the same theoretical foundations and concerns as FORIN (see Section 3.1), their work is just as applicable for the academic field of disaster causality research. Their emphasis on the importance of national and local governments to drive, distribute and define the consequences of population dynamics further supports FORIN's core meaning, and this paper's focus on older adults and natural hazards.

Treating this risk driver with greater appreciation by drawing upon these scholars' insights may strengthen its utility for this FORIN investigation. "Composition" ((see point 1) above) supplements attention to a specific social group at all scales of analysis. At the macro level, this can help connect the particular population patterns within a low-elevation coastal zone to underlying migratory processes and national and regional development policies (McGranahan et al, 2007; Balk et al, 2009). At the micro level, it can enable more detailed examination of the unsafe conditions for older adults within a locality, including their residential distribution and living arrangements, and how these were affected by municipal and national governments' decisions and actions.

Employing a population dynamics perspective for this investigation can demonstrate its benefits for FORIN but could also assist those who developed it. Across current vulnerability research, population dynamics has conventionally been conceived in the language of population growth. This is exemplified by FORIN's definition of the term. It is also evident in Martine & Schensul's work, where concern is channelled towards the proliferating phenomenon of urban vulnerability in Asian and African countries with youthful, growing populations.

Vulnerability scholars' increasing focus on areas at earlier stages of their urban transitions has shaped this tendency to treat population dynamics as synonymous with population growth. Such research is undoubtedly important, as it is a response to the major knowledge gaps surrounding risk trajectories in these regions. However, researchers must not overlook the full range of population processes that can construct patterns of vulnerability to natural hazards, both within these urbanising contexts and within more urbanised countries such as Japan. In fact, of all the foundational scholars mentioned in Section 3.1, only Cutter & Finch (2008) acknowledge the potential by-product of urban migration and growth – the construction of social vulnerability for the people and places left behind.

Thus, the case study used in this paper (see Section 2.5) may extend the comprehension of the population dynamics–social vulnerability relationship even further, by placing a spotlight on: a) urban ageing and shrinkage dynamics in the unique demographic context of Japan, b) the construction of these dynamics in a natural hazard-prone coastal area, and c) the role of these dynamics in determining differential and fatal social vulnerability to a tsunami-induced disaster event.

Therefore, an adapted FORIN provides an analytical framework that can explore my central Research Question and meet my primary Research Aim: to unveil the reasons for older adults' differential disaster deaths in Minamisanriku in greater analytical depth.

4. Methodology

A complementary approach advocated and outlined by Oliver-Smith et al (2016) in the FORIN guide can enable the analytical framework, built in the previous Chapter, to be best operationalised to explore the Research Question in depth.

4.1 Retrospective Longitudinal Analysis (RLA)

RLA is concerned with the place-based re-analysis of a disaster event, to uncover the reasons for particular patterns of disaster losses over space and time. It operates through two moments: description and analysis. The first moment was covered in Chapter Two, where the demographic and geographic concentration of mortality across the disaster zone was discerned, and described in a specific Sanriku town. This served as a necessary background to the second moment, analysis.

The analysis will occur in Chapter Five, aiming to provide an explanation for the description. It will investigate and identify the key factors, actors and processes that constructed older adults' differential and fatal situation of social vulnerability in the 2011 tsunami in Minamisanriku. It will advance through a longitudinal research path and narrative, locating critical unsafe conditions within the disaster event and site, before more deeply contextualising these by moving beyond the confines of the proximate, immediate context. It will be structured upon the conceptualisation of disaster construction established in Section 3.1: unsafe conditions, risk drivers, and development-based root causes. However, as shown by Figure 4.1, it will be adapted to the framework in Chapter Three, centring older adults and regarding population dynamics as the risk driver. In operation, by moving through the multiple levels of this longitudinal analysis, a deeper understanding of their deaths in the town will be elucidated.

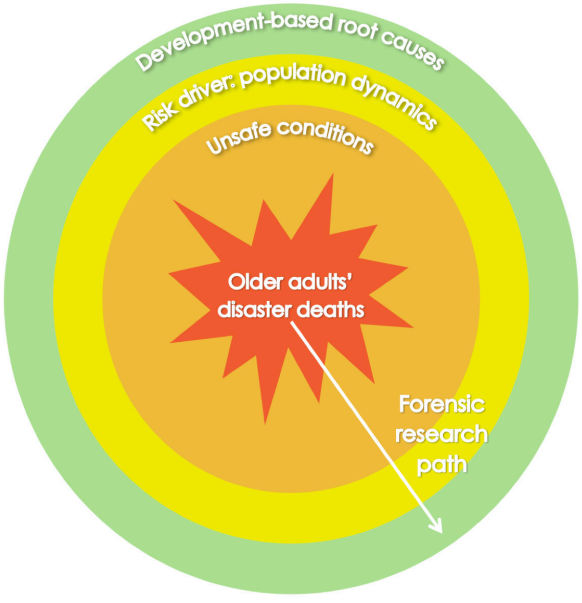


Figure 4.1: RLA research design, adapted from Oliver-Smith et al (2016) (Author, 2019)

4.2 Case study design

RLA operates through a case study. Chapters One and Two showed the rationale for using the 2011 Tōhoku disaster, and the need to focus on municipalities along the Sanriku Coast. The decision to ground investigation in a single town was informed by the perceived shortcomings of contemporary literature on the event, which has tended to conduct regional-level analyses to the detriment of in-depth, detailed, local examinations (see Section 2.5). Minamisanriku was deemed an ideal option, as the component of governance seemed particularly central for comprehending differential mortality. Additionally, refining focus on a specific social group within this locality may sharpen RLA's narrative even further.

4.3 Data sources

The RLA will be formed through desk-based research, by critically reviewing the body of available and relevant literature. It is necessary to appreciate the range of contributory factors constructing disaster, to align with FORIN's desire for more integrated research (see Section 3.1). A range of primary and secondary research will be incorporated, including applicable information from scholars in the post-disaster context (see Section 2.4). The publications reviewed will represent a variety of disciplinary backgrounds including demography, geography, geology, gerontology, Japanese studies, disaster science and sociology. National and municipal government websites will be consulted to obtain open-access data, including historical legislation and local plans on disaster preparedness, and to acquire population statistics. Without being able to conduct personal fieldwork, translating and utilising Japanese documentation is essential for maximising FORIN's acuity.

5. Analysis

Using the FORIN framework and approach built over the previous two Chapters, attention now turns to:

Why did death disproportionately affect older adults in Minamisanriku in the 2011 Tōhoku tsunami?

Probing the unsafe conditions in the immediate context of the event in the town, I will locate a critical cause of older adults' differential deaths in the tsunami. I will then incorporate the underlying population drivers and development-based root causes into this analysis, to contextualise more deeply their heightened situation of social vulnerability and, ultimately, to illuminate key elements in its construction over space and time.

5.1 Unsafe conditions

Natural hazards

The disaster's natural hazards are a logical entry point for this longitudinal analysis. As the largest earthquake to hit Japan on record, and in direct proximity to the north-eastern Honshu coastline, the size of the geophysical components appears central for understanding older adults' mortality in 2011. Indeed, across the region, inundation heights greatly exceeded those in previous major events (Goda et al, 2013). In Minamisanriku, wave sizes (12.2m-23.9m) dwarfed those of 1960 (3.0m-5.6m), 1933 (2.2m-10.5m) and even 1896 (2.7m-12.6m) (Minamisanriku Planning Division, 2016). Consequently, over 92% of victims across the disaster zone died as a result of drowning (EERI, 2011).

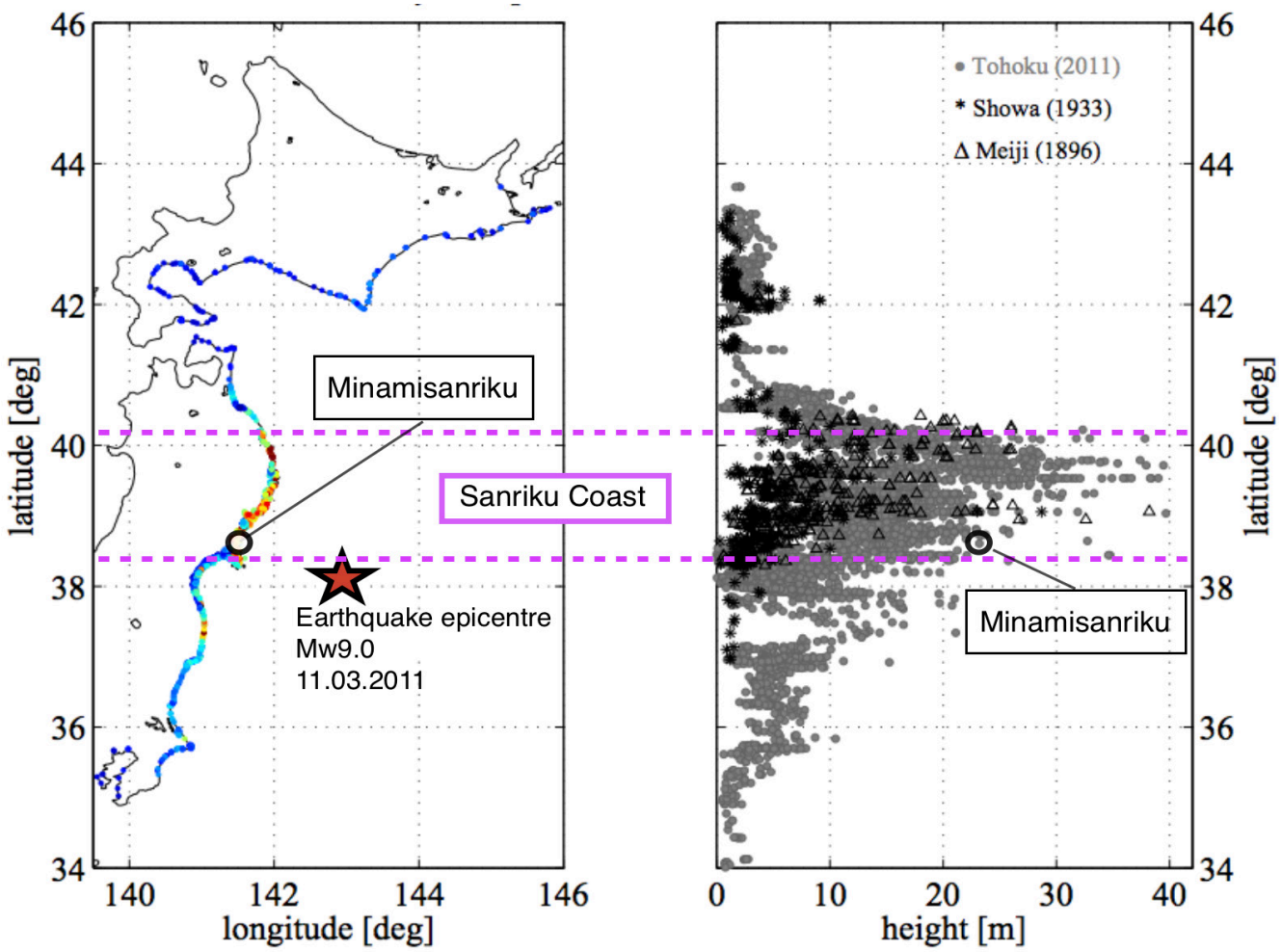


Figure 5.1: Tsunami height across the disaster zone (Mori et al, 2012; adapted by Author, 2019)

However, while the tsunami was undoubtedly the immediate cause of deaths, its centrality for comprehending mortality patterns has been widely downplayed. Research across affected areas has undermined any correlation between tsunami height, arrival time, and mortality (see Muhari et al, 2012; Suppasri et al, 2016; Latcharote et al, 2018). Indeed, wave heights in Minamisanriku were lower than in many other Sanriku towns because of its shallower ria characteristics (Figure 5.1). However, its overall fatality rate was relatively high (Figure 5.2) (Fraser et al, 2013). Therefore, to better understand older adults' fatality, attention must shift away from the tsunami towards its interaction with other aspects within the municipality.

Residential distribution

The town's concentration in a low-elevation coastal inlet increased the exposure of all its inhabitants. 85% of the population resided in the inundation zone, one of the highest proportions of all affected municipalities (Fraser et al, 2013; Yotsui et al, 2014). Close residential proximity to the shoreline was predominantly attributed to livelihood convenience for its local fishing economy (Faure Walker, 2013). However, it has also been linked to other factors, including topographical constraints preventing housing development at higher elevation. Without major port infrastructure, which provided buffers in larger towns, Minamisanriku's residential areas, especially Shizugawa, bore the brunt of the tsunami (Matanle, 2013).

Older adults' living arrangements likely heightened their social vulnerability within the town. Tatsuki (2013) found that more lived in single or couple household occupancy than in institutional care homes in Miyagi municipalities, compared to neighbouring prefectures. These observations have been attributed to Miyagi's changing social policies. Since 2006, it had led national efforts to reform care laws to reduce costs by piloting a 'community-based integrated care system' (Dahl, 2018). This was designed to enhance everyday support for older adults, by providing a local network of services while allowing continued residence in home-living environments (Ogawa, 2009). However, this may have had the opposite intended effect in a tsunami emergency, and appears to be a differentiating factor in Minamisanriku, one of the few Sanriku towns in Miyagi Prefecture. If this system did create a more scattered residential distribution in Minamisanriku, older adults would have been more exposed to the tsunami than in other Sanriku municipalities.

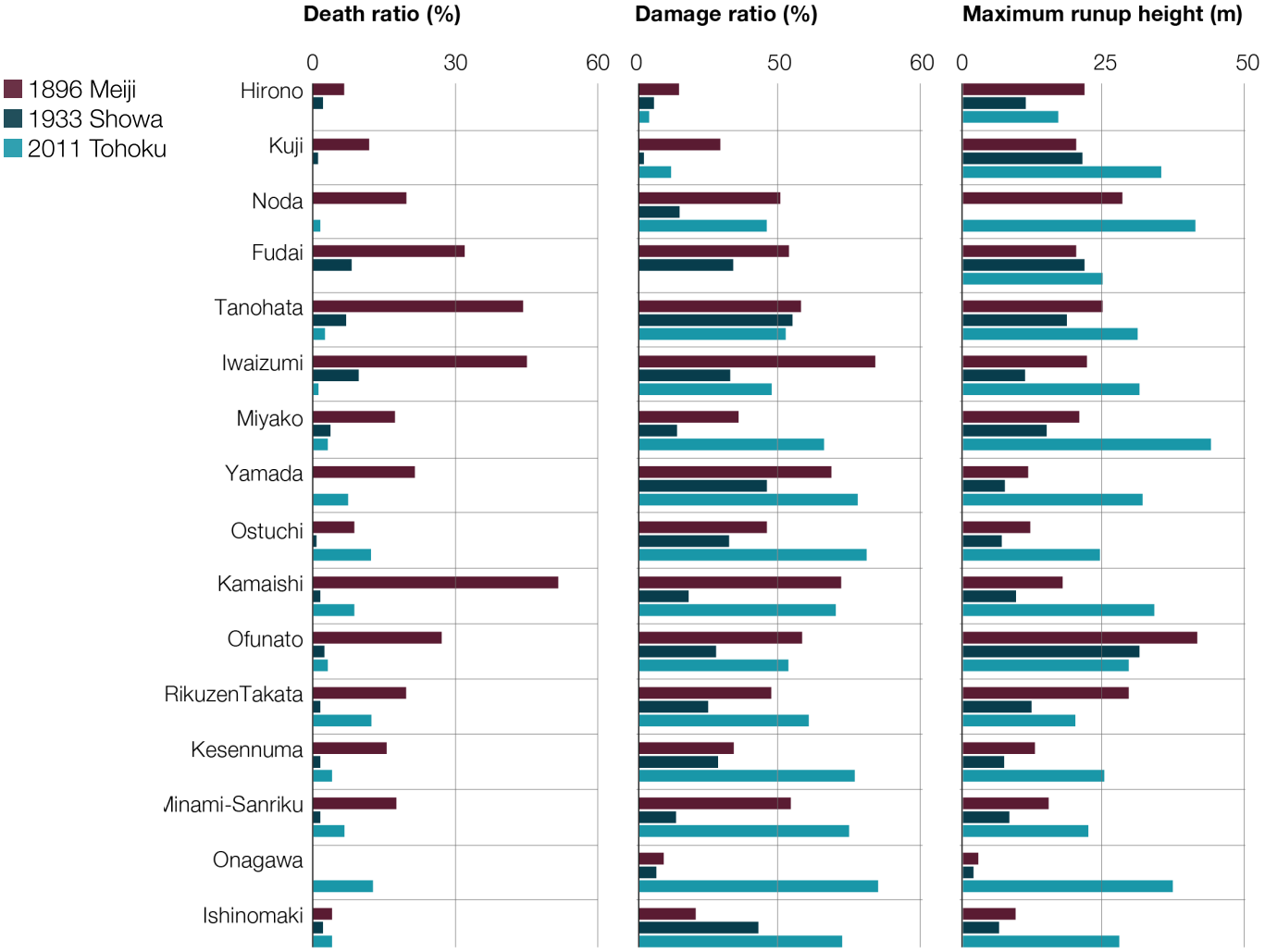


Figure 5.2: Undermining the correlation between tsunami size and disaster deaths (Suppasri et al, 2013a)

Tsunami countermeasure failures

Protective measures were imperative for mitigating the potential consequences of Minamisanriku's exposure. However, issues with countermeasures and protocols led directly to the loss of lives. Its structural barriers (see Section 2.3) did not provide the expected levels of protection. Breakwaters were overtopped and river gates buckled, resulting in its high inundation area. While these failures could be partly attributed to the tsunami's force and size, reports have criticised their design and quality. For example, their dimensions were based upon the significantly smaller 1960 event, and their construction materials were found to have undermined their stability and strength (Takashi et al, 2011; Suppasri et al, 2013a; Raby et al, 2015).

The EWS, a crucial part of the evacuation apparatus, was also blighted by operational troubles. Across the disaster zone, the system severely underestimated the tsunami's size. In Miyagi Prefecture EWS predicted waves of just +4m, only amended 24 minutes after the earthquake, when the maximum warning of +10m was issued. This update was entirely insufficient as the tsunami likely hit about a minute later, surpassing heights of +23m (Muhari et al, 2012). The EWS' errors seem to mirror the factors leading to the shortcomings of the town's physical countermeasures. Indeed, JMA (2013) blamed the system's inaccuracies on it being untested in an active event, and also being programmed to the dimensions of the 1960 hazard. In Minamisanriku, however, EWS' failures in 2011 may have had an even greater detrimental effect on evacuation. Its underestimation of the hazard directly contrasted with experiences in 2010 when the EWS predicted +4m waves, which failed to materialise (Naylor et al, 2018).

Yet, tsunami-planning problems seem to extend to more fundamental aspects in Minamisanriku. 31 out of 78 evacuation buildings were inundated, equating to the third highest municipal proportion in the region (Murai, 2011; Suppasri et al, 2013a). Factors such as the tsunami's size and the residential concentration in a low-elevation ria must have contributed to this. However, some researchers (see Sawai, 2012; Suppasri et al, 2013a; Raby et al, 2015) have observed the inappropriate designation of shelters in many Sanriku towns and associated this to ambiguities within national legislation which informed local disaster planning. The Disaster Countermeasures Basic Act (see Section 2.1) grouped earthquake and tsunami as similar hazards and required municipalities to implement a general evacuation plan, despite both needing divergent strategies (Sawai, 2012). As a consequence, the tsunami threat may have been side-lined in evacuation plans across Sanriku, probably due to the greater frequency of earthquake events. This seems true for Minamisanriku where, despite its imposing physical tsunami countermeasures, more basic elements of evacuation planning may have been lacking.
Ultimately, the shortcomings of countermeasures and protocols designed to maximise protection for Minamisanriku's population undermined its tsunami preparedness. When considering these general failures along with older adults' likely living arrangements in the town, concerns emerge about the state of evacuation plans for this specific social group.

Evacuation behaviour

Negative behaviour may also have contributed to Minamisanriku's death toll. Deviations from drills were reported throughout Sanriku, for reasons such as returning to check on businesses, trying to evacuate by car or helping family members (see Sawai, 2012; Yun & Hamada, 2015; Nakasu et al, 2018). The extent of deviations in Minamisanriku is unclear. However, any detrimental behaviour must be considered alongside the countermeasure failures shown in the previous Subsection.

It is highly unlikely that older adults would have ignored these warnings. Historically, they have been regarded as a source of wisdom and psychological strength in Japanese tsunami events, especially in Sanriku (Muramatsu, 2011). In Minamisanriku, experiences of previous tragedies, and the local advancements in preparedness since 1961, would have informed their awareness of tsunami threat (Suppasri et al, 2013a). As such, it seems misleading to assert that "misguided belief system" (Nakasu et al, 2018, p.21) led to their differential deaths. Rather, concerns should surround older adults' ability, not their intentions, to evacuate.

Age-related evacuation protocols

Multiple scholars have questioned the age appropriateness of disaster plans (see Yamori, 2012; Asai, 2015; Kodama, 2015). The national evacuation policy centred tsunami-tendenko, a maxim originating from the Sanriku Coast following the losses of families in the 1933 event. This dictated a survival strategy promoting immediate and individual evacuation, to minimise the chances of tomo-daore ('going down together') (Yamashita, 2008). Yet, a strategy based upon independence and speed is fundamentally unsuitable for an age group more likely to be physiologically hindered.

The need for age-related assistance was acknowledged by national and municipal governments, but not acted upon with urgency. The Evacuation Guideline for People with Special Needs (2005) listed older adults as a group requiring registered evacuation supporters, presenting steps for its municipal implementation across Japan. Yet, by 2011, 78% of municipalities had not assigned supporters (Tatsuki, 2013).

It is likely that this assistance was absent in Minamisanriku in 2011. Increasing this probability, Tatsuki (2013)

found that Miyagi's piloted care system had not planned for such scenarios and would have been unsuitable in times of emergency without sufficient evacuation supporters. Indeed, interacting with the unsafe conditions established in Section 5.1, the absence of age-related evacuation planning seems the critical factor expressing older adults' differential deaths in Minamisanriku. This vital planning omission must be explored in greater depth to understand how and why it occurred. Responsibility for this will be revisited towards the end of this Chapter (see Section 5.3) after a wider and deeper exploration into its causes and consequences.

5.2 Risk driver: population dynamics

Ageing composition

Minamisanriku's population profile appears essential in defining mortality patterns in the 2011 tsunami. Sanriku was disproportionately aged relative to other areas of the disaster zone, with over 32% of its population over the age of 65 in 2010. In Minamisanriku, more than 30% were over 65, which, despite being lower than Sanriku's average, far exceeded that for Sendai Plain municipalities in Miyagi (24%) and the national average (23%) (SBJ, 2010). As such, the consequences of failing to assign evacuation supporters for older adults in Sanriku towns would have been greater, and their residential dispersal in Minamisanriku would have exacerbated this even further.

The inadequacies of Sanriku's evacuation protocols have grown over time, as the proportion of older adults within Japan has increased. Unfortunately, disaggregated municipal-level data appears to be inaccessible. However, the ageing of Minamisanriku's population seems to reflect the national trajectory, which expanded from 4.9% in 1950, 7.1% in 1970, and 11.9% in 1990, to 23% over the age of 65 in 2010 (SBJ, 2012). By 2010, Japan had become the world's most aged population, due to various long-term demographic factors since the post-World War II (WWII) baby boom period, including fertility rate decline, increased life expectancy, and, particularly, cultural changes surrounding marriage and childbearing (Muramatsu, 2011; Kudo et al, 2015; Ziomek, 2017).

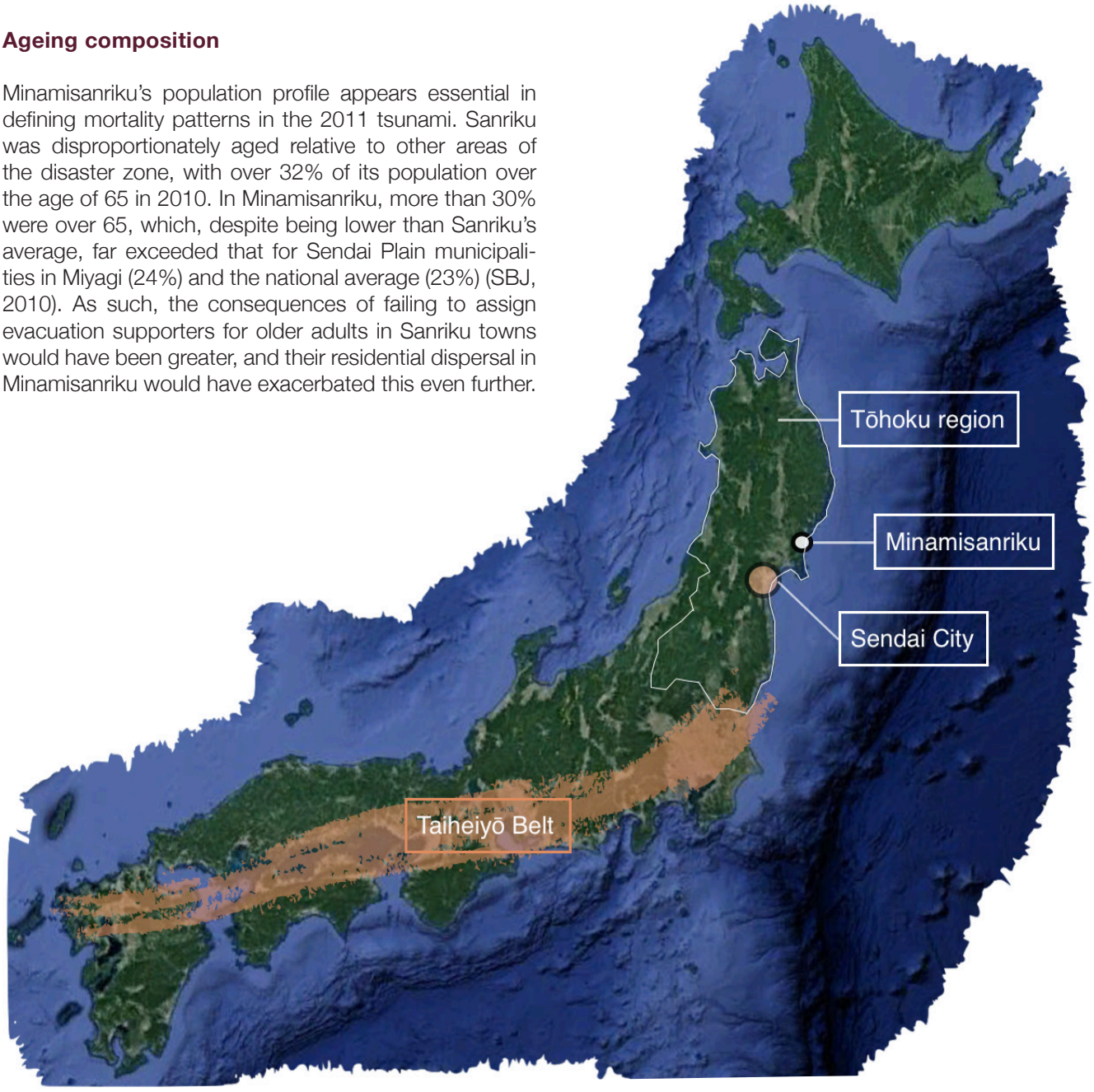


Figure 5.3: Minaminsanriku's distance from Japan's industrial centres (Google Earth, adapted by Author, 2019)

However, ageing and its causes are not central to comprehend disaster deaths in Minamisanriku. As stated, its population was not as aged as most Sanriku towns. Furthermore, outside Tōhoku, some rural municipalities comprised over 50% older adults (Matanle & Rausch, 2011). Instead, it was Minamisanriku's location on the Sanriku Coast, and the other unsafe conditions in the town (see Section 5.1), that increased the significance of its population profile in shaping mortality patterns. As such, investigation must turn towards probing: (a) the greater dispersal of older adults in Sanriku than other areas of the disaster zone, and (b) the failure of government actors to adjust evacuation protocols to the changing needs of national and local ageing populations between 1960 and 2011.

Out-migration and population shrinkage

Underlying population processes shaped older adults' distribution in the Tōhoku region. The growing concentration of older adults in Sanriku resulted predominantly from migratory movements within Tōhoku. Since 1955, Minamisanriku endured a general trend of decline, from 22,943 residents in 1970, to 21,401 in 1990, and 17,429 in 2010 (SBJ, 2012). In fact, similar trajectories have affected Ishinomaki City, its much larger neighbouring municipality that, despite increasing from 177,597 residents in 1970 to 186,064 in 1980, decreased to 160,826 in 2010 (SBJ, 2012).

The shrinkage of Tōhoku's smaller municipalities has been predominantly attributed to working-age social and economic migration towards the dominant industrial area in the region, Sendai City, since 1955 (see Ogawa, 1986; Wang, 2012). Indeed, in contrast to Minamisanriku, Sendai City has encountered rapid and continuous growth, increasing from 118,984 residents in 1920, to 425,272 in 1960, 664,868 in 1980, and 1,045,986 in 2010 (SBJ, 2012). Thus, as a small fishing town situated in a hazard-prone area, and in close proximity (96km) to Sendai, this narrative of out-migration, population shrinkage and ageing appears coherent for Minamisanriku.

The strength of these processes underpinning Minamisanriku's population changes must be considered within national dynamics. Between 2005 and 2010, populations in 38 of Japan's 47 prefectures declined, with only nine either stabilising or growing due to in-migration, including Miyagi Prefecture (SBJ, 2010). Miyagi did not shrink, solely due to Sendai City's growth (at the expense of Tōhoku's other prefectures). However, at national level, Sendai's importance seems relatively minor, accounting for just 1% of the national population in 2010 (SBJ, 2010). In comparison, the metropolitan areas comprising the Taiheiyō Belt (Figure 5.3) contained over 61%, with Greater Tokyo alone holding almost 25 million inhabitants (SBJ, 2010). In fact, scholars have argued that expanding population polarities, nationally, regionally and prefecturally, have solidified economic disparities and political inequalities within Japan – an observation labelled as kakusa shakai ('society of widening gaps') (see Yamada, 2006; Matanle & Rausch, 2011; Matanle, 2011).

5.3 Development-based root causes

Post-WWII development priorities and their distribution

The population drivers that shaped the pre-disaster concentration of older adults in Sanriku cannot be divorced from the national development pathway from which they emerged. Migratory dynamics can be traced to government decisions following WWII (Muramatsu, 2011; Matanle & Rausch, 2011; Matanle, 2011; Thiri, 2017). This period saw the formation of a new government tasked with forging a pathway to rebuild a country depleted by the human, physical and financial costs of war. The 1955 System – a co-alliance between the Liberal Democratic Party (LDP), organised businesses, and the Ministry of International Trade and Industry – prioritised industry and the economy, which materialised into the 'economic miracle', a period of rapid growth between 1945 and 1991 through which Japan became the world's second-largest economy. In fact, apart from the years 1993-94 and 2009-12, this government has almost continuously been in power, indicating the strength and stability of this development pathway, and its priorities (Johnson, 1982; Matanle & Rausch, 2011; Cho, 2014).

Government decisions to distribute industrial policies within certain geographic areas triggered nationwide processes of metropolitan migration to power and sustain Japan's economic growth. Reasons for the allocation process are unclear but were likely informed by the status of cities prior to WWII. Policies were contained predominantly in the Taiheiyō Belt (Figure 5.3), a considerable accumulation of infrastructure, production and people, forming Japan's industrial core. However, for Minamisanriku and other Sanriku towns, the designation of Sendai City as an industrial area in 1962 would have had the greatest impact on their populations, triggering out-migration (Ogawa, 1986; Sorenson, 2002; Thiri, 2017).

Older adults and the national development pathway

Yet, the priorities of the post-WWII development pathway also shaped the unsafe conditions facing Minamisanriku's older adults in 2011. In contrast to national government's extensive efforts to rebuild Japan's economy through industrial growth, scholars have criticised its historical reactivity towards older adults (see Muramatsu, 2011; Tatsuki, 2013; Dahl, 2018). Indeed, after WWII, the LDP designated their welfare as the responsibility of families, extending pre-war norms. Not until the 1990s, with rising concerns about a rapidly ageing workforce, was the need for

government-led social care officially acknowledged (Tsutui & Muramatsu, 2007; Avenell, 2009). The widespread omission of evacuation assistance and existence of and gaps in Miyagi's piloted system (see Section 5.1), indicate that by 2011 the national government was not in control of their care, either unable or unwilling to protect older adults in everyday life, let alone in disaster scenarios.

However, it is too hasty to solely blame national government's inactions for older adults' social vulnerability in Minamisanriku in 2011. The piloted care system and The Evacuation Guideline for People with Special Needs (2005) exhibit national attempts to protect this social group, albeit with limited success. Furthermore, since the 1960s there have been government-led efforts to mitigate kakusa shakai. For example, both jiba sangyō shinkō jigyō (Regional Industry Promotion Projects) in the 1960s, and isson ippin (One Village One Product) in the 1970s were intended to boost the economic importance of smaller urban municipalities, and halt Sanriku's population shrinkage (Knight, 1994; Matanle, 2011). Rather, other aspects, including the continuously rapid ageing of Japan's population and the economic recession since the 1990s, would have undermined these government initiatives and strengthened the population processes driving the distribution of older adults in Sanriku.

Locating governmental responsibility

Why was evacuation assistance for older adults not employed in Minamisanriku despite its need being recognised?

On the face of it, accountability rests with Minamisanriku's government. Responsibility to implement disaster preparedness was assigned to the municipality through both the Disaster Countermeasures Basic Act (1961) and The Evacuation Guideline for People with Special Needs (2005). Additionally, the Omnibus Decentralisation Act (1999), Comprehensive Decentralisation Law (2000), Trinity Reforms (2004-06) and the Great Heisei Merger (2005) were all intended to transfer greater administrative and fiscal authority to local governments, to allow them to respond to the changing needs of their populations (Cho, 2014).

Yet, in reality, the expectation for municipal governments to provide evacuation assistance appears unrealistic. In 2006, an Organisation for Economic Co-operation and Development (OECD) report raises concerns about their ability to maintain high levels of hazard preparedness. It acknowledges the transfer of greater responsibilities to local governments, including those for education, social services, health care, public housing, infrastructure, police and fire services, as well as disaster planning. However, it questions their financial capacity to effectively maintain all aspects of earthquake and tsunami preparedness, citing their long-standing financial struggles. Sanriku governments, tasked with protecting their ageing and shrinking populations, may also have lacked the human resources to implement this national legislation and provide evacuation supporters for older adults.

As such, responsibility for this critical planning omission seems to shift towards the national government. Their failure to redistribute resources to municipal authorities and their historic inability to provide everyday protection for older adults was reflected in mortality patterns across the disaster zone, but especially in Sanriku's more aged and tsunami-susceptible towns. For Minamisanriku, the failure to adequately adapt evacuation protocols to the needs of its changing population whilst piloting a care system ill-prepared for emergency scenarios resulted in older adults' differential disaster deaths in the Tōhoku tsunami.

6. Discussion

The analysis in Chapter Five employed an adapted FORIN framework and approach to investigate the Research Question:

Why did death disproportionately affect older adults in Minamisanriku in the 2011 Tōhoku tsunami?

Having conducted this investigation, I can now reflect critically upon the Research Aims of this paper to:

1. Illuminate the reasons for older adults' differential disaster deaths in minamisanriku by probing in greater depth than current analyses.

2. Adapt and operationalise a framework and approach at the forefront of disaster causality research, and test its utility for future research and practice.

6.1 Findings

This RLA revealed the anthropogenic construction of disaster in Minamisanriku in the 2011 Tōhoku tsunami. In doing so, it demonstrated the insufficiencies of previous research: a) narrowly searching for causality within the natural hazard event or shallowly across the entire disaster zone (see Aldrich & Sawada, 2015; Suppasri et al, 2016; Latcharote et al, 2018); b) overly emphasising the significance of victims' behaviour and intentions to explain disaster death tolls (see Yun & Hamada, 2015; Nakasu et al, 2018); and c) generally assuming the importance of older adults' physiological characteristics to explain their differential mortality. Instead, it illustrated the need to acknowledge a far fuller breadth and depth of contributory actors, factors and processes, at multiple spatial and temporal scales of analysis, in shaping older adults' heightened situation of social vulnerability to the tsunami, especially in Sanriku. In particular, it affirmed the centrality of both national and municipal governments, their priorities, decisions, responsibilities, abilities, and their relationship, in driving and defining it.

A critical cause was extracted in the proximate context, the absence of age-related tsunami evacuation planning. However, the RLA revealed that this vital omission, and its causes and consequences, could only be understood through broader and deeper contextualisation:

1. While responsibility for this omission seemed to lie with Minamisanriku's government, moving focus beyond the disaster event revealed that resource constraints hindered their ability to protect an ageing municipal population, and shifted culpability towards the national government.

2. This omission was not an isolated instance, but a widespread manifestation of on-going struggles to provide everyday social care for older adults, with their needs seemingly side-lined in the national development pathway since WWII.

3. The particular consequences of this omission were shaped by the unsafe conditions facing this social group in Minamisanriku, but significantly defined by its population changes since 1955. As a small urban municipality in an historically hazard-prone coastal area and in close proximity to a government-allocated industrial centre, its out-migration, population shrinkage and ageing were driven by the 1955 System: its industrial priorities, their selective geographic distribution within Japan, and the strength and stability of its economic development pathway.

However, the remaining information gaps must be acknowledged. In the micro context, in particular, social and spatial unknowns surround local evacuation plans (routes and shelter locations) and residential distribution, and there is an absence of published community-based accounts to clarify the evacuation issues encountered within the town.

Uncertainties surround the ability of Minamisanriku's government to have introduced or implemented age-related evacuation protocols. Despite reportedly conducting annual drills, did they not realise the urgency of adapting disaster plans to their ageing population's needs? Were they not adapted due to resource constraints? Were concerns raised to national government about the feasibility of the 2005 Evacuation Guideline or the dangers of Miyagi's piloted care system?

Probing the national-municipal government relationship even further seems key for better understanding this planning omission in Minamisanriku and across Sanriku. Filling these knowledge gaps would verify the accuracy of this RLA.

6.2 Utility of an adapted FORIN framework

These remaining uncertainties should not undermine the utility of this FORIN. After all, this desk-based forensic investigation met this paper's primary Research Aim, to illuminate the reasons for older adults' disaster deaths in greater depth than current analyses of the event. Its success was principally due to decisions to tailor this framework to the case study. Chapter Two informed this process, presenting a thorough preliminary contextualisation of the disaster and its aftermath, and a literature overview. As such, a more refined research focus than Nakasu et al. (2018) and others could be produced, onto a particular social group within a town. In operation, this allowed the longitudinal narrative to more coherently connect the contemporary unsafe conditions with historic development-based root causes, far from the proximate context.

Building a population dynamics perspective also unlocked FORIN's analytical value. Acting upon the limited guidance of Oliver-Smith et al (2016) to merely centre a suitable risk driver in analysis was deemed insufficient. Rather, incorporating disciplinary insight from Martine & Schensul (2013) and other progressive demography scholars strengthened the use of the risk driver, and supported the focus on older adults. In operation, not only did this perspective help to connect the multiple levels of analysis, it also revealed more socially and spatially acute details within the local context, as exemplified throughout Section 5.1. As such, this investigation supported Martine & Schensul's (2013) calls for population dynamics to be treated as much more than a macro and distant driver, to become a more functional component for vulnerability research, including FORIN.

Yet, applying this perspective for this case study also confirmed that both demography and vulnerability researchers must become more conscious of the ways in which this risk driver can construct social vulnerability to natural hazards in regions at different stages of urban transition, beyond conventional narratives of urban population growth (see Section 3.2.3). This is recognised by authors within the Japanese context, including Muramatsu (2011), Matanle (2011; 2013), Matanle & Rausch (2011) and, in particular, Kudo et al (2015) who calls for greater attention to population ageing as an emerging research agenda for sustainable development. However, as populations around the world continue to age, we must become increasingly aware of how urban development and population processes drive demographic and geographic patterns of social vulnerability to physical events, especially for older adults.

6.3 Implications for future disaster causality research and practice

This forensic investigation must be acted upon.

Firstly, more socially and spatially disaggregated data and documentation is needed to maximise the efficacy of disaster causality research. Without being able to conduct fieldwork and collect vital on-the-ground insight, the quality of existing data is fundamental to FORIN's ability to produce more accurate explanatory analyses. Here, the importance of collecting community-level information was highlighted by both the knowledge gaps outlined in Section 6.1, and the apparent scarcity of detailed disaster mortality statistics in municipal, national and international databases (see Section 2.2).

Secondly, researchers must be empowered by FORIN's value, not deterred by the complexities of conducting disaster causality research. The necessity of exposing and filling data gaps through desk- and field-based research should be acted upon. Without in-depth, integrated examination, misconceptions surrounding disaster events and mortality patterns will continue to persist, and recovery plans will continue to unintentionally reproduce social vulnerability, as evident in Sanriku towns (see Section 2.5). As shown in the previous Section, FORIN's operational challenges can be eased by better adapting it to its context and the data available. Oliver-Smith et al (2016) and FORIN's other authors could offer more detailed guidance on the process of adapting and employing FORIN to improve its accessibility and, consequently, its impact.

Thirdly, this investigation has shown that FORIN does hold utility for disaster risk reduction research and practice, but could have far greater impact. Beyond merely offering insights through backward-looking re-analyses, FORIN could provide a forward-focusing actionable tool, as advocated by some of its creators (see Burton, 2014; 2015). Building upon this paper's findings could demonstrate FORIN's potential. Conducting an RLA into the post-disaster problems in this case study (see Section 2.4), and comparing its findings with those of this investigation, could reveal striking similarities in the factors, actors, drivers, and root causes identified. For example, the physical prioritisation which defined Japan's development pathway and Minamisanriku's reputation for tsunami preparedness has seemingly continued following the event, in recovery and reconstruction plans, to the detriment of social welfare. Population trajectories have also continued, exacerbating the burden of recovery problems on older adults, and creating new situations of age-related vulnerability in Sanriku. As such, comparing a disaster and post-disaster RLA would clarify whether FORIN may have helped practitioners and policymakers to alleviate older adults' differential social vulnerability in Sanriku towns. More broadly, such a project could verify FORIN's wider value for informing disaster risk reduction, and recovery and reconstruction efforts beyond this case study.

7. Conclusion

This paper hopes to inspire others to conduct comprehensive forensic disaster research. Probing the plight of older adults in the 2011 Tōhoku tsunami, it has demonstrated the urgency for, but difficulties of, achieving Priority One of the Sendai Framework for Disaster Risk Reduction. Sadly, too few such investigations currently exist, even for such a well-known disaster as this; it is imperative that researchers realise their importance and act upon this principal priority with far greater urgency. Only through better comprehending disasters and their development-based drivers can more effective efforts be made to tackle their construction around the world. Only through ambitious, progressive, probing, and integrated research, such as FORIN, can this process even begin. As such, I hope this project can motivate others to pursue and promote the untapped potential of better understanding disaster causality.

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