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TECHNICAL NOTE

COMPARISON BETWEEN THE EMERGENCY RESPONSES TO THE 2010-11 CANTERBURY EARTHQUAKES AND THE 2024 NOTO PENINSULA EARTHQUAKE

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ABSTRACT

This technical note presents comparisons between the emergency response and recovery efforts following two significant seismic events: the 2010–11 Canterbury Earthquake Sequence in New Zealand and the 2024 Noto Peninsula Earthquake in Japan. Drawing on the author's firsthand observations from both events, the paper highlights key differences in infrastructure resilience, emergency coordination, and community recovery. The aim is to inform future disaster response strategies in New Zealand by learning from Japan's approach, particularly in terms of speed, adaptability, and community integration.

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INTRODUCTION

This paper outlines key observations from the response to the 2024 Noto Peninsula earthquake and compares them where relevant to the 2010-2011 Canterbury Earthquake Sequence response. It is not intended to be an exhaustive list - nor is it intended as a critique of either response - but is intended to fuel discussion and makes recommendations for consideration to improve future New Zealand disaster responses.

EARTHQUAKE PROFILES

The well-documented Canterbury Earthquake Sequence began with a magnitude 7.1 quake in September 2010, followed by a more devastating magnitude 6.3 event in February 2011 that struck Christchurch directly. The shallow depth and proximity to the urban centre resulted in significant structural damage and loss of life.

In contrast, the January 2024 Noto Peninsula Earthquake struck near Suzu with a magnitude of 7.5 at a shallow depth of about 10km, caused by reverse faulting along a rupture zone extending more than 100km. The quake produced violent shaking, with peak ground acceleration measured in excess of 2.7g which is further shown in Figure 1. Geological surveys documented fault slips of up to 10m, triggering landslides, liquefaction, and a small tsunami [1].

The Noto region is characterised by mountainous terrain and small coastal settlements, which shaped the pattern of destruction. Urban impact was concentrated in towns like Wajima and Anamizu, where traditional timber-framed houses and aging infrastructure proved particularly vulnerable. These geological conditions and settlement patterns defined the nature of emergency response and recovery, which had to contend with widespread isolation and difficult access routes.

Table 1 shows a comparison of key characteristics from the two earthquake events.

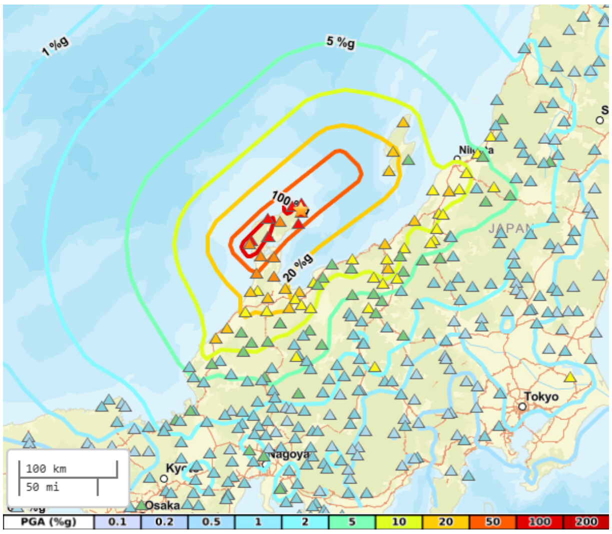

Figure 1: Peak ground acceleration plot for the 2024 Noto earthquake, showing location relative to larger cities such as Tokyo and Nagoya [2].

Table 1: Comparison of key characteristics.

Feature	Canterbury 2010-2011	Noto Peninsula 2024
Magnitude	7.1 (September 2010) 6.3 (February 2011)	7.5 (January 2024)
Depth	Shallow	Shallow
Urban Impact	Christchurch	Wajima, Anamizu
Terrain	Urban, majority flat	Mountainous coastal peninsula
Population Density	Medium	Low

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ECONOMIC IMPACT

The two shaking events illustrate how local geology, urbanisation, and economic context shape disaster consequences. The Noto event was driven by shallow reverse faulting at ~10 km depth, producing extremely violent shaking with peak ground accelerations in excess of 2.7g at near-fault stations [1].

Despite this, the economic toll was relatively contained with the Japanese government estimating direct physical damage at ¥1.1–2.6 trillion (NZ$12–29 billion) and insured losses were modest by global standards, at ¥91–136 billion (NZ$1-1.5 billion) [3, 4]. The most acute impacts were regional with port inoperability due to seismic uplift and declines in local tourism [5, 6].

By contrast, the Canterbury earthquake sequence struck at a major urban centre. Although smaller in magnitude, the shallow strike-slip rupture of February 2011 generated peak ground accelerations of approximately 2.2g, causing catastrophic building collapse and severe liquefaction [7].

The consequences were nationally transformative with 185 deaths, ~7,000 injuries, and direct damage of NZ$40-45 billion, equivalent to around 20% of New Zealand's GDP at the time [8, 9]. Insurance claims exceeded NZ$31 billion, making it one of the largest insured loss events globally [10]. Unlike Noto, where the macroeconomic effect was limited, the Canterbury sequence disrupted Christchurch's central business district, erased much of its office and retail stock, and triggered long-term zoning, land-use, and housing market challenges that reshaped the city's trajectory for more than a decade, and continues to do so to this day.

IMMEDIATE RESPONSE

Roads and Transport

In the aftermath of the Noto Peninsula Earthquake, road damage was widespread, exacerbated by seasonal snow and moisture. Slips revealed a thin layer of organic material over smooth bedrock, which acted as a slip plane. Impressively, road crews had already smoothed many approaches and abutments with asphalt within the first fortnight, even where large level variations had formed as shown in Figure 2.

Figure 2: An example of the main highway being converted to a one-way single lane up the peninsula. A 'B-road' was utilised for the reverse direction of travel down the peninsula.

Road signage was promptly installed, and speed limits were consistently maintained at 40 km/h throughout the entire peninsula, avoiding the erratic speed changes often seen in post-disaster zones. Notably, traffic cones were used sparingly - only where absolutely necessary - unlike in Christchurch, where their overuse led to public fatigue and desensitisation.

A particularly effective strategy in Noto involved creating a traffic loop using one lane of the A-road (main highway) in one direction and one lane of the B-road (secondary highway) in the other. This allowed traffic to flow around damaged sections, eliminated the risk of any head-on collisions, and facilitated smoother repairs and traffic management.

Rubble was neatly piled on the unused lanes, enabling uninterrupted travel to Wajima without the need for temporary traffic lights or stop-go signs. Mobile site offices mounted on trucks were observed along the highway, providing nimble and responsive bases for operations.

The Shinkansen bullet train resumed service within 48 hours, although its route across the base of the peninsula meant it was less affected by shaking which was centred further up. Regular railway lines on the peninsula were still under repair, with workers actively restoring service.

Road tunnel lighting was disabled throughout the route, relying solely on emergency reflectors. However, this posed no significant issue due to the reduced speed and effective use of headlights.

Housing

Damage to residential structures in Noto was severe, particularly among older, traditional-style houses with timber framing and heavy tile roofing. These homes were built before key seismic requirements were introduced by Japan's Building Standards Act in 1981. Many homes had experienced soft-storey collapse, reduced to rubble, in. In several cases, the ground floor collapsed while the upper floor remained relatively intact, with porch roof tiles and framing visibly resting on the pavement. Figure 3 shows a number of the damage mechanisms mentioned in this paragraph. It

Figure 3: Typical building damage to traditional housing stock. Left hand side shows a two-storey home in which the ground floor has collapsed (soft-storey) such that the porch roof is now level with the ground. In the foreground is a single-storey home which has separated from the adjacent building to the right in a soft-storey mechanism.

Tarpaulins were widely used as temporary ridge flashing (given winter snow conditions), secured with ropes and sandbags - a common sight across the whole peninsula.

Tarpaulins were also used widely for temporary weathertightness in the Canterbury aftermath. However, the summer season and use of lighter-weight sheet roofing materials reduced the need for such widespread usage.

Some piled concrete slab homes in coastal bays exhibited a ~100mm void beneath the entire slab, suggesting settlement of soft soils relative to the pile bases (or pile thrust). Residual drifts were observed to be extremely large, in some cases reaching in excess of 10%. Homes on the rocky parts of coastline generally fared better than those located in basins or bays (soft soil), which suffered extensive damage. The sheer volume of total collapses was overwhelming, even before reaching the more populated Wajima.

Impressively, every residential home in the area had been placarded within the first four days - an indication of thorough prior preparation and training. Notably though, the writing on many of these placards had almost faded entirely in a short period of time. The author found that in Japan many pens are 'erasable' using the friction generated from a rubber to evaporate the ink. When the substrate under the placards heated in the sun, the writing simply evaporated suggesting the need for indelible markers only on placards to ensure that crucial information is not lost in the weeks and months that follow.

Non-Residential Buildings

In Anamizu, retrofitting to non-residential buildings appeared minimal. However, the local supermarket remained open and undamaged, suggesting pockets of resilience. This was further exemplified by the handful of buildings which had been seismically retrofitted and were providing bases for post-disaster support.

Wajima Hospital's structure was intact and functioning, but its doors were severely damaged and permanently strapped open - an issue in winter conditions that highlights the need for improved non-structural element resilience (Figure 4).

Figure 4: Non-structural damage to the hospital doors causing them to be strapped open in sub-zero temperatures. A great example of the need for displacement capacity in critical non-structural elements.

Evacuation windows in multi-storey buildings were clearly marked with red triangles, and many remained open. This aspect is one that New Zealand could learn from in order to direct emergency services to evacuation points with fire-ladders and the like.

Foundation failures were observed in many buildings, including two mid-rise buildings in Wajima, one of which is pictured in Figure 5. Subsequent analysis has suggested that the performance of the liquefiable soils was not adequately allowed for in the pile design of these buildings.

Across the peninsula, there was a clear trend that heavier buildings combined with non-ductile detailing performed poorly and experienced partial or full collapse. This was unsurprising and aligned well with the experiences in Canterbury.

Figure 5: Pile cap failure in a 5-storey apartment building in Wajima.

Organisation and Coordination

Emergency coordination in Noto was highly visible and efficient. Portable loudspeakers in Anamizu broadcast announcements audible throughout the town, providing real-time updates to residents.

Temporary tents, portaloos, drop-in toilet buildings, and food depots were set up quickly, and a large military presence was actively engaged in support operations. These elements are stockpiled by the government in four locations across Japan ready for rapid deployment following an event – examples are shown in Figures 6 and 7. All elements ultimately make their way to the disaster site, but the closest site can respond first and then the rest follow.

Figure 6: One of the portable emergency toilet blocks stored in bulk in four locations around Japan, ready for deployment in an emergency.

Flat-pack emergency housing opened on 7 February, approximately five weeks after the quake. While local media criticised this as a delay, from a New Zealand perspective, this timeline was relatively fast.

Insulated, white tents were distributed and used in the interim, providing essential warmth in snowy conditions, prior to the flat-pack villages being opened. Camper vans were also employed as temporary housing solutions in big-box retailer carparks.

Figure 7: Thermally insulated emergency tents for red placarded homes, deployed from bulk storage in four locations around Japan.

In Wajima, the military established a base at a local school. Hot lunches were served outside medical facilities across the town, and portable water tanks were made available to residents. Streets were impressively tidy, with rubble swept onto building sites, allowing pedestrians to move freely. Cordons were minimal, often just a single line of plastic tape, relying on public common sense.

Communication

Earthquake alerts were received via text and read out (automatically translated to the primary device language so accessible to people not fluent in Japanese) prior to aftershocks, and town-wide sirens also sounded. An example alert is shown in Figure 8.

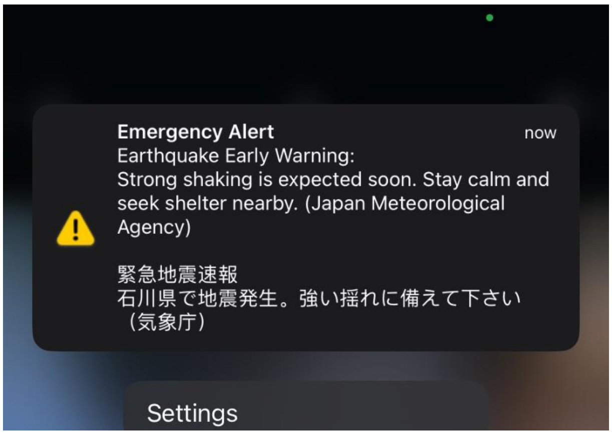

Figure 8: Earthquake early warning alerts automatically translated into the primary language of each mobile device. This one arrived approximately 10-15 seconds before shaking commenced.

Tsunami signage (Figures 9 and 10) was clear and consistent throughout coastal areas, although no tsunami occurred in the regions of the Peninsula visited.

Figure 9: Typical tsunami evacuation signs dotted every 200-300m around the coastline.

Figure 10: Typical disaster shelter signage at shelter locations.

SHORT-TERM RECOVERY SUMMARY

Short-term recovery in Noto was marked by rapid reopening of essential services and efficient deployment of temporary housing. The Anamizu supermarket remained operational, and flat-pack housing was established within weeks. Despite criticism from local media, the speed of response was commendable by international standards. The immediate recovery exemplified a community and country primed for natural disasters through proactive preparation.

Hot meals and water distribution were organised promptly through widespread community engagement and the use of camper vans and insulated tents provided flexible housing options. The absence of cordons facilitated community mobility and allowed residents to participate in clean-up and recovery efforts. The overall tidiness of streets and the visible presence of support services contributed to a sense of resilience and order, and distracted looting and other antisocial behaviours.

LONG-TERM RECOVERY AND RECONSTRUCTION

Japan’s approach to long-term recovery emphasised mobility, flexibility, and community integration. The use of mobile site offices and adaptive traffic systems enabled ongoing repairs without disrupting daily life. In contrast, Christchurch’s rebuild involved a degree of ‘on the fly’ planning and regulatory changes, which, while necessary, led to delays and public frustration.

Community input in Japan appeared informal but effective (relying on readiness and communication in advance of natural disasters), with residents actively engaged in cleanup and rebuilding. New Zealand's process was more structured, involving formal consultation and policy reform. Both approaches offer valuable insights into balancing efficiency with inclusivity in reconstruction efforts.

TECHNOLOGICAL ADVANCEMENTS

Technological integration played a significant role in Japan's response. Early warning systems provided crucial seconds of advance notice, and the rapid restoration of the Shinkansen demonstrated infrastructure resilience. Mobile coordination tools and GIS mapping supported efficient resource deployment. Social media was used to share updates, coordinate aid, and connect communities.

These advancements contrast with the technological landscape in New Zealand during the 2011 earthquakes, highlighting the importance of continued investment in disaster technologies.

LESSONS LEARNED AND POLICY IMPLICATIONS

The Noto earthquake recovery suggested the following lessons for future New Zealand recovery efforts:

- Avoid overuse of traffic cones to prevent public desensitisation and maintain visual clarity.
- Implement flexible traffic routing systems to preserve mobility during recovery.
- Use only indelible markers for placards, not regular pens.
- Further enhance non-structural resilience in critical facilities, such as hospitals and schools.
- Invest in early warning systems and public alert infrastructure to improve preparedness.
- Streamline emergency housing deployment, especially in cold climates, using insulated tents and mobile units before something more substantial can be built.
- Stockpile temporary equipment such as tents and toilet blocks at multiple locations to speed up response times after an event.
- These recommendations underscore the value of adaptive, community-focused disaster management.

CONCLUSIONS

The responses to the Canterbury and Noto Peninsula earthquakes demonstrate the importance of agility, coordination, and community engagement in disaster recovery. Japan's emphasis on mobility, rapid assessment, and minimal disruption offers valuable lessons for New Zealand.

As seismic risk remains a constant threat, future preparedness must blend technological innovation with practical, human-centred strategies. International collaboration and shared learning will be essential in building resilient communities capable of withstanding future disasters.

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