

The Transition from Private to Public Insurance for Natural Hazards: A Review of International Experiences

Ilan Noy & Tomáš Uher
School of Economics and Finance
Te Herenga Waka – Victoria University of Wellington

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1. Introduction

Disasters caused by natural hazards such as floods, storms, volcanic eruptions, or earthquakes lead to social, economic and environmental damages. Disaster losses have been increasing over time, due to economic development and population growth, which increase the number of people and assets in harm's way, and due to climate change, which is affecting the frequency and intensity of extreme weather events. According to one large global reinsurer, in the last 30 years the relative disaster loss burden compared to global GDP has doubled (Swiss Re, 2024).

Disaster loss compensation is important as it helps the affected people repair or replace the damaged assets, and thus recover faster. Liability rules are typically used to guide loss compensation for the victims of manmade (e.g., terrorism) or technological disasters, as the liable party is often easy to identify. Loss compensation for natural-hazard disaster is different as liability is not easily established. Compensation is typically provided through public assistance or from insurance claim payments (Faure, 2016). For disasters triggered by natural hazards, governments have historically had a major role in providing this ex-post relief from public funds, but this practice is associated with several difficult-to-resolve issues including considerations of fairness, the availability of current funds (liquidity), fiscal sustainability (solvency), and the adequacy of such a system over time and the misincentives it might create.

The alternative to direct provision of compensation from the government is the use of disaster insurance as an ex-ante financing mechanism. However, disaster insurance is associated with its own challenges, including concerns about insurability, low consumer demand, and information asymmetries leading to adverse selection and moral hazard (Botzen, 2021).

Natural hazard disasters are particularly difficult to insure through the private market, and private insurers have sometimes 'retreated' from providing this coverage. So, governments oftentimes end up acting as insurers, reinsurers, or insurers-of-last-resort, either through public-private partnerships or through fully public systems. In countries such as Switzerland, Aotearoa New Zealand (NZ), and Spain, Public Disaster Insurance (PDI) schemes were established as early as the 1920s, 1940s and 1950s, respectively. In the second half of the 20th century, many other countries including the US, Japan, Norway, France, Turkey, and Algeria followed. Currently, with rapidly increasing risk from weather-related disasters because of climate change, private insurance retreat is happening more frequently, and the need for sustainable disaster risk insurance system is gaining public policy attention in many places.

The countries or jurisdictions which are yet to establish PDI systems (or are considering amending or expanding current systems – the NZ case) can look to existing PDI systems for lessons about the creation and implementation of well-designed schemes that can successfully serve their stated purpose. Useful lessons can also be extracted from analysing how existing PDI schemes have performed historically or are currently performing. Concurrently, it may also be beneficial to investigate the process of PDI establishment itself.

In this report, we discuss the process of PDI establishment and attempt to identify recurrent themes associated with the process, including PDI establishment incentives, the role of risk knowledge, government deliberations and legislative proposals for PDI establishment, and the surrounding changes in disaster mitigation. Section 2 describes the disaster loss compensation systems present in the countries preceding PDI establishment and some of their limitations. Section 3 deals with incentives to establish PDI, where we show that many PDI systems were established following a major disaster and consequent adverse effects on the private insurance and public sectors. In Section 4, we detail the PDI establishment process as regards the initial legislative proposals and studies, the creation and implementation of the schemes and the surrounding broader changes in disaster mitigation. In the last section we conclude by summarising the main implications of these past experiences to current and future ones and what is still missing in our knowledge about the performance of these systems.

2. Pre-transition: Compensation of Damages

Before the establishment of a Public Disaster Insurance programme (PDI), disaster loss compensation is usually provided through post-disaster relief programmes - oftentimes ad hoc - and through private disaster insurance. Whether the resources are obtained from the government, private relief organisations, or from private insurance and re-insurance depends on the institutional setups, on the historical experience with catastrophic events, on political dynamics, and on the availability of funds from these stakeholders. High-income countries often have a lot more private insurance coverage, while in lower-income countries and communities the insurance gap (risks that are not insured) is typically much larger.

2.1 Government relief

The provision of post-disaster relief and loss compensation by the government has a very long history and was (and in many cases still is) the primary or the only means of disaster loss compensation in many countries. For example, in the United States, relief for disaster victims has been provided by the federal government since the country's founding (Collier, 2014), and in China, government post-disaster food support can also be found around the same time (Shiue, 2004). The willingness to use public resources for post-disaster assistance can be traced to values of solidarity and collective responsibility, as well as a more efficient solution to the problem that disasters were widely seen as unpredictable 'Acts of God' that are impossible to prevent. Government relief was the main system for post disaster loss compensation in most of the countries which eventually transitioned to a PDI system, including the USA, France, Belgium, Norway, China, and Turkey.

Compensation of disaster losses from public funds is linked to several potential concerns. First, it can create a large and unexpected public expenditure when catastrophic events happen, a time when revenue streams may be diminished as well. They thus may necessitate borrowing (if that is possible and affordable), the printing of money, or the redirection of funds originally intended for other purposes.

Second, the compensation provided may be inadequate to cover losses fully or sufficiently or may not do so in a timely manner, thus delaying recovery. In France, where post-disaster

assistance used to be provided through a “Secours Fund”, only low compensation amounts of up to 20% of incurred damage were provided on a piecemeal basis and the system was inadequate to cover large-scale losses (Barry, 2024; Charpentier et al., 2022). In Belgium, the provision of government assistance was associated with long waiting times and difficulties with calculating the payments, as the payments were, similarly to many other countries, reliant on the government’s disaster declaration (Schwarze et al., 2011). In the United States, government relief is not disbursed proportionally to damages, so that more severe disasters receive less aid per damage (Waters et al., 2024). The FEMA Individual Assistance payments, the main method of direct payments to households and small businesses, typically only cover a small fraction of the experienced loss (Smiley et al., 2024).

Third, the provision of post-disaster government relief may create charity hazard – i.e., it reduces incentives to engage in ex ante risk reduction. Post disaster assistance can encourage households and businesses to pursue risky behaviours (e.g., moving to high-risk areas, or constructing and occupying disaster-prone structures) and prevent them from reducing or otherwise transferring the risk (Andor et al. 2020; Raschky and Weck-Hannemann, 2007). In contrast, uncertain payments reduce the incentives to invest in the first place if investors are worried about the risk to their assets.

2.2 Private insurance

Disasters caused by natural hazards are difficult to insure by private insurers (Kusuma, et al., 2019). Predicting natural-hazard losses is difficult and entails a high degree of uncertainty. This makes it difficult for insurers to estimate their expected losses accurately and leads them to set premium rates with a significant ‘uncertainty premium’.

The possibility of catastrophic losses that are highly correlated—i.e., when many claims are caused by the same event—also requires insurers to hold large amounts of capital in reserves, so that it can be mobilised if a catastrophic event happens. Alternatively, it forces insurers to buy costly re-insurance contracts. Thus, correlated risks make insurance more expensive (Jaffee and Russell, 1997).

Insurers also face adverse selection, whereby only individuals in high-risk zones are willing to purchase insurance, which makes risk pooling difficult. Once only high-risk property owners choose to insure themselves, the price of insurance becomes very high, making it too costly even for those relatively high-risk to insure. The resulting high insurance premium prices also make insurance prohibitively expensive to budget-constrained households.

Beyond these market forces, insurance is typically subject to regulatory and political pressures. Given the high public profile of disaster insurance – it is often discussed in the media – the sector often faces pressure from governments and regulators to keep insurance coverage available and affordable, sometime below what the insurance companies may consider profitable, or actuarially fair.

The confluence of these factors typically becomes more prominent after the occurrence of catastrophic events requiring large insurance payouts. These events have often led insurers

to decline to renew existing cover for natural hazards or withdraw from new markets. We term this, following Storey et al. (2017), an ‘insurance retreat’.

In addition to the challenges to supply private insurance, the demand for disaster insurance from homeowners and businesses can also be low due to behavioural misperceptions or the asymmetric availability of information. Meyer and Kunreuther (2017) detail six behavioural biases that reduce the demand for disaster risk reduction more broadly, but specifically pertain to the demand for insurance as well: optimism, inertia, myopia, amnesia, simplification, and herding. All these ‘conspire’ to reduce the demand for disaster insurance, and thus exacerbate the ‘insurance gap’ problem. Feess et al (2023) investigate the role of asymmetric information, when the insurer is better informed about the natural hazard risk than the insured and show that this asymmetry is likely to lead to under insurance.

These supply and demand issues associated with the provision of private-sector disaster insurance generally lead to very low private insurance penetration rates for natural hazard coverage. Consequently, in most cases, a relatively small fraction of disaster losses has historically been compensated through private insurance.

In several countries which eventually established a PDI scheme, private disaster insurance became unavailable when insurers decided to exclude coverage for some (or all) natural hazards. This was the case, for example, in France, Japan, New Zealand, and Denmark. In France, disasters were excluded from insurance policies due to a lack of reliable statistics, and a substantial accumulation of high risk through adverse selection, especially for flood risk (Magnan, 1995; Charpentier et al., 2022). Earthquake insurance was deemed by insurers to be too costly to maintain due to a risk of catastrophic losses in the case of an earthquake event occurring in the southeast of the country (Magnan, 1995).

In Japan, insurers were essentially forced to compensate the damages from the Great Kanto Earthquake in 1923 even though earthquake-related fire was explicitly excluded from fire policies, and this post-earthquake fire caused most of the damage (Yoneyama, 2009). Later attempts by the Japanese government to require insurers to include earthquake and fire coverage were resisted by the industry and eventually a PDI was formed (Giroj, 2022; Morimiya, 1984). In the Netherlands, where PDI has long been considered but not yet established, floods are excluded from coverage due to the unique and highly concentrated character of flood risk in a country in which many assets and much of the economic activity takes place below sea level (Jongejan and Barrieu, 2008). That, however, has led the Dutch government to invest a lot of resources in flood prevention; and flood defences in the Netherlands are built to a higher standard than almost anywhere else.

Even in countries where private disaster insurance was available before PDI establishment, it was typically associated with low penetration rates. In Turkey, the penetration of earthquake insurance in residential properties was 5% on average: 15% in Istanbul, 2% outside Istanbul, and almost none in the low-income middle-class segment of the property market (Yazici, 2005; Gurenko, 2006). According to Gurenko (2006), disaster insurance was in low demand, as the Turkish public did not trust insurance products in general. On the supply-side, the private insurance sector was unable to adequately cover large and/or recurrent losses. Many of the insurance companies had limited capital buffers and lacked risk management expertise (Gurenko, 2006; Cummins and Mahul, 2008). Low penetration

rates of private natural hazard insurance are prevalent also in other countries. In California, residential earthquake take-up was 25% according to Jarzabkowski et al. (2018), and half that according to Marshall (2018). Coverage rates were less than 1% in Taiwan for earthquakes (Coutaz, 2018), and in Thailand for floods (Orie and Stahel, 2013). In Italy, only 5% of climate-related disaster losses were insured between 1980 and 2020 and less than 5% of homes were insured against earthquakes (Parodi et al., 2023). Perazzini et al. (2024) argue that the private insurance market in Italy cannot provide sufficient cover for flood and earthquake risks due to the mismatch between individuals' willingness to pay and insurers' capital and solvency requirements.

The UK represents an atypical case as higher penetration rates were attained partially by using a government's threat of nationalisation if insurers fail to deliver sufficient and affordable flood coverage to private, commercial and industrial properties (Mysiak, 2015). Flood insurance had been available through private insurers due to the insurance industry's voluntary agreement with the government dating back to 1961 (Jiang et al., 2019) and later renewed with the establishment of the FloodRe scheme a decade ago. In several cases (including the UK) insurers initially agreed to provide flood insurance no matter what the risk is, as the government assumed responsibility for flood prevention, including land use regulation and real estate development, and guaranteeing independence to insurers (Crichton, 2002; Huber, 2004; Jiang et al., 2019).

3. Reasons for Establishing a PDI

PDI schemes have generally been established in countries when and where: (1) the disaster risk is high enough for significant disaster losses to occur (either because of a single catastrophic event or a series of recurrent smaller-scale events); (2) neither government relief nor private insurance are seen as adequate to sufficiently and sustainably compensate these losses.

Depending on what system of disaster loss compensation is being used in the country, large disaster losses put pressure on private insurance, on public funds, or on both. In the case of the insurance sector, occurrence of a major disaster event often leads to full insurance retreats, to limits on coverage, and to higher conditionality leading to increasing concerns about affordability. For the public sector, the provision of government relief following major events leads to high public expenditure, which can be politically difficult and/or fiscally unsustainable and might necessitate borrowing or redirection of funds from other spending priorities. Ultimately, these options have been perceived to be suboptimal for covering disaster losses fully and sustainably. Governments in various countries appear to intervene in the provision of disaster insurance and establish a PDI scheme when the status quo was perceived to have become unsustainable, often in the aftermath of a crisis (e.g., the bankruptcy of private insurance firms in the aftermath of a large event).

3.1 Disaster losses

For many countries, a strong incentive and an opportunity to develop an alternative system for loss compensation arose after an occurrence of a major disaster event. In other cases, the impetus for government intervention may be traced to recurring disaster events of

smaller magnitude. Large disaster losses caused by these events in combination with insufficient or incomplete loss compensation systems made it clear to governments, and possibly to other stakeholders including the insurance industry, that a change was needed. Table 1 presents a selective list of disaster events which played an important role in PDI establishment in various countries.

Table 1: The list of disaster events linked to PDI establishment across countries

Country/State	Event/s	PDI Scheme	Year of PDI establishment
Japan	1964 Niigata earthquake	Japanese Earthquake Reinsurance	1966
USA	1965 Hurricane Betsy	National Flood Insurance Program	1968
USA	Atlantic and Gulf hurricanes (≈1950-1970)	State insurers of last resort (Wind Plans and Beach Plans)	≈1968-1971
Iceland	1973 volcanic eruption, 1974 avalanche	Icelandic Penal Insurance	1975
France	1981 Saône and Rhône floods	Catnat	1982
Denmark	Multiple extreme weather events (1980-1990)	Danish Storm Surges Council	1991
Hawai'i	1992 Hurricane Iniki	Hawaii Hurricane Relief Fund	1993
Florida	1992 Hurricane Andrew	Residential Property and Casualty Joint Underwriting Association, Florida Hurricane Catastrophe Fund	1992-1993
California	1994 Northridge earthquake	California Earthquake Authority	1996
Turkey	1999 İzmit Earthquake	Turkish Catastrophe Insurance Pool	2000
Taiwan	1999 Chi-chi Earthquake	Taiwan Residential Earthquake Insurance Program	2001
Thailand	2011 Thailand flood	National Catastrophe Insurance Fund	2012
New Zealand	1942 Wairarapa Earthquake	Earthquake and War Damage Fund (later renamed the Earthquake Commission)	1945
UK	Multiple flood events (1998 onwards)	Flood Re	2016
Australia	Multiple extreme weather events (2010-2020)	Cyclone Reinsurance Pool	2022

These examples of major disaster events, all of which eventually led to the establishment of PDIs, caused billions of US\$ in damages and losses, and most relevant to the formation of the PDI, were perceived to have had severe effects on the public and, in some cases, the solvency of insurance companies.

The 1965 Hurricane Betsy was at the time the most impactful hurricane on record and the first hurricane associated with damages exceeding USD 1 billion (Clark, 1966). The 1992 Hurricane Andrew led to economic damages of over USD 25 billion and insured losses of USD 15.5 billion, making it the costliest hurricane event in the US up to that time (Lecomte and Gahagan, 1998). The 1994 Northridge earthquake caused insured losses of USD 12.5 billion, which reportedly corresponded to over 80 years of collected earthquake premiums in California (Jarzabkowski et al., 2018). The 1999 İzmit earthquake caused over 17,000 deaths and over USD 12 billion in damages (Paudel, 2012). The 2011 Thailand floods were by far the costliest disaster in Thailand's modern history, leading to USD 46 billion in total losses and USD 15 billion in insured losses (World Bank, 2011; Swiss Re, 2021). In Northern Australia, several major extreme weather events impacted the region between 2010-2020, with 2011 Tropical Cyclone Yasi being one of the most severe storms in the region's history and the devastating 2019 floods impacting Townsville and the surrounding areas in North Queensland (AGT, 2021). In Spain, it was an occurrence of a catastrophic fire in 1941 that spurred the idea to cover disaster losses from a war loss fund that was funded by a surcharge on fire insurance premiums (Greene, 1972).

Even before these crucial events occurred in these respective countries, preceding disaster events would have spurred early interest in government intervention for disaster insurance. Examples include the 1992 Erzincan earthquake and the 1998 Adana–Ceyhan earthquakes in Turkey (Yazici, 2005), or the 1951 floods in Kansas and Missouri in the US, after which the first proposals calling for establishment of a national flood insurance scheme were made (AIR, 2005). Disaster occurrence created interest in PDI also in countries where a PDI scheme has not yet been established - for example in Italy with the earthquakes in 1980 in Irpinia and 2009 in L'Aquila (Gizzi, 2015). Romania appears to be an exception as the establishment of its PDI does not seem to be related to a specific disaster event (or a series of events) (Bulugea, 2011).

3.2 Disaster effects on the private insurance sector

Given the inevitability of some disaster losses and the benefits from an efficient compensation system for these losses, the incentives to establish PDI are to a large degree related to the inability of the private insurance sector to offer affordable insurance and effectively provide this compensation. In some countries, disaster insurance was, for a period, offered by the private sector until disaster insurability issues arose, typically due to the occurrence of a large or recurrent disaster event(s). In some cases, high disaster losses even led to a depletion of insurers' capital reserves, their inability to satisfy remaining claims because of solvency or liquidity challenges, and consequent bankruptcies. Even for insurers and reinsurers who were able to sustain operations post-disaster, high losses led to re-appraisals of the risks in their portfolio, and consequent rate increases and limits on coverage – i.e., an insurance retreat (Storey and Noy, 2017). In other countries, private insurance was never widely available, and the private sector never entered the market.

In the US, most PDI schemes (e.g., the NFIP, CEA in California, and the Florida Hurricane Catastrophe Fund), and many other state insurers of last resort were established after an insurance retreat, or insurers' threat of a retreat. Flood insurance in the US was offered by private insurers in the early 20th century, but large losses following massive flooding in Mississippi in 1927-1928 led almost all companies to stop offering this coverage, and only very few private companies continued to offer flood insurance. In the following decades and until the establishment of the National Flood Insurance Program in 1968, flood loss compensation was provided primarily through government relief. In California, insurance companies have been legally required to offer earthquake insurance alongside home insurance since 1985. After the 1994 Northridge earthquake, some insurers began withdrawing from the home insurance market altogether because of their reluctance to continue offering earthquake cover (Roth, 1998). This triggered the establishment of the CEA.

In Florida, low insurance availability for properties at high risk was already a problem before 1992, but it became both more salient and more widespread following the destruction wrought by Hurricane Andrew (Mcchristian, 2012). In its aftermath, the insurers attempted to significantly raise premiums, justifying these increases on the large losses from the hurricane (Kunreuther and Lyster, 2016). After the premium increases were prohibited by lawmakers, many insurers decided to decline to renew their existing policies and stop offering new ones (Lecomte and Gahagan, 1998). In Hawai'i, following the 1992 Hurricane Iniki, roughly 40,000 policyholders were faced with having to purchase more expensive insurance policies with premiums 4-5 times higher than before the event. About half of homeowners had their policies not renewed. This led to a real estate industry slowdown as these homeowners were not able to meet the requirements of mortgage lenders, similarly to what happened in California (FEMA, 2011; Middleton, 2012). Insurance withdrawal and premium increases following hurricane losses also occurred in other US southeastern coastal states (e.g., Texas, North and South Carolina, Mississippi, and Louisiana), where residual schemes in the form of beach or wind plans (i.e., insurers of last resort) were eventually established, mainly in the 60s and 70s (Pompe and Rinehar, 2008; Hartwig and Wilkinson, 2016).

Following large disaster events, issues of both insurance availability and affordability were present in other countries as well. In Turkey after the 1999 Izmit earthquake, insurers either refused to cover buildings not resistant to earthquakes or would only accept very high premiums (Başbuğ-Erkan and Yilmaz, 2015). In Thailand after the 2011 floods, some insurers began to exclude flood cover – a cover which had previously been provided as a complement to standard fire insurance policies for almost free (Kunreuther and Lyster, 2016). Other insurers instituted rate hikes and binding limits (Orie and Stahel, 2013).

In the UK and Australia, issues of affordability prevailed. In the UK, flood insurance affordability in high-risk areas became a concern due to both increasing flood losses (beginning with two major flooding events in 1998 and 2000) and advances in flood mapping which threatened to shift the pricing set up to risk-based pricing, and consequent steep rate hikes for those at high risk (Charpentier et al., 2022).

In Northern Australia, significant insurance and reinsurance premium increases were linked to a series of storm and flood events in the 2010s. It was estimated that in 2016, 20% of properties did not have home insurance in Northern Australia compared to 11% in the rest of the country, and high premiums were deemed to be the main reason (AGT, 2021).

3.3 Disaster effects on the public sector

In countries that primarily or partially relied on the government to provide post-disaster relief and loss compensation, large disaster losses led to high government spending and political concerns about these expenditure (e.g., Norway, USA, Turkey, Belgium). These effects were present even in regions where private disaster insurance was available, but insurance coverage was insufficient to cover much of the incurred losses (e.g., California). High post-disaster spending created an incentive for governments to reduce spending and free the resources for other means (potentially including efforts to reduce disaster losses in the first place through investment in prevention and mitigation). The need to find an alternative to compensating losses from the public purse led governments to explore the use of disaster insurance and the potential for government involvement in this market.

Fiscal considerations appear to have played an important role in likely the earliest case of PDI establishment, in Switzerland. There, disaster victims used to be compensated through charity collections.¹ But as these were seen as unreliable and increasingly inadequate to cover the losses, the issue of how to effectively assist disaster victims became a prominent policy focus in the early 20th century. Ultimately, the view that compensating the losses from public funds would not be fiscally prudent led to the decision to implement a cantonal disaster insurance scheme that started in the 1920s (Jarzabkowski et al., 2022b).

In the US, the incentives to establish federal flood insurance were largely connected to the escalating costs of disaster relief in the 1950s and 60s. Between 1952 and 1966, federal disaster assistance increased from USD 52 million to USD 374 million (Elliott, 2021), and the conditions for providing relief were being gradually relaxed (Collier, 2014). Importantly, the significant disaster relief provided in the aftermath of the 1964 Alaskan earthquake, the 1965 Washington State floods and tornadoes in Indiana, and 1965 Hurricane Betsy all served as an impetus to reconsider PDI and later pass the legislation that established the NFIP (Collier, 2014).

In France, the system for post-disaster relief was overstretched and unanimously deemed inadequate following the major 1981 floods (Charpentier et al., 2022). In Belgium, the disaster fund's reserves were depleted following windstorm Daria in 1990, which initially led to insurers being mandated to offer storm coverage before a public-private partnership was eventually established (Brugge and Faure, 2008).

In Turkey, the government was obligated to extend credit and build housing for those affected by earthquakes (Phaup and Kirschner, 2010). Post-earthquake public expenditure had been increasing following several earthquakes in the 1990s and peaked with the

¹ Adam Smith already noted that in his 1776 book *The Wealth of Nations*: "The canton of Unterwald in Switzerland is frequently ravaged by storms and inundations, and is thereby exposed to extraordinary expences. Upon such occasions the people assemble, and every one is said to declare with the greatest frankness what he is worth in order to be taxed accordingly." (book V, chapter II, p. 359).

catastrophic 1999 Izmit earthquake, leading the government to immediately enact the previously-designed earthquake insurance scheme in its aftermath (Yazici, 2005). In addition to the large fiscal burden, Turkey's growing financial needs for reconstruction after the 1999 earthquake began to negatively affect World Bank funded projects, giving it an incentive to get involved as well (Gurenko, 2006).

3.4 Risk knowledge as an incentive or an enabling factor

The growth of risk knowledge, risk assessments, and catastrophe modelling played an important role in shaping disaster insurability and enabling or incentivising PDI establishment across countries. These technical advances allow for better estimates of expected disaster losses and risk assessments on a more spatially detailed scale, increasing the ability of insurers to price risk differentially, and thus increasing disaster insurability concerns in places where the risk is highest.

Jarzabkowski et al. (2023) posit that both too little and too much risk knowledge lead to the inability of the private insurance industry to offer affordable disaster coverage. Too little risk knowledge is associated with the era preceding modern advancements in risk modelling, but it persists even today in lower-income countries who lack the resources required for the utilisation of existing technologies. Without sufficient risk knowledge, insurers do not tend to offer disaster insurance as they lack the means to estimate expected disaster losses, set premiums, and buy affordable re-insurance. In the modern context where risk knowledge is relatively high (especially in high-income countries), insurers can estimate expected losses relatively well, and are able to also assess risk at a spatially detailed level. Consequently, where risk-based premiums are employed, high risk knowledge means less cross-subsidization of the risk and high insurance costs for those exposed to high risk. In this way, either too little or too much risk knowledge can lead to a lack of private disaster insurance coverage and therefore the establishment of a PDI.

Jarzabkowski et al. (2023) link the creation of early PDI schemes (e.g., in France, Switzerland, New Zealand, and California) to too little risk knowledge and issues with availability, while the creation of more recent schemes (e.g., in the UK and Australia) is linked to more sophisticated risk modelling, and consequently affordability concerns for those facing high risk. In the UK, the premiums for high-risk households were kept affordable for a long time through an informal cross-subsidy as insurers' risk knowledge was insufficient to identify the spatial distribution of the risk. Technical advances and the resulting potential for the use of spatially informed risk-based premiums were a threat to this cross-subsidization, and consequently to insurance unaffordability for households facing high risk. In the early 2010s, the newly formed public insurer estimated that without it an 'insurance gap' will open, resulting from these technological advances (Charpentier et al., 2022), and flood insurance may become unaffordable for approximately 200,000 households (Flood Re, 2016).

Flood Re, the UK's PDI for flood risk, was established to address these affordability concerns and to slow down the transition to risk-based premiums, on the basis that a rapid transition would involve premium hikes which are not compensated by reductions in other

costs such as mortgages (Charpentier et al., 2022). Australia has encountered similar issues with disaster insurance affordability. The issue is most prevalent in Northern Australia, a region that is exposed to tropical cyclones, and where flood premiums are twice as expensive as compared with the rest of the country (ACCC, 2020; Paddam et al., 2022). A Cyclone Reinsurance Pool was established in 2022 to address these issues of insurance affordability and availability (Jarzabkowski et al., 2022a).

Alternatively, the growth of technical knowledge served as an enabling factor in countries such as the US and Turkey. In the US, the original proposals for a federal flood insurance system in the 1960s were largely based on the use of risk-based premiums, which were enabled by technical advances in risk mapping (Collier, 2014).² In Turkey, the establishment of a PDI after the 1999 earthquake may not have been possible without the advances in catastrophe modelling, the collection of large datasets, and advanced simulation techniques. These increased insurers' and reinsurers' confidence in risk estimates and contributed to enhanced insurability (Linnerooth-Bayer et al., 2011).

4. The PDI Establishment Process

A PDI scheme is typically established when the inadequacy of the existing disaster loss compensation system is recognized and perceived by government actors as an important issue that requires intervention. The process of PDI establishment can be divided into two phases: (1) early proposals, including discussions within the government and with other stakeholders, culminating with the passage of legislation; and (2) the initiation and implementation of the insurance scheme.

The specific details of PDI establishment and the length of this process differs across countries – from years to decades. In many cases, the insurance industry is heavily involved in the formative process. Some governments may also allow for participation of the wider public. For example, in Australia, following the announcement of the government's intention to create a reinsurance pool, the Reinsurance Pool Taskforce initiated several public consultations in which other stakeholders were able to voice their views and possibly influence the development of the scheme, by addressing questions and commenting on the draft legislation and regulations (Jarzabkowski et al., 2022a). In contrast, in Hungary, the details of the scheme were negotiated between the government and the insurance industry without much public input (Linnerooth, 2005).

4.1 Legislative proposals and studies

Typically, before any legislative proposal to establish a PDI is approved, there is a period when early proposals are made and the potential for PDI establishment is explored through feasibility studies or other types of assessments. The deliberations characteristic for this phase may involve negotiating the various details of the scheme including the potential sharing of liability between the government and the insurance industry. Also debated is what is insurable, the structure of premiums, the scheme's funding, the prevention of adverse

² Despite these proposals, in practice, the premiums ended up being cross-subsidised to avoid issues of unaffordability, and to deal with political constraints.

selection (possibly through mandates) and moral hazard (possibly through conditionality clauses), and other related topics. We summarise the proposals and discussions of these topics in the following subsections.

4.1.1 Early proposals

In Japan, a very early suggestion for a national compulsory insurance system which would also cover natural hazards was made in 1878 by a German economist invited by the Japanese government (Giroj, 2022). Later in 1933, private insurers resisted the government's efforts to require them to offer disaster cover, as this was only a decade after the catastrophic Tokyo earthquake. In 1948, a proposed government-sponsored earthquake insurance failed to gain approval for budgetary reasons, and because the government was unwilling to re-insure the scheme (Morimiya, 1984; Phaup and Kirschner, 2010). After the 1964 Niigata earthquake and public calls for the creation of an earthquake insurance system, the regulator of the insurance industry proposed that private insurers create and offer earthquake insurance to the public. The industry rejected this proposal because of the difficulties of obtaining sufficient reinsurance, and their consequent inability to set affordable rates. The next proposal involved a fully state-based scheme, after which the insurers agreed to compromise and create a public-private partnership with a goal of prioritising insurance affordability and loss mitigation and recovery, rather than a complete scheme providing full compensation for all losses (Takeda, 2004). The system that exists today still only provides partial coverage (Nguyen and Noy, 2020).

The issue of public disaster insurance was also raised early in the 20th century in Norway, but following several proposals, a committee appointed in 1918 to investigate the issue concluded that there was no basis for PDI establishment. A later committee in 1957 reached a similar conclusion, before the scheme was again recommended by a committee in the 1970s, and legislation establishing an insurance scheme was finally passed in 1979 (Consortseguros, n.d.).

In the US, national flood insurance has been repeatedly proposed since the 1950s, especially following several major floods. The scheme was initially conceived as a complement to the provision of government relief, but eventually as an alternative to it (Collier, 2014). It was apparent that private insurance cannot provide affordable rates due to the correlated risk inherent in the spatially extensive nature of fluvial floods, and the sector's inability (at the time) to quantify this risk accurately enough (Pasterick, 1998).

In 1956, the Federal Flood Insurance Act was passed with the intention of devising a federal flood insurance scheme. However, the resulting proposal for the scheme lacked the insurance industry's support and adequate technical studies specifying the potential liabilities to the government (Elliot, 2021). Consequently, congress refused to fund the scheme (Knowles and Kunreuther, 2014). The National Flood Insurance Program (NFIP) was finally established in 1968 with the passage of the National Flood Insurance Act, after a proposal was jointly agreed to and submitted by the federal government and the insurance industry (Gallardo, 1984; Pasterick, 1998).

In France, the initial considerations for the implementation of a public insurance program were put forward in the 1970s, but the project was abandoned until deliberations re-started in the early 1980s (Bidan, 2001). While these deliberations initially concerned a fully state-

based solution based on funding the existing relief fund by a tax imposed on insurance companies, the government eventually presented a draft law advocating a mixed system, involving both insurance companies and the public sector (Barry, 2024).

In Australia, a formation of a reinsurance pool supported by a government guarantee was recommended in a 2011 governmental report on flood insurance availability and affordability. However, the Northern Australia Insurance Premiums Taskforce established in 2015 did not endorse this report's conclusion and suggested that although a reinsurance pool could deliver premium reductions, the government would be assuming significant risk and entering an arrangement from which it may be unable to extricate itself in the future (AGT, 2021). In 2020, the Australian Competition and Consumer Commission concluded that the insurance affordability issues facing consumers would best be addressed by direct subsidies and that a formation of a government insurer/reinsurer (1) may not necessarily bring premium reductions without government subsidies and (2) cannot be justified based on availability concerns, as private insurers continue to supply insurance (ACCC, 2020). Despite this conclusion, the Australian government announced the formation of a cyclone reinsurance pool a year later.

In Italy, approximately 40 bills concerning proposals for a national insurance system against natural hazards have been proposed since the 1980s. Gizzi et al. (2021) identified two main barriers to the promulgation of these laws. The first barrier is related to the potential compulsory nature of the scheme. While large disaster damages and the resulting heavy burden on public funds resulted mostly in proposals based on a mandatory scheme, such mandatory insurance scheme was perceived as politically difficult.³ A mandate would be seen as an additional tax, in a reality of already high taxes. The second political barrier was related to the issue of illegal buildings, as it was proposed that the insurance system will provide only limited benefits for owners of illegal buildings. Eventually, a law mandating businesses to buy disaster insurance and establishing a public reinsurance scheme was passed at the end of 2023 (Tayel, 2024).

In the Netherlands, a PDI scheme has not been established, but several proposals for it have been made. The introduction of a public-private flood insurance was discussed between the government and the private insurers between 2006 and 2010. Similarly to Italy, the political support for PDI establishment appears to have been limited due to the compulsory nature of the proposed schemes, with the government ending the discussions on the basis that compulsory levies on insurance premiums were undesirable. A 2013 proposal by the Dutch insurance union to introduce a flood insurance pool was rejected by the Dutch government due to concerns about limiting competition in the insurance market (Surminski et al., 2015).

4.1.2 Feasibility studies

The potential for PDI establishment as well as the assessment of the scheme's optimal structure is often explored in more detail through government-authorised feasibility studies. In the US following Hurricane Betsy in 1965, The Southeast Hurricane Disaster Relief Act of

³ Providing information about high ex-post aid may increase support for a mandatory flood insurance scheme, which is perceived to be fairer compared to public aid (Garbarino et al., 2024).

1965 authorised a study exploring alternative means of aid provision and loss compensation. A year later, two governmental reports, one from the Task Force on Federal Flood Control Policy and the other from the Secretary of Housing and Urban Development, were published. While the former included broader assessments of floodplain use, Knowles and Kunreuther (2014) mention that the latter was described as a “less cautious advocacy for moving ahead with flood insurance” (p. 334). But while the reports made a case for insurance as a risk-reduction measure through the use of risk-based premiums, policymakers argued for broader relief based on the scheme’s compensatory role (Elliott, 2021). The recommendations made by these reports informed the congressional discussions on the authorisation of a federal flood insurance program soon thereafter.

In Turkey, feasibility studies were conducted both after the 1992 Erzincan earthquake and the 1998 Adana earthquake. After the catastrophic 1999 İzmit earthquake, the previously studied scheme was rapidly implemented (Yazici, 2005). In Taiwan, a major long-term research study of a comprehensive permanent disaster insurance scheme was initiated at the time of launching the Taiwan Residential Earthquake Insurance Pool (Walker, 2003).

Exploring the potential for PDI establishment often involved studying the existing PDI schemes in other countries. For example, the deliberations in the UK before FloodRE was established included analysing the CEA and NFIP from the US. In Turkey, CEA and New Zealand’s Earthquake Commission (EQC) were explored. In Romania, various European disaster insurance schemes were studied (Gavriltea, 2017).

4.1.3. Debating premiums

The use of risk-based premiums versus other pricing arrangements (e.g., a flat premium, typically set as a percentage of the insured value regardless of the risk associated with the insured asset) was frequently an important part of the discussions surrounding PDI establishment. In the US, the establishment of the NFIP was largely accompanied by a discourse about individual responsibility and the desire to use risk-based premiums (Barry, 2024). The experts advising the government on the scheme design (typically economists and floodplain geographers) were concerned that a failure to use risk-based premiums would incentivize moral hazard, where individuals may continue to move to and develop in hazardous areas as they would not have to pay the full cost of insuring the risk they are incurring. However, even though most of the proposals that were considered involved the use of risk-based premiums, the ultimate program that was implemented did not implement them. Premiums were uniformly set and kept far below actuarially fair levels for decades after the establishment of the scheme, so that the scheme ran very large deficits (Collier, 2013; Elliott, 2021).

In France, a proposal for the use of flat premiums was put forward, but the Senate argued for the use of risk-based premiums. Ultimately, the National Assembly ended up rejecting this proposed modification (Barry, 2024). Risk-based premiums were also considered for PDI established in the UK. However, the FloodRe scheme was established in part to avoid a rapid transition to such actuarially-accurate pricing that will create affordability issues for some homeowners in flood-prone areas (Kunreuther and Lyster, 2016). Thus, the eventual set up did not include risk-based pricing at all. In Australia, in contrast, premium subsidies were proposed but rejected on the grounds that subsidies would dull risk reduction incentives and

constitute only a short-term and potentially costly solution (AGT, 2021); though the system that was eventually instituted includes its own set of explicit and implicit subsidies and potentially substantial public liabilities. Generally, while experts almost universally advocate for risk-based premiums (sometimes accompanied by vouchers to overcome affordability concerns), the political legislative process frequently settles on flat premiums that are often unrelated to risk. Sometimes, the preferred solution is a halfway compromise between these two extremes, with some flattening of the premium-risk curve that involves only partial cross subsidisation from low-risk to high-risk asset owners.

4.2 Scheme creation

Once necessary legislation authorising PDI establishment is passed, the creation of PDI schemes involves many other regulatory and operational decisions, depending on many factors including the scheme's structure or the level of involvement of the insurance industry. In the cases where a new insurance/reinsurance institution needs to be established, these may include setting up governance and administrative structures, designing business and information systems, training staff, and conducting risk management and actuarial analyses. In many cases, the schemes make use of the existing insurance distribution networks and the task of distributing and administering the policies is delegated to private insurance companies, even if the full risk is still covered by the PDI.

As regards risk analysis, when sufficient risk information cannot be obtained from private insurers (e.g., when private insurance is not well established), PDI establishment may first require risk assessment and mapping on a large scale. In the US, the implementation of NFIP required local authorities to develop "flood insurance rate maps", which were to be used to establish which communities should be offered flood insurance and to calculate premiums for policyholders. However, this process turned out to be more difficult than anticipated, and resulted in delays as the local information needed to produce these maps was often not available, and the Federal Insurance Administration did not develop a rate-setting method to connect the newly obtained risk data to insurance pricing (Elliott, 2021).

Any PDI scheme funding represents another crucial consideration. The NFIP was funded through the National Flood Insurance Fund, which had authority to borrow from the US Treasury. There was no initial capitalization provided to the fund, and it consequently had to borrow often, even though the salaries of employees, as well as the costs of flood mapping and floodplain management, were initially paid by appropriation from Congress (Pasterick, 1998).

The CEA in California was initially capitalised by a combination of up-front cash paid by the participating insurers, post-event assessments on insurers and on CEA earthquake policyholders, reinsurance and borrowing in the capital market (Roth, 1998). The CEA has seen the first use of capital markets to back earthquake losses and the highest reinsurance commitment at the time of USD 2 billion (Roth, 1998). In Turkey, the government and the World Bank provided ex-ante funding to create a market, and the scheme initially relied on reinsurance and a contingent loan from the World Bank to fund its claims paying ability (Cummins and Mahul, 2008).

In some cases, PDI establishment involved cooperation with international organisations such as the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR), which provided technical assistance and funding. The World Bank was involved in PDI establishment in several countries including Turkey, Morocco, and Romania. In Turkey, the World Bank played a significant role providing financial assistance and coordinating technical support from catastrophe modelling and brokerage firms to help structure the scheme's premium, the scheme's underwriting and its risk management programs. The results from the catastrophe models and high-quality data on risk exposure were subsequently provided to the global reinsurance market, which helped the scheme to obtain reinsurance (Cummins and Mahul, 2008). These PDI programs in middle-income countries, however, did not replace private insurance cover before or after it retreated, but rather attempted to fill an insurance gap that has never been previously filled.

4.3 Implementation

Upon their establishment, some schemes (e.g., NFIP, California, Turkey, Algeria, Hungary) encountered a slow uptake in demand for their insurance policies, especially in the cases where the purchase of insurance by households or businesses was not required by law, the law was not enforceable or enforced, and where the premiums were perceived to be high. In the US, only the communities which conducted risk mapping and assessment were supposed to be admitted into the program, but as there were delays with risk mapping, the government launched an emergency program which removed this requirement in order to increase insurance uptake (Elliott, 2021; Knowles and Kunreuther, 2014). Despite this and low premiums rates, communities were slow to join the program and even within those communities who joined, few individuals purchased coverage. A 1973 legislative revision required properties receiving federally backed mortgages to maintain flood insurance helped to increase participation (Kunreuther and Lyster, 2016; Pasterick, 1998). Even that requirement, however, is typically only partially and sporadically enforced.

In Turkey, the insurance uptake was slow even though obtaining this insurance became compulsory in urban areas. The efforts to distribute the policies were slowed down by low public risk awareness, mistrust, and misinformation about the insurance. Furthermore, many insurance companies administering the policies had insufficient information on the scheme themselves. The government attempted to address this by launching public education campaigns (Gurenko, 2006).

In California, after the establishment of the CEA, many households cancelled their earthquake insurance policies due to high deductibles. A year after the scheme was established, only a half of the anticipated policies were underwritten (Kunreuther, 1999). Still today, only about 12% of homeowners purchase these policies. Similarly, in Algeria, the first post-establishment assessment revealed a low penetration rate of 4% for private dwellings and 8% for commercial and industrial properties (UNISDR, 2013). In Hungary, the uptake of insurance provided by the Wesselenyi Miklos Compensation Fund was too low to justify continuing its operations, and the fund, which began operating in 2003, was closed in 2016 as households' contributions were only able to cover operational costs (Palaria, 2019; Linnerooth, 2005).

Some schemes were associated with a somewhat higher uptake. The insurance system in Taiwan had experienced a steady growth since its establishment with household coverage of 30% achieved by 2012, 11 years after its establishment (Cheng, 2020). In some cases, the uptake increased following the occurrence of disaster events. Following Hurricane Andrew in 1992, this was the case for both the already existing Florida Windstorm Underwriting Association (FWUA) and the newly formed Florida Residential Property and Casualty Joint Underwriting Association (FRPCJUA). For the FWUA, the number of hurricane policies increased from 62,000 to 417,000 during the five years following the storm (Vellinga et al., 2001). The FRPCJUA initially sold policies with lower-than-actuarial rates, which led to overexposure and consequent attempts to reduce exposure by reducing uptake (CPCU, 1999).

Some PDI schemes were created only to serve a transitory purpose. The UK's FloodRe was devised ostensibly to smooth the transition to risk-based premiums, and once premiums are risk-based, it was assumed that flood insurance will again be provided primarily through private insurers. In Thailand, the scheme was designed to function for three years until reinsurers could re-assess their exposure and insurance could be fully provided by the private sector (Kunreuther and Lyster, 2016). Indeed, the Thai fund was terminated in 2017 as better reinsurance options became available and no additional major disasters occurred (UNDP, 2023a). There is cause for scepticism that FloodRE will also manage this transition back to private insurance

The Hawaiian Hurricane Relief Fund which provided hurricane insurance for homeowners following the 1992 Hurricane Iniki was also established as a temporary measure (FEMA, 2011). By 2000, private insurers in Hawai'i were mostly choosing to write their own policies and the fund stopped underwriting policies (Kousky, 2010); though as of 2024, the fund is still available to issue new policies should private insurers retreat from the market again.

Public insurers-of-last-resort were established in many states of the US mainly in the 1960s and 70s. Their operations were limited spatially rather than temporally, as these (re)insurance policies were initially available only in selected high-risk regions. Other regions became eventually eligible for coverage after further retreat of private insurers occurred in those states (Kousky, 2010). For example, the Texas Windstorm Insurance Association (TWIA) was originally created to provide coverage in designated areas of the Texas coast (TWIA, 2016). In North Carolina, The North Carolina Insurance Underwriting Association (NCIUA) was intended to cover only the North Carolina barrier islands (NCIUA, 2021). In Florida, the primary purpose of FWUA was to provide coverage for the Florida Keys. In all these cases, other areas became eligible for coverage in the following years (Lecomte and Gahagan, 1998; McChristian, 2012).

4.4 Changes in mitigation and government relief

PDI establishment often coincides with various legislative changes related to disaster management, the provision of post-disaster relief, land use zoning policies, or other areas of disaster risk management policy. All of these are intimately connected to the way a PDI will perform and the incentives (or disincentives) it will create.

In France, the establishment of the scheme was accompanied by changes in land use planning guidelines and an introduction of various associated risk reduction strategies (Sandberg et al., 2020). Local authorities were required to map their risk, which was intended to be used to limit construction in high-risk regions. As in other cases, however, the short-term benefits of urban development ended up being prioritized over long-term risk management, over minimizing the public fiscal liability for the PDI, and over other social and environmental considerations (Barraque, 2021). In the US, the provision of subsidized NFIP policies was made contingent on the communities adopting and enforcing floodplain management regulations (Pasterick, 1998).

Once a PDI is established, the rules for the provision of post-disaster government relief may also need to be adjusted to take the existence of the new scheme into account. This adjustment is relevant even for the uptake of the scheme, as generous provision of government aid can reduce the incentives to acquire insurance (Kraehnert et al., 2021). Indeed, in Algeria, where there is a lack of coordination between the disaster insurance scheme and the Fund for Natural Disasters and Major Risks through which disaster relief is provided, government relief is much more widely used than the insurance scheme (UNDP, 2023b). However, in most other countries, the provision of government relief was revised once a PDI was introduced. In Romania, the provision of post-disaster relief was removed for non-insured households and noncompliance with the compulsory insurance law is even punished by a fine (Simpson, 2018).

In Norway, the provision of government relief was preserved but revised so that the damage covered by the insurance scheme would not be eligible for compensation from the funding for relief (Bull, 2018). In the US, flood relief recipients are required to maintain flood insurance to receive any future assistance, which could explain why the provision of flood relief increases flood insurance enrolment (Bhattacharyya et al., 2024).

In Turkey, the government's responsibility to rebuild dwellings destroyed by disasters through subsidised loans was removed once the earthquake insurance scheme was put in place, but this change proved to be politically difficult to sustain. By 2006, the government had twice passed special earthquake assistance legislation enabling the provision of post-earthquake assistance to uninsured homeowners (Gurenko, 2006).

4.5 Length of the process

The length of the process of establishing PDI varies significantly across countries. Typically, it had taken at least several years and in some cases decades for the scheme to be established since it was first considered by the government. In the UK, the government and the insurance industry have been in a continuous dialogue about how to manage the growing flood losses for more than 15 years before the law establishing FloodRe was passed. The reinsurance pool in Australia was established 10 years after the measure was recommended in a governmental report. In Romania, it apparently took “many years” (p. 763) to decide on the scheme's structure (Gavriletea, 2017). In the US, President Truman first proposed national flood insurance 17 years before it was eventually established (Knowles and Kunreuther, 2014).

In some cases, however, the establishment and implementation of the scheme happened much faster, within months. In Turkey, the decree law which laid the legal foundation for the TCIP was passed just 4 months after the 1999 İzmit earthquake, and as PDI schemes had already been investigated in the preceding years, the scheme took 9 months to begin offering coverage (TCIP, 2011). In Iceland, a PDI bill entered force 5 months after a committee which was meant to propose a compulsory insurance scheme was appointed, and this happened just 10 days after a deadly avalanche event. The scheme was operational 4 months later (Island, n.d.). In Hawai'i, the Hurricane Relief Fund was formed in 1993, a year after Hurricane Iniki hit the island (FEMA, 2011).

5. Conclusions

This report has recorded some of the relevant steps in the often-occurring transition from a disaster response system that relies on a combination of private insurance and state assistance to one that relies (mostly) on public insurance. This transition occurred in many countries, and many of the processes involved were common to many of these transitions. The main motivation for this report was the realisation, not argued here, that the same dynamics of transition will occur in Aotearoa New Zealand for non-seismic risks. Indeed, many of the triggers that frequently initiate this process of transition have already occurred, including, unfortunately, a catastrophic set of disaster events. The unusual rainstorm in Auckland during its Anniversary Day, and two weeks later extra-tropical cyclone Gabrielle, both in early 2023, were responsible to an unprecedented damage. Each of these caused almost NZ\$ 2 billion in insured losses, while the costliest event up to 2023 was the extra-tropical storm that sunk the Wahine Ferry in 1968, and caused insured damages of 'only' about NZ\$ 0.2 billion of damage.⁴

Ultimately, the transition process to a Public Disaster Insurance (PDI) involves a continuous and continuing set of decisions that must be taken. At first, the failures and deficiencies of the current system are exposed, which then requires a decision to institute a PDI, and a decision whether to structure it as a government-owned entity or as a Private-Public Partnership.⁵

The process then requires a whole menu of decisions that are both shaped by considerations of the incentives they create, and the political realities in which they are being weighed. This process can take from months to decades, and requires periodic re-assessment even once a PDI has been running, as its weaknesses and strengths sometimes become apparent only over time.

Some of the topics that require analysis and need to be resolved, once the failures of the status quo become apparent, and a decision to set up a PDI has been taken, are:

⁴ These figures are all in 2024 NZ\$. The data is from: <https://www.icnz.org.nz/industry/cost-of-natural-disasters/>.

⁵ Here, we don't focus on this institutional detail (fully public or private-public partnership) because in almost all cases, even the PPP solution entails the government taking on most of the risk, while only operational responsibilities are allocated to the private insurers (this is the case, for example, in both the NFIP in the US and FloodRE in the UK).

1. **Risk Assessment.** Is risk assessment required to determine eligibility for the public scheme? How should it be done? How can risk assessment be completed accurately and on time, and by whom?
2. **Pricing Premiums:** Should premiums be set so that they reflect the true risk (risk-based pricing)? Should the owners be charged a flat fee? Some-combination of these two extreme positions? Should affordability concerns guide pricing? Should they dominate?
3. **Moral Hazard, Adverse Selection, and other behavioural dis-incentives:** How can the PDI minimize the risk of moral hazard (i.e., when risk reduction is dis-incentivized by the presence of insurance) and adverse selection (i.e., when only entities facing the highest risk choose to buy the insurance)? How can the PDI overcome other issues with decision making (such as short-horizon thinking, or herd behaviour).
4. **Financial Sustainability.** How can the set up ensure that the proposed PDI has sufficient funds to cover large-scale disasters from substantial reserves, available credit, or reinsurance arrangements? What happens if the system is not adequately funded?
5. **Equity and Accessibility.** How can the PDI ensure equitable access to affordable insurance? Should the PDI be addressing geographic (or other) disparities in risk exposure across different regions, groups, communities and peoples?
6. **Adaptability and Flexibility.** How can the PDI be set up so it can adapt to changing risks, especially within the context of anthropogenic climate change which is increasing frequency and severity of some natural hazards? How can the PDI be set up to continuously improve, and especially to enable modifications if deficiencies in the structure of the scheme becomes apparent?
7. **Political and Social Acceptance.** How can the scheme maintain social and political support (or at least a social license to continue its operations)? How can one ensure transparency in how the system operates, including how premiums are set, how funds are managed, and how claims are processed so that social acceptance does not deteriorate?
8. **Crisis Response and Recovery.** How can the PDI support an efficient claims settlement process that facilitates efficient and rapid response and recovery? How can the PDI ensure that recovery does not lead to re-establishment of already realised risks and instead promotes build-back-better outcomes.

These topics are analysed in detail in the companion report to this one.

6. References

- ACCC. (2020). Northern Australia Insurance Inquiry Final report. Australian Competition and Consumer Commission. Retrieved 12 April 2024 from <https://www.accc.gov.au/system/files/Northern%20Australia%20Insurance%20Inquiry%20-%20Final%20Report%20-%2030%20November%202020.pdf>
- AGT. (2021). Reinsurance pool for cyclones and related flood damage. Australian Government the Treasury. Retrieved 12 April 2024 from https://treasury.gov.au/sites/default/files/2021-05/c2021-175678_reinsurance_pool_cp.pdf
- AIR (2005). A Chronology of Major Events Affecting the National Flood Insurance Program. American Institute for Research. Retrieved 12 April 2024 from https://www.fema.gov/sites/default/files/2020-07/fema_nfip_eval_chronology.pdf
- Andor, Mark A., Daniel Osberghaus, Michael Simora, 2020, Natural Disasters and Governmental Aid: Is there a Charity Hazard? *Ecological Economics*, 169, 106534.
- Barry, L. (2024). The moral economies of natural disasters insurance: solidarity or individual responsibility? *Journal of Cultural Economy*, 17(1), 39–54.
- Başbuğ-Erkan, B. B., & Yilmaz, O. (2015). Successes and failures of compulsory risk mitigation: re-evaluating the Turkish Catastrophe Insurance Pool. *Disasters*, 39(4), 782–794.
- Bhattacharyya, A., Wang, H. H., & Hastak, M. (2024). Impact of post-disaster federal assistance on the national flood insurance program. *International Journal of Disaster Risk Reduction*, 102, 104290.
- Bidan P. (2001). Catastrophe Insurance in France: The Natural Disaster Compensation Scheme. NFT 4/2001. Retrieved 12 April 2024 from <https://nft.nu/en/catastrophe-insurance-france-natural-disaster-compensation-scheme> <https://nft.nu/sites/default/files/2001403.pdf>
- Botzen, W. J. (2021). Economics of Insurance Against Natural Disaster Risks. In *Oxford Research Encyclopedia of Environmental Science*. Oxford University Press. <https://doi.org/10.1093/acrefore/9780199389414.013.712>
- Bull, H. J. (2018). Natural damage Insurance: the Norwegian model. *Scandinavian Studies in Law*, 64, 46-55.
- Bulugea, M. (October, 2011). Natural Disaster Insurance Pool – PAID Review of the first year of activity. PAID. World Forum of Catastrophe Programs. Retrieved 12 April 2024 from https://www.ccrif.org/partnerships/WFCP/Sessions/Day2/Romania_PAID_WFCP_Meeting_Oct_2011.pdf
- Charpentier, A., Barry, L., & James, M. R. (2022). Insurance against natural catastrophes: balancing actuarial fairness and social solidarity. *The Geneva Papers on Risk and Insurance*, 47(1), 50-78.
- Cheng, W. C. (2020). Comparative Studies on the Similarities and Diversities of the Legislations Regarding Earthquake Insurance in Asia-Examples of Japan, New Zealand and Taiwan. *US-China Law Review*, 17, 225.

- Clark, G. B. (1966). The Hurricane Season of 1965. *Weatherwise*, 19(1), 12–22. <https://doi.org/10.1080/00431672.1966.9930501>
- Collier, S. J. (2014). Neoliberalism and Natural Disaster: Insurance as political technology of catastrophe. *Journal of Cultural Economy*, 7(3), 273–290.
- Consorteguros (n.d.). The Norwegian natural catastrophe compensation system in the past and the future. Consorteguros Digital Magazine. Retrieved 12 April 2024 from <https://www.consortegurosdigital.com/en/numero-02/front-page-02/the-norwegian-natural-catastrophe-compensation-system-in-the-past-and-the-future>
- Coutaz, G. (2018). Evolution of Disaster Risk Management in Taiwan. In: *Coping with Disaster Risk Management in Northeast Asia: Economic and Financial Preparedness in China, Taiwan, Japan and South Korea* (pp. 61–84). <https://doi.org/10.1108/978-1-78743-093-820181005>
- Crichton, D. (2002). UK and global insurance responses to flood hazard. *Water International*, 27(1), 119-131.
- Cummins, J. D., & Mahul, O. (2008). *Catastrophe Risk Financing in Developing Countries: Principles for Public Intervention*. World Bank, Washington DC. <https://doi.org/10.1596/978-0-8213-7736-9>.
- Elliott, R. (2021). Insurance and the temporality of climate ethics: Accounting for climate change in US flood insurance. *Economy and Society*, 50(2), 173-195.
- Faure, M., & Bruggeman, V. (2008). Catastrophic risks and first-party insurance. *Connecticut Insurance Law Journal*, 15, 1.
- Faure, M. G. (2016). In the aftermath of the disaster: Liability and compensation mechanisms as tools to reduce disaster risks. *Stanford Journal of International Law*, 52, 95.
- FEMA. (2011). *Hawaii Hurricane Relief Project Full Mitigation Best Practice Story*. Federal Emergency Management Agency. Retrieved 12 April 2024 from <https://www.fema.gov/ko/node/453545#:~:text=In%20response%20to%20this%20crisis,for%20approximately%20155%2C000%20policyholders%20statewide>.
- Garbarino, N., Möhrle, S., Neumeier, F., & von Schickfus, M. T. (2024). *Disaster aid and support for mandatory insurance: Evidence from a survey experiment*. CESifo Working Paper No. 406.
- Gavriletea, M. D. (2017). Catastrophe risk management in Romania and Transylvania' specifics. Issues for national and local administrations. *Economic research-Ekonomska istraživanja*, 30(1), 761-776.
- GFP. (2016). Morocco's National Catastrophe Risk Insurance Program. Green Finance Platform. Retrieved 11 April 2024 from <https://www.greenfinanceplatform.org/policies-and-regulations/moroccos-national-catastrophe-risk-insurance-program>
- GIROJ. (2022). Earthquake insurance in Japan. General Insurance Rating Organization of Japan. Retrieved 12 April 2024 from <https://www.giroj.or.jp/english/pdf/Earthquake.pdf>

Gizzi, F. T., Potenza, M. R., & Zotta, C. (2015). The insurance market of natural hazards for residential properties in Italy. *Open Journal of Earthquake Research*, 5(1), 35-61.

Gizzi, F. T., Porrini, D., & De Masi, F. (2021). Building a Natural Hazard Insurance System (NHIS): The Long-lasting Italian Case. *Sustainability*, 13(21), 12269.

Greene, M. R. (1972). The Spanish Insurance Industry: An Analysis. *Journal of Risk and Insurance*, 39(2), 221–243. <https://doi.org/10.2307/251882>

Gurenko, E.N. (2006) *Earthquake Insurance in Turkey: History of the Turkish catastrophe Insurance Pool*. World Bank.

Hartwig, R. P., & Wilkinson, C. (2016). *Residual market property plans: From markets of last resort to markets of first choice*. Insurance Information Institute.

Huber, M. (2004). Insurability and regulatory reform: Is the English flood insurance regime able to adapt to climate change?. *Geneva Papers on Risk and Insurance*, 29(2), 169-182.

Jaffee, D. M., & Russell, T. (1997). Catastrophe insurance, capital markets, and uninsurable risks. *Journal of Risk and Insurance*, 205-230.

Jarzabkowski, P., K. Chalkias, E. Cacciatori, R. Bednarek, (2018). *Between State and Market: Protection Gap Entities and Catastrophic Risk*. Cass Business School, City, University of London, 26th June 2018.

Jarzabkowski, P., Meissner, K., & Unger, C. (2022a). Australia's new Cyclone Reinsurance Pool: Implications for insurance in a climate changed future. *Australian Environment Review*, 37(3), 43-45.

Jarzabkowski, P., Cacciatori, E., Chalkias, K., Gallagher. (2022b). *Disaster Insurance in Switzerland: The Cantonal Public Sector Insurance System*. The University of Queensland, Australia.

Jarzabkowski, P., Chalkias, K., Cacciatori, E., & Bednarek, R. (2023). *Disaster insurance reimagined: Protection in a time of increasing risk*. Oxford University Press.

Jiang, Y., Y. Luo, and X. Xu. (2019). Flood insurance in China: Recommendations based on a comparative analysis of flood insurance in developed countries. *Environmental Earth Sciences* 78 (3): 1–11.

Jongejan, R., & Barrieu, P. (2008). Insuring large-scale floods in the Netherlands. *The Geneva Papers on Risk and Insurance*, 33, 250-268.

Kawachimaru, K. (2005). Disaster Risk Management in Japan. *Catastrophic Risks and Insurance*, 303-319.

Knowles, S. G. & Kunreuther, H. C. (2014). Troubled waters: the national flood insurance program in historical perspective. *Journal of Policy History* 26(3), 327–353. DOI: 10.1353/jph.2014.0017.

Kraehnert, K., Osberghaus, D., Hott, C., Habtemariam, L. T., Wätzold, F., Hecker, L. P., & Fluhrer, S. (2021). Insurance against extreme weather events: An overview. *Review of Economics*, 72(2), 71-95.

Kunreuther, H. (1999). Insurance as an integrating policy tool for disaster management; the role of public-private partnerships. *Earthquake Spectra*, 15(4), 725–745.

Kunreuther, H., & Lyster, R. (2016). The role of public and private insurance in reducing losses from extreme weather events and disasters, *Asia Pacific Journal of Environmental Law*, 19(1), 29-54.

Kusuma, Aditya, Cuong Nguyen, Ilan Noy (2019). “Insurance for Catastrophes: Why are Natural Hazards Underinsured, and Does It Matter?” In: Okuyama and Rose (eds.) *Advances in Spatial and Economic Modelling of Disaster Impacts* (2019, Springer), 43-70.

Lecomte, E., and K. Gahagan (1998). Hurricane insurance protection in Florida. In H. Kunreuther and R. Roth, Sr., eds., *Paying the Price: The Status and Role of Insurance against Natural Disasters in the United States*. Washington, DC: Joseph Henry Press, 97–124.

Linnerooth-Bayer, J., Vári, A., Mechler, R. (2005). Designing a Disaster Insurance Pool Participatory and Expert Approaches in Hungary and Turkey. *Catastrophic Risks and Insurance*, 267-290.

Linnerooth-Bayer, J., Mechler, R., & Hochrainer, S. (2011). Insurance against Losses from Natural Disasters in Developing Countries. Evidence, gaps and the way forward. *IDRiM Journal*, 1(1), 59-81.

Magnan, S. (1995). Catastrophe insurance system in France. *Geneva Papers on Risk and Insurance*, 474-480.

Marshall, D. (2018). An overview of the California Earthquake Authority. *Risk Management and Insurance Review* 21(1), 73–116.

McChristian, L. (2012). *Hurricane Andrew and insurance: The enduring impact of an historic storm*. Insurance Information Institute, 16. Retrieved 12 April 2024 from https://www.iii.org/sites/default/files/paper_HurricaneAndrew_final.pdf

Meyer, Robert, Howard Kunreuther 2017. *The Ostrich Paradox: Why We Underprepare for Disasters*. Wharton School Press.

Middleton, D. (2012). *Insurance shocks market behaviour and government responses: international case studies with relevance to New Zealand*. Earthquake Commission.

Morimiya, Y. (1984). Demand for natural disaster insurance. *Geneva Papers on Risk and Insurance*, 271-279.

Mysiak, J., & Pérez-Blanco, C. D. (2016). Partnerships for disaster risk insurance in the EU. *Natural Hazards and Earth System Sciences*, 16(11), 2403-2419.

NCIUA. (2021). *North Carolina Insurance Underwriting Association Coastal Property Insurance Pool Manual of Rules and Procedures*. North Carolina Insurance Underwriting Association. Retrieved 12 April 2024 from <https://pdf4pro.com/cdn/north-carolina-insurance-underwriting-association-8b0cb.pdf>

Nguyen, C., I. Noy (2020). Comparing Earthquake Insurance Programs: How Would Japan and California Have Fared After the 2010-2011 Earthquakes in New Zealand? *Disasters* 44(2), 367-389.

- OECD. (2015). *Disaster Risk Financing: A global survey of practices and challenges*. OECD, Paris. Retrieved 12 April from <http://dx.doi.org/10.1787/9789264234246-en>
- Orie, M., & Stahel, W. R. (Eds.). (2013). *Insurers' Contributions to Disaster Reduction: A Series of Case Studies*. Geneva Association. https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public/ga-2013-geneva_report-7.pdf
- Paddam, S., Liu, C., & Philip, S. (2022). *Home insurance affordability and socioeconomic equity in a changing climate*, Actuaries Institute, August 2022. Accessed online at <https://actuaries.logicaldoc.cloud/download-ticket?ticketId=38cecc1c-68e2-4433-8822-58cd3d0ccf42>.
- Parodi, A., Chiumento, A., Mandala, A. (2023). *Italy's insurance holes expose state finances to disasters*. Reuters. Retrieved 10 April 2024 from <https://www.reuters.com/business/finance/italys-insurance-holes-expose-state-finances-disasters-2023-06-29/>
- Pasterick, E., T. (1998). The National Flood Insurance Program In: H. Kunreuther, and R. Roth, Sr., eds., *Paying the Price: The Status and Role of Insurance against Natural Disasters in the United States*. Washington, DC: Joseph Henry Press, 125-154.
- Paudel, Y. (2012). A comparative study of public—private catastrophe insurance systems: lessons from current practices. *Geneva Papers on Risk and Insurance*, 37(2), 257-285.
- Perazzini, S., Gnecco, G., & Pammolli, F. (2024). A public—private insurance model for disaster risk management: an application to Italy. *Italian Economic Journal*, 10(1), 225-267.
- Pompe, J. J., & Rinehart, J. R. (2008). Property Insurance for Coastal Residents: Governments' Ill Wind". *The Independent Review*, 13(2), 189-207.
- Raschky, P. A., & Weck-Hannemann, H. (2007). Charity hazard—A real hazard to natural disaster insurance? *Environmental Hazards*, 7(4), 321–329.
- Roth, R., J., Jr. (1998). Earthquake insurance protection in California. In H. Kunreuther and R. Roth, Sr., eds., *Paying the Price: The Status and Role of Insurance against Natural Disasters in the United States*. Washington, DC: Joseph Henry Press, 67-
- Sandberg, E., Økland, A., & Tyholt, L. (2020). Natural perils insurance and compensation arrangements in six countries. KLIMA 2050 Report #21. <https://hdl.handle.net/11250/2659936>
- Schwarze, R., Schwindt, M., Weck-Hannemann, H., Raschky, P., Zahn, F., & Wagner, G. G. (2011). Natural hazard insurance in Europe: tailored responses to climate change are needed. *Environmental Policy and Governance*, 21(1), 14-30.
- Shiue, CH. (2004). Local Granaries and Central Government Disaster Relief: Moral Hazard and Intergovernmental Finance in Eighteenth- and Nineteenth-Century China. *Journal of Economic History* 64(1):100-124.
- Storey, Belinda, Ilan Noy (2017). Insuring property under climate change. *Policy Quarterly* 13(4)
- Storey, Belinda, Ilan Noy, Sally Owen, Wilbur Townsend, Suzi Kerr, Rhian Salmon, David Middleton, Olga Filippova, and Vanessa James (2017). *Insurance, Housing and Climate*

Adaptation: Current Knowledge and Future Research. *Motu Note #27*. Motu Economic and Public Policy Research.

Storey, B., Owen, S., Zammit, C. et al. (2024). Insurance retreat in residential properties from future sea level rise in Aotearoa New Zealand. *Climatic Change* 177, 44.

Surminski, S., Aerts, J. C., Botzen, W. J., Hudson, P., Mysiak, J., & Pérez-Blanco, C. D. (2015). Reflections on the current debate on how to link flood insurance and disaster risk reduction in the European Union. *Natural Hazards*, 79, 1451-1479.

Swiss Re. (2021). *The world's costliest flood: the 2011 Thailand flood 10 years on*. Swiss Re Institute. Retrieved 12 April 2024 from <https://www.swissre.com/dam/jcr:18bd73c2-4bf1-4e47-91b3-c3bb7c5c96e3/EI-21-2021-thailand-10year-anniversary.pdf>

Swiss Re. (2024). New record of 142 natural catastrophes accumulates to USD 108 billion insured losses in 2023, finds Swiss Re Institute. Accessed 25 June 2024 from <https://www.swissre.com/press-release/New-record-of-142-natural-catastrophes-accumulates-to-USD-108-billion-insured-losses-in-2023-finds-Swiss-Re-Institute/a2512914-6d3a-492e-a190-aac37feca15b>

Tayel, Karin. (2024). Insurers' Duty to Contract Mandatory Catastrophic Insurance. <https://www.dlapiper.com/en-au/insights/publications/derisk-newsletter/2024/mandatory-catastrophe-insurance-insurers-duty-to-contract>.

TCIP. (2011). *The Turkish Catastrophe Insurance Pool: Compulsory Earthquake Insurance Annual Report 2011*. Retrieved 12 April 2024 from https://www.dask.gov.tr/upload/Dask/Raporlar/Faaliyetraporlari/Ing%20Faaliyet%20Raporlar/2011_Annual_Report_TCIP.pdf

TWIA. (2016). *Texas Windstorm Insurance Association Media Briefing Book*. Texas Windstorm Insurance Association. Retrieved 12 April 2024 from <https://www.twia.org/wp-content/uploads/2016/01/Media-Briefing-Book-01.27.2016.pdf>

UNDP. (2023a). *Inclusive insurance and risk financing in Thailand*. Retrieved 12 April 2024 from <https://www.undp.org/sites/g/files/zskgke326/files/2023-03/Thailand%20insurance%20diagnostics%20summary.pdf>

UNDP. (2023b). *Inclusive insurance and risk financing in Algeria*. Retrieved 12 April 2024 from <https://irff.undp.org/sites/default/files/2024-01/undp-irff-diagnostic-algeria.pdf>

UNISDR. (2013). *Making Algeria Resilient Achieving Disaster Risk Reduction in the Arab States*. The United Nations Office for Disaster Risk Reduction. Retrieved 12 April 2024 from https://www.preventionweb.net/files/32443_unisdralgeriafinal.pdf

Waters, L., Best, K., Miao, Q., Davlasheridze, M., & Reilly, A. C. (2024). Under-reported and under-served: disparities in US disaster federal aid-to-damage ratios after hurricanes. *International Journal of Disaster Risk Reduction*, 106, 104430.

World Bank. (2011). *The World Bank Supports Thailand's Post-Floods Recovery Effort*. Retrieved 12 April 2024 from <https://www.worldbank.org/en/news/feature/2011/12/13/world-bank-supports-thailands-post-floods-recovery-effort>

Yazici, S. (2005). The Turkish Catastrophe Insurance Pool (TCIP) and Compulsory Earthquake Insurance Scheme. *Policy Issues in Insurance Catastrophic Risks and Insurance*, (8), 349.

Yoneyama, T. (2009). The great Kanto earthquake and the response of insurance companies: a historical lesson on the impact of a major disaster. *Hitotsubashi Journal of Commerce and Management*, 43(1), 11-26.

Appendix

Workshop on Private to Public Insurance Transition

Date Held: Tuesday, 3.9.2024

Workshop leaders: Ilan Noy, Toni Collins, Olga Filippova, John Hopkins, Sally Owen, Ceridwyn Roberts, and Belinda Storey.

Taking notes: Tomáš Uher

The workshop held during the QuakeCoRE Annual Meeting in Napier in September 2024 focussed on several dimensions of the challenges inherent in the transition from a private insurance system (whereby the risk from natural hazards is covered by private insurance contracts purchased in a largely unregulated market) to a public system (whereby the risk is covered by insurance policies issued or supported by a public entity owned by the government).

The aim of this workshop was to identify some of the pitfalls inherent in this transition and suggest ways in which some of these identified challenges can be met. What follows below is not a faithful transliteration of the discussion in the workshop, but a summary of some of the main ideas and suggestions that emerged out of the discussions that took place.

About 40 people signed up and attended the 3-hour workshop; all were attendees of the QuakeCoRE Annual Meeting, and included post-graduate students, academic and industry researchers, policymakers, and professionals with work experiences that are related to the issues discussed.

The text below is divided into sections, each one of them representing a theme that repeatedly was mentioned during the workshop.

Scheme design and communication

Given the size of Aotearoa's disaster insurance market, public disaster insurance (PDI) scheme should be implemented at the national level, rather than separately across regions, to achieve sufficient levels of risk pooling and diversification. A scheme focussed only on high-risk areas will not be able to pool risk adequately, and will need to be constantly adjusted as the patterns of risk change and new risks get exposed.

However, community engagement during PDI development is necessary to ensure that the policies are customized to the specific needs and priorities of affected communities; especially as the required solution has to be of a one-size-fits-all

design. Therefore, the scheme transparency is even more crucial, as it can greatly impact the public's trust, the scheme's effectiveness, and its overall success.

The design of the PDI should account for the unique characteristics of differing hazards and associated risk management practices, as well as the differences between urban and rural populations (e.g., the potential implications of the different per capita infrastructure costs).

Insurance policies should not be limited to only covering the actual damage caused but should allow for and incentivise "Build Back Better" options, potentially employing designs that facilitate quick future recoveries. Examples of "Build Back Better" disaster insurance mechanisms can be found in Australia, in the US (e.g., storm policies in North Carolina allowing for endorsements in the form of strengthening the roof), or in the UK (Flood Re). Where appropriate, insurance policies should also support relocation (e.g., when and where the risk level is deemed too high).

As both these options (Build Back Better, and 'managed relocations') may lead to higher costs, implementation of mechanisms to provide support to the PDI, and increase the financial viability of these options in affected communities should be considered.

Claims management represents another important consideration. The system should be able to process claims and provide payouts in a timely manner even following major events with many damage claims. The pros and cons of delegating claims management to the private sector versus leaving it in the remit of the public insurer must be carefully weighed. The issue of slow disbursement of insurance claim payouts leading to adverse outcomes following the Canterbury earthquakes was mentioned repeatedly. In this context, the possibility of utilising lump sum payments based on house size or other factors would need to be explored (something similar is implemented in Japan by the local public insurer).

As regards government communication on PDI implementation, it was stressed that the information provided to different parties (e.g., the public, central and local governments, private insurers, other private actors) must be consistent. All relevant stakeholders need to understand the scheme as regards its purpose, design and structure. This will help to align expectations and reduce misunderstandings, thereby enhancing trust and cooperation between insurer and insureds.

Risk Assessment

What kinds of properties will be covered? Is risk assessment required to determine eligibility for the public scheme? How should it be done? By whom? What risk thresholds should be used?

Workshop output

The group highlighted that risk assessment (RA) should cover all hazards (both acute and chronic), including indirect risks (e.g., reduced property access due to transport infrastructure damage), and be consistent and objective (free of any biases or incentives to adjust risk). The RA processes should iterate, be periodically updated, and involve direct reporting to the organisation managing the PDI.

Assessments should be conducted using a unified national methodology, though the PDI could consider allowing local governments to set risk thresholds (for purposes such as determining insurance eligibility or pricing) locally. This, however, needs to be done in incentive-compatible way so that local governments have no incentive to set thresholds that are 'too high' or 'too low'. Such incentive-compatibility may not be easy to achieve.

The RA will likely need to be carried out by a multitude of actors, including modellers, and technical experts from national and local government agencies, scientific and research institutions, and private sector consultancies.

The RA outputs should be publicly available to all parties, considered at various levels (e.g., property, community, region), and be reliable enough so they can influence land use planning. As RA outputs are made publicly available, implications of such a decision (e.g., on homeowners or property values) need to be carefully assessed. Apart from assessment of the current risk levels, likely future risk changes should be considered, with a moderately long horizon (several decades).

Scheme eligibility rules need to be devised so that they disincentivize poor land use planning decisions, and eligibility should ideally be determined early in the building cycle (e.g., pre-consent). The group found it difficult to determine eligibility requirements for existing properties, but noted potential grandfathering issues, which may arise from the provision of premium discounts for older buildings or from exempting older buildings from new rules and regulations in general. Such decisions could lead to increased financial strain on the insurance scheme, reduce incentives for risk mitigation, and lead to other adverse outcomes. However, eligibility rules also need to include ethical and equity considerations, which may involve some level of grandfathering.

Pricing Premiums

Should premiums be set so that they reflect the true risk (risk-based pricing)? Should property owners be charged a flat fee? Some-combination of these two extreme positions (i.e., community pricing)? Should affordability concerns guide pricing? Should they dominate?

Workshop output

The group noted that premium levels need to be determined in combination with the level of provided coverage. The implications of different pricing strategies (e.g., risk-based premiums without subsidies, risk-based premiums with some level of needs-based subsidies, flat premiums, community pricing) need to be carefully assessed with respect to the scheme's sustainability, affordability, distributional effects (especially through impacts on housing prices), and fairness. It is essential to understand the impacts on different groups and assess which communities may face significantly higher premiums and determine their capacity to absorb these added costs.

The group emphasized that insurance pricing strategies should also acknowledge social risk alongside the risk from physical hazards. This social risk (an externality) may lead vulnerable groups to being disproportionately impacted by the cost of insurance. The idea of paying premiums through property rates, rather than through a separate insurance contract, was raised as well.

As regards subsidy provision, the group suggested that disaster insurance should be perceived as a product with wide societal benefits (significant positive externalities), for which a certain level of government subsidisation may be desirable, highlighting the importance of solidarity and risk sharing principles. Government subsidy, or a guarantee provision of the cover were also deemed necessary by the group based on the likely future increases in risk due to climate change. However, the subsidy levels and structure need to be designed carefully to achieve a balance between considerations of equity, financial sustainability, and incentivisation of risk reduction.

Other equity factors, such as the risk of property owners not passing their subsidy-related cost reductions to tenants, also need to be considered. To ensure subsidies are provided where they are most needed, subsidy provision could be based on insureds' income levels or other relevant need-based metrics. A voucher system could represent a potential method of premium subsidy provision, with vouchers available after a needs assessment. This, however, may complicate the insurance product, and may conflict with a desire to achieve universal coverage.

Support for vulnerable groups could also be provided externally to insurance (e.g., through existing benefits and social safety net systems). Some participants questioned whether premium subsidies should be offered to businesses whose wider public benefits are perceived to be quite limited.

The level of subsidy transparency to the property owner and other parties also needs to be considered. A direct (and transparent) subsidy was deemed optimal. Its benefits may include higher financial stability (a consequence of risk reduction over time), scheme flexibility (the premium can be adjusted with the changing risk levels), and a sustained role for private insurers to continue operations. The informational value of transparent subsidies as relates to incentivising risk-informed decisions was highlighted. However, the group cautioned that a transparent subsidy may represent political risk, as it may not receive support from the public or its representatives if it is perceived to be very high. While a certain level of premium subsidies could be attractive initially, it could eventually lose public and political support, especially if the subsidy levels keep increasing over time. The indirect subsidy option, in which a government guarantee for catastrophic events is provided (i.e., most of the subsidy is not transparent), could also be considered.

As regards the use of risk-based versus flat premiums, the group advocated for the use of flat premiums and highlighted their benefits with respect to equity considerations. However, flat premiums may face opposition from the owners of low-risk properties, as these would in practice be cross-subsidising the owners of high-risk properties (which is also the current case of insurance provided by the Natural Hazards Commission). The use of risk-based premiums was advocated for by the another group in the context of addressing the risk of moral hazard. Such a pricing strategy should possibly be implemented gradually and over time to alleviate affordability concerns; though other jurisdictions found it politically very difficult to implement such a gradual change (with strong political incentives to 'kick the can down the road' to some future date).

Providing premium reductions or subsidies even before risk reduction measures are fully implemented may lower the immediate cost burden for policyholders and therefore promote faster adoption of such strategies.

Mandates and Adverse Selection

How can the scheme minimize the risk of adverse selection (i.e., when only entities facing the highest risk choose to buy insurance)? How can the scheme overcome

other issues with decision making (such as short-term thinking, or herd behaviour)? Should the insurance be mandated only for properties with mortgages?

Workshop output

The group proposed that the risk of adverse selection can be addressed by making insurance coverage mandatory. The participants noted that proposals for a mandatory scheme may face uncertain political support, presenting potential barriers to implementation, and acknowledged that a long-term cross-party support may be required for successful operation of PDI. Adverse selection risk could also be mitigated through the utilisation of risk-based pricing, as the premiums for low-risk properties may be low enough to not represent a barrier for insurance adoption for homeowners. Clear and effective communication from the government would play an important role in increasing the likelihood that such a strategy addresses adverse selection risk effectively.

It was also recommended that if disaster insurance is offered by both public and private insurers, care should be taken to prevent an imbalance where the private insurers primarily cover low-risk properties, leaving high-risk properties disproportionately concentrated in the portfolio of the public insurer. This could be facilitated through mandating that private insurers' portfolios include a certain fraction of high-risk properties or limiting the provision of insurance for some perils solely to the public insurer.

Moral Hazard

How can the scheme minimize the risk of moral hazard (i.e., when risk reduction is dis-incentivized by the presence of insurance)? Can the scheme prevent new construction in high-risk areas? Can it incentivise retrofitting of existing buildings?

Workshop output

The group highlighted the need to change the public's attitude towards disaster risk and the importance of incentivising risk reduction for individuals, businesses and communities. This attitude shift could be partly achieved through increased efforts in public education and communication on disaster risk, which would enhance the public's understanding of the hazards they face, as well as the importance of risk mitigation and taking proactive measures. An example may be specific knowledge kits developed by regional emergency management offices. The efficacy of public

education campaigns, however, will need to be assessed, and exclusive reliance on them is probably unwarranted.

Risk reduction incentives should be provided through both insurance-related mechanisms, such as premium discounts or conditionality attached to insurance coverage, or through other systems (e.g., property rates discounts).

Other insurance-related mechanisms for incentivising risk reduction and addressing the risk of moral hazard associated with insurance provision should also be considered. For example, coverage could be adjusted on several dimensions and based on appropriate risk reduction investments (e.g., risk-based excess levels or caps on the amount covered).

Equity and Accessibility

How can the scheme ensure equitable access to affordable insurance? Should the scheme address geographic (or other) disparities in risk exposure across different regions, groups, communities and peoples?

Workshop output

The group highlighted the importance of using inclusive approaches within the Natural Hazards Commission and other organisations responsible for designing and implementing the PDI. The PDI scheme should be inclusive not only to the owners of property, but should also provide support and coverage for renters (especially temporary renters/workers) possibly through the provision of contents insurance.

The group highlighted that a PDI should address the issue of low disaster insurance coverage for marae and possibly other types of community assets (e.g., faith-based buildings such as churches). This could be done through the development of a marae-specific insurance product (or an insurance product for community assets more broadly). Such a product should primarily seek to address the challenges faced by marae located in high-risk areas. The design, implementation and operation of such a scheme should involve engagement with hapu and iwi leadership.

The existence of several Māori insurance initiatives was noted. The participants emphasized that while maraes are often located in hazard-prone areas, marae relocation is complicated due to community ties to the land on which they are built and the restrictions on land titles in the rohe. Many marae were established on sites that became available post colonisation, after original locations became untenable. Any approaches encouraging marae relocation or implementing changes which

could prompt such moves should be approached with caution so as not to exacerbate the legacy of land loss and disconnection from cultural heritage.

The group also pointed out several issues related to disaster insurance for property contents, including the lack of coverage (currently maybe only around 50%; though data is not really available), high insurance complexity, price fluctuations, and difficult access. The group advocated for a tier-based contents insurance system which would aim primarily to enable and speed up recovery, and cover the contents value based on select property characteristics (e.g., house size), reducing the need for maintaining inventories and only covering 'basic' needs. Payouts could be provided based on a proof of need.

It was noted that the issues associated with insuring intangible assets (taonga) could be addressed through technological solutions such as digital heritage since their financial value is not a reflection of their value to their communities.

Other parts of the system

What does the establishment of the scheme mean for other parts of the risk management system? Should it require other modifications to the system? To resource management and planning, to banking, or to private insurance?

Workshop output

It was proposed that the insurance claim management system must be scalable to deal with catastrophic events and incorporate comprehensive and proactive planning. It was also stressed that the general aim of risk reduction efforts should not be the full elimination of risk, which may be impractical and highly cost-ineffective, but rather its reduction to manageable levels.

The group pointed out the distinct perspectives and approaches to disaster risk management between the central and local governments and suggested that a fundamental shift of central and local government dynamics may be needed to enhance risk reduction outcomes. This would concern addressing issues such as the tension between the central and local governments, mismatches between objectives of different departments ministries (e.g., densification of urban areas versus risk reduction), and departments' tendency to pursue primarily their own objectives.

An overarching whole-of-government disaster risk management policy may be required to improve coordination and enable more effective implementation of risk reduction measures, including the provision of public insurance. Such policy could

elevate the importance of risk reduction and climate adaptation within the government so that all departments must integrate these priorities into their planning and decision-making processes. Interdepartmental coordination could also be enhanced through strategic networking initiatives.

PDI should represent a component of a comprehensive risk management strategy and be effectively integrated within it. This integration would ensure that insurance policies do not serve solely as a post-event financial recovery mechanism, but also support other risk management measures and vice versa. The importance of coordinating PDI (as well as risk management more generally) with land use planning was emphasized. The potential problems which may arise from the distinct decision-making timeframes used by insurers and land use planners need to be assessed and addressed.

As regards the implications of PDI establishment on risk reduction activities, the group highlighted that they may vary depending on how responsibility for scheme implementation and management is assigned at different levels of the government (e.g., central and local) and within government departments. Delegating scheme management to the central government could incentivise the relevant departments to emphasise risk reduction and climate adaptation, and represent an opportunity to centralise these efforts, possibly enabling more efficient coordination. However, higher centralisation could face opposition from the public and local governments. It was recommended that certain aspects of scheme management should be assigned to local governments, which could enhance coordination between the scheme and other local government activities important for risk reduction such as land zoning, leading to improved risk reduction outcomes. The delegation of responsibilities between the central and local governments could adhere to the “nationally led, locally decided” principle.