# PLANNING FOR DISASTER:

# LEARNING LESSONS FROM ONAGAWA, A SMALL TOWN ALMOST DESTROYED IN THE JAPAN TSUNAMI OF 2011

## Introduction

The Great East Japan Earthquake of March 11, 2011 was the most powerful seismic event in that country's recorded history[1]. It generated the largest tsunami to strike the north-east coast of the main island, Honshu, in more than 1000 years[2]. Onagawa, a small fishing town at the inner edge of the Oshika peninsula (the closest point of Honshu to the offshore epicentre of the quake), suffered more property damage per area, and greater loss of life per capita, than anywhere else within the disaster zone. Over 80% of the built environment was destroyed, and almost 10% of the population killed.

For architects, geologists, and other earth-scientists, the remains of the town have since become a field site for studying the physical effects of a major-scale tsunami. But the experience of Onagawa bears closer analysis. This was a community of over 10,000 people, living in a highly developed and relatively prosperous modern industrial nation. The Japanese islands are subject to greater seismic instability – and greater risk of related natural disasters – than any other landmass on Earth. As a consequence, their coastal towns and cities are notably well prepared in terms of forecasting expertise, advance warning systems, structural resilience, emergency protocols, and mitigation strategies.

In the case of Onagawa, some of these protective measures undoubtedly saved lives, but others were negated by the sheer scale of the event, or compromised by factors that must now be accounted for. The town's subsequent recovery has been largely dictated by policy decisions beyond the control of surviving residents and evacuees, which raise further important questions about the role of disaster-stricken home and business owners in the rebuilding of their own lives and communities.

The rare and extreme magnitude of this particular earthquake and tsunami may invite the wider global public to assume that it will not happen again in their lifetime – or if it does, that it will affect only Japan. Instead, it should be taken as a reminder of the threats that now extend to almost every shoreline.

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[1] The earthquake registered 9.0 on the Richter Scale, and a maximum 7 on Japan's own seismic intensity scale. (Source: Japan Meteorological Agency)

[2] Analysis of sedimentary deposits has confirmed that a previous megathrust earthquake generated a tsunami of equivalent size – with wave heights of over 10 metres – along the Sanriku coast in 869 AD, a disaster referred to as the "Jogan event". (Source: Professor Mitsuhisa Watanabe, Toyo University)

While tsunamigenic seaquakes, underwater landslides, and volcanic eruptions are most common in the Pacific “Ring of Fire”, they have also been known to occur in the Indian, Atlantic, and Mediterranean oceans, and could recur at any time with little warning[3]. Urban coastal populations are growing worldwide, and most rapidly in cities with limited resources to plan and build for sudden-onset natural catastrophes. This term may equally apply to extreme weather events.

Climate change projections indicate a future of rising sea levels, heavier rains, and more frequent and severe storm surges. Hurricane Sandy, which flooded large sections of New York in October 2012, has been variously described as “yet another wake-up call”[4] and “a disturbing sign of things to come”[5]. In the UK, it is clear that the security of London will increasingly depend on effective flood risk management, as will the continued existence of smaller port towns.

This report should be read in light of such factors – the continued unpredictability of seismic hazards, the increasingly uncertain dynamics of hydro-meteorological hazards, and the general increase in people and property exposed to those risks. Its central proposition is the absolute necessity of disaster mitigation and recovery planning as a core strand of public policy, and a fundamental concern in all decisions relating to land use.

Current levels of readiness tend to be calibrated according to the most recent or most “likely” disaster scenarios, and defences based on such limited expectations tend to be overwhelmed, as was seen in Japan on March 11, 2011. That disaster must alert us to the benefits of preparing for the worst, and the example of Onagawa shows us what the “worst” really means.

In assessing the full impact on a single community, we can extrapolate the wider implications for planners and policy-makers around the world, with particular reference to the British Isles.

## A note on research methodology

The primary material for this report was gathered through field research and interviews with residents and relevant professionals in Onagawa, conducted

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[3] “Tsunamis are **ubiquitous**,” writes Professor Edward Bryant in his book Tsunami: The Underrated Hazard (Cambridge University Press, 2001). Bryant is the head of the School of Geoscience at the University of Wollongong, Australia, and among the most vocal proponents of the view that until tsunami hazards are fully understood, no coastal area can be considered “safe”.

[4] By United Nations “Climate Chief” Christiana Figueres. Source: hinkprogress.org/politics/2012/11/24/1232221/un-climate-chief-calls-out-us-for-climate-inaction-hurricane-sandy-is-yet-another-wake-up-call

[5] The words used by former US Vice-President Al Gore in response to Hurricane Sandy, supported by a number of voices from within the scientific community. Source: https://www.commondreams.org/headline/2012/10/30-9

during four separate visits in April 2011, July 2011, March-April 2012 and October-November 2012. All questions and answers were recorded, transcribed, and translated by native Japanese speakers, then re-checked for accuracy. A full list of translators and selected interviewees is provided separately. The research has been supplemented with outside references and interviews from other sources, as detailed in footnotes.

## 1. ONAGAWA: "THE MOST DAMAGED TOWN ON THE COAST"[6]

As it stood before the disaster, Onagawa was a relatively typical and traditional Japanese harbour town, or "minato machi", consisting of a central port and 15 incorporated fishing villages[7] in adjoining inlets. Like other such towns along the Sanriku coast of the Tohoku region, its history, culture, and economy had been defined by close proximity to the sea, and a majority of residents were employed in local fisheries or related businesses.

At 2.46pm local time on March 11, 2011, a powerful megathrust earthquake occurred some 70 kilometres offshore, in the submarine tectonic fault zone between the "Okhotsk" and "Pacific" plates. The resulting tsunami arrived onshore approximately 25 minutes later, creating the highest waves along the "rias" section of the Sanriku coast, where submerged river-valleys form a fjord-like landscape of steep cliffs and narrow inlets. Located at the southern end of the rias, just north of the Sendai plain, Onagawa was flooded by waves of over 15 metres[8], which inundated the harbour, town centre, and surrounding residential areas. Coastal bathymetry and topography channelled seawater through developed land in plains and valleys to run-up heights of 30 metres[9].

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[6] As described by Tsutomu Yamanaka, Program Coordinator for Japan Platform, a relief agency working in Onagawa after the disaster. (Source: "Revisiting A Tsunami-Struck Town In Japan" by Tetsuhiko Endo, Huffington Post, January 22 2012, retrieved from, http://www.huffingtonpost.com/tetsuhiko-endo/small-town-still-feeling-_b_1208746.html)

[7] The modern town was established as an administrative unit in 1926, but its constituent settlements date back for centuries, with many local families claiming over 10 generations of residence (Source: Onagawa-Cho records office)

[8] Source: "Executive Summary of Urgent Field Survey of Earthquake and Tsunami Disasters by the 2011 Off the Pacific Coast of Tohoku Earthquake", Port and Airport Research Institute (PARI), 25 March 2011, retrieved from www.pari.go.jp/en/files/items/3496/File/20110325.pdf

[9] Source: "Critical Factors For Run-Up and Impact of the Tohoku Earthquake and Tsunami", by Irene Kostaki et al, International Journal of Geoscience, 2011, 2, 310-317. Retrieved from, http://www.academia.edu/906958/Critical_Factors_for_Run-

A total of 116.4 hectares were inundated in the central port. 5,374 buildings were washed away or damaged beyond repair, including 2,979 houses (over 82% of buildings and 60% of homes in the main town, while many outlying villages were almost entirely destroyed)[10]. 829 residents were killed[11], from a pre-disaster population of 10,059[12], leaving Onagawa almost decimated.

Though causally related, the earthquake and tsunami may be considered separate events with different effects – a far greater proportion of resulting death and damage were caused by the tsunami. However, the extreme size and scale of the latter does not "explain" the full extent of this disaster, which was both mitigated and exacerbated by human factors. An overview of the planning issues outlined in this section is provided below in Table 1:

| Planning element | Preparedness and prevention | Mitigation and recovery | Future actions |
|---|---|---|---|

up_and_Impact_of_the_Tohoku_Earthquake_Tsunami

[10] Source: http://www.yomiuri.co.jp/dy/national/T110910003370.htm
[11] Including those residents registered missing, presumed dead, as of August 2012 (source: Onagawa-Cho records office)
[12] Source: These figures are based on the Onagawa-Cho town census of 2010, but it should be noted that more recent records were lost in offices damaged or destroyed at the town hall by the March 11 tsunami.

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|---|---|---|---|
| Warning systems | Enhancement and testing of current systems across range of potential earthquake/tsunami scenarios | Deploy systems and monitor effectiveness in terms of accuracy and public usage | Address current technical limitations in conveying real-time information |
| Structural defences | Design, build and test structures to enhance resistance and resilience | Deploy walls, gates and barriers as first line of defence, provide purpose-built shelters for evacuation | Monitor climate change and adapt to new standards |
| Nuclear Facilities | Maximise structural capacity for seismic shock and flood resilience, enhance failsafes and backup power supplies | Engage alerts and emergency protocols, initiate shutdowns as needed, monitor effectiveness | Assess security and placement of nuclear facilities in the context of future seismic hazards and flood risks |
| Land use | Regulate zoning and spatial planning to minimise risk-exposure of population and key infrastructure | Survey flooded areas, assess vulnerabilities, apply findings to plans for reconstruction | Consider safety and long-term viability of coastal communities with reference to climate change and seismic hazards |
| Public awareness | Ensure public understanding of potential hazards, and familiarity with relevant emergency procedures | Alert residents to the danger, effect evacuation as required, inform and involve survivors in recovery and reconstruction | Make public awareness the cornerstone of community resilience |

## 1.1 Warning systems were effective, but also flawed and limited

Japan's Earthquake Early Warning System (EEWS)[13] was triggered within seconds of the initial seismic rupture – although Onagawa's close proximity to the epicentre allowed residents little time to react in advance of the quake itself. Tsunami warnings[14] followed within three minutes, and nationwide alerts were duly issued by the Japan Meteorological Agency (JMA) via TV, radio, and cellular phone networks[15]. In the interval before the tsunami arrived onshore, the alert was further transmitted through Onagawa by loudspeakers mounted on streets, rooftops, and emergency dispatch vehicles – advising residents to go to high ground and designated emergency shelters (see below).

Many interviewees later testified that their lives had been saved by these warning systems, but anecdotal evidence also suggests the current limitations of the operating technology, which initially underestimated both the magnitude of the earthquake[16] and the size of the resulting tsunami.

As a consequence, the earliest announcements from Japan's national television network, NHK[17], projected wave heights of a few metres. Those projections rose to over 10 metres only after 3pm local time – or more than 15

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[13] This system, also known in Japan as "Kinkyu Jishin Sokuho", uses real-time data from multiple seismographs to estimate the focus, magnitude, and intensity of a given tremblor, then transmit near-instant alerts to local authorities, public transport operators, etc.

[14] Japanese tsunami alerts rely on the Deep-ocean Assessment and Reporting of Tsunami (DART) system – pressure recorders on the seabed and detection buoys at the surface relay information by satellite to land stations estimating the size and arrival time of tsunami waves onshore. This technology is deployed throughout the Pacific as a vital element of the International Warning System (IWS), co-ordinated by the Intergovernmental Oceanographic Commission of UNESCO.

[15] This phone-alert system is known as Area Mail Disaster Information Service, and enabled by "cell broadcast" technology, which relays JMA alerts directly from local cell towers to every handset within range. At the time of the March 11 earthquake and tsunami, this option was available to customers of Japan's three leading network providers – NTT Docomo, "au", and Softbank.

[16] EEWS technology assumes a "single-point" epicentre for a given earthquake, and cannot track an increase in magnitude over time – in this case the source of the earthquake was a spreading rupture in a fault-line 300km long and 150km wide. Sources: "Japan Faces Up To Failure Of Its Earthquake Preparations" by Daniel Cyranoski (Nature, 471, 556-557), The 2011 Off The Pacific Coast Of Tohoku Earthquake, Masao Yamada, (Earth Hazard Division Kyoto University. Retrieved from http://eqh.dpri.kyoto-u.ac.jp~masumi/ecastweb/110311/index.htm)

[17] Even after powerful earthquakes it is common for tsunami waves to measure in centimetres, and register as barely perceptible to observers. Because of the confusion caused in this case, NHK subsequently announced that it would cease the practice of "live-tracking" changes in water levels and broadcast only estimates of projected wave height.

minutes after the disaster, and less than 10 minutes before the first waves arrived onshore. Furthermore, NHK's live updating of the change in water heights showed increases of 20-25 centimetres[18] at a time, leading some to misunderstand these figures as estimates of the final wave height.

According to survivors, this low figure had a direct bearing on individual decisions to remain in or return to homes and offices during the critical minutes available for escape – thus exposing them to incoming waves that were vastly larger than those initial projections.

### 1.2 Structural defences and shelters were inadequate to the hazard

Onagawa's purpose-built coastal defences consisted of a three-metre caisson breakwater at the mouth of Onagawa Bay – primarily designed to protect against storm surges – and a six-metre seawall around the main harbour. Both were partially sunk by the earthquake (as it caused the land to subside by up to 1.2 metres along the shoreline) and subsequently destroyed by the tsunami[19]. These structures are believed to have had a slight retarding effect on the energy of the incoming waves[20], but did little to reduce the damage at the waterfront.

15 public buildings had been pre-designated as assembly points and evacuation shelters – all buildings at a minimum of six metres above sea level, as per the maximum anticipated wave height extrapolated from past tsunamis in the area (1896, 1933, and the so-called "Chile Tsunami" of 1960 – see section 1.7). However, the incoming tsunami far exceeded these minimums, and 12 of the shelters were overtopped and/or inundated[21].

The most critical breach occurred at the Onagawa Municipal Hospital – over 16 metres above sea level but less than 100 metres from the waterfront. In the interval between the earthquake and tsunami, several hundred residents evacuated to the hospital by car or on foot, as it was the closest shelter and highest ground available in the town centre. At the moment of impact, the tsunami overtopped the hill and flooded into the hospital, killing an estimated 16 people in the car park, and 4 inside the building.

Only three shelters were located at a sufficient distance behind or above the

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[18] Source: Interview with Christopher Gomez of the University of Canterbury, New Zealand. Gomez's research into planning failures that contributed to the March 11 earthquake and tsunami were further detailed in a talk at the 6th annual Australasian natural hazards management conference, August 21-22, 2012, titled "How Japan Planned Its Way Into the 2011 Tohoku Disaster".

[19] Source: Toshiaki Yaginuma, Onagawa-Cho planning department

[20] Source: Toshiaki Yaginuma, Onagawa-Cho planning department

[21] Source: Toshiaki Yaginuma, Onagawa-Cho planning department

inundation line to avoid flooding altogether, most notably the Dai-Ni (number two) elementary school and the Sogotaikan sports centre.

### 1.3 Building codes and practices provided outstanding resistance against the earthquake, but no protection from the tsunami

A majority of modern (post-1980) buildings in Onagawa had been "quake-proofed" according to current regulations[22]. Some older structures had been "retro-fitted" to increase their seismic load capacity in line with those standards. Others had not, and several of these were seen to collapse[23] during the earthquake of March 11, but most of Onagawa's built environment remained intact, with damage limited to loose interiors and external features such as roof slates. Given the degree of shaking[24], this is testament to the level of resistance now afforded by Japanese construction codes.

However, the lightweight materials that helped houses and low-rise buildings to withstand the ground force of the earthquake – principally timber and sheet metal – provided no protection against the horizontal force of the tsunami[25]. Much larger and heavier reinforced concrete buildings were also torn from their foundations by the incoming surges and/or the drag effect of withdrawing seawater ("run-down")[26].

According to Professor Brian Hobbs of Glamorgan University – a structural

[22] Japanese building codes have evolved in response to past earthquakes. Prompted by the 1948 Fukui earthquake, the 1950 Building Standards Act and Law established design minimums for wood-beam length and concrete load capacities, collectively known as "kyu-taishin". An amendment was made in 1971 to ensure that all wooden structures were fitted with reinforced concrete foundations (but only in urban areas). After the Miyagi earthquake of 1978, existing legislation was enhanced and expanded by the New Earthquake Resistant Building Standard Amendment of 1980, with new regulations known as "shin-taishin", stipulating that a building "should not collapse" even in a quake of magnitude 7 or higher. Further measures followed the Great Hanshin (or Kobe) Earthquake of 1995, with particular emphasis on braces, beams, and foundations. New warranty regulations and tougher criteria for certificates and inspections were introduced from 2000-2006. (Source: "Selling Tokyo", retrieved from http://sellingtokyo.wordpress.com/real-estate-faq/earthquake-building-codes-in-japan/)

[23] Source: interview, Masunori Kusaka of Urban Renaissance – chief architect for reconstruction of public housing Onagawa

[24] Which was classed as "extreme" by the United States Geological Survey. Source: http://earthquake.usgs.gov/

[25] Source: Professor Brian Hobbs, Glamorgan University

[26] Certain observers have speculated that the effects of the earthquake – liquefaction and shearing – weakened the pile foundations of these larger buildings to the force of the tsunami. Source: The Great East Japan Earthquake: Facts And Implications For Flood Risk Management (lead author/editor Vana Tsimopoulou)

engineer and technical adviser to the Red R disaster relief network – it is theoretically possible to design buildings for greater resistance and resilience against both earthquakes and tsunamis, but the high cost involved would make it difficult for governments to demand such standards of contractors by way of legislation. Aesthetic considerations might also make such properties less appealing to developers and buyers[27] – the resulting structures would by necessity look more like "bunkers" than homes, shops, or offices.

### 1.4 Onagawa Nuclear Power Plant was "remarkably undamaged"[28]

Located six kilometres outside the town at Koyadori Bay, the Onagawa Nuclear Power Plant was the closest such facility to the epicentre of the March 11 earthquake. However, this facility was largely protected from the tsunami by a 14-metre seawall, and a ground level set 20 metres above the shoreline[29]. (The seawall at the Fukushima Daiichi Plant, by contrast, measured only 5.7 metres, which largely accounts for its extensive flood damage and resulting reactor fires and meltdowns[30].) It is worth noting that these structural protections can be partly attributed to public pressure from local residents and anti-nuclear campaigners in the development phase of the plant throughout the 1970s. External safety concerns compelled its owners, the Tohoku Electric Power Company[31] to raise the height of the wall, and the elevation of the site itself, from the levels outlined in their original construction plans[32].

By the time of the disaster, local confidence in the security of the ONPP was such that some 200 residents of the nearest homes sought refuge there after the earthquake, and the plant became an ad-hoc evacuation centre for several months afterward[33]. Sujit Samaddar, a lead inspector for the International Atomic Energy Agency (IAEA), later remarked that Tohoku Electric had set "a very good example" for other nuclear facilities in IAEA member states[34].

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[27] Sources: Masunori Kusaka, Professor Brian Hobbs

[28] The conclusion of an IAEC inspection team, as quoted in the World Nuclear News, August 10, 2012, retrieved from http://www.world-nuclear-news.org/RS-Onagawa_plant_remarkably_undamaged_says_IAEA-1008124.html

[29] Source: interview with ONPP plant spokesman Aizawa Toshiyuki

[30] The Fukushima Daiichi Plant is located approximately 120 kilometres south of Onagawa, and roughly 50 kilometres further from the epicentre than the ONPP.

[31] Not to be confused with the Tokyo Electric Power Company, owners of the Fukushima Daiichi Plant, which is commonly known by the acronym TEPCO.

[32] Sources: interviews with Onagawa resident and anti-nuclear campaigner Ikuo Fujinaka, Professor Tamotsu Hashimoto-Gotoh of Kyoto University, and ONPP spokesman Aizawa Toshiyuki

[33] Source: interview, ONPP spokesman Aizawa Toshiyuki

[34] Source: World Nuclear News, August 10, 2012, retrieved from http://www.world-nuclear-news.org/RS-

However, it is also important to recognise that the magnitude of the March 11 earthquake exceeded the ONPP's design capacity, causing malfunctions to operating systems and a small fire in a turbine room. An underwater surge from the tsunami flooded a lower basement. A powerful aftershock on April 8, 2011 caused a spill of radioactive water from a pool of spent fuel rods[35]. In an interview conducted for this report, ONPP spokesman Aizawa Toshiyuki admitted that the combined impact of the earthquake and tsunami had caused more than 600 "minor" technical problems at the plant.

While nuclear industry insiders have claimed the ONPP as a model of good practice in disaster mitigation, many residents consider the events of March 11 and subsequent incidents to constitute a series of close calls. Public attitudes have changed in the wake of this disaster, and the future of the plant, which remains in cold shutdown, has since become a highly contentious issue in local debates over reconstruction proposals (see section 2.6).

### 1.5 Land use and spatial planning left residents and properties exposed

Over 80% of Onagawa's land area is mountainous, and unsuitable for development[36]. By necessity, commercial and residential use had been concentrated in the main valley and plains, with industrial facilities – fisheries and seafood processing plants – built on reclaimed land at the waterfront. However, local planning decisions (or a lack of planning restrictions) served to increase property and population exposure to the incoming tsunami on March 11[37]. The town centre – banks, shops, etc – and the largest residential district, Shimizu-Cho, were located at low elevations immediately behind the harbour. Inevitably, these areas suffered the greatest property damage and loss of life.

It is clear that cultural and commercial concerns – bound up in the community's self-identification as a "minato machi", or "harbour town" – had been prioritised over flood defence in the town's physical layout. Despite its close proximity to the sea, and previous experience of damaging tsunamis (see below), local policy-makers had instituted very few of the suggested countermeasures outlined in Japan's official Guidebook For Tsunami Hazard Planning[38]. For

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Onagawa_plant_remarkably_undamaged_says_IAEA-1008124.html

[35] Sources: Tohoku Electric official update, April 10 2011, retrieved from http://www.tohoku-epco.co.jp/pr/onagawa/hatudensyo.html

[36] Sources: Toshiaki Yaginuma, Masunori Kusaka

[37] Source: The Great East Japan Earthquake: Facts And Implications For Flood Risk Management (lead author/editor Vana Tsimopoulou), which contends that up to 80% of Onagawa's population were exposed to the tsunami hazard, a higher percentage than almost every other affected area.

[38] Issued by the government to local authorities in collaboration with the National Land Agency, the ministries of Agriculture, Construction, and Transport, the Forestry and Fisheries Structural Improvement Bureau, the

example: no “buffer district” had been established between the shoreline and populated areas, no “control forests” had been planted to absorb the impact of a potential tsunami, and most waterfront industrial facilities had not been reinforced to reduce run-up and block debris from penetrating inland.

The harbour, town centre, and low-lying districts were not designated “danger areas”, as allowed for – but not explicitly stipulated – by article 39 of Japan’s Basic Construction Law, and development in those areas was effectively unrestricted. Furthermore, key social infrastructure was also located at relatively low elevations, with the result that police, fire, and coast guard stations were inundated by the tsunami, as well as Onagawa Town Hall, thus reducing the response capacity of emergency services and civic authorities.

### 1.6 The public were not trained or prepared for a major-scale tsunami

The Japanese culture of earthquake preparedness had been fostered in Onagawa through education programmes and regular emergency drills for all students from kindergarten to high school. Public sector staff received training in evacuation procedures, and most private businesses conducted their own drills along similar lines[39]. Residents interviewed for this report said that they reacted calmly to the first earthquake alert on March 11, and behaved as they had been trained – taking cover under desks and open doorways, for example.

In the interval before the tsunami, however, many seemed less sure of proper protocol. Some ran for high ground at designated shelters, as advised by the town’s public address system – though elderly residents were less able to do this quickly, and no special provisions had been made for their evacuation. Others remained in or returned to their homes and businesses after the initial earthquake, believing that the tsunami alert was an automatic response, and not an accurate reflection of the imminent threat (indeed, as detailed above, initial JMA warnings vastly underestimated the height of incoming waves).

Certain employers instructed their staff back to work, or to clear up minor damage caused by the earthquake[40]. Younger people purposely stayed near

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Japan Meteorological Association, the Fire and Disaster Management Agency

[39] As mandated by the Disaster Countermeasures Act, which requires both “public bodies” and “legal bodies carrying out public business” to conduct disaster risk reduction operations, draft emergency protocols in line with the Basic Plan For Disaster Management, and participate in the Central Disaster Management Council. The act also legislates for private sector personnel to take “responsibility” for disaster risk reduction, and private citizens to “take measures” and “make contributions” to help ensure disaster preparedness. (Source: National Report Of Japan On Disaster Reduction, for the World Conferenc On Disaster Reduction, Kobe-Hyogo, 18-22 February 2005)

[40] Source: Several fishery employees attested to this, as did surviving employees of the 7/7 bank near Onagawa waterfront.

the waterfront to watch the waves come in[41], believing themselves to be safe on the second or third floor of public or private buildings. In an interview conducted for this report, Onagawa town planner Toshiaki Yaginuma said: “a basic sense of awareness was strikingly absent at the time of the tsunami”.

This point should be considered absolutely critical – even in a town, and a country, with a well-developed technical and professional capacity for disaster preparedness, it seems clear that insufficient attention had been paid to the public’s understanding of those provisions. In theory, the minutes between the earthquake and tsunami should have allowed enough time for a majority of the population to be safely evacuated, whether on personal initiative or by some pre-organised emergency protocol. That so many residents remained in the exposed area close to the waterfront even after such a powerful earthquake can only be seen as a failure of disaster planning and policy.

Simply put, the public had not been adequately informed as to the potential scale of the hazard, or the most fundamental imperative in tsunami readiness: to get to the highest ground available, as quickly as possible.

### 1.7 The problem of “living memory”

Being so close to a major fault zone, Onagawa had experienced powerful earthquakes in 1611, 1896, and 1933, each of which generated sizeable tsunami waves onshore. Stone markers in several nearby locations commemorated these past disasters and warned against building at low elevations close to the shoreline. In the years since, these warnings had been largely ignored and/or forgotten. While minor earthquakes are an everyday occurrence in Japan, tsunamis remain relatively rare.

The only fatal example to occur in the Tohoku region within living memory[42] was the so-called “Chile tsunami” of May 1960, when a high-magnitude earthquake near Valdivia, Chile, caused long-range destruction across the Pacific, and particularly to north-eastern Japan.

Onagawa had been badly damaged by incoming waves of approximately five

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[41] Source: Higaki Atsunori, head coach of Onagawa Cobaltore Football Club, told the writer that he had remained on the second floor of the team clubhouse after the initial earthquake, having assumed that he would be safe from the imminent tsunami – until an older club employee advised him to evacuate the building. This assumption may be taken as broadly representative, and many residents of Atsunori’s age group (18-35) reported similar experiences.

[42] Like most rural Japanese towns, Onagawa has a markedly ageing population, and several elderly residents told the writer that they also remembered the 1933 disaster.

metres[43], and it was generally assumed that this was as high as any future tsunami could or would get. The town's concrete seawall and evacuation shelters were built after that event, and effectively based on that assumption[44].

This corresponds to a wider tendency in disaster planning, whereby countermeasures are designed to prevent a repeat of a recent occurrence, rather than protect against the maximum potential hazard.

Geological evidence suggests that the so-called "Jogan event" – a major earthquake in the same region, circa 869 CE[45] – produced a tsunami of roughly equivalent proportions to that of March 11 – but local knowledge and expectations were focused on the only such disaster that (older) present-day residents had personally experienced. As a consequence, many Onagawans were psychologically unprepared for the threat presented by this tsunami.

Several interview subjects for this report told the writer that they did not know, or believe, that waves of such heights were even possible. They attributed the high death toll in Onagawa to this shared sense of disbelief. Survivor Toshihiko Sato said: "Nobody thought the water would come so high, and that's why so many lost their lives. By the time they saw it was so much bigger [than the "Chile tsunami"] it was too late for them to move."

Such factors are difficult to quantify, but this disaster provides telling evidence that even a relatively well-informed public can be caught off-guard by hazards with recurrence cycles that exceed the average lifetime. Planners elsewhere should consider the implications for other countries with even longer return periods between such events, and where the public are less aware of seismic hazards. This cognitive problem may also apply to other natural hazards – "100 year storms" etc.

## 2. "MOVING THE WHOLE TOWN UPHILL"[46]:

## RESPONSE, RECONSTRUCTION, RELOCATION

In the short-term, the Japanese government responded quickly and decisively to the disaster. An emergency response team, including then-Prime Minister Naoto Kan, was formed within four minutes of the first earthquake alert, and a

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[43] Source: Surviving A Tsunami: Lessons From Chile, Hawaii and Japan, US Geological Survey, retrieved from, http://pubs.usgs.gov/circ/c1187/

[44] Source: Toshiaki Yaginuma, Onagawa Planning Office

[45] Source: Professor Mitsuhisa Watanabe, Toyo University

[46] The title of an algorithmic land survey of Onagawa by Yusuru Isoda, Associate Professor of Tohoku University, for the Tohoku Geographical association: http://tohokugeo.jp/disaster/articles/e-contents19.html

disaster response headquarters was established in less than half an hour[47].

Official survey teams and “inter-prefectural emergency rescue units” were immediately dispatched to the affected areas, comprising police, fire, and coast guard services, specialists from the Ministry of Land, Infrastructure, Transport and Tourism, and trained responders from Japan’s Self-Defence Forces (SDF)[48]. By March 26, 2011 these units had rescued some 26,000 people across the Tohoku region (though it should be noted that the tsunami caused many thousands of drowning deaths within the first hour of the disaster, leading to a much higher casualty rate, and a lower percentage of live rescues, than would be expected of an earthquake alone[49]).

Onagawa’s relative remoteness, and damage or blockage to narrow access roads, obstructed the arrival of search and rescue workers by several days, and several fishing villages in more secluded bays and inlets were cut off for as long as a week. Because of the town’s relatively small size and population, however, evacuation centres were able to provide sufficient food, water, and other essentials[50]. Less than one week after the disaster, the main shelter at the Sogotaikan sports complex was also providing medical care, psychological counselling[51], teaching for schoolchildren, and callisthenics for the elderly.

On both national and local levels, the Japanese response provided many such examples of good practice in emergency management. However, no pre-existing plans or provisions had been made for the long-term reconstruction of entire coastal communities. In Onagawa, as in many other towns and villages along the rias coast, all plains had been inundated, and low-lying areas further exposed to future flood risk by extensive subsidence from the earthquake.

Soon after the disaster it was generally agreed among policy-makers and residents that new housing should be sited at higher elevations. An early

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[47] Source: Damage Assessment And Need Survey by Asian Disaster Reduction Center and International Recovery Platform, retrieved from http://www.adrc.asia/documents/disaster_info/20113.11_Earthquake&Tsunami_in_Japan.pdf

[48] See footnote 46

[49] Source: interview, Professor Brian Hobbs

[50] The nearby city of Ishinomaki, because of its much larger population of evacuees, presented SDF response teams and relief workers with greater difficulties in supplying essential provisions.

[51] A “heart-caring” room was provided at the Sogotaikan evacuation centre for psychological counselling, and at least 100 mental-health professionals were dispatched to Onagawa, but many evacuees said they preferred not to discuss their traumas with strangers, and there remains a significant stigma attached to psycho-theraputic practice in Japan. Further reference: http://www.mb.com.ph/node/314662/fear#.UOm_NYnjkoY

survey of 236 affected communities found that 80% of evacuees were broadly in favour of upward relocation[52]. There were local and historical precedents for this – some of the same towns and villages had previously moved upslope in response to past tsunamis – but it had never been attempted on the scale now under discussion. The logistical complexities would be particularly acute in Onagawa, where the only land suitable for building – including reclaimed land on which the port and fisheries had been developed – was now considered too "dangerous" for residential use.

In the months that followed, geographers from Tohoku University conducted an algorithmic search for developable land on the surrounding mountainsides, using cartographic models to consider variables of slope angle, area size, and distance above the inundation-line[53]. This study and others determined that new building sites could only be made available by "artificial modification", and the extensive terracing of surrounding mountainsides.

The newly-formed Onagawa Reconstruction Design Committee (ORDC) entered into a partnership with the public-private design firm Urban Renaissance (UR) to draft an initial plan on this basis: Six areas of forested mountainside (later expanded to 10, and amounting to a total of 236 hectares) would be cleared and terraced, and the excavated earth would be transplanted to the shoreline, raising the waterfront and central plains by 5.4 metres.

The town's land area was divided into 8 zones according to use. New planning regulations would prohibit residential use below a certain elevation, with only industrial and commercial use permitted in lower-lying areas (on the proviso that tall buildings be placed up to 500 metres apart, and evacuation measures improved). The initial timeframe for redevelopment proposed that residential construction be prioritised through 2012, infrastructure from 2013-2015, and commercial and industrial facilities from 2016-2018. This plan was submitted to the Japanese government's interim Reconstruction Headquarters (see section 2.1) in September 2011, with an initial budget request of nine billion yen[54].

At time of writing, however – early December 2012 – preliminary earthwork for residential reconstruction has barely begun, and the planning process has proven highly problematic, for reasons outlined below. But the issues raised by this disaster are not unique to Onagawa, or Japan. Other recent tsunamis in the Pacific region, and devastating storms in the Atlantic and Caribbean, have forced policy makers to consider the future viability of coastal communities, particularly given the growing threat posed by rising sea levels and extreme weather events associated with climate change.

[52] Source: City Planning Institute of Japan
[53] Source: "Moving The Whole Town Uphill" by Yuzuru Isoda See footnote 45
[54] Sources: Toshiaki Yaginuma of Onagawa-Cho planning office,
Professor Hiroshi Suzuki of the ORDC, Masunori Kusaka of UR.

In Japan as elsewhere, the traditional response to major coastal disasters has been a relatively straightforward reconstruction of destroyed properties and assets, coupled with deployment and enhancement of structural defences, such as seawalls. In recent years, however, the limitations of this strategy have become obvious, as such defences tend to exacerbate the effects of coastal erosion and strip away the buffering capacity provided by beaches and tidal zones – as was seen in Galveston, Texas in 2008, when Hurricane Ike breached the defensive structures first erected in response to a catastrophic hurricane over 100 years earlier[55].

Ike, Katrina, and most recently Hurricane Sandy have led some geologists to call for a new land use policies along the gulf coast and eastern seaboard of the United States, with suggested options ranging from restrictions on all new development in exposed areas to the managed retreat and relocation of at-risk populations. The question of retreat – as opposed to rebuilding – is slowly coming to define the debate over planning for natural disasters, though most of its proponents have noted that governments, business owners, developers, and the general public tend to be averse to the idea of abandoning public and private assets, regardless of the hazard.

A policy of managed retreat or coastal realignment has been adopted in other, certain areas of the United States, such as Pacifica State Beach in California[56], as well as sections of the UK (see section 4.7) and parts of New Zealand[57]. The legal and social complexities of retreat and relocation remain relatively untested in populated urban areas however, and the experience of Onagawa after the tsunami only highlights the need for their urgent consideration. It seems reasonable to suppose that any issues arising from the reconstruction of a relatively small coastal community would only be amplified in any larger town or city following a similar disaster. An overview of the issues discussed in this section is provided below in Table 2:

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[55] Source: “Walls Won’t Stop Superstorms”, Salon, Nov 6 2012, retrieved from /www.salon.com/2012/11/06/sandy_recovery_walls_wont_stop_superstorms

[56] Source: National Oceanographic and Atmospheric Association (NOAA), retrieved from http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_retreat.html

[57] Source: “Managed Retreat From Coastal Hazards”, Christopher Turbott and Andrew Stewart Ltd for Environment Waikato, retrieved from http://www.waikatoregion.govt.nz/PageFiles/5405/tr06-48.pdf

| Recovery issue | Cause | Consequence | Improvement measures |
|---|---|---|---|
| Indecision | Lack of co-ordination between national, prefectural, and municipal governments, absence of any pre-existing agency dedicated to long-term disaster recovery planning | Delays in positive action, prolonged uncertainty for victims and survivors, inefficient oversight of reconstruction | Develop specialised and coordinated decision-making agencies at local and national levels for post-disaster planning |
| Centralisation | Failure to empower local authorities and reduce economic dependence on central treasury | Inability of local governments to act on recovery plans or raise necessary revenues | Devolve key powers to towns and prefectures for post-disaster planning, ensure training for local government staff |
| Public anger and confusion | Insufficient attention to emotional needs of disaster victims, failure to inform and involve residents in key decisions | Mistrust of local authorities and outside consultants, refusal to cooperate with recovery plans | Engage with community on all issues of reconstruction, build consensus before proceeding |

| | | | |
|---|---|---|---|
| Unclear legal and financial rights | Failure to clarify the inheritance, mortgage, insurance and compensation status of affected residents after the disaster | Protracted period of uncertainty for victims and survivors, a lack of consistent information on which to make vital life choices | Codify all legal and financial systems to expedite payouts and property transfers in the event of a natural disaster |
| Disparity of public/private funding | Local over-reliance on fishing and nuclear industries, declining tax base and revenues, lack of appeal to other investors | Chronic lack of revenue for reconstruction, limited options for expansion of local commerce | Support proactive community plans for renewal, foster relationships with private sector, broaden range of incentives and business plans |

## 2.1 Indecision and a lack of national leadership

It is not within the remit of this report to account for the mechanics of Japanese politics, but the current system can be seen to work against effective post-disaster planning. The country's frequent experience of seismic and meteorological emergencies has resulted in the creation of various government departments for mitigation and management[58]. However, no dedicated agency exists to anticipate the demands of reconstruction or coordinate that process in the event of a major-scale earthquake and tsunami, and the government was conspicuously slow to establish one in this case.

A Reconstruction Design Council was not formed until one month after the disaster. Its first framework for recovery was published three months later, and largely confined to general principles – articulating a need for community-focused recovery and solidarity between the relevant agencies[59]. In an

[58] Foremost among these is the Central Disaster Management Council, convened by act of parliament in 1998 with a remit to establish disaster-resilient transport and communications infrastructure, a disaster "watch" system, and further the process of "earthquake-proofing" and retrofitting the built environment. Source: National Report of Japan for the World Conference on Disaster Reduction, retrieved from http://www.unisdr.org/2005/wcdr/preparatory-process/national-reports/Japan-report.pdf

[59] This long delay has been largely attributed to hesitance on the part of the ruling Democratic Party of Japan (DPJ) in passing critical reconstruction bills and budgets, but also to parliamentary opposition from their main rivals the Liberal Democratic Party (LDP), which rejected the DPJ's offer to form a joint government in response the crisis, and repeatedly insisted on the resignation of Prime Minister Naoto Kan, who eventually stepped down on September 2,

interview conducted for this report, Onagawa Reconstruction Design Committee (ORDC) chairman Professor Hiroshi Suzuki[60] criticised that body for its failure to take "positive action" in responding to the proposals of front-line planners, or the needs and opinions of residents within the disaster zone. A more comprehensive Reconstruction Agency (RA) was not operational until February 2012, almost one year after the disaster.

Three "response offices" were opened in the worst-hit prefectures – Fukushima, Iwate, and Miyagi – with a local branch in Ishinomaki City assuming responsibility for Onagawa and many other neighbouring towns and villages. At present, however, that office is staffed by only three full-time personnel. Residents and on-site professionals – including Professor Suzuki and UR's chief architect Masunori Kusaka – continue to question the RA's capacity to consider specific plans and budget allocations according to the circumstances of each affected community. From their perspective, this agency adds another layer of bureaucracy between local and national government, further slowing and confusing the process[61].

## 2.2 Centralisation and provincial dependence

In the years before March 2011, a number of reform bills had been passed by the Japanese Diet (parliament), with the stated purpose of devolving greater power and responsibility to prefectural and municipal governments. In practice, however, these changes have served to reduce Tokyo's control over those local authorities without allowing them act independently, or raise revenues according to their needs. Most provincial towns still depend on the central treasury for at least 30% of core funding.

After this disaster, the ruling Democratic Party of Japan (DPJ) passed an emergency supplementary budget, and an Act on Special Financial Support For Promoting Group Relocation For Disaster Mitigation, which by which the treasury would provide up to 94% of vital reconstruction funding through subsidies and other means. However, this initial budget had little visible effect in terms of new public works within the affected areas[62], and an upper-limit on those subsidies meant that a greater proportion of the financial burden would

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2011. Kan later publicly apologised for the government's failure to respond more quickly and decisively to the need for urgent action. Source: "Politics: Kan Won" by Michael Cucek, MIT Center For International Studies. This article was included in a digital collection of essays titled Reconstructing 3/11, and distributed by Abiko Free Press, www.abikofreepress.com

[60] Of Fukushima University, also head of the Housing and Planning Network

[61] Source: "Reconstruction Agency Faces Urgent Problems", Daily Yomiuri, Feb 12, 2012, retrieved from http://www.yomiuri.co.jp/dy/national/T120211003511.htm

[62] Source: Takuji Okubo of Societe Generale

fall back on the affected communities.

In June 2011, Miyagi Prefecture commissioned an internal estimate of prospective costs for rebuilding/relocating a town of 10,000 people with an annual budget of 6 billion yen, which corresponded closely to Onagawa's size and revenues. Their projected total was 210.7 billion yen, of which the town would be required to cover 116.5 billion – over 20 times its annual budget[63].

Simply put, Onagawa cannot afford to rebuild itself, and does not have the authority to do so, because all related proposals must be submitted through the national Reconstruction Agency for planning permission and funding allocation. It should also be noted that Onagawa's own planning department was not necessarily well-placed or qualified to make critical decisions in the wake of the disaster. Its offices and paper records had been destroyed with the town hall, and most of its staff had suffered personal losses and traumas.

Having no previous experience of reconstruction planning, the department came to rely heavily on outside consultants, who in turn lacked any local knowledge or understanding of the community. UR architect Masunori Kusaka told the writer that the land surveys and studies produced by many of those consultants were "purely geological, or technical", and did not address the various social, cultural, environmental and economic factors that served to make their subsequent recommendations unpopular, or unworkable.

Also, perhaps in a bid to normalise their duties in new surroundings (first the town's emergency headquarters at the Onagawa Number 2 elementary school, then a prefabricated temporary town hall) local officials resumed certain bureaucratic routines that were not suited to the circumstances. For example, the standard policy of "jinji idou" – which requires that most civil servants are assigned new roles at the beginning of a new fiscal year, irrespective of skills or experience – was effected as usual in April 2012, with the result that key personnel were removed from the planning department and replaced by staff with little or no working knowledge of ongoing projects[64].

### 2.3 The difficulties of planning around emotions and attachments

In the immediate aftermath of the disaster, over 5000 displaced Onagawa residents were accommodated in public buildings that had been repurposed as emergency shelters – including the Sogotaikan sports centre, the upper floors of the municipal hospital, and the town schools. Evacuees interviewed for this report said that living at such close quarters helped to preserve their sense of community, bolster their morale, and compensate for their loss of privacy.

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[63] Source: http://www.yomiuri.co.jp/dy/national/T110910002044.htm
[64] Source: Masunori Kusaka (UR)

They also said, however, that subsequent arrangements served to dissipate much of that communal spirit, as residents were assigned by lottery to rapidly-constructed temporary housing units in Onagawa and elsewhere (see section 2.4). While town officials believed this to be the "fairest"[65] system, many residents considered it to be an enforced separation that would leave them isolated[66]. Several groups of friends and former neighbours refused to accept the units assigned to them, and insisted on being housed together.

Some also claimed that they were less inclined to remain in Onagawa if new permanent public housing was to be allocated by a similar lottery system, as proposed by the ONRC in May 2011. Understanding that planners were obliged to make the most efficient use of the limited land available within the new sites cleared for residential use, these interviewees nevertheless felt that a lack of choice in where they were to live, and who would be their neighbours, might defeat the purpose of their remaining in Onagawa – to stay as close as possible to fellow survivors, to the places where their homes had been, and to where their loved ones had died or gone missing[67].

As indicated by initial surveys, a majority of residents have accepted that they cannot rebuild on their original plots of land, in areas now classified as "dangerous". Many told the writer that they would no longer feel safe living so close to the shore, and support the basic relocation plan for that reason alone.

There remains, however, a substantial minority who continue to reject that plan, particularly in Onagawa's incorporated fishing villages. The residents of Koyadori, for example, where many houses are still largely intact, said they intend to return to live and work there, regardless of any new prohibitions.

A significant proportion of fishermen and women from all 15 of those villages have further refused to consider their proposed consolidation into two new communities on higher ground, where they would be out of sight and easy reach of their boats and equipment. These concerns may be seen as both commercial and cultural, as they residents claim to depend on the sea not only for their livelihood, but also their sense of identity.

The relocation plan has therefore proceeded without their consent, raising questions of social justice, and even of legality – if future zoning regulations

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[65] Source: Toshiaki Yaginuma, Onagawa-Cho planning department

[66] Some also expressed anger that this system did not prioritise the elderly or families with young children.

[67] Of almost 900 people confirmed or presumed dead after the tsunami, over 200 bodies had not yet been recovered as of October 2012, and family members maintained that they would not leave Onagawa while there remained a possibility, however remote, that their loved ones might yet be found.

make it “illegal” for residents to live within a certain limit of the shoreline, this is not to say that authorities can legally compel them to accept relocation.

Further debates have arisen over the specific areas selected for development. The outdoor athletics stadium at the Sogotaikan sports complex was initially seen by planners as ideal for this purpose – 24.5 hectares of flat land at 33 metres above sea level, which would allow for the rapid construction of new, permanent housing – but their decision to proceed was suspended at a public forum in July 2011. At that meeting, attended by the writer, members of the public argued that the athletics track and field was not only an asset, but also a repository of good memories – the venue for their children’s sporting achievements, and some of their own happiest moments. The planning committee agreed on that basis to preserve at least some of the site’s facilities.

Neither could the public agree on ORPC plans for a memorial park at the waterfront, incorporating reinforced concrete buildings which had been toppled by the force of the tsunami: a police box, a ferry terminal, and a vitamin supplement retailer. As early as April 2011, it had been proposed that the buildings should remain as permanent monuments, but many residents said that the sight of these buildings caused them continued distress. (At time of writing, a final decision had still not been made.)

These debates have served to highlight the need for planners and policy-makers to consult and involve survivors in decisions that not only affect their future but impact on their sense of the past – which may be no less important to the process of recovery.

### 2.4 Inadequacy of temporary housing

Apart from the issues raised by lottery allocation, as detailed above, the temporary housing units provided for evacuees have proven generally unfit for purpose. Though constructed by different companies (Mitsui, Daiwa, Sekisui) to slightly different specifications, these units were generally designed to last approximately two years[68]. In the winter of 2011-2012, less than one year after the disaster, many of these homes developed leaks, electrical faults, and other structural and insulation problems[69].

Onagawa Reconstruction Design Committee (ORDC) chairman Hiroshi Suzuki has said that not enough consideration was given to the strong possibility that residents would have to live in these units for a prolonged period, and that “quality of life” was not sufficiently prioritised in the construction phase.

According to Suzuki, Japan’s Prefabricated Building Association “colluded” with

[68] Sources: Hiroshi Suzuki, Masunori Kusaka, Toshiaki Yaginuma

[69] Source: Interviews, Satoshi Ito of the Onagawa Reconstruction Support Centre, residents/evacuees Ikuo Fujinaka, Rie Shimanuki

Miyagi's prefectural government (and also the governments of Fukushima and Iwate prefectures) to effectively monopolise contracts for the building of these units. A notable exception is the complex of 1800 "experimental" housing units on the site of the town's former baseball field, specially contracted by the town government[70] and designed by Shigeru Ban Architects.

Given Onagawa's lack of flat land, Ban and his team proposed a three-story framework to allow for the stacking of repurposed shipping containers in a "chequerboard" arrangement to make the best use of available space. These units – sized at 19.8, 29.7, or 39.6 square metres according to occupancy – contain a number of design features lacking in the other temporary homes, including built-in storage cabinets, private sleeping quarters, and open living spaces with natural light. They were designed for easy assembly, durability[71], and ecological sustainability (using reconstituted wood and paper for interior walls and beams), but also for comfort and aesthetic appeal.

Shigeru Ban told the writer, "even temporary homes should be beautiful, because they are supposed to ease the minds of people living there"[72]. The complex itself was also designed to facilitate a renewed sense of normalcy, with the units arranged around a covered "market-area" and an indoor "community hall". According to Masunori Kusaka and the Reconstruction Support Centre, the 189 families assigned to these units now enjoy the highest living standards (and report the fewest problems) of any evacuees in the disaster zone. Shigeru Ban has taken on the additional work of amending and improving existing units designed by other companies.

Shigeru Ban Architects have previously designed temporary post-earthquake housing and emergency shelters in Kobe (1995) Turkey (2004) and Hualin, China (2008) – with similar results and equally positive responses from displaced residents. The firm's methods and criteria should be considered in planning and construction for all such housing after future disasters.

### 2.5 Uncertainty over mortgage, insurance, and inheritance status

The reconstruction plan proposed by the ORDC requires that the town be allowed (and subsidised by the treasury) to purchase both previously

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[70] Usually, these contracts can only awarded by prefectural governments, but a disaster by-law within Miyagi Prefecture allows local mayors and/or municipal governments to place their own orders for temporary housing units. Source: Interview, Shigeru Ban. See also: "Onagawa Container Temporary Housing", World Architects Review, retrieved from http://www.world-architects.com/en/projects/project-current-review/35682_onagawa_container_temporary_housing

[71] According to Shigeru Ban Architects, these units conform to Japanese seismic-load capacity building codes for permanent housing.

[72] In a personal interview conducted in March 2012

undeveloped land at high elevations, and the plots within the inundation zone on which damaged or destroyed properties had formerly stood. In the latter case, both local and national authorities ruled that these purchases would effectively be compulsory[73], and owners would be obliged to accept whatever compensation was offered. For many months after the disaster, however, no firm decisions were made, and no clear guidelines produced, as to the financial rights and obligations of those residents who had lost their homes.

In that period, the government was unable to reach an agreement with those banks who insisted that payments would still be due on outstanding mortgages, even if the property in question had been destroyed. As recently as November 2012, the relevant lenders conceded that a maximum of five million yen would be written off each mortgage, but the balance in excess of that figure was still subject to repayment[74].

At the same time, less than 15% of homeowners in Onagawa had been covered by private disaster insurance. As in other towns and cities, the majority subscribed to Japanese public insurance system that provides cover against earthquakes and related fire and flood damage, but also puts a cap on payouts. (If total property losses from any one disaster exceed 5.5 trillion yen, then government-sponsored insurers and re-insurers can reduce payouts to policy-holders[75].) Again, after more than 18 months of protracted debate, residents were informed that they could expect to receive 12%-25% of the value of their homes, plus a one-off payment for the compulsory purchase of their land, adjusted according to their pre-disaster value.

In Onagawa, these combined payments would amount to an average of eight million yen per household[76]. When compared to the average cost of building a new home – approximately 20 million yen – it was obvious that most residents could not afford to rebuild privately, and would therefore be reliant on the public housing provided by the ORDC's reconstruction plans. Those who did have the means to rebuild did not have ready access to land on which to do so. In either case, all those who wished to remain in Onagawa will have to wait years for the relevant sites to be cleared and terraced for development – the first phase of new public housing is not scheduled for completion until 2014.

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[73] Sources: Masanori Kusaka (UR), Toshiaki Yaginuma, Onagawa-Cho planning department

[74] Sources: Masunori Kusaka (UR), Hiroshi Suzuki (ORDC), Onagawa-Cho planning department, http://www.japantimes.co.jp/text/nb20120609a3.html, "The Worst Possible Catch 22", retrieved from http://thenewjapan.blogspot.com.ar/2012/10/the-worst-possible-catch-22.html

[75] Sources: The Guide To Buying Property In Japan (Dillon Communications 2012), Reinsurance Association of America

[76] Source: Onagawa-Cho planning department

Delays and postponements to the timescale for reconstruction initially proposed by the ORDC were further prolonged by the issue of inheritance. Many of Onagawa's destroyed and damaged properties had been bequeathed to surviving relatives of tsunami victims, whose resulting rights complicated the process of purchasing that land for development. According to Masunori Kusaka, this issue remains unresolved as of December 2012, and continues to cause doubt as to whether reconstruction can go ahead as planned.

Faced with this ongoing uncertainty, coupled with the drastic loss of employment effected by the disaster, and attendant pressures on the local school system, many families have subsequently left Onagawa to make arrangements elsewhere. The town hall estimates that the official population has dropped below 6000 people, and anecdotal evidence suggests that this figure is now substantially lower[77]. It can therefore be seen that a general lack of coherence between the various agencies and institutions, and the absence of any pre-existing system for defining post-disaster rights and payments, has demonstrably reduced the town's prospects for recovery.

Most residents consulted for this report complained that the government and banks have failed to inform or advise them on the options available.

For every delay and obstruction that has prolonged their uncertainty, or narrowed those options, the more people have left Onagawa, thus reducing size and potential tax base of the redeveloped town that planners are now working to realise.

### 2.6 Lack of effective partnership between public and private sectors

The near-total destruction of Onagawa exposed the full extent of its reliance on two main sources of revenue and employment – the local fisheries, and the Onagawa Nuclear Power Plant (ONPP). Both of these industries were effectively stopped dead by the disaster. All waterfront facilities and harbours were devastated, and the ONPP has remained cold shutdown since March 11.

At a series of public meetings in April 2011, the town council, reconstruction planning committee, and representatives for local workers agreed that the recovery of the fishing industry was essential to the Onagawa's immediate economic future. The earliest available emergency subsidies were directed into the purchase of new boats and equipment (though some local business owners said they considered this "preferential treatment"[78]).

[77] Resident Ikuo Fujinaka conducted a private survey or remaining residents in October 2012, and found the number to be less than 4000

[78] Resident Ito Isamu, a local shoji-manufacturer (shoji are Japanese wood-framed window and door panels) told the writer that at least 40% of Onagawa residents were not employed by the fisheries, and that this figure was not duly accounted for in the earliest recovery and relief plans.

Both residents and officials proved less certain as to the future role of the Onagawa Nuclear Power Plant (ONPP). Prior to the disaster, the plant had come to provide the largest share of the town's income, through fixed property taxes and subsidies proceeding from electric power laws[79]. In the fiscal year 2009, these revenues accounted for 65% of Onagawa's 6.4 billion yen annual budget. Since the plant's inception in 1984**,** its owners, the Tohoku Electric Power Company had also heavily invested in public works, including the Sogotaikan sports centre (the town's main evacuation shelter after March 11), the municipal hospital, and the Marine Pal (a waterfront fish market and maritime museum that had been Onagawa's principal tourist attraction).

A small minority of critics had previously argued that Tohoku Electric and other nuclear power companies effectively "bribed" Onagawa and other coastal towns into hosting facilities that generate electricity for bigger cities such as Tokyo[80]. In the wake of the crisis at the Fukushima Daiichi plant, many more residents became sceptical about the safety of the ONPP and nuclear power in general, a shift in popular opinion that was reflected across Japan (and in other parts of the world). Interviewees expressed opposing views as to whether the plant should be reactivated, as its revenues would help to fund the town's recovery.

Town council member Hiroshi Takano told the writer that most of his constituents now felt that safety was more important, and that "the money from the plant would hardly begin to cover the costs of reconstruction here". Campaigning on an anti-nuclear platform in the council elections of November 2011, Takano and two-like minded candidates won the largest percentage of the vote, and now form a bloc against the ONPP in local government[81].

Takano and others also expressed the opinion, later borne out by reports in the Asahi Shimbun and other newspapers, that many private investors would be reluctant to work in Onagawa and neighbouring towns specifically because of their concerns about the plant and the consequences of radiation leaks.

This must be seen as an ongoing obstacle to recovery plans, which depend on attracting new investors and stakeholders, both to provide immediate funding, and to reverse the town's pre-disaster decline. For several generations, Onagawa had been suffering the same problems as many other areas of rural

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[79] Principally, the Electric Power Development Promotion Law.

[80] A number of interviewees made this point, including Ikuo Fujinaka, a local teacher and long-term resident who had first come to Onagawa as a student to protest the construction of the ONPP. Lifelong resident Toshihiko Sato said of the ONPP: "If this plant is so safe, why didn't they build it in Tokyo? All the power it generates is going there anyway."

[81] At 567 votes, Takano himself came within seven votes of beating the most popular candidate Ryoichi Sasaki (574).

Japan – slow depopulation, a growing generation gap, and a lack of employment opportunities. The three prefectures worst affected by the disaster – Miyagi, Iwate, and Fukushima – were among the poorest in Japan, accounting for just 4% of the country's total GDP[82].

These prefectures have been designated a Special Zone For Reconstruction, and each has submitted their own proposals for attracting new foreign and domestic investment. Miyagi's incentives included tax breaks for new businesses in coastal areas, exemption from real estate tax in acquiring land for factories and offices, tax credit on corporate income tax, five-year exemptions from fixed property asset taxes, and many other subsidies[83].

Even within Miyagi prefecture, however, there remains a rural-urban divide in terms of investment. Onagawa's relative remoteness and lack of available land have made it less appealing to business than larger urban areas on the adjoining Sendai plain, including the nearby city of Ishinomaki, and Sendai itself, where new IKEA superstore and Amazon call centre have been built under these incentives. Masunori Kusaka told the writer, "private companies don't really want to come here". One key exception is Kajima, the major construction firm now contracted to undertake the engineering work that will terrace the selected sites for development. Kajima are nominally required to work in partnership with UR and the ORDC by order of the national Reconstruction Agency. However, Kusaka and others have expressed concern that neither of the latter bodies will have sufficient power or influence to "check or control" the work of a much larger and wealthier private company.

Kusaka cited the fact that some of that work has already gone ahead without due consultation of residents (see section 2.3). Professor Yoshiteru Murosaki – of Kobe University's department of Architecture and Civil Engineering, and a key figure in reconstruction planning after the Great Hanshin (Kobe) earthquake of 1995 – told the writer that large construction companies with close ties to the Japanese government[84] have effectively dictated the terms of reconstruction so as to secure the most profitable contracts, placing undue emphasis on such large-scale engineering projects as the best or only option for reducing future flood risks.  Professor Murosaki and others have pointed

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[82] Source: Built Environment Professions In Disaster Risk Reduction: Response Guide For Humanitarian Agencies In Japan

[83] Source: The Japan Society Of Civil Engineers: International Symposium On Engineering Lessons Learned From The Great Earthquake, retrieved from http://jaee.gr.jp/event/seminar2012/eqsympo/Great_East_Japan_EQ_Symposium.pdf

[84] Collusion between the Japanese government and major domestic construction companies has been well-documented, and some of the most recent examples are archived here: http://factsanddetails.com/japan.php?itemid=799&subcatid=146

out that various “hard” structural and engineered defences were breached or destroyed on March 11, thus exposing the limits of this option (see section 3.4)

### 2.7 Community-based recovery and the case of Takenoura

In the aftermath of this disaster, community groups known as “machizukuri” have proven more pro-active than any local or national government body:

- Onagawa citizens and small business owners were instrumental in the establishment of the “container-mura” – a temporary market of food outlets, shops, and services in rented container units, where many of those who had lost their original properties were able to provide for fellow residents and begin rebuilding their livelihoods within three months of the disaster. This was later supplemented with a larger shopping village on the grounds of Onagawa High School, which was also largely organised by public committee.

- A local newspaper, titled the Mineko Times, was established, written, printed and distributed by civilian volunteers from June 2011. According to co-founder Hirofumi Endo (a local teacher), this primarily functioned as a newsletter for vital post-disaster information, but also served a social function in “helping to keep the town together”.

- A civilian-run radio station – Onagawa Saigai (or “disaster”) FM – was also established by popular demand in the month after the tsunami, and granted a government licence to operate as a provisional broadcaster. Station chief Tatsunori Matsuki told the writer that this station was originally intended to transmit vital information only, but became “a kind of lifeline, and a sign of normality” in the months that followed, as the volunteer DJs began playing music and inviting listeners to tell stories, announce birthdays, etc.

- Through charitable donations and foundation grants, a Non-Profit Organisation was established to print and distribute community currency – to be spent on local goods and services within Onagawa only. Certain outside relief workers were subsequently paid in these special bank notes, which were also issued to all visitors in exchange for standard Japanese yen, and accepted by all outlets in the above-mentioned retail facilities.

- The Onagawa Reconstruction Liason Committee, a citizen’s non-profit organisation formed by popular assembly on April 19, 2011, had submitted two detailed draft proposals for redevelopment within a year of the disaster. Their suggestions included shopping malls, street art, entertainment facilities, and imported grapes and flowers from Europe that could be grown and sold locally, amounting to a complete commercial overhaul of Onagawa. Co-chairmen Kiso Kikawada (a local boat designer) and Takahiro Aoyama (a former civil servant in Onagawa’s chamber of commerce) told the writer that a renewed reliance on

the fishing industry would only further narrow Onagawa's prospects for the future, and it was therefore essential to advance "new ideas for what a small town can be". Kikawada admitted that these proposals constituted an "ideal vision", but argued that their targets could be achieved if municipal and national governments were prepared to use this disaster as an opportunity to "think and act differently".

The fishing village of Takenoura provides a further case in point. A geographically discrete district of Onagawa Town with its own small community council, the village was almost entirely destroyed by the tsunami, with only two of 60 houses remaining on the site. Eleven residents were killed on March 11, and a further six died of shock and exposure before search and rescue teams could arrive. The residents were subsequently dispersed to evacuation centres and later temporary housing in over 30 different locations.

Takenoura, however, was among the communities most strongly opposed to the post-tsunami consolidation and relocation of Onagawa's fishing villages. Local organiser Shigeo Suzuki consulted with civil engineering and design firms in Ishinomaki, identified four potential development sites at higher elevations, negotiated their purchase with the landowners, and drafted a detailed reconstruction plan by September 2011.

Former residents were kept informed by telephone, and voted on every decision. While some were initially reluctant to accept the move to higher ground for the reasons outlined above[85], and others were unable to commit to a plan that might yet take years to effect, a consensus was reached by which almost every survivor approved Suzuki's proposals and pledged to return to Takenoura as soon as possible.

The villagers celebrated their annual "shishimai matsuri" – or "lion-dancing festival" – as usual in 2011, its performers travelling between the various evacuation shelters and temporary housing units in traditional costume. Shigeo Suzuki told the writer that he and his former neighbours believed that the preservation of customs and traditions was no less important to the village's recovery than the reconstruction of housing and fishing facilities.

In paying equal attention to both the practical requirements and the social/cultural elements of post-disaster planning, Takenoura's approach demonstrates the value of grass-roots organisation, and their approach suggests that affected communities should be empowered and encouraged to take charge of their own recovery insofar as possible.

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[85] According to Shigeo Suzuki, two elderly residents of one surviving house refuse to be moved from it, arguing that they may not live long enough to see the village redeveloped.

Masunori Kusaka said that he had presented Takenoura's plan to the Onagawa municipal government as "a model for how these things should be done", and the town approved that plan in December 2011 (although its execution has since been subject to the delays outlined above, and the necessary funding has not yet been forthcoming).

## 3. BEYOND ONAGAWA

While earthquakes and tsunamis on the scale of March 11 are extremely rare – even in Japan – much smaller seismic events can also cause significant loss of life and property damage in exposed coastal regions. Though described in one report as comparatively "modest-sized"[86], a tsunamigenic seaquake off the coast of Samoa killed more than 200 people across several adjoining South Pacific island nations in September 2009. That disaster came less than five years after the catastrophic Indian Ocean tsunami of December 2004, which had alerted the international community to an urgent need for more research into seismic hazards in that area, and expanded network of warning systems[87].

It is also important to note that earthquakes and tsunamis do not necessarily represent the most pressing threat to coastal areas worldwide. Over 90% of natural disasters in the last 50 years have been hydro-meteorological[88] in origin, and climate change projections indicate that extreme weather events will occur with greater frequency and intensity over the next century[89].

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[86] Towards Improved Tsunami Disaster Risk Reduction – Reflections From The Antipodes, Dale Dominey-Howes, retrieved from http://www.tdmd.org.tr/TR/Genel/9.Oturum/Tema_D.D.Howes.pdf

[87] As a direct result, the first Deep-Ocean Assessment and Reporting of Tsunami (DART) station was deployed in the Indian Ocean two years later. The US National Oceanographic and Atmospheric Association (NOAA) has also been notably proactive in widening its own spectrum of DART buoys in the Pacific and Caribbean, and a new tsunami warning system has also been successfully tested for the North Atlantic and Mediterranean.
Sources: http://www.noaa.gov/features/tsunami/warning_system.html, "Mediterranean Tsunami Warning System Passes Its First Test", Sofia Echo, August 11 2011, retrieved from http://www.sofiaecho.com/2011/08/11/1137548_mediterranean-tsunami-warning-system

[88] Source: Michael Jarraud, Secretary General of the World Meteorological Association, in his World Meteorological Day Message, retrieved from http://www.wmo.int/worldmetday/message_2012_en.html

[89] The mechanics of this process remain uncertain, but the Intergovernmental Panel on Climate Change (IPCC) has stated that it is both "observable" and "unequivocal". Source: Climate Change 2007, IPCC Synthesis Report, http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms1.html

Any number of vulnerable coastal areas may benefit from a closer examination of pre and post disaster planning in Onagawa – not just in terms of mitigating seismic hazards (which are generally less well understood in developing Pacific Island nations such Indonesia and Samoa – see section 3.3) but also in adapting to hydro-meteorological hazards such as typhoons and tropical cyclones. The combined risk posed by these hazards are expected to make the Asia-Pacific region a particular area of concern in the coming decade, especially when combined with rapid population growth and urbanisation, which will see 400 million people at risk of coastal flooding by 2022[90].

Surverys of developed nations such as Australia and New Zealand after the Japan earthquake and tsunami also revealed a relatively low level of flood risk awareness, and a lack of demonstrable progress in planning since the Indian Ocean tsunami of 2004. As regards the Atlantic, Caribbean and elsewhere, environmental scientists are broadly agreed that recent severe storms such as Hurricane Sandy – which caused major flooding, widespread damage, and at least 74 deaths[91] across the eastern United States in October 2012 – have been amplified by increased moisture in the atmosphere, rising sea levels, and increased ocean temperatures[92].

It has also been proposed by the volcanologist Professor Bill McGuire[93], among others, that the processes of climate change may have a growing impact on plate tectonics. A sea level rise of one metre – accepted by the Intergovernmental Panel on Climate Change (IPCC) as well within the range of recent projections[94] – would add one metric tonne per cubic inch of pressure to undersea and coastal faults, thereby adding to the instability in those seismic networks. The melting of ice-caps in Greenland and Antarctica might also activate previously dormant faults, triggering the earthquakes and underwater slides that can generate major scale tsunamis. This theory posits a future of increased and inter-related seismic and hydro-meteorological risk.

Currently, these hazards are assessed and forecast by different models,

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[90] Source: Asian Development Bank, Key Indicators for Asia Pacific 2012, http://www.wilsoncenter.org/sites/default/files/ADB_Key%20Indicators%202012%20Report.pdf

[91] As of November 1, 2012. Source: http://www.nydailynews.com/new-york/hurricane-sandy-death-toll-reaches-74-article-1.1195335

[92] Source: http://www.guardian.co.uk/environment/blog/2012/oct/30/hurricane-sandy-supersized-climate-change

[93] McGuire is a professor of geohazards at University College London, and director of UCL's Benfield Hazard Research Centre

[94] Sources: IPCC, Topic 3, Section 3.2.1: 21st century global changes, p. 45, in IPCC AR4 SYR 2007, America's Climate Choices: Panel on Advancing the Science of Climate Change, Board on Atmospheric Sciences and Climate, Division on Earth and Life Studies, National Research Council of the National Academies (2010). "7 Sea Level Rise and the Coastal Environment".

according to different causes. Their worst effects, however, may be seen as broadly comparable. When compounded by high tides, a storm surge can have a tsunami-like impact. A joint study by US-based civil and environmental engineers has found that Hurricane Katrina and the Indian Ocean tsunami exerted similar forces on man-made structures[95]. (Rapid flooding of rivers and streams can also produce some of those effects inland[96].)

It should therefore be considered that certain planning and policy measures must also be transferable. The case of Onagawa suggests both “positive” and “negative” lessons in terms of mitigation and management. An overview of these lessons is provided below in Table 3:

| **Planning successes in Onagawa** | **Key factors** | **Wider lessons** |
|---|---|---|
| Warning systems | Advanced alert technology | Adapt existing systems to other locations and hazards |
| Design mechanisms | Building codes developed to enhance seismic load capacity | Advance Japanese “earthquake proof” building codes as a design model for |

[95] Source: Lessons From Hurricane Katrina Storm Surge on Bridges and Buildings, By Ian N Robertson, H Ronald Riggs, Solomon Yim and Yin Lu Young

[96] Source: Interview, Professor Brian Hobbs, University of Glamorgan

| | | |
|---|---|---|
| | | all seismic zones |
| **Planning failures in Onagawa** | **Key factors** | **Wider lessons** |
| Event was not anticipated | Over-estimation of forecasting systems, over-reliance on flawed risk maps | Drive forward forecasting science and technology, develop disaster plans and protocols that do not depend on official projections |
| Public was not ready | Japan's "preparedness culture" emphasises earthquakes over tsunamis, limited awareness of risk based on living memory and recent experience | Impress the need for self and vertical evacuation among at-risk coastal populations, develop plans for seismic and/or meteorological hazards in context of geological time |
| **Questions raised in Onagawa** | **Key factors** | **Wider lessons** |
| Should relocation be a considered as a pre-emptive measure? | Cost of pre-disaster relocation set against post-disaster rebuilding, long-term viability of communities exposed to hazards, social justice for stakeholders | Consider in context of climate change and rising sea levels, assess limits of rebuilding and defence, foreground issues of relocation and retreat in all long-term coastal planning |
| "Hard" or "soft" counter-measures? | Comparative benefits of engineering and policy measures in reducing loss of life | Introduce a continuous multi-layered system of defence for all at-risk areas, incorporating design, |

| | | |
|---|---|---|
| | and property, measured against weaknesses of each approach in isolation | technology, legislation, coastal management and public awareness |

### 3.1 The “success” of March 11

In assessing the impact of this disaster, a number of Japan-based professionals have emphasised the general effectiveness of existing countermeasures when set against the scale and suddenness of the emergency. At the Japan Times Forum for Disaster Prevention[97], Shota Hattori[98] claimed that there had been no issue of “seismic adequacy” in the structures that sustained the most powerful shaking from the earthquake, and that up to 480,000 lives had therefore been saved by “design mechanisms”.

According to a separate study[99], over 90% of those lives were also subsequently saved from the tsunami by warning systems and evacuation protocols, which facilitated the escape of all but 30,000 people (the approximate number of the total dead and missing) from homes, offices, and public buildings within one kilometre of the shoreline. This relative “success” in mitigation was attested to in Onagawa by Lieutenant-Colonel Saigo Kinya, commander of SDF relief operations, who told the writer that he would have expected an even higher death toll if judging by the extent of the destruction.

The aforementioned professionals have produced recommendations for various improvements or enhancements to the relevant information systems. At the Japan Times Forum for Disaster Prevention, Hideo Watanabe[100]in particular spoke of a need for more advanced computer models to simulate earthquake motion and tsunami propagation, and more detailed and streamlined alert transmissions to provide essential real-time data. The goal, he said, was a system that advises users when, where, and how to evacuate, accounting for such variables as traffic flow and relative times and distances between the incoming tsunami and the nearest safe ground or shelter.

It is clear that such technologies should be adopted elsewhere, and adapted to other hazards. One notable example is Australia’s newly-developed ANUGA

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[97] Held on May 31, 2012, transcript retrieved from http://www.japantimes.co.jp/ads/pdf/0531p10-11.pdf

[98] CEO of Kazo Keikaku Engineering

[99] Study For Effective Countermeasures Against Earthquake and Tsunami Disasters: Lessons Learned From Disaster and Recovery, retrieved from http://www.us-jpri.org/en/reports/seminar/ishiwatari20110721.pdf

[100] Manager of resilience engineering at IBM Research

system[101], which allows hydrodynamic modelling for multiple coastal inundation scenarios, simulating waterflow through the built environment from river or estuarine flooding, storm surges, and tsunami events.

It is also clear, however, that many nations now designated "extreme risk"[102] from those hazards lack the resources to follow the lead of Japan or Australia. Indonesia is a case in point, a developing country made prone to flood risks by a host of exacerbating factors[103]: rapid and largely unplanned urbanisation on low plains with inadequate drainage, land subsidence through groundwater extraction, soil erosion through deforestation. Despite suffering the worst effects of the Indian Ocean tsunami in 2004, Indonesia has since implemented few countermeasures. The current warning system is limited to emergency TV broadcasts, which proved of limited use in the most exposed rural areas during the more recent earthquake and tsunami off Western Sumatra in 2009, as many communities are largely without household electrical appliances.

Mobile phones, however, are fairly ubiquitous, and it was later suggested[104] that even the most simple and affordable adaptation of Japan's cell-broadcast alert system would have saved lives.

### 3.2 The "failure" of March 11

According to James Mori of the Kyoto Disaster Prevention Institute (a key member of the 2011 Tohoku Earthquake and Tsunami Joint Research Group), the most urgent implication of this event is the fact that it was "largely unanticipated". Mori describes March 11 as "disheartening" for everyone involved in prediction and mitigation, as it demonstrated the insufficiency of data on which official forecasting models and seismic risk maps are based.

That data is essentially historical. Through analysis of past ruptures in the various Japanese fault networks, geoscientists from the government's

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[101] Developed by Geoscience Australia and the Australian National University

[102] The top 15 countries identified as most at risk from "extreme weather and geophysical events" by the Natural Disaster Risk Index, (produced by the risk advisory company Maplecroft) Bangladesh, Indonesia, Iran, India, and China. Source: http://www.clickgreen.org.uk/analysis/general-analysis/121351-15-nations-at-"extreme-risk"-according-to-natural-disaster-index.html

[103] As identified by Hiroshi Baba of the Japan International Cooperation Agency, in his report "Trends and Impacts of Flood and Tsunami in Vulnerable Coastal Areas", retrieved from http://www.preventionweb.net/files/globalplatform/entry_presentation~trendsandimpactsoffloodandtsunamiinvulnerablecoastalurban.pdf

[104] By Costas Synolakis, a tsunami expert with the Department of Civil and Environmental Engineering at the University of Southern California in an interview with Voice of America, retrieved from http://www.voanews.com/content/tsunami-warning-systems-lessons-from-japan-118017249/167190.html

Headquarters for Earthquake Research extrapolate a pattern of recurrence and project estimates of the risk to particular areas within a certain timeframe.

The resulting hazard maps are compiled and distributed by the Earthquake Disaster Reduction Division of the Ministry For Science. The most recent maps issued before this disaster, in March 2009, indicated a 30%-40% chance of a rupture in the offshore region of the Sanriku coast within 10 years, and a 60%-70% chance within 20 years[105].

The same projections forecast a magnitude of up to 7.5 on the Richter scale, equivalent to past earthquakes in the local fault network. By Japanese standards, however, this represented a comparatively low risk, particularly when set against the potential threat posed by the theoretical "Tokai" earthquake predicted to strike the Tokyo area in the near future.

Professor Robert J Geller of Tokyo University has repeatedly argued that the government's forecasting system is demonstrably flawed, as earthquakes have frequently occurred without warning in areas identified as lower-risk[106]. Furthermore, he has suggested that official focus on seismic threats to Tokyo in particular may have engendered a "false sense of security" in other parts of the country – including the Tohoku region[107]. This claim seems to have been borne out by the events of March 11, when the earthquake and tsunami were substantially more destructive than anticipated by official maps and models.

Geller has since written[108]: "All of Japan is at risk from earthquakes, and the present state of seismological science does not allow us to reliably differentiate the risk level in particular geographic areas. We should instead tell the public and the government to 'prepare for the unexpected' and do our best to communicate both what we know and what we do not."

The last disaster of equivalent scale to strike Onagawa and the Tohoku region is believed to have been the so-called "Jogan event" of 879 AD, for which some sedimentary evidence exists, but the seismic data necessary to form a pattern of recurrence dates back barely half that far. As James Mori has said: "The lesson is that 400-500 years of historical records is not enough."[109]

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[105] The seismic hazard map for Tohoku divided the north-eastern region into five separate zones and projected seven different earthquake scenarios based on known patterns of historical recurrence. (Source: Japan Headquarters for Earthquake Research Promotion)

[106] Source: http://www.japanprobe.com/2012/01/25/earthquakes-cannot-be-predicted-official-japanese-quake-forecasting-system-is-flawed/

[107] Source**: "**Shake-Up Time For Japanese Seismology" by Robert J Geller, Nature issue 472, 407-409 (28 April 2011)

[108] See footnote 105

[109] Mori was speaking at the annual meeting of the American Association for the Advancement of Science in Vancouver, February 19, 2012.

That lesson has profound worldwide relevance. If existing maps and models cannot provide a complete or accurate assessment of the risk to specific regions of Japan – a country that leads the world in prediction technology and related geo-science – then the risk to other coastal nations is even more difficult to assess, where data on earthquakes and tsunamis with longer return periods is even less complete.

Until those risks are better understood, the burden will fall on planners and policy-makers to develop long-term, adaptive approaches based on geological timeframes, as opposed to existing records, or more recent historical experience. In those terms, it can be seen that the March 11 earthquake and tsunami was broadly predictable, as the "Jogan event" was known to have been comparable in scale, but the probability of recurrence was not duly considered in contemporary models and scenarios.

### 3.3 Public awareness and vertical evacuation

Two simple but vital considerations have emerged from studies of this and other recent flood-related disasters: the life-saving factors of "vertical" and "self" evacuation. In short, the death toll of such events is minimised where high ground or elevated shelter is available, and where the public are sufficiently informed to get to one or the other as quickly as possible.

Despite repeated historical exposure to seismic hazards, and the abundance of mountains within close proximity, a surprising number of people in Onagawa and other Tohoku towns and villages failed to escape even given enough time and repeated warnings to do so in the interval between the earthquake and tsunami. Some possible reasons for this have been outlined in earlier sections, but it is generally assumed that many members of the Japanese public have forgotten the fundamental lessons of past disasters, and/or now place too much confidence in existing engineered defences and emergency provisions.

Tabayashi Tamura, a 70-year-old resident of Onagawa, suggested that younger Japanese are more prone to misconceptions in this regard, and told the writer that his own generation had been taught to "save themselves" – in contrast to those residents who had been killed attempting to save co-workers[110] or family members. One study noted that a group of students in the

[110] The most widely-publicised example of this was Sato Mitsuru, a commissioner with the Onagawa-based Sato Fisheries Corporation, who was seen to lead a group of Chinese research students to safety before returning to search for his family. He was later registered missing and presumed dead. Source: http://www.japanprobe.com/2011/03/19/company-executive-swept-away-by-tsunami-after-saving-chinese-workers/

town of Kamaishi elected to evacuate to high ground without waiting for instructions to do so, thereby providing a model of good public practice for future reference.

This “self-evacuation” was prioritised among the recommendations of a UNESCO report entitled The Great East Japan Tsunami and Tsunami Warning Systems: Policy Perspectives – “if a strong earthquake or tremors persist for a long time, **do not wait for an official evacuation order**”. Other coastal nations have evinced even less public awareness of the need for immediate evacuation to high ground after an earthquake. According to US coastal engineer Costas Synolakis[111], this lack of awareness proved critical on Samoan and Tongan islands during the tsunami of 2009, where a number of residents were killed while attempting to evacuate in their cars, when they might have survived by climbing surrounding hillsides on foot[112].

That disaster, combined with other recent seismic and hydro-meteorological emergencies in the Pacific region, has compelled the US National Oceanic and Atmospheric Administration (NOAA) to admit to “inconsistencies” in domestic policy and planning for such hazards. On its advice, and under the counsel of New Zealand’s GNS Science and Massey University Joint Centre for Disaster Research, Washington State has developed its own federally-funded multi-agency vertical evacuation strategy, titled Project Safe Haven[113].

Other coastal states are expected to follow. Where natural high ground is not available – as on many low-lying South Pacific islands now at risk from rising sea levels – the construction of resistant and well-equipped evacuation towers is now be considered an urgent priority[114].

### 3.4 Post-disaster rebuilding, or pre-emptive relocation?

[111] Source: http://www.voanews.com/content/tsunami-warning-systems-lessons-from-japan-118017249/167190.html
[112] Source: www.eeri.org/site/images/eeri_newsletter/2010_pdf/Samoa-Rpt.pdf
[113] Source: http://www.crew.org/sites/default/files/GHCoFinal_small.pdf
[114]Sources: “Strengthening Decision Making for Tsunami Early Warning in the Pacific Islands”, Pacific Disaster Centre, retrieved from http://www.pdc.org/PDCNewsWebArticles/2006tsunamiworkshop/Pacific_Islands_UNESCAP.pdf
Climate Change and the Pacific Islands, Ministerial Conference on Environment and Development in Asia and the Pacific, Aug31-Sept 5, 2000, www.unescap.org/mced2000/pacific/background/climate.htm
NOAA South Pacific Basin Tsunami Service Assessment, www.nws.noaa.gov/om/assessments/pdfs/tsuanami_%20south_pacific10.pdf

Japanese legislation allows for at-risk coastal communities to be moved to higher ground, under the Land Agency's Safety Relocation Program of 1972. The program stipulates, however, that this provision can be applied "only in areas that have suffered a disaster"[115]. Which is to say that residents of towns and villages subject to seismic hazards can only be moved to safety after their homes have already been damaged or destroyed.

Now that Onagawa and many other communities are planning for just this kind of move, the question must be asked as to whether it is feasible, or preferable, for exposed populations to relocate before a potential disaster can occur.

In an interview for this report, Professor Yoshiteru Murosaki[116] pointed out that current plans do not extend to areas beyond the disaster zone, or account for the fact that the next major natural disaster is just as likely to occur in some other part of the country (or, indeed, in another country altogether). By the logic of new regulations, the March 11 inundation zone has been classified as "dangerous" and unfit for residential use. Murosaki reasoned, however, that the residents of almost every Japanese fishing town and village are subject to the same hazards, and such limited relocation plans are therefore nonsensical.

While it is not practical for Japan's entire coastal population to be relocated en masse, it may be no more feasible in the long-term for Japan or any other coastal nation to continue building and rebuilding in vulnerable areas – especially given the demonstrable limits of even the most costly structural defences. On the US eastern seaboard, coastal engineers and geologists are proposing a complete cessation of development in areas at risk from sea level rise and erosion, followed by a managed withdrawal of human habitation[117].

In other at-risk regions, the relocation of untenable settlements is becoming a matter of necessity. Villages in Fiji[118]have already begun to move inland to avoid the worst effects of climate change, while the entire nations of Kiribati and the Maldives are now seeking to purchase land in other countries for wholesale resettlement[119].

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[115] Source: Japan Guidebook For Tsunami Hazard Planning http://www.adrc.asia/documents/disaster_info/20113.11_Earthquake&Tsunami_in_Japan.pdf

[116] See section 2.6

[117] "Hurricane Sandy: Rebuilding is Madness" by David Gessner, Salon, November 3 2012, retrieved from http://www.salon.com/2012/11/04/hurricane_sandy_rebuilding_is_madness/

[118] Source: www.salon.com/2012/09/19/first_village_relocated_due_to_climate_change/

[119] Sources: http://www.telegraph.co.uk/news/worldnews/australiaandthepacific/kiribati/9127576/Entire-nation-of-Kiribati-to-be-relocated-over-rising-sea-level-threat.html http://www.stimson.org/spotlight/treading-water-climate-change-the-maldives-

Many other nations may be facing similar decisions in the near future. Planners and policy makers should be aware of the issues and objections raised by that process as now underway in Onagawa:

- Government should be supportive of relocation, and sensitive to questions of social justice – encouraging rather than enforcing
- Efforts must be made to preserve culture and traditions, particularly of coastal communities when moving inland or upland
- Residents should be consulted and involved in the planning process insofar as possible, and forums must be created for public debate
- Relocation should be considered as one possible option within region-specific programmes of Integrated Coastal Management (ICM)

### 3.5 The need for multi-layered resistance and resilience

Existing counter-measures – both "hard" (or engineered) and "soft" (social and environmental) – demonstrably reduced but failed to prevent widespread loss of life and extensive property damage in Onagawa and along the Sanriku coast. Tsunami hazard researcher Christopher Gomez[120] has subsequently conducted studies of the entire affected region, and found that both categories of defence were compromised by poor planning decisions.

The effectiveness of seawalls and breakwaters, for example, was negated where rivers had been channelled through residential areas, allowing the tsunami to surge up those channels, and cause catastrophic damage when the banks were overtopped[121]. In some towns, the only roads available for evacuation followed the path of those rivers, thus exposing residents to the hazard even as they were attempting to escape in their vehicles.

Social provisions commonly included the use of schools and other public buildings as pre-arranged assembly points and evacuation shelters, but in many towns and villages these had been built at low elevations, close to the shoreline, and were subsequently inundated. Gomez has also found that "hard" and "soft" defences effectively cancelled each other out in certain respects. In the decades after the second world war, Japan's public works

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and-de-territorialization/

[120] See footnote 17

[121] As in Onagawa's Shimizu-Cho district, where the Onagawa River had been channelled through a low-lying and densely-populated area of housing, but more catastrophically in nearby Okawa, where the tsunami surge overtopped and demolished an elevated bank of the Kitakami River, flooding the local elementary school, and killing 74 children and 10 staff.

programmes were dedicated to the goal of full employment – resulting in constant, large-scale engineering projects which included the construction of concrete seawalls and hillside cladding around much of the coastline.

Gomez suggests that the long-term effects of this have been a generalised over-confidence in those protections, and an over-reliance on the government's capacity to ensure their safety. At the same time, economic pressures and "discontinuous politics" have allowed residents, planners, and developers to build up modern communities in areas exposed to significant flood risks – even towns and villages that had previously been relocated to higher ground as a result of past tsunamis.

For Gomez and others, the key lesson of this disaster has been the need to "find a continuum between hard and soft solutions". The Japanese government's own recovery and reconstruction plan[122]makes a priority of adding "multiple layers" of defence: coastal embankments, strategic green areas of pine and mango forest to absorb the impact of storms and tsunamis, reformed zoning regulations, improved disaster education programmes, enhanced "cloud" data storage to prevent disruption to business, etc[123].

All nations now facing increased flood risks must begin to take this multi-layered approach to resistance and resilience, in which the Netherlands has been particularly pro-active. A recent study of the Great East Japan Earthquake and Tsunami compiled by Dutch analysts[124] further recommends a long-term adaptive approach by which measures are taken to delay those "tipping-points" where present policies are no longer practical or cost effective – such as urban investment in drainage systems, or the purchase and allocation of land in potential buffer zones around vital infrastructure.

It remains, of course, for politicians – and, ideally, an informed public – to decide on the level of protection they feel is necessary and/or affordable: "The higher the level of protection, the lower the probability of flooding, however the more extreme the design conditions, and the consequences of failure".[125]

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[122] Developed through the Ministry of Land, Infrastructure, Transport and Tourism

[123] Sources: Tsunami Preparedness Report, New Zealand Civil Defence, http://www.civildefence.govt.nz/memwebsite.nsf/Files/Tsunami_Preparedness_report/$file/Final_Tsunami_Preparedness_report_part_4.pdf
"Planning For Disaster Mitigation", George Parasas-Carayannis, retrieved from http://tsunamisociety.org/CrossStraits.pdf

[124] The Great East Japan Earthquake: Facts And Implications For Flood Risk Management (lead author/editor Vana Tsimopoulou)

[125] The Great Eastern Japan Earthquake and Tsunami Book (see footnote 120), pp 65

### 3.6 Building community resilience and "social capital"

The political scientist Professor Daniel Aldrich[126] has advanced the view that the most closely-bonded communities tend to be the most resistant to the impact of a natural disaster, and the best able to effect a recovery. His studies of New Orleans after Hurricane Katrina, Asian coastal cities after the Indian Ocean tsunami of 2004, and Kobe after the Great Hanshin earthquake of 1995, have all shown that "social capital" – the extent to which community members engage in regular contact and shared activities – strengthens that community's resilience to a greater degree than "wealth or good governance".

In the aftermath of the March 11 earthquake and tsunami, Aldrich found similar evidence of small villages and neighbourhoods responding more quickly and concertedly to the disaster than larger and more prosperous urban areas. The experience of Onagawa provides several examples of success and failure in these terms. Warning systems and evacuation protocols, while broadly effective, can be seen as essentially "technocratic" solutions.

On March 11 these measures did not account for the fact that a large percentage of Onagawa's population was elderly, and physically unable to move quickly to higher ground. A more "social" solution for the future, as suggested by Aldrich, would be an emergency plan that incorporates a priority list of less-mobile residents for urgent evacuation, or establishes a local rapid-action group among immediate neighbours, with each member assigned specific responsibilities in the event of a future disaster.

Throughout the Tohoku region, the will of local stakeholders has been a driving force in reconstruction, while also giving rise to forceful opposition, as also seen in Kesennuma, and Rikuzen Takata – where residents insisted that new public and private housing developments be intermingled to preserve their sense of community, rather than separated to different sites as initially planned. Remarking on the above[127], the visiting architect Kotaro Nakamura wrote that: "architects and engineers will be much more effective in helping these people when we incorporate the intangible aspects of the recovery process and try to understand the real issues of community resilience specific to the area before plans are made".

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[126] Aldrich is professor of political science at Purdue University, a research fellow of the University of Tokyo, and author of the book, Building Resilience: Social Capital in Post-Disaster Recovery (University Of Chicago Press). He was interviewed twice for this report, in April and October 2012.

[127] "Learning Lessons From Japan's Quake-Tsunami Disaster" by Kotaro Nakamura, U-T San Diego, August 17, 2012, retrieved from http://www.utsandiego.com/news/2012/aug/18/tp-lessons-from-japans-quake-tsunami-disaster/

The events of March 11 also made clear that community resilience should also be developed as a means of risk reduction before a potential disaster has even occurred. The United Nations has identified this issue as a core strand of its current framework for disaster mitigation[128], and emphasised "the need to support local government and non-state actors as the frontline of risk reduction". While that goal may be furthered through direct funding and facilitation of local disaster management plans and community-based hazard "watch" schemes, it may also be achieved indirectly, by simply fostering those "civic and voluntary activities" suggested by Daniel Aldrich, which strengthen social bonds and thereby improve that community's capacity to work together before, during, and after an emergency.

Aldrich has cited positive examples from around the world, including neighbourhood focus groups in Nicaragua and South Africa, arranged by the London School of Hygiene and Tropical Medicine. He has also identified Japanese "matsuri" or "festival" culture as defining example of "social capital" – as seen in Takenoura after the tsunami (see section 2.7), but also in Kobe and Tokyo districts affected by the major earthquakes of the 20th century[129].

The relatively simple act of organising local festivals based on shared traditions may in itself strengthen the resilience of the participants, and government support of such events may be no less beneficial than investment in physical infrastructure.

## 4. CONSIDERATIONS FOR THE UK

The United Kingdom is far less likely to experience a major earthquake or tsunami than coastal nations in the Pacific or Mediterranean, as underlying tectonic plates are generally more stable than in those volatile subduction zones. This is not to say that the British Isles have never been subject to major seismic disturbances – 7000 years ago, a submarine landslide off the continental shelf of Norway caused a tsunami that submerged the Shetland and Orkney islands, and penetrated deep into mainland Scotland.

A joint study by the National Oceanography Centre (NOC) and Natural Environment Research Council (NERC) is currently underway to determine whether submarine slides in the Arctic region may trigger similar events in the

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[128] The UN Framework For Action 2005:2015, Building The Resilience Of Nations and Communities To Disasters, adopted into the Hyogo Framework for Action and Built Environment Practice at the World Conference on Disaster Reduction held in Kobe (Hyogo Prefecture), January 2005

[129] Source: Daniel Aldrich. Further reference: "How To Weather A Hurricane" by Daniel Aldrich, New York Times, August 28, 2012, retrieved from www.nytimes.com/2012/08/29/opinion/community-works-best-against-a-natural-disaster-html?_r=0

future, and whether any such risk might be increased by climate change[130].

Volcanic eruptions and earthquakes in more seismically active areas of the Atlantic ocean – particularly around the Canary Islands – have also been identified as potential sources of tsunami hazard to the UK. The Lisbon earthquake of 1755 triggered waves of over three metres on the south coast of England, damaging harbours in Devon and Cornwall[131].

The cause of an earlier disastrous flood in the Bristol Channel and Severn Estuary remains a matter of debate. On January 30, 1607[132], over 500 kilometres of the coastal lowlands were inundated from Devon to South Wales, and up to 2000 people were killed. Simon Haslett, a professor of Physical Geograohy at the University of Wales, and Edward Bryant of the University of Wollongong[133], have contended that this was a tsunami, triggered by a submarine slide off south-west Ireland, or a seabed earthquake off south-west Britain. Haslett has supported that claim with analysis of boulder deposits and sand layers, and anecdotal evidence from contemporary sources that described the “wave motion” of the incoming waters.

A separate study by Risk Management Strategies (RMS) concluded that the flood was more likely caused by a wind-driven storm surge, coupled with an extreme high tide. Whichever theory is correct, however, the effect of that event is the more pressing consideration, as the resulting water levels may have exceeded the design capacity of today’s structural defences[134].

Any repeat occurrence might also overtop the protective walls of nuclear power stations within the inundation zone – including the decommissioned facility at Berkely, the active site at Oldbury, and the plant at Hinkley port, which is currently being redeveloped (see section 4.5).

More generally, storm surges are expected to become a greater threat as sea levels rise due to climate change and natural land movements (a process known as “isostatic rebound” has been ongoing since the last ice age, causing the lower or southern portion of the British Isles to sink as the upper or northern section rises[135]). UK climate change projections, as of the most recent

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[130] Source: NERC, http://noc.ac.uk/news/uk-tsunami-threat-be-assessed-£23-million-research-project

[131] Source: Haslett

[132] Or January 29, 1606, according to the pre-Gregorian calendar

[133] See footnote 3

[134] According to Haslett, contemporary plaques and church inscriptions indicate that the 1607 flood reached heights of 7.4 metres. If a similar event were to occur at high tide, the resulting waters might be pushed above seawalls built to current design minimums of 8.7 metres above ordinance datum.

[135] Source: Facing Up To Rising Sea Levels (Building Futures and ICE, 2007)

official estimates in 2009, allow for a significant variance in that rise, from 12 to 76 centimetres by 2095, with a worst-case "high-impact" scenario of a 1.9 metre increase before the year 2100 given outside consideration[136].

Recent summers have seen greater unpredictability in rainfall patterns and repeat flooding of certain low-lying urban and rural areas, impressing upon government and local authorities the need for improved mitigation and management. Sources consulted for this report attested to a greater sense of urgency and awareness in UK emergency planning, particularly since the summer floods of 2007, which prompted both the Pitt Review[137] and the passing of the Flood and Water Management Act in 2010.

However, the summer of 2012 proved even wetter than 2007[138] – or almost any other summer on record – with recurrent flooding episodes throughout the year, from April to December. As this report was being completed, winter storms caused severe flooding on the south coast of England and in eastern Scotland, with a large section of Lossiemouth harbour wall destroyed, and residents evacuated in Stonehaven and Peterhead[139].

This year's floods are only the most recent reminders of the threat that is expected to intensify in coming years and decades, and the damage they have caused – an estimated £1 billion[140] – must be set against ongoing budget and staff cuts to local emergency planning departments and an overall drop in spending on flood defence (see section 4.5).

Clearly, there remain significant areas of concern as regards the UK's capacity to plan for and withstand a potential disaster. And while the possibility of a "British Onagawa" remains extremely remote, there are lessons from Japan that may yet be applied to the UK's flood-prone towns and villages. An overview of these lessons is provided below in Table 4:

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[136] Source: Parliamentary Office of Science and Technology postnote number 342 (October 2009)
[137] The Pitt Review: Lessons Learned From 2007 Summer Floods.
[138] Source: Summer Floods in the UK: Comparing 2007 and 2012, Air Worldwide Nov 26 2012. Retrieved from http://www.air-worldwide.com/Publications/AIR-Currents/2012/Summer-Floods-in-the-UK--Comparing-2012-and-2007/
[139] "Storms and high tides cause damage across eastern Scotland" BBC News, 15 December 2012. Retrieved from http://www.bbc.co.uk/news/uk-scotland-north-east-orkney-shetland-20739484
[140] "UK insurers face $1.6 bln flood bill: PwC", Reuters, 23 November 2012. Retrieved from http://www.reuters.com/article/2012/11/23/us-insurance-floods-idUSBRE8AM0OK20121123

| UK planning issue | Lesson from Japan | Future Action |
|---|---|---|
| Building on floodplains | Development in flood-prone areas exposes people and property to hazards and increases the potential for disaster | Empower English local authorities to better regulate development, legislate for higher resistance and resilience in building design, hold authorities, developers, and contractors liable |
| Forecasting for hazards | Coastal hazards can recur with little or no warning on geological timescales, and escalate beyond the capacity of alert and response systems | Invest in forecasting science and modelling technology to minimise the uncertainties presented by climate change, explore potential seismic risks to UK coastlines, improve existing telemetry and alert systems |
| Insurance status | Unclear and/or unfair | Introduce a coherent and |

| | | |
|---|---|---|
| | insurance schemes exacerbate the suffering of home and business owners after a disaster | socially just new system of flood insurance, accounting for climate change, also codifying rights and responsibilities of insurers, developers, architects, and home owners |
| Budgeting for disaster | Investment in risk reduction could offset costs of post-disaster recovery, inconsistent central funding can leave local areas struggling to afford mitigation measures and/or reconstruction | “Ring-fence” funding for flood defence schemes, secure budgets and staff for vulnerable areas, consider Dutch models for offsetting costs of climate change, encourage involvement of private sector |
| Nuclear facilities | Nuclear power plants are vulnerable to coastal hazards | Consider exposure of existing and planned facilities in coastal Britain, enhance resistance and resilience to maximum potential risks posed by climate change |
| Community resilience | Local residents are the most directly invested and affected stakeholders in at-risk coastal areas | Inform and empower citizens in vulnerable areas to make choices and take action in reducing risk |

## 4.1 Building on the floodplains

When the tsunami struck Onagawa, the majority of lives were lost and properties destroyed in low-lying areas where the building of homes and businesses had not been restricted by existing legislation. This was in large part because so little other land was suitable and/or available for development – an issue common to every affected town and village along the “rias” of the Sanriku coast. The UK faces equivalent pressures, as population density and attendant demand for housing, particularly in the south-east, has led to extensive development in areas at risk from tidal and fluvial flooding.

But while Scotland, Wales, and Northern Ireland have all effectively prohibited new building on their respective floodplains within the last 18 years, England has continued to allow it – thus exposing ever-more people and properties to a growing hazard. As noted in the Pitt Review, of the 55,000 properties affected by the summer floods of 2007, over 25% had been built on the floodplain within the last 25 years.

Professor David Crichton has been particularly vocal in pointing out the various policy flaws and failures that contribute to this state of affairs, including the government's apparent support of contractors and developers who give large party donations. (Such collusion is even more conspicuous in Japan, and considered a key factor in related issues of land use and vulnerability.)

Furthermore, as owners find it harder to obtain insurance for properties within at-risk areas, developers have been more inclined to build for customers who don't require mortgages: schools and hospitals, sheltered housing, homes for children and old-age pensioners[141]. Onagawa and other tsunami-stricken Japanese communities should be regarded as a warning to those developers, in showing what can happen when vital social infrastructure is built within potential inundation zones – while Onagawa municipal hospital was only partly destroyed, the elementary school at Okada was entirely flooded, resulting in the deaths of over 70 children.

As Professor Crichton has also noted, however, English law does not hold planners, architects, or developers responsible for the consequences of death or damage that may occur if new properties in at-risk areas should fail to withstand a flood event. (He suggests that such a law be introduced.)

The most obvious way to reduce that risk would be a complete end to building on the floodplain, but the Pitt Review of 2007 explicitly rejected this as "not realistic". Indeed, future developments such as the proposed Thames Hub will radically increase the number and density of structures within a major flood hazard area – up to 200 homes per hectare, plus over one million square metres of commercial space. This project has been advanced in tandem with various protections and countermeasures, including a new barrier to replace the existing Thames Barrier, which will reach the end of its operational life in 2030**.** Such measures are, however, more defensive than preventative.

Successful risk reduction in urban areas of the floodplain will require more investment in sustainable drainage and sewage systems to mitigate or reverse the negative effects of impermeable roads and buildings. New legislation is also required to ensure that residential and commercial properties within the floodplain are constructed to resistant and resilient design standards[142].

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[141] Source: "Flood Plain Speaking" by Professor David Crichton, retrieved from http://www.cii.co.uk/knowledge/claims/articles/flood-plain-speaking/16686

[142] As David Crichton makes clear in the above document, this in turn requires that both contractors and insurers provide for new building practices, such as "flood-proofing" of doors and windows, and placement of electrical sockets higher than anticipated flooding levels. While Scotland already legislates for "resilient reinstatement" of damaged properties after a flood event, no such law yet exists in England.

The destruction caused by the March 11 earthquake and tsunami should not suggest that UK planners have nothing useful to learn from their Japanese counterparts, who have decades of experience in building and rebuilding towns and entire cities on narrow coastal plains, and have developed a system of urban flood management that consistently absorbs the worst effects of seasonal typhoons and related storm surges.

This system is based on a policy of "total watershed management" and flood control legislation[143], whereby public and private sectors share costs and legal responsibilities for installing and maintaining the necessary facilities to regulate the flow of stormwater. Homeowners are further obliged to install storm sewers with infiltration functions[144]. Retarding ponds and basins are established around key infrastructure in urban areas, and tracts of undeveloped land are purchased around flood risk zones to provide buffer or storage capacity.

Steven Fifer, a spokesman for the Institute of Civil Engineers (ICE), told the reporter that planners in the UK are beginning to adopt the latter of these measures. If building is to continue on England's floodplains, however, more adaptive and innovative structures must be considered as possible options for the future. Private firms such as Floodline Developments are proposing sustainable and resilient housing to incorporate flooding into their designs – "can-float" homes, for example, which sit on flotation cells in dry channels, and rise or fall safely as the channel floods and empties. Planning permission has been granted for one such home on the Thames at Marlow[145].

### 4.2 Warning, forecasting, and modelling issues

Generally speaking, hydro-meteorological hazards are much easier to anticipate than seismic events. Current forecasting models and satellite monitoring systems can identify and track potentially destructive storms several days in advance of any direct threat to the UK, thus giving the Met Office and Environment Agency (EA) sufficient time to issue the warnings.

A commonly-cited case in point is the tidal surge along the east coast of England in November 2007, when a low pressure system in the North Sea, combined with the highest tide in over 50 years, presented an imminent danger to communities in several counties. The EA issued 8 severe flood warnings, 24 flood watches, closed the Thames Barrier, and gave advice for the evacuation of low-lying regions. Even with all these measures in operation,

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[143] Principally the Flood Damage Control Law For Specified Urban River Basins, or Law number 77, introduced in 2003

[144] Source: "Trends And Impacts of Flood and Tsunami in Vulnerable Coastal Areas", Hiroshi Baba, Japan International Cooperation Agency

[145] Source: "Preparing A Defence" by Katie Puckett, RICS magazine, July 2012

however, the EA later admitted that the affected coastal communities had come “within a whisker” of disaster.

As also demonstrated in Onagawa, it must be understood that existing warning systems are not infallible. The telemetry equipment used by the EA to monitor local river levels and activate flood alerts failed in several places during the summer floods of 2007[146] and 2008. New, improved devices were subsequently installed in many at-risk areas, as per the recommendations of in the Pitt Review, but these too failed to trigger alerts before the River Coquet flooded in September 2012, leaving residents of Rothbury Village with no warning of the imminent threat to their homes and businesses[147].

Clearly these technologies must be further improved and refined. Better use might also be made of ubiquitous consumer electronics such as smartphones – Japan’s cell-broadcast earthquake alert system could be easily adapted to weather-based hazards by the Met Office, EA, and network providers, perhaps in the form of downloadable applications or “apps”. Just as Japanese disaster-prevention professionals have called for more advanced computer modelling of seismic hazard scenarios, it is also clear that new models will be also needed in the UK, to provide more accurate assessments of the increased risk posed to vulnerable areas by climate change, rising sea levels, and coastal erosion.

NERC and the Proudman Oceanographic Laboratory play a leading role in this work, and its Flood Risk From Extreme Events (FREE) programme points the way towards “clouds-to-catchment-to-coast” models which will help predict flooding of rivers, estuaries, urban conurbations, mixed land use areas, and the coastal shelf. Research and development, however, may require greater commitment and investment than is currently allowed by public funding, and as NERC have pointed out, “there is no incentive for the private sector to develop storm surge models”[148].

Planners should impress upon their partners in government and industry the value of such models in reducing the level of “uncertainty”[149] that currently

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[146] Sources: The Pitt Review, Flood Plain Speaking

[147] Source: “Village Was Not Warned Of Flood”, Northumberland Gazette, September 27 2012, retrieved from http://www.northumberlandgazette.co.uk/news/village-was-not-warned-of-flood-1-4966478

[148] Source: Storm Surge Report, NERC, retrieved from http://www.nerc.ac.uk/business/casestudies/documents/storm-surge-report.pdf

[149] Directly addressed in the Building Futures report titled Living With Water: Visions Of A Flooded Future: “Perhaps the most immediate effect of climate change is the level of uncertainty we are forced to deal with.”

defines all considerations of climate change and its effects. More detailed models will in turn generate more reliable hazard maps, allowing planners to make better-informed decisions on land use and mitigation measures, and helping to prevent costly losses and damages.

### 4.3 The outstanding question of insurance

After the March 11 earthquake and tsunami, a majority of residents in Onagawa and other towns were left uncertain as to their insurance status for many months, and unable to cover their losses by the minimal payouts that were eventually forthcoming. As such, it may be seen that Japan's heavily-subscribed government insurance scheme effectively prolonged and intensified the stresses placed upon survivors (see section 2.5)[150].

Obviously, that system does not present a fair or viable model for the UK to follow, but rather an example of how insurance concerns can add to the effect of a disaster where victims might have hoped for relief. At time of writing, however, the UK's own system remains in limbo, as the government and Association of British Insurers (ABI) have failed to reach agreement on new provisions for the estimated 200,000 households now at "significant risk" from flooding[151]. The issues at stake have been well-publicised, as the previous system (by which low rates in flood-risk areas were effectively subsidised by payments in safer areas) was considered untenable.

The existing statement of principles subsequently agreed in 2008 (by which flood victims were provided cover at higher premiums) is set to expire in June 2013, at which point many homeowners may be refused cover entirely. While that eventuality seems unlikely, the reluctance of both government and industry to accept each other's proposals for alternative schemes[152] does not bode well for a solution that will benefit homeowners in terms of affordable cover. The ongoing impasse over represents an obstruction to disaster planning in the UK, as principal stakeholders in at-risk areas face the prospect of seeing their properties devalued or even abandoned by the systems under which they were

[150] It should also be noted that this is the only scheme for cover that most Japanese householders can afford, as the country's vulnerability to natural disaster has driven up the cost of private insurance premiums to the point that only high-income owners tend to purchase it.
[151] As defined by the Environment Agency's benchmark level for probability of one major flood event every 75 years.
[152] As of early December 2012, the government had apparently rejected the ABI's proposed "non-profit" scheme that would compensate for higher premiums in flood-risk areas with levies on home policies across the UK. Under this scheme, the government would have been required to provide a temporary overdraft facility to pay claims from flooding that might occur before the necessary reserves had been accumulated.

formerly protected.

This prospect carries with it the strong possibility of social blight in those areas, especially if free-market principles are allowed to dictate the terms of cover, leaving those properties potentially uninsurable and raising attendant questions of social justice. A fair and sustainable model for flood insurance must be considered an integral part of defending homes in at-risk areas, and the people who live in them. The Joseph Rowntree Foundation[153] has suggested alternatives that might better address current needs: a "choice-sensitive" system based on the risks resulting from individual decisions, or a "fairness as social justice" scheme by which insurance would be provided independently of those individual risks, as a matter of social responsibility.

Indeed, the government and insurers must be seen to bear some responsibility for allowing construction to continue on floodplains while failing to establish a coherent system that provides both affordable cover for property owners and strict accountability for planners, architects, and developers.[154] At the same time, there must also be an onus on the owners themselves to know their level of risk and take appropriate steps to mitigate where possible – as is generally required of Japanese homes and businesses (see section 4.2).

The Royal Institute of Chartered Surveyors has produced a Clear Guide To Flooding[155] which advises owners to request an assessment when leasing property, and to use "accurate commercial search engines" that provide vital information on ground and surface water, with data and risk models, and in some cases factor in possible reservoir and dam bursts (the Environment Agency's public site only offers risk data on river and coastal flooding).

Other public sources, such as Know Your Flood Risk, provide further information on services and flood-resistance equipment available to owners – air brick covers, window and door baffles, non-return valves etc[156].

### 4.4 The problem of funding

In Onagawa, members of the town planning department and reconstruction committee told the writer in plain terms that more spending on mitigation measures before the March 11 disaster would have prevented much of the cost incurred by resulting damage. This basic equation is common to other

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[153] Source: "Social Justice and the Future of Flood Insurance", Joseph Rowntree Foundation

[154] Source: "Flood Plain Speaking", David Crichton

[155] Source: retrieved from www.rics.org/flooding

[156] Sources: RICS magazine, July 2012, Mary Dhonau, chief executive of Know Your Flood Risk, www.knowyourfloodrisk.co.uk

recent natural disasters – the Dutch design company Arcadis have calculated that a $15 billion dollar spend on such measures before Hurricane Katrina would have saved up to $200 billion in recovery and reconstruction costs[157].

After the floods of 2007, a number of reports from different sectors identified existing budgets as insufficient to the task of defending UK coastlines and catchment areas against both existing hazards and the anticipated threats presented by climate change. The Institute of Civil Engineers (ICE)[158] made particular note of "yo-yo funding", by which government investment in that defence appeared to fluctuate as budgets were diverted elsewhere – the Department for Environment, Food and Rural Affairs (DEFRA) had recently made cuts to compensate for shortfalls in other areas[159].

ICE's call for "ring-fenced" funding and long-term investment in flood-risk management was echoed in the Pitt Review, which also recommended that "government should have pre-planned rather than ad hoc arrangements to contribute toward the financial recovery" in the event of future flooding on the scale seen that year. As of 2012, however, it appears that funding has been subject to further cuts as the current government continues to reduce public spending. Capital funding for new flood defence schemes and maintenance budgets for existing defences have been substantially reduced in the last fiscal year[160]. At a local authority level, key departments have been downsized or amalgamated, and key positions discontinued, including senior resilience officers and heads of emergency planning[161]. Community Resilience UK (CRUK) have described these cuts as a "false economy", given that savings made now may only add to the cost of a future emergency: "Cuts to any element of the overall response … can do nothing but diminish capability."

When consulted for this report, CRUK spokesman Glenn Scully said that the absence of ring-fenced funding for local responders to meet the varying "emergency planning needs" of their particular areas prevents their fulfilling a statutory requirement mandated by the Civil Contingencies Act of 2004.

In late November 2012, the government announced £120 million of new funding to expedite new DEFRA flood defence schemes in Leeds, Ipswich, and

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[157] Source: "Preparing A Defence" by Katie Puckett, RICS magazine, July 2012

[158] In a report titled Flooding: Engineering Resilience

[159] The report also noted that the Environment Agency's spending on related project management had recently been criticised by the National Audit Office (NAO)

[160] Source: "Call for extra £20 million flood defences", Pilita Clark, Financial Times, July 10, 2012

[161] Source: Community Resilience UK, which has closely monitored these developments and provided an ongoing list of these staff and department cuts at http://www.communityresilience.cc/emergency-management/ep-cuts

other vulnerable areas – some of which had previously been underway when their initial funding was suspended. Similar schemes remain postponed or cancelled in other areas, and reduction of the EA maintenance budget[162] may further work against the implementation of Pitt Review recommendations, such as dredging of flood-prone rivers[163].

The bottom line according to government, as noted in the Pitt Review and the current National Flood and Coastal Erosion Risk Management Strategy for England, is that the EA – and, by extension, the taxpayer – cannot be expected to bear the full cost of current and future defences.

This line of thinking accounts for the stipulations of the Flood and Water Management Act, which require Lead Local Flood Authorities (LLFAs) to source outside investment that will top-up central government funding – and the growing emphasis on "economic benefits", as all new proposals for flood-risk management projects are required to show a return of 120% or more on their initial cost[164]. This approach has yielded positive results in some areas, such as the Cleveleys Seawall, which was jointly funded by DEFRA, the EA, the North-West Development Agency, and Wyre Borough Council to simultaneously provide flood protection and a new public promenade, and bring additional economic benefit in terms of tourism. However, the ongoing financial crisis has also made third-party funding less available.

Certainly, the private sector must be encouraged, if not legally obligated, to invest in flood management schemes. It can only help for local authorities to promote "corporate social responsibility", and impress upon business the potential savings to be made in spending now to prevent even greater potential losses in future.  The experience of Onagawa provides another case in point here, as earthquake and tsunami of March 11, the Tohoku Electric Power Company (owners of the Onagawa Nuclear Power Plant) has again become the single biggest private investor in the town's infrastructure, and is now spending money on new roads and flood defences that could have been more affordably outlayed over years or decades before the disaster.

It is clear, however, that potential economic return cannot be the only factor in

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[162] From £108.1 million in 2010/11, to £84m in 2011/12, with a further reduction to £60.7m scheduled for 2014/15

[163] Source: "Did Cuts In Dredging Rivers Cause Floods?" by Louise Gray, Daily Telegraph, December 2012, retrieved from http://www.telegraph.co.uk/earth/earthnews/9714518/Did-cuts-in-dredging-rivers-cause-floods.html

[164] Source: "Private Funding Pledges For Flood Defences Reach £30M in six months", Jo Stimpson, New Civil Engineer, 21 October 2011, retrieved from http://www.nce.co.uk/news/water/private-funding-pledges-for-flood-defences-reach-30m-in-six-months/8621494.article

deciding what, and where, is protected. Nor should current economic policy be the sole arbiter of future disaster planning in the UK. The Netherlands, which faces even greater flood risks, has budgeted for long-term adaptive planning in such a way that up to 1.5 billion funding will be released annually over the next century, thereby keeping costs manageable on a year to year basis[165].

There remains also the matter of priority. In an interview for this report, Professor Robert Nicholls of Southampton University and the Tyndall Centre for Climate Change said: “It is simply not true to say that the government, or the taxpayer, can’t pay for flood defence. If we made it a priority, as we do health or education, I’m fairly certain that we could make the funds available.”

### 4.5 The Nuclear Factor

The Great East Japan Earthquake and Tsunami caused reactor fires and failures at the Fukushima Daiichi nuclear power plant that led to a meltdown and a potential global catastrophe. The full extent of the damage may not be known for decades, in terms of harm done to human, animal, and plant life exposed to the released radiation, not to mention the social and psychological effects on residents who were forced to evacuate and may never return to their homes. As with every other country that employs nuclear power, the UK has been obliged to reassess the vulnerability of its installations, and reflect on any lessons that might be learned from the disaster in Japan.

A subsequent report by HM Chief Inspector of Nuclear Installations Mike Weightman, titled Fukushima And The UK Nuclear Industry, concluded that events in Japan provided “no cause to cease any existing or planned nuclear operations in the UK”. The principal rationale for this seems largely sound, in that the direct cause of the disaster was a seismic hazard “far beyond the most extreme natural events that the UK would be expected to experience”.

The report also notes that the IAEA had identified design deficiencies at Fukushima Daiichi and other Japanese nuclear plants, with particular reference to tsunamis, well before the disaster occurred. The resulting faults and failures on March 11 were not found to reveal any “gaps” in existing Safety Assessment Principles for UK nuclear facilities, though the inspector did recommend that older plants and storage sites be brought up to current design standards as a matter of national priority, and that locations with a flooding risk

[165] Source: “Preparing A Defence” by Katie Puckett. RICS magazine, July 2012

be given particular consideration for possible layout changes and enhanced protections. This last point goes some way to acknowledging the potential hazard posed by natural events that the UK **is** expected to experience.

The aforementioned flood of 1607, whether caused by tsunami or storm surge, should be factored into future planning decisions as one such event that may well recur, particularly given the subsequent isostatic "sinking" of Britain's south-west peninsula and the ongoing rise of global sea levels at a rate of 2mm per year. Risk Management Strategies (RMS) has identified the nuclear plants at Hinkley Port and Oldbury as "vulnerable to being flooded by extreme water levels higher than anticipated in the design of the facilities"[166].

RMS also advises that UK safety regulators give due consideration to the damage caused by Windstorm Martin at the Blayais nuclear power plant in south-west France on December 27 1999 – a storm surge on Girande estuary exceeded the design capacity of that plant by over one metre, overtopping its defences and flooding lower levels, causing circuit failures and forcing a shutdown of all four reactors. An increase in the frequency and intensity of such weather events is likely to put similar strain on plant defences in the UK.

The UK nuclear industry, and British policy-makers, might also consider the case of Onagawa nuclear power plant, which withstood the worst effects of the March 11 earthquake and tsunami, while sustaining minor flooding and structural damage (see section 1.4). The threat to its reactors was effectively contained, and subsequently gave rise to a number of new resistance and resilience measures[167], but the close call itself[168] – coupled with events at Fukushima – was sufficient to turn a significant proportion of the public against the facility, its owners, and the local officials who supported its re-activation.

Residents attested that this was a deciding factor when casting their votes the local elections of November 2011. The rejection of several pro-nuclear councillors, as well as the mayor himself, in favour of candidates who opposed the power plant, or at least expressed an ambivalence that reflected the public mood. This renewed and emboldened scepticism was felt across Japan and around the world, demonstrating how a single disaster may impact on policy.

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[166] 2007-1607 Bristol Channel Floods: A 400-year retrospective, an RMS Special Report

[167] According to ONPP spokesman Aizawa Toshiyuki, these will include an 800-metre long coastal levee around the plant, a tide barrier around rooms housing the seawater pumps, stronger watertight doors, and a new power system to ensure continued supply if a flood affects the main generator and/or diesel backups

[168] Onagawa resident Hirokoshi Oka and several others observed that the damage to the ONPP might have been far worse if the tsunami waves had not been refracted and retarded by the geomorphology of Koyadori Bay

It is, therefore, in the interests of industry and government to plan for disaster in such a way that nuclear facilities are not only secure against the maximum possible hazard, but also **perceived** to be safe by consumers, and voters.

### 4.6 Authority and responsibility in UK disaster planning

In Japan, the March 11 earthquake and tsunami exposed a disparity between national government and local authority, whereby pre-disaster planning in affected areas had not been sufficiently regulated, and post-disaster planning has been slowed, confused, and obstructed by a chronic lack of coordination. The United Kingdom can learn a valuable lesson from this, given that the ICE and Pitt Review identified similar issues after the floods of 2007.

The government's own Planning Policy Statement on Development and Flood Risk (PPS25) requires local authorities to ensure that all building in flood-risk areas is suitably resistant and resilient, but economic pressures, demand for housing, and a lack of relevant expertise in local planning departments has served to work against the consistent implementation of that policy[169].

A Building Futures[170] report from the same year, titled Living With Water: Visions Of A Flooded Future, underlined this point: "We can currently discern little integration or co-ordination between the multitude of different master plans and local development frameworks, and the increasing number of overlapping strategies." The Pitt Review recommended the further empowerment of local authorities to regulate flood management, the expanded right of the Environment Agency to challenge development proposals, and a general need for better coordination between them.

The EA, as per Pitt Review recommendation number 2, subsequently assumed responsibility for national oversight of all flood risk. The Flood and Water Management Act of 2010 transferred front-line responsibilities to Lead Local Flood Authorities (LLFAs). In terms of emergency management, sources consulted for this report attest to a general improvement in communications during flood events. Paul Wooster of the search and rescue team Rapid UK said he had observed a "lack of clarity" among responders in 2007, and had since noticed "much better organisation" between the fire service[171], police, and boat crews. He attributed this change to the working party formed to solve this problem after the Pitt Review, and a growing institutional awareness of the

[169] Source: ICE's report Flooding: Engineering Resilience
[170] A 'think-tank' constituted by the Royal Institute of British Architects
[171] The Fire Service remains the primary responder in flood events, and search and rescue falls within their command system.

need for effective disaster risk reduction.

As seen in Japan, a rapid and well-organised first response is vital to saving lives, particularly in the event of a sudden-onset flood disaster and with an attendant threat of drowning. In Onagawa and elsewhere, however, it quickly became clear that local emergency planning could have been much improved even in areas that were nominally primed and prepared for disaster.

As such, it should be noted that there remains a "scattershot"[172] and reactive approach to emergency management planning (EMP) in the UK. Besides the budget and staff cuts outlined in section 4.4, it is clear that some authorities are more committed than others – some boroughs and districts have only one emergency planning officer (EPO), some councils have given over all responsibility for EMP to other Category 1 responders, such as police and fire services, as allowed for by the Civil Contingencies Act of 2004.

That act also requires that responders contribute to Local Resilience Forums (LRFs) and develop multi-agency strategies for addressing local hazards, but as the risk profile varies from one region to another, so does the level of commitment. According surveys conducted by CRUK, many LRFs do not reach their performance targets or demonstrate their capabilities to the public, and some never run any live exercises to identify potential improvements.

Clearly, more must be done to establish a uniformity of practice across local authorities, secure top-down support and resourcing for town and district councils, and impress upon planning departments their vital role in front-line flood defence. It would also be of benefit to the public if specific responsibilities were both clarified and expanded.

Anecdotal evidence from Hebden Bridge in West Yorkshire – a regular site of flooding at the confluence of two rivers, which was again badly flooded in June 2012 – suggests that the local council[173] refused to assist in the protection of private property (provide sandbags etc) on the grounds that their only statuary obligation was the strategic defence of infrastructure[174].

### 4.7 Options and obligations for an uncertain future

More so than Japan, where future disasters are made all but inevitable by seismic fault networks and a lack of available land – with the result that a vast majority of the population live in vulnerable coastal regions – the United Kingdom still has time to adapt to climate change, and a range of choices in facing the increased risks it may present. These choices were delineated in a 2007 study by the ICE and Building Futures, titled Facing Up To Rising Sea

[172] The term used by CRUK spokesman Glenn Scully
[173] Calderdale Metropolitan Borough Council
[174] Source: CRUK

Levels: The Future Of Our Coastal And Estuarine Cities.

Three basic options were presented: “attack”, “retreat”, or “defend”, and each of these scenarios applied to the vulnerable cities of Hull and Kingston-Upon-Thames. None of those choices would be easy to make, and all seem drastic from today’s vantage point. To “attack”, for example, would involve building over water, or onto new swathes of reclaimed land. “Retreat” would mean the abandonment of now populated urban areas, and the sacrifice of their infrastructure. And “defence” would require ever-more extensive and costly walls and barriers. Consulted for this report, Professor Robert Nicholls told the writer that these choices should now be subject to wider debate and due consideration as part of any long-term approach to disaster planning:

“Some people think we must retreat, and moving to the hills is our only option, but there are others if we choose to exercise them. To take just one alternative, if you give an engineer enough money he will build you a 50 metre seawall. But do you want to pay for it? And would you want to live behind it?”

Nicholls and other UK coastal engineers have also made clear that a “hard” solution in one area can often create a problem in another – concrete barriers and embankments may simply transfer flood risks to a weaker section of a given coastline, and deprive the shore of sediment that might have helped protect against erosion. Traditional “hold-the-line” policies have been evolving to allow for more flexible shoreline management plans (SMP), and controlled “realignment” of tidal zones where salt marshes and mudflats may absorb and neutralise the impact of encroaching seas. In other areas, defensive options may yet prove viable, such as the aforementioned scheme at Clevelys[175].

As Nicholls puts it, the best approach is likely to be “some sensible combination” of all the available options. Planners in Japan have come to a similar conclusion. The ongoing relocation and reconstruction of Onagawa is itself a combination of retreat and defence, involving both a major engineering project and a new, sustainable approach to land use and spatial planning.

The complexities of that process however, and the issues it has raised in terms of logistics, economics, and social justice, should serve to remind UK policy makers that only they can decide what and where to protect, and that it would be better to make choices before a disaster forces them to. The government has recently come to acknowledge the long-term challenges presented by climate change and by some of the plans by which its worst effects may be mitigated.

In responding to the Climate Change Projections of 2009 (CCP09), the Parliamentary Office of Science and Technology noted the likelihood of

[175] Source: Facing Up To Rising Sea Levels (Building Futures and ICE)

conflicts between fresh and saltwater environments, wetlands and agriculture, and residents and planners – particularly in those areas where new SMPs might discourage investment and impact on land and property values, thereby causing blight in those areas (as happened in parts of Norfolk when details of second-generation SMPs were published)[176].

By the EA's own admission, "It is not technically, economically, or environmentally feasible to prevent flooding and coastal erosion altogether"[177], and the agency's coastal advisor Nick Hardiman has explicitly stated that there is "not much economic justification for protecting certain coastal communities"[178]. This being the case, it must be stated again that economics should not be the only criteria on which such decisions are made, and that social and cultural factors – not to mention the emotions and attachments of residents – should be considered integral to any long-term adaptive approach to climate change. If the most vulnerable coastal communities are made to feel lower-priority than residents of more heavily-invested urban areas (particularly London, for which the EA is currently developing a 100-year flood management plan known as Thames Estuary 2100), then disaster planning may create fault-lines for social discontent and inequality.

At the same time, it is clear that the government cannot be expected provide indefinite and ever-costlier protection for areas subject to continued erosion and constant, growing flood risk. The British public, for its part, would be better empowered to confront that risk if better advised as to their rights and responsibilities. In 2009, the government noted that there "there is concern among coastal stakeholders that communities are not properly informed, although some suggest it is difficult to engage individuals until they perceive their direct interests are affected"[179]. Public perception, however, is partly the responsibility of government. A recent study shows that a significant proportion of British homeowners are not prepared or insured for flooding, and do not know their level of risk or their options for reducing it[180]. This situation might be improved with a national resilience awareness programme.

At present, the UK has no equivalent for Japan's annual Disaster Management

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[176] Parliamentary Office of Science and Technology postnote number 342 (October 2009)
[177] Source: the Environment Agency's National Flood and Coastal Erosion Risk Management Strategy for England
[178] Source: "Preparing A Defence" by Katie Puckett, RICS magazine, July 2012
[179] Parliamentary Office of Science and Technology postnote number 342 (October 2009)
[180] RiskCentral flood risk study, December 2012, retrieved from: http://www.ambiental.co.uk/riskcentral/new-study-suggests-uk-not-prepared-for-flooding/

and Volunteer Week (every January 15-21) or Disaster Prevention Day[181]. Canada has an Emergency Preparedness Week[182], and September is now designated National Preparedness Month in the US[183]. Glenn Scully of CRUK describes a "complete lack of centralised engagement with the public on the issue", even as those communities most at risk are effectively teaching themselves resilience through repeated exposure to flooding.

He cites the residents of Hebden Bridge as possessed of "a healthy dose of realism, a determination to return to normality, and a strength that seems to come from their historical precedence for coping". This could just as easily describe the residents of Onagawa. And as in Japan, planners and policy makers should be working to support and include these communities in decisions that affect their homes, businesses, and futures.

## CONCLUSION

The Great East Japan Earthquake and Tsunami was undoubtedly a rare event, and in many ways particular to the circumstances of the affected region. It served to highlight, however, the continued unpredictability of hazards that can lead to major natural disasters at any time, and with little or no warning.

It also proved again the crucial point first made by US geographer Neil Smith: "There is no such thing as a natural disaster". Which is to say that all the death and damage it caused can be attributed to human choices and decisions. If we are to continue living in areas exposed to seismic and hydro-meteorological hazards – and urban coastal populations are growing even as climate change intensifies the risks – then we must begin to plan around uncertainty itself.

This is the defining feature of the future, and while floods may not be predictable, they are also increasingly probable. With this in mind, the experience of Onagawa suggests a number of lessons for planners and policy-makers outside Japan, including the United Kingdom:

- Even the most advanced existing science and technology cannot provide a full and accurate picture of long-term natural hazards to a given area, particularly where those hazards are subject to environmental change. Development and investment in modelling and forecasting can only improve our capacity for disaster planning.

- Short-term warning and alert systems are not infallible, but Japan has made effective use of available and affordable technology – most notably

[181] Every September 1, the date of the Great Kanto or Tokyo Earthquake in 1923
[182] Source: http://getprepared.gc.ca/cnt/rsrcs/ep-wk/tlkt-eng.aspx
[183] Source: http://www.ready.gov/

mobile phone networks – which could and should be adopted by other at-risk nations, and adapted to local hazards.

- Land use and spatial planning must minimise the exposure of people and property to potential disaster. The experience of Onagawa should serve as a reminder of the urgent need for local authorities and national agencies to restrict or prohibit development in at-risk areas.

- Neither structural defences nor social counter-measures should not be considered sufficient in themselves to protect people and property from a given hazard – only multi-layered systems of resistance, resilience, and preparedness can effectively reduce the impact of a potential disaster

- The most extreme seismic or weather events may occur on geological timescales which far exceed the average human lifespan. It is important for planners and policy-makers, and the public at large, to consider the possibility that they may also occur at any time, and to be prepared for the maximum potential hazard, as opposed to the worst examples within recent history, or "living memory"

- It is always more expensive to reconstruct after disaster than to invest in planning and mitigation measures – both public and private funding should be encouraged and allocated accordingly. Indeed, it may be possible to spread the cost of disaster prevention over time, whereas funding issues after the event tend to prolong and exacerbate the impact of the disaster. All those involved in planning and mitigation should be working to effect the necessary change in public policy and corporate philosophy.

- Natural hazards cannot be mitigated out of existence, and in some areas they are now posing an ever-greater threat. In those communities exposed to growing risks from sea level rise, coastal erosion, and frequent flooding, relocation should be considered as a preventative measure, rather than a reactive and enforced strategy after the event.

- Disaster planning should not be dictated by the economic or political systems of the day, but considered a fundamental requirement of present and future society. As such, sustained investment and legislation must be secured in perpetuity, with protocols developed for all contingencies, including reconstruction – so as to avoid or minimise the kind of confusion and suffering evinced in Onagawa after the tsunami.

- The residents of at-risk towns and cities must be empowered and informed as to the hazards they face, the responsibilities they bear, and the options and resources available to them. These communities must not be considered past or potential victims, but the first and last line defence. With

support and advice from planners and policy-makers, a resilient society can be built up from ground level, and future floods need not be disasters.