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Title:

Insurance options in a climate changed future: The way forward for urban climate policy and practice

Short Title:

Insurance options in a climate changed future

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Abstract

Disaster insurance is central to how cities respond and adapt to climate change because insurance releases global capital to pay for local recovery and reconstruction in the aftermath of extreme weather disasters. Yet, rather than supporting climate adaptation, insurance markets appear to be retreating in the face of climate change, with many cities facing unaffordable and unavailable disaster insurance. Loss of insurance has devastating effects on cities, given its crucial role in social, business, and financial systems, providing a critical safety net for many, and supporting other important economic functions, such as mortgages and lending. This paper explains why cities and regions that are highly exposed to climate risk have become uninsurable and maps potential insurance options for urban policymakers. While there is no simple solution for declining insurance affordability and availability, we map two potential options; a risk pool, legislated by government to subsidize insurance for those who are uninsurable in the private sector, and a private-sector individual property parametric product to support a post-disaster cash injection. These two options have precedent and could, therefore, improve the insurability of people in climate-exposed cities. However, policymakers need to be aware that these options must be accompanied by risk reduction strategies. We conclude with two final thoughts for policy makers and city authorities about insurability during a time of changing climate. Firstly, investing in programs to embed risk management capabilities is necessary to support individuals and communities to live with increased risk exposure and act upon either of the above insurance options. Secondly, addressing the insurance crisis is critical to avoid the growing problem of uninsurability for those at high risk, which will widen inequality and potentially lead to unplanned climate migration for climate-exposed cities.

Keywords

Insurance, insurance crisis, insurance protection gap, insurance risk pools, climate-exposed cities, parametric insurance, disaster risk reduction

Summary for Policymakers

Addressing the insurance crisis is a priority for governments wanting to maintain strong urban economies. As there is no simple solution for the complex problem of uninsurability in

high-risk urban areas, we propose broadening the insurance ecosystem for countries in which insurance is predominantly private sector to incorporate both government-legislated risk pooling and individual parametric insurance for businesses. These two options should be used in tandem, and together with a long-term comprehensive data collection and risk reduction program:

- **Government-legislated risk pool.** Government-legislated risk pools are typically not-for-profit insurance schemes to provide traditional indemnity-based insurance to policyholders who would otherwise struggle to access or afford it in the private market. By covering multiple types of weather disasters, and being compulsory across a population, risk pools can reduce premium costs, build a large pool of insured policyholders from whom to collect premiums, and cover the losses to each of these policyholders from all the main perils affecting a country. Such pools will support insurability of residents and small businesses in climate-exposed cities and urban policymakers can also draw from risk pool data to support urban planning and development.
- **Parametric insurance.** Parametric insurance is triggered by a disaster – such as a flood at a certain height, or wind at a certain speed – rather than by a loss. Typically, it pays a pre-agreed amount when the trigger is met, often within hours or days of the event. It is thus different to indemnity-based insurance since it does not pay to reconstruct specific damages to a property but rather provides rapid cash to the policyholder to spend as they see fit for their post-disaster needs. Parametric insurance holds potential as a private sector option for businesses, that urban policymakers can also consider as supplements to, or even substitutes for government-based disaster relief payments.

Introduction: An insurance crisis

The disaster insurance market is central to how cities respond and adapt to climate change (Bulkeley, 2013; Knuth & Taylor, 2016). This is because insurance releases global capital to pay for local recovery and reconstruction in the aftermath of extreme weather disasters (Collier & Cox, 2021; Collier et al., 2021). Yet, rather than supporting climate adaptation, private sector insurance markets appear to be retreating in the face of climate change, with

many communities facing unaffordable and unavailable disaster insurance (Jarzabkowski et al., 2023; Taylor, 2020). For example, insurance is increasingly unaffordable¹ or unavailable² in disaster-prone areas such as for wildfire in California, hurricane in Florida, and hailstorms in the Midwest and Great Plains (Bittle, 2024b; Gall, 2023; Sellers, 2023), with escalating insurance costs in many hitherto stable insurance markets, such as Australia, Canada and the UK (Di Sabatino, 2023; Gausden, 2019).

While some countries, such as the USA, Switzerland, Spain and France, have embraced various public-sector disaster insurance schemes that, while they often attract criticisms³ (Kousky, 2022), can counter the problem of uninsurability, others rely on private-sector insurance to protect their citizens (Collier & Cox, 2021). Yet, private-sector disaster insurance appears to be in crisis due to escalating premium prices and increasingly limited availability, (Collier et al., 2021; Jarzabkowski et al., 2023). This insurance crisis causes significant social and economic problems even before disaster strikes because in advanced economies insurance is taken-for-granted (Elliott, 2021) and underpins home ownership, lending, and project financing (Grant, 2012). Without insurance, cities will be slower to recover from disaster, local real estate markets and businesses will lose value, and displaced residents will lose employment and social networks (Lee & Evans, 2020; Taylor, 2020).

This paper reports on our research into Australian cities and regions already known to be at high-risk of flood, that suffered devastating losses during the 2022 floods. We explain why these areas of Australia are no longer insurable. Australian cities and regions provide a useful context to consider insurance options given Australia's vulnerability to climate impacts (Hutley et al., 2022), high levels of household debt (Breibach et al., 2019), and as

¹ As unaffordable is a relative concept, studies propose that affordability be calculated as a percentage of household income (Kousky & Kunreuther, 2014). The Actuaries Institute of Australia calculates 'extreme insurance stress' as a premium costing four or more weeks of gross household income (Paddam et al, 2023). Such prices are an indicator that a property is no longer feasibly insurable in the private sector..

² Another indicator is when private sector insurance policies are not offered in areas of high risk, generating an availability problem (Mills et al., 2005). For the purposes of this paper, we therefore define properties that face unaffordable or unavailable premiums as uninsurable within the private market (Jarzabkowski et al., 2023).

³ Public-sector disaster insurance schemes have been criticized for suppressing premium prices and thus enabling people to a) remain or build, in high-risk locations, and b) fail to undertake risk-mitigation measures (Baker, 2000).

one of the least insured advanced economies (Fan, 2016). In 2024, 15% of Australian households faced extreme levels of insurance stress, paying as much as seven weeks of pre-tax income in annual premiums (Paddam et al., 2024). Already one-in-20 Australians have cancelled their property insurance because they could no longer afford the premium (Bradshaw et al., 2023). The problem is exacerbated for households and businesses in Australia's flood-prone towns and regions (Paddam et al., 2023). Yet, Australia has no government-based or public-private insurance scheme to address the problem of flood uninsurability. Furthermore, simply developing such a scheme will not, on its own, necessarily provide a solution. The uninsurability problem faced by Australian cities is increasingly a problem for many countries, even those with government-based insurance schemes. City councils and local governments need to understand why flood prone areas are uninsurable in the private sector and the limitations involved in proposing a public-sector insurance scheme (Elliott, 2021; Jarzabkowski et al., 2023), to review their options for alternative means of disaster protection. That is the purpose of this paper.

Loss of insurance has devastating effects on cities, given its crucial role in social, business and financial systems, providing a critical safety net for many and enabling other important economic functions, such as mortgages and lending (Grant, 2012; Hecht, 2007). Home ownership accounts for half of household wealth in Australia and is one of the most important aspects of stability, well-being, and social integration through employment, schooling and family connection (Trounson, 2020). Landlords, unable to access insurance, will also struggle to participate in a robust residential rental market, yet one in three householders in Australia are renters (Australian Bureau of Statistics, 2022) with rental markets central to affordable urban living (Perucca et al., 2023). Without insurance, businesses also will have their credit and growth compromised; both businesses that own their properties and businesses that rent from commercial landlords (Taylor, 2020). These features of ensuring home ownership, robust rental markets, and business credit and growth are not unique to Australia but relevant to most cities.

Addressing the insurance crisis is, therefore, a priority for governments wanting to maintain strong urban economies. As there is no simple solution for the complex problem of uninsurability in high-risk urban areas of Australia (and globally), we propose options for

broadening the insurance ecosystem to involve both public and private provision, as some countries are already doing. When taken together, and accompanied by risk mitigation measures, these suggestions can help cities and the communities that live and work within them adapt to climate change.

The paper is structured as follows. First, we explain why high-risk locations are becoming uninsurable. We then describe why people and businesses in these locations can no longer enter the traditional indemnity insurance risk transfer process and detail the implications of becoming uninsurable. We conclude with two possible options for addressing uninsurability, being implementing a government-legislated risk pool and development of parametric insurance products, each of which option we explain below.

What is the problem? Understanding why high-risk areas are no longer insurable

In this section we explain the risk-transfer process and the complex factors involved in insurance premium pricing that, together, make flood-prone Australian cities and regions uninsurable in the current private indemnity insurance market.

The risk transfer process

Traditional indemnity insurance is a comprehensive product that pays for loss and reconstruction costs, management of the reconstruction process, and provision of a warranty for that reconstruction. As depicted in Figure 1, policyholders (A) pay a premium (i) to transfer their risk of loss to insurers (B). Insurers are then responsible to pay for future losses arising from a disaster. If a loss occurs, insurers will pay claims as specified in the terms and conditions of the insurance policy (a). In an old adage, *insurers use the premiums of the many to pay for the losses of the few*; using premiums collected as capital reserves that they invest to ensure their solvency to pay claims.

However, insurers must also protect themselves from a disaster that gives them many claims at once, such as a single large flood or series of floods throughout a region. To do so, they spread risk by diversifying the policies in their portfolio across regions and types of hazard

such as flood, fire and windstorm (Kousky, 2022). They then decide how many losses across this portfolio they can pay from their own capital reserves and how much risk they should transfer to global reinsurers (C), for which they pay a premium (ii). While reinsurance purchase is a cost to insurers, they cannot do without it, as they are regulated to ensure that they have enough reserves to pay even a large run of claims from an unprecedented disaster (Bednarek et al., 2021). Reinsurance is a global market that provides insurance for insurance companies, bringing global capital to pay for the mass local claims (b) that occur after an extreme weather disaster (Jarzabkowski et al., 2015; Taylor & Weinkle, 2020). Thus, insurance is prearranged financing for disaster losses, in which global capital flows to reconstruct local properties after a disaster.

Insert Figure 1 about here

While risk transfer can work well, it can also complicate the availability of affordable insurance (Kousky & Cooke, 2012), as the local, national and global risk transfer process is a key driver of the pricing of premiums. To explain why many people are no longer able to access an affordable premium through this process, we now explain how insurance pricing works.

Premium pricing: A complex beast.

A premium price represents a complex combination of factors, including risk assessment of the potential hazard, the vulnerability of properties to that hazard, the projected losses, the potential future costs such as building materials, labour for reconstruction, and temporary housing, the cost of insurance and reinsurance capital, and the operating costs of the insurance company (Kunreuther et al., 2013).

Hazard exposure is a major driver of premium increases due to what is termed risk-reflective pricing (Hampton & Curtis, 2022). Data on property exposure to damage from weather events has become more granular (Carrillo et al., 2022; Collier, 2008; Jarzabkowski et al., 2015). Risk assessment models incorporate detailed, often address-level data that help determine which individual properties are at risk of losses from specific hazards (Bouk, 2015;

Meyers & Hoyweghen, 2017). This risk assessment feeds into pricing models, so that properties in higher-risk locations or those with structural features that are not designed to withstand a particular weather event, are charged higher premiums that are considered to more accurately reflect the property's risk of damage from weather disasters (de Vet et al., 2019; McAneney et al., 2016). Every major weather loss adds to this body of knowledge and further impacts risk-reflective pricing models so that individual properties assessed to have a high risk of loss are increasingly priced out of the insurance market (Jarzabkowski et al., 2023; Paddam et al., 2023).

Increasing cost of weather losses. While premium rises are most acute in higher-risk locations, all policy holders experience premium rises due to increasingly severe and/or frequent weather. Following extreme weather disasters, including extensive flooding across many parts of Australia in 2022, Australia's insurers incurred heavy losses. The South-East Queensland and New South Wales flood events of February and March 2022 caused over AUD\$6 billion in insured losses; the costliest insured event in Australia's history (Insurance Council of Australia, 2023). Later in 2022, flood events also occurred in New South Wales in July, Tasmania, New South Wales and Victoria in October, and in Western Australia in December. The costs to insurers for claims from these properties, combined with the economic climate, made insurance more expensive, driving up the cost of insurance to all policyholders. This is because the cost of insurance is also shaped by wider economic trends, including inflation, rising construction costs, supply chain disruption and surging fuel prices. Inflation peaked at the end of 2022 at its highest point since 1990 (Reserve Bank of Australia, 2023) and construction costs recorded the largest ever annual increase soaring 11.9% over 2022 (Ezzy, 2023). In response to these increasingly severe disasters and the costs of rebuilding, household insurance premiums rose 46% on average across Australia between March 2022 and March 2023 (Paddam et al., 2023).

Cost of reinsurance. For advanced economies such as Australia, reinsurance capital is an important part of the recovery from extreme weather events. However, reinsurers, having taken a proportion of risk from insurers around the world, are also financially exposed to the costs of global weather events. Global losses, both insured and uninsured, from weather disasters rose to USD\$250 billion in 2023 (MunichRE, 2023). Most of this loss is attributed to

flood and storm damage (World Meteorological Organization, 2023). Much of the ability to pay claims following disasters is underpinned by reinsurance payouts to insurers. Reinsurers are therefore, like insurers, increasing the costs of reinsurance to ensure that they have sufficient capital reserving to pay for the increased losses. Damaging weather events, capital market investment⁴, and inflation and interest rates, means that reinsurance costs have risen by 37% on average globally, with some countries such as the US recording price rises between 45-100% (Smith, 2023). Taken together these factors drive increases in reinsurance which are passed on to all insurers and particularly to those in highly risk-exposed countries with vulnerable housing stock, such as Australia (Aon Securities, 2020).

Climate uncertainty. The problem of increasing weather volatility and losses arising from climate change also adds to premium pricing through a so-called ‘uncertainty factor’. Insurers will factor in additional charges to manage the possibility of large and surprising losses on which they may need to pay claims, as they will, in turn, be charged more by their reinsurers for this volatility in their portfolio (Harrington et al., 2013). As climate change generates more extreme weather events (World Meteorological Organization, 2021), prior experience of weather and its impacts provide a less accurate representation of what the future will hold. For insurers and reinsurers, this uncertainty over the way weather events and their extremes will change has an associated cost to cover unexpected losses, and this flows through to premium pricing (Collier et al., 2021; Elliott, 2021).

Properties unable to enter the risk transfer process are uninsurable

All the above factors of hazard exposure, cost of weather losses, cost of reinsurance, and climate uncertainty affect risk assessment and pricing of individual properties. As shown in Figure 2, properties with lower hazard exposure may still see their prices rise to cover the broader costs of weather losses and reinsurance, along with some climate uncertainty, but are likely to remain within the affordable band of premiums. People in these properties are insurable because they can enter the risk transfer process. However, the factors have a

⁴ Global reinsurance pricing is also affected by the wider capital markets. Reinsurance products are a diversified investment for other capital markets. Hence, they are also prone to inflow of capital from pension funds and hedge funds when returns on reinsurance are relatively strong, or represent a valuable diversification from other capital risks (Borscheid et al., 2013; Jarzabkowski et al., 2015; S&P Global, 2019).

compounding effect, so that properties with high hazard exposure are assessed as such high risk that they are given very high prices. These properties, which formed the basis of our cases in Australia, typically in flood exposed areas, are uninsurable. Even if their owners can find a company willing to offer them an insurance policy, the premium will be unaffordable, so that they cannot enter the risk transfer process. Properties that fall into this category are, and will remain, uninsurable in the immediate and foreseeable future, since the underlying conditions driving pricing cannot be changed.

For cities and regions with a high percentage of the population exposed in this way, the implications of being unable to enter the risk transfer process are profound. Recent reports suggest that some 50% of Louisiana residents are struggling to find an insurance policy (Henderson, 2023), with average annual premiums for homes in the Louisiana cities of Kenner and New Orleans projected to be \$11,108 and \$10,687 in 2024 (Rosanes, 2024). These premiums represent 8.5 and 9.4 weeks of median household income⁵ for Kenner and New Orleans, respectively (United States Census Bureau, 2023). Premium prices will be even more severe for those in specific higher-risk streets or zip codes (Taylor & Knuth, 2024). The likelihood is that, similar to Australia, many properties in such areas have simply become uninsured. In the wake of a disaster, the burden of recovery for these properties falls first and primarily on uninsured homeowners, who are often already the more vulnerable in society, and who then fall into debt, poverty and homelessness following a disaster (Birss et al., 2024). In offering support and relief to this growing group of vulnerable uninsureds, a further burden will fall upon city, state, and federal disaster relief funds. Many of the cities and towns most affected may simply fail to bounce back after disaster, as real estate values suffer (Taylor & Knuth, 2024) and businesses lose customers (You & Kousky, 2023).

Insert Figure 2 about here

[Options for addressing uninsurability](#)

⁵ Based on data collected for the 2023 American Community Survey 1-Year Estimates by the United States Census Bureau; median household income for Kenner and New Orleans was \$68,166 and \$55,580 respectively.

There is no simple solution for the complex problem of uninsurable properties explained above. Here, we map two potential options that planners and policy makers could consider; a risk pool, legislated by government to subsidize insurance for those who are uninsurable in the private sector, and a parametric product for individual businesses which can be offered in the private sector, to provide a post-disaster cash injection, rather than indemnifying reconstruction of a property. We propose these two options because they have been implemented in other countries. They could, therefore, improve the insurability of Australian cities albeit that they have specific caveats that need to be considered in their implementation.

Government-legislated risk pool

Government-legislated risk pools are typically not-for-profit insurance schemes to provide insurance to policyholders who would otherwise struggle to access or afford it in the private market (e.g., Flood Re in the UK; Toka Tū Ake Earthquake Commission (Toka Tū Ake EQC) in New Zealand; the National Flood Insurance Program (NFIP) in the USA). The key feature of such schemes, also known as Protection Gap Entities (PGEs), is that they intervene in the risk transfer process to ensure that insurance remains available to address some disaster insurance protection gap (Jarzabkowski et al., 2023). They do so by either providing insurance directly to policyholders (B in Figure 1), as in the case of Toka Tū Ake EQC in New Zealand, or providing reinsurance to the insurers in a country (C in Figure 1), as in the case of Flood Re in the UK. National risk pools may be single peril, covering one key hazard that threatens insurance availability and affordability, such as Flood Re which covers only flood, or multi-peril, covering several hazards that would otherwise be difficult to insure, such as Toka Tū Ake EQC, which covers earthquake, tsunami, volcanic eruption, landslip, and some specific types of storm and flood losses.

One way that risk pools make insurance affordable is by subsidizing the policyholder's premium, so reducing its true market cost in the private sector. For example, Flood Re in the UK is a reinsurance pool that receives a £10 GBP levy from every homeowner policy, making a capital fund that is then used to reduce the costs of insurance to those in areas of high flood risk. This mechanism, known as a risk redistribution process (Jarzabkowski et al., 2018),

is effective in lowering insurance premiums to high-risk homeowners. For example, premium reductions of more than 50% were achieved on previously flooded homes in the UK after the implementation of the Flood Re scheme (Flood Re, 2023). Effectively such risk pools diversify risk across the entire insured population and redistribute the benefits of this diversification by subsidizing premiums to those at high risk to ensure that they can remain in the pool of insureds.

National risk pools provide traditional, indemnity-based insurance that covers reconstruction costs on insured properties, and that can be used to demonstrate insurance for the purposes of mortgages and lending (Collier et al., 2021). This known way of insuring is typically offered on residential properties and small businesses and does not require any new insurance products or more sophisticated knowledge than already exists with such property owners. They simply buy their insurance policy and the disaster component of the policy, which is subsidized by the pool to ensure it remains affordable, is passed to that pool to provide the cover for any claims. Such pools therefore have potential to enable uninsurable property owners in highly exposed regions to enter the risk transfer process. In particular, they allow towns and villages where a peril is highly concentrated, that might otherwise have no access to insurance to remain insured. For example, much of the entire village of Sedgeberrow in the UK was flood exposed, suffering a major flood in 2007. Following the introduction of Flood Re in the UK in 2015, residents of this village found that their premiums dropped from several thousand GBP to figures in the hundreds, bringing them back into the risk transfer process. National pools have been effective in maintaining affordable insurance policies for residential, small business, and landlord-owned properties in countries such as France, Spain, Switzerland and the UK, (Kousky & French, 2023). However, they do have some key conditions and caveats that policymakers should understand as part of advocating for any such solution.

Risk pools are rarely used for medium-sized or large businesses. Risk pools work on cross-subsidization from areas of low risk to those at high risk. Such subsidies are not typically used for profit-generating businesses, because the cost of insurance at its true, risk-reflective rate, is considered part of the cost of doing business. Small businesses are, however, covered by some schemes, such as France and the USA, because of their relatively lower profit

margins and centrality to the fabric of local communities (French & Kousky, 2023).

Nonetheless, a risk pool will still benefit medium-sized and large businesses within a city or region because it provides insurance to homeowners, which is essential for a robust residential market and the ongoing presence of residential consumers and employees.

Establishing an effectively designed pool can be politically and socially challenging. One of the key criticisms of such pools is that, by suppressing premium prices, they can encourage growth and a sense of 'security' in high risk locations, and thus compound rather than reduce risk (Baker, 2000). Or that property owners might fail to take risk reduction measures such as raising their homes above flood levels or using flood resilient materials, knowing that subsidized insurance will cover flood damages. Indeed, one long-standing criticism of the National Flood Insurance Program (NFIP) in the USA is that it has enabled subsidized building on flood plains (Bedient, P., quoted in Kimmelman, 2017). Any risk pool can only be sustainable as a financial option if accompanied by a well-designed, long-term program for risk reduction (Kousky & Kunreuther, 2014).

While risk pooling is a key option, it is therefore important that policymakers consider how they can use the risk pool to support urban planning decisions such as managed retreat and the development of building standards suited to a climate changed future. Because a risk pool is required to provide the insurance policies in those areas that would, in the private market, be uninsurable, it amasses significant data about high-risk properties and neighbourhoods. In countries such as Switzerland, these data feed back into planning approvals so that areas already flagged as high risk by the risk pool cannot be approved for new developments or, where they are approved, need to conform to specific resilient building standards (Jarzabkowski, Cacciatori, et al., 2022). Urban planners might, therefore, draw from risk pool data to devise and implement new conditions for both planning approval and construction standards. As shown by the NFIP, data from a government insurance scheme is not always used as an input into planning. However, in some countries, such as New Zealand, Toka Tū Ake EQC has been effective in zoning areas for buy back following disaster (Canterbury Earthquake Recovery Authority, 2016), while Flood Re in the UK has used the scheme to target key houses for build-back-better programs in flood-prone areas (Flood Re, 2022). Hence, while there are political challenges in integrating policies

across government departments, urban planners and policymakers should strive to make any risk pool data integral to other planning, building and reconstruction plans.

Such integration is critical because a risk pool is also affected by the factors driving risk assessment and premium pricing in Figure 2. The rising cost of insurance nationally and globally, alongside the increasing frequency and severity of disaster and losses, means that a pool will still face rising insurance costs (Flood Re, 2023; Keucheyan, 2023). We recommend policymakers use risk pool data in an integrated way to implement a sustained program of risk reduction to prevent escalation of losses and costs, including an ongoing program of retrofitting and build-back-better on homes at risk, enforcing construction codes for all rebuilding and new building, planning restrictions for new building and development in exposed areas, and investment in broader resilience measures within neighbourhoods. These measures will be necessary to ensure that the pool is able to maintain affordable insurance premiums over the long-term.

Parametric products

Parametric insurance, also known as event-based or index-based insurance, is a form of insurance that is triggered by a disaster – such as a flood at a certain height, or wind at a certain speed – rather than by a loss. It pays a pre-agreed amount if that magnitude of weather event occurs, often within days of the event (Unnava, 2020). It is thus different to indemnity-based loss, since it does not pay to reconstruct or make good but does provide rapid cash to the policyholder. Parametric products, such as catastrophe bonds (Polacek, 2018), and disaster liquidity products (Jarzabkowski, Bednarek, et al., 2022) are already widely used as sources of insurance and reinsurance capital, particularly for large corporations, civic bodies, and as sovereign disaster response products. However, our focus in this paper is on their use for individual businesses, where they have been tested, albeit are not as widespread. As we explain, developments in parametric insurance indicate that they are an increasingly likely option for individual businesses in hazard prone cities.

Individual parametric products can be taken out by individual businesses against a specified hazard and a cash payment is made when pre-agreed triggers from that hazard are met.

Individual parametric insurance is well tested on commercial properties. For example, FloodFlash in the UK is an UnsurTech offering parametric products to individual businesses in the UK and USA (FloodFlash, 2023). A business owner decides the height of a flood that they will need protection from (the trigger), and how much money they want to receive if the flood goes to that level (the cash payment). It then buys a parametric product in which that amount of money will be paid to it, if the flood rises to the specified level. Typically, and in the case of FloodFlash, the parametric product is not used to indemnify loss, meaning not to repair losses on or reconstruct a property. Rather, its key purpose is to provide a rapid cash payment after an event and that payment is not tied to reconstruction of specific damage caused by the event. For example, the owner of a butcher shop or convenience store might decide that, if they have a flood of 1 metre in their property, they will need \$50,000 USD to clean up the property and replace damaged stock. They can buy a parametric that will trigger at 1 metre and provide them with that amount of money, which they can use to do repairs, cleaning, or replacement of goods, or indeed any other purpose that they see fit. These products can complement or provide flexible alternatives to traditional indemnity-based insurance.

While they have the advantages of speed and flexibility of payment, parametric products have some important limitations that need to be understood when considering this option. First, establishing the trigger for a parametric product necessitates an independent third party to declare that the event has occurred. For FloodFlash, their flood gauge technology, which is tamper proof and affixed to the individual property, serves as the trigger but other independent means such as government flood gauges may be needed to clearly assess flood levels, which can vary for different properties even in the same street. Second, in what is referred to as basis risk, the parametric that is established might not actually meet the needs of the policyholder; it might be too high so that they it does not trigger despite the fact that they have suffered damage and loss (Polacek, 2018). Third, these products are still quite novel, and so need further testing to establish what constitutes the best trigger for any given need, and how that trigger can be independently assessed (Lin & Kwon, 2020).

These limitations mean that it is absolutely critical for business owners to be fully educated that a parametric product is different to an indemnity product, and decide how best they

will use it for their post-disaster needs. In a traditional indemnity insurance product, the insurance company assesses the risk and the cost of recovery and reconstruction as part of providing a price. In a parametric product, this assessment of what the risk is, and how much money will be needed post-disaster is done by the owner of the business. As business owners will fund their recovery and repairs from the payment received, they will need to undertake:

- a) Decisions about the right level of cover for their recovery needs and at what magnitude. For example, do they want enough money for some reconstruction costs to be covered, or do they simply want to ensure they have cash flow to cover business costs such as salaries and loss of revenue for a short period of business interruption during the immediate aftermath of the disaster.
- b) Effective planning of how to use the lump sum received to support loss containment and getting back to business. Otherwise, the many financial demands on a business following a disaster may absorb the payment received without getting the business back on its feet.
- c) Unlike indemnity insurance, where the costs of reconstruction are covered, the burden of any repairs and rebuilding will fall on the business owner, who will need support with well-informed mitigation measures that are likely to reduce their loss costs.

We, therefore, recommend that parametric policyholders are fully informed about what the parametric product they purchase will and will not provide, and that they have clear post-disaster plans about how they will use any payment received to help with business recovery, alongside risk mitigation capabilities to reduce their likely losses.

Individual parametric products are not typically suited for homeowners. Choosing a parametric product that will meet a homeowner's needs requires post-disaster planning and risk management capabilities that are often beyond typical household insurance-based decision making (Kunreuther & Pauly, 2015). For homeowners, bringing their residence to a habitable standard post-disaster is critical, which traditional indemnity-based insurance is designed to provide. These same issues are likely to be relevant for small, often family-

owned businesses that may not have sophisticated risk management capabilities. Hence, city planners need to consider the capability endowment of the business owners in their region, when considering individual business parametric products as one option for insurance.

Finally, as a private sector option, individual business parametric insurance is prone to the factors that are driving rising premiums. The key reason why it may be less expensive or more available than a typical indemnity product are twofold (Lin & Kwon, 2020). First, there are slightly lower costs to the insurer, who does not need to do such extensive calculations of the future costs of reconstruction as part of providing the product, and this saving can be passed on in the cost of the product. Second, business owners can buy a smaller product, primarily aimed at post-disaster clean up, rather than reconstruction. This may be attractive to businesses, particularly those renting their premises, or those with strong mitigation in place that means they are able to contain their post-disaster costs.

Despite these caveats, urban policymakers will benefit from understanding parametric products and supporting their constituents to engage with them. As the strain on the public purse increases in the face of repeated disasters and losses continue to rise (Emrich et al., 2022), urban policymakers could therefore consider whether parametric products might constitute a top up, supplement to, or even substitute for, the state and federally-funded disaster relief payments their individual business constituents might usually receive. They might also consider how they could innovate with such products to incentivize risk sharing, such as providing government-funded post-disaster payments on a matched basis to those individual business constituents who had also taken out their own parametric product.

Final thoughts

We conclude with our final thoughts for policy makers and city authorities about insurability during a time of changing climate: the importance of embedding risk management capabilities and considering that the alternative of ‘doing nothing’ will generate further inequities (Birss et al., 2024). Firstly, investing in programs to develop risk management capabilities is necessary to support individuals and communities to live with increased risk exposure and act upon either of the above insurance options. Community-based risk

professionals can help property owners evaluate the amount of potential loss they face and the various funding sources and response strategies they can draw upon in the event of a loss. They may also support people in deciding on risk mitigation measures to reduce the likelihood of future loss and damage, which will be beneficial in reducing disaster costs and enhancing the speed of recovery. Indeed, scholars increasingly advocate for community-based housing resilience agencies to support the individuals in those communities to develop disaster resilience capabilities (Birss et al, 2024). For example, (Lamb et al., 2022) find that resident-owned housing cooperatives support people in low-income communities with accessing financial resources and climate adaption capabilities. While these capabilities are important regardless of the availability of insurance options, such agencies might also support homeowners and small business owners with understanding the links between risk reduction, insurance options, and the implications for post-disaster recovery.

In addition, such capabilities will support people in deciding on the amount of insurance that is feasible to support them in getting back on their feet. Importantly, they will help to ensure that people are knowledgeable, can be incentivised to invest in risk mitigation measures, and have clear and workable plans for using any post-disaster payments to support their recovery. This will support all types of decision-making around insurance, particularly those involving parametric options where much of the evaluation of risk, and decisions about amounts and uses of post-disaster funding are transferred to the policyholder. Policymakers should be aware that these capabilities will require continuing investment at multiple levels, and by different agencies (such as the housing resilience agencies noted above). Capability building should therefore be viewed as an ongoing process as knowledge, populations and climates change over time.

Secondly, policy makers should consider the implications if uninsurability for those at high risk remains unaddressed. Increasingly reports shows that lack of insurance disproportionately affects those who are already vulnerable (Elliott, 2021; Paddam et al., 2022). If allowed to continue unchecked, uninsurability has potential to fragment society, widening inequality and potentially leading to unplanned climate migration (Birss et al., 2024). We touch briefly on these points below.

- a) Some uninsured households and businesses will have the funds to restore or rebuild without insurance. Such wealthy property owners will potentially stay in cities with areas of high hazard exposure, providing there are enough services for these areas to remain attractive and viable. However, it is important to recognise that even wealthy uninsureds are taking a risk that, in a changing climate, they have the knowledge and wealth to cover their own losses and that the city will retain value as a place to live and to have property assets.
- b) Less wealthy uninsureds are likely to suffer widening inequality as they no longer have a critical safety net following a disaster and, without an insurance policy, are increasingly unable to access mortgage and lending markets. Loss of access to insurance and other financial systems disproportionately affects those who already face other vulnerabilities (Elliott, 2021).
- c) Without insurance or other financial options, cities may experience a reduction in long-term and casual labour supply for key industries leading to commercial and residential decline. An attrition of residents, employees, employers, and customers will effectively comprise unplanned migration (Bittle, 2024a), with negative impacts on community well-being, and the availability of services.

In conclusion, access to affordable disaster insurance is a key underpinning factor of most cities and regions, enabling home and business owners to take out mortgages, access lending, and recover and reconstruct after extreme weather. The increasing effects of climate change-driven extreme weather on exposed regions means that many people can no longer afford insurance or simply find that it is not available. The knock-on effects of uninsurability include increased vulnerability, rising poverty, and homelessness, all of which disproportionately affect these individuals and constitute a challenge for city planners. This paper suggests two key options – government-legislated risk pools and private-sector individual business parametric products – that city planners and policymakers could consider as a means to address the problem of uninsurability. Importantly, any such options should be considered as a key accompaniment to, rather than substitute for, a sustained program of investment in risk mitigation measures to decrease risk exposure at the individual property and community levels.

List of References

- Aon Securities. (2020). *Reinsurance Market Outlook - September 2020*.
- Australian Bureau of Statistics. (2022). *Housing Occupancy and Costs*.
<https://www.abs.gov.au/statistics/people/housing/housing-occupancy-and-costs/2019-20>
- Baker, T. (2000). Insuring morality. *Economy and Society*, 29(4), 559-577.
<https://doi.org/10.1080/03085140050174787>
- Bednarek, R., Chalkias, K., & Jarzabkowski, P. (2021). Managing Risk as a Duality of Harm and Benefit: A Study of Organizational Risk Objects in the Global Insurance Industry. *British journal of management*, 32(1), 235-254. <https://doi.org/10.1111/1467-8551.12389>
- Birss, M., Casey, A., Esposito, M., Graetz, N., Knuth, S., Ponder, C. S., & Taylor, Z. J. (2024). *Shared fates: A housing resilience policy vision for the home insurance crisis*.
- Bittle, J. (2024a). *The Great Displacement: Climate Change and the Next American Migration*. Simon & Schuster.
- Bittle, J. (2024b, 25 May). 'Kitty cat' storms hitting US heartland are growing threat to home insurance. *The Guardian*.
<https://www.theguardian.com/environment/article/2024/may/24/hail-storm-tornadoes-midwest-home-insurance>
- Borscheid, P., Gugerli, D., & Straumann, T. (2013). *The value of risk: Swiss Re and the history of reinsurance*. Oxford University Press.
- Bouk, D. (2015). *How Our Days Became Numbered*. University of Chicago Press.
- Bradshaw, S., Gardner, J., Gergis, J., & Blashki, G. (2023). *Climate trauma: The growing toll of climate change on the mental health of Australians*.
<https://www.climatecouncil.org.au/wp-content/uploads/2023/02/Report-Climate-Change-and-Mental-Health.pdf>
- Breidbach, C., Culnane, C., Godwin, A., Murawski, C., & Sear, C. (2019). *FinFuture: The Future of Personal Finance in Australia*.
https://www.unimelb.edu.au/_data/assets/pdf_file/0004/3145612/FinFuture_White_Paper.pdf
- Bulkeley, H. (2013). *Cities and climate change*. Routledge.
- Canterbury Earthquake Recovery Authority. (2016). *Residential Red Zone Survey*.
<https://www.dpmc.govt.nz/sites/default/files/2017-03/cera-rrz-surveyreport-feb2016.pdf>
- Carrillo, G., Telljohann, D., & Nyce, C. (2022). The 30th anniversary of hurricane Andrew: Evolution of the Florida homeowners insurance market. *Risk Management and Insurance Review*, 25(3), 239-270.
- Collier, S. J. (2008). Enacting catastrophe: preparedness, insurance, budgetary rationalization. *Economy and Society*, 37(2), 224-250.
- Collier, S. J., & Cox, S. (2021). Governing urban resilience: Insurance and the problematization of climate change. *Economy and Society*, 50(2), 275-296.
- Collier, S. J., Elliott, R., & Lehtonen, T.-K. (2021). Climate change and insurance. *Economy and Society*, 50(2), 158-172. <https://doi.org/10.1080/03085147.2021.1903771>
- de Vet, E., Eriksen, C., Booth, K., & French, S. (2019). An Unmitigated Disaster: Shifting from Response and Recovery to Mitigation for an Insurable Future. *International Journal of Disaster Risk Science*, 10(2), 179-192. <https://doi.org/10.1007/s13753-019-0214-0>

- Di Sabatino, A. (2023, August 2). What's the future for Canada's reinsurance rates? *Canadian Underwriter*. <https://www.canadianunderwriter.ca/insurance/whats-the-future-for-canadas-reinsurance-rates-1004236180/>
- Elliott, R. (2021). *Underwater: Loss, Flood Insurance, and the Moral Economy of Climate Change in the United States*. Columbia University Press.
- Emrich, C. T., Aksha, S. K., & Zhou, Y. (2022). Assessing distributive inequities in FEMA's Disaster recovery assistance fund allocation. *International Journal of Disaster Risk Reduction*, 74, 102855. <https://doi.org/https://doi.org/10.1016/j.ijdr.2022.102855>
- Ezzy, K. (2023). *East Coast Floods: One year on* https://www.corelogic.com.au/data/assets/pdf_file/0017/13355/2303-CoreLogic-East-Coast-Floods-One-year-on.pdf
- Fan, I. (2016). *The Australian commercial insurance market*. https://www.swissre.com/dam/jcr:4b6f427b-9d8f-49e8-b63b-3147dd07a6e1/Expertise_Publication_The_Australian_commercial_insurance_market.pdf
- Flood Re. (2022). *Flood Re launches world first 'Build Back Better' scheme to help households after a flood* <https://www.floodre.co.uk/wp-content/uploads/Press-Release-BBB-Flood-Re-FINAL.pdf>
- Flood Re. (2023). *How Flood Re Works?* <https://www.floodre.co.uk/how-flood-re-works/>
- FloodFlash. (2023). *About FloodFlash*. <https://floodflash.co/about-floodflash-commercial-flood-insurance/>
- French, K., & Kousky, C. (2023). The effect of disaster insurance on community resilience: a research agenda for local policy. *Climate Policy*, 1-9. <https://doi.org/10.1080/14693062.2023.2170313>
- Gall, M. (2023, 7 June). Why insurance companies are pulling out of California and Florida, and how to fix some of the underlying problems. *The Conversation*. <https://theconversation.com/why-insurance-companies-are-pulling-out-of-california-and-florida-and-how-to-fix-some-of-the-underlying-problems-207172>
- Gausden, G. (2019, 19 May). Pensioners' Home Insurance Soared from £300 to £3,300 in Four Years Due to Flood Risk, Even Though they'd Lived There for Four Decades. *This is Money*.
- Grant, E. (2012). *The social and economic value of insurance*. https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public/ga2012-the_social_and_economic_value_of_insurance.pdf
- Hampton, S., & Curtis, J. (2022). A bridge over troubled water? Flood insurance and the governance of climate change adaptation. *Geoforum*, 136, 80-91. <https://doi.org/10.1016/j.geoforum.2022.08.008>
- Harrington, S., Niehaus, G., & Yu, T. (2013). Insurance Price Volatility and Underwriting Cycles. In G. Dionne (Ed.), *Handbook of Insurance* (2 ed., pp. 647-667). https://doi.org/10.1007/978-1-4614-0155-1_23
- Hecht, S. (2007). Climate change and the transformation of risk: Insurance matters. *UCLA Law Review*, 55(6), 1559-1620. file:///C:/Users/uqkmeiss/Downloads/SSRN-id1159853.pdf
- Henderson, M. (2023). *Homeowners Face Insurance Challenges*. https://www.lsu.edu/manSHIP/research/centers-labs/rcmpa/research/la_survey_reports_pdf/2023_la_survey_report_2.pdf

- Hutley, N., Dean, A., Hart, N., & Daley, J. (2022). *Uninsurable Nation: Australia's most climate-vulnerable places*. https://www.climatecouncil.org.au/wp-content/uploads/2022/05/CC_Report-Uninsurable-Nation_V5-FA_Low_Res_Single.pdf
- Insurance Council of Australia. (2023). *Insurance Catastrophe Resilience Report 2022-2023*. https://insurancecouncil.com.au/wp-content/uploads/2023/09/20897_ICA_Cat-Report_Print-2023_RGB_Final_Spreads.pdf
- Jarzabkowski, P., Bednarek, R., Chalkias, K., & Cacciatori, E. (2022). Enabling rapid financial response to disasters: Knotting and reknitting multiple paradoxes in interorganizational systems. *Academy of Management Journal*, 65(5), 1477-1506.
- Jarzabkowski, P., Bednarek, R., & Spee, P. (2015). *Making a Market for Acts of God: The Practice of Risk-Trading in the Global Reinsurance Industry*. Oxford University Press.
- Jarzabkowski, P., Cacciatori, E., Chalkias, K., & Gallagher Rodgers, R. (2022). *Disaster insurance in Switzerland: The cantonal public sector insurance system*. <https://espace.library.uq.edu.au/view/UQ:a1c4b99>
- Jarzabkowski, P., Chalkias, K., Cacciatori, E., & Bednarek, R. (2018). *Between state and market: Protection gap entities and catastrophic risk*.
- Jarzabkowski, P., Chalkias, K., Cacciatori, E., & Bednarek, R. (2023). *Disaster Insurance Reimagined: Protection in a Time of Increasing Risk*. Oxford University Press. <https://fdslive.oup.com/www.oup.com/academic/pdf/openaccess/9780192865168.pdf>
- Keucheyan, R. (2023). The “Environment Making State” and Climate Change: The French “Cat Nat” Reinsurance Scheme Under Strain. *Antipode*, 55(2), 506-526. <https://doi.org/10.1111/anti.12901>
- Kimmelman, M. (2017, November 11). Lessons From Hurricane Harvey: Houston’s Struggle Is America’s Tale. *The New York Times*. <https://www.nytimes.com/interactive/2017/11/11/climate/houston-flooding-climate.html>
- Knuth, S., & Taylor, Z. (2016). Climate Finance. *International Encyclopedia of Geography: People, the Earth, Environment and Technology*, 1-6.
- Kousky, C. (2022). *Understanding Disaster Insurance: New Tools for a More Resilient Future*. Washington, DC: Island Press.
- Kousky, C., & Cooke, R. (2012). Explaining the failure to insure catastrophic risks. *The Geneva Papers on Risk and Insurance Issues and Practice*, 37(2), 206-227.
- Kousky, C., & French, K. (2023). *Inclusive Insurance for Climate-Related Disasters*. <https://www.ceres.org/resources/reports/report-inclusive-insurance-climate-related-disasters>
- Kousky, C., & Kunreuther, H. (2014). Addressing Affordability in the National Flood Insurance Program. *Journal of Extreme Events*, 01(01), 1450001. <https://doi.org/10.1142/s2345737614500018>
- Kunreuther, H. C., & Pauly, M. V. (2015). Insurance Decision-Making for Rare Events: The Role of Emotions. *NBER Working Paper No. w20886*. <https://ssrn.com/abstract=2555406>
- Kunreuther, H. C., Pauly, M. V., & McMorro, S. (2013). *Insurance and behavioral economics: Improving decisions in the most misunderstood industry*. Cambridge University Press.
- Lamb, Z., Shi, L., Silva, S., & Spicer, J. (2022). Resident-Owned Resilience: Can Cooperative Land Ownership Enable Transformative Climate Adaptation for Manufactured

- Housing Communities? *Housing Policy Debate*, 33, 1-23.
<https://doi.org/10.1080/10511482.2021.2013284>
- Lee, B. A., & Evans, M. (2020). Forced to move: Patterns and predictors of residential displacement during an era of housing insecurity. *Soc Sci Res*, 87, 102415.
<https://doi.org/10.1016/j.ssresearch.2020.102415>
- Lin, X., & Kwon, W. J. (2020). Application of parametric insurance in principle-compliant and innovative ways. *Risk Management and Insurance Review*, 23(2), 121-150.
<https://doi.org/https://doi.org/10.1111/rmir.12146>
- McAneney, J., McAneney, D., Musulin, R., Walker, G., & Crompton, R. (2016). Government-sponsored natural disaster insurance pools: A view from down-under. *International Journal of Disaster Risk Reduction*, 15, 1-9.
<https://doi.org/10.1016/j.ijdrr.2015.11.004>
- Meyers, G., & Hoyweghen, I. (2017). Enacting Actuarial Fairness in Insurance: From Fair Discrimination to Behaviour-based Fairness. *Science as Culture*, 27, 1-27.
<https://doi.org/10.1080/09505431.2017.1398223>
- Mills, E., Roth, R., & Lecomte, E. (2005). Availability and Affordability of Insurance Under Climate Change. A Growing Challenge for the U.S. *Journal of Insurance Regulation*, 25.
- MunichRE. (2023). *Record thunderstorm losses and deadly earthquakes: the natural disasters of 2023*. Retrieved 11 April from
<https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2024/natural-disaster-figures-2023.html>
- Paddam, S., Liu, C., & Philip, S. (2022). *Home insurance affordability and socioeconomic equity in a changing climate*.
<https://actuaries.asn.au/Library/Opinion/2022/HIAGreenPaper.pdf>
- Paddam, S., Liu, C., & Philip, S. (2023). *Home Insurance Affordability Update*.
<https://www.actuaries.asn.au/docs/thought-leadership-reports/home-insurance-affordability-update.pdf>
- Paddam, S., Liu, C., Philip, S., Smith, R., & Nagarajan, S. (2024). *Home Insurance Affordability and Home Loans at Risk*. Actuaries Institute. <https://www.actuaries.asn.au/public-policy-and-media/our-thought-leadership/reports/home-insurance-affordability-update-and-home-loans-at-risk/>
- Perucca, J., Freeman, S., & Farha, L. (2023). The True Cost of Financialization: Housing, Human Rights, and Climate Change. *Journal of City Climate Policy and Economy*, 2(1), 20-36. <https://doi.org/10.3138/jccpe-2023-0201>
- Polacek, A. (2018). Catastrophe bonds: A primer and retrospective. *Chicago Fed Letter*, 405.
<https://doi.org/10.21033/cfl-2018-405>
- Reserve Bank of Australia. (2023). *Statement on Monetary Policy – February 2023*.
<https://www.rba.gov.au/publications/smp/2023/feb/inflation.html>
- Rosanes, M. (2024, 2 April). Rising home insurance rates predicted in 2024. *Insurance Business*. <https://www.insurancebusinessmag.com/us/guides/rising-home-insurance-rates-predicted-in-2024-483555.aspx>
- S&P Global. (2019). *Convergence capital will remain key for reinsurers despite recent losses*.
<https://www.spglobal.com/ratings/en/research/articles/190828-convergence-capital-will-remain-key-for-reinsurers-despite-recent-losses-11103819>
- Sellers, M. (2023, 11 July). Major insurance company abandons homeowners in two key states. *Insurance Business Magazine*.

- Smith, I. (2023). Reinsurance costs rise up to 200% as Ukraine war and extreme weather bite. *Financial Times*. <https://www.ft.com/content/f5f9d450-c539-47a7-bc5c-44a8db57e74e>
- Taylor, Z., & Knuth, S. (2024). *The Insurance Crisis is a Housing Crisis*. The Climate and Community Project. <https://www.climateandcommunity.org/insurance-crisis-is-housing-crisis>
- Taylor, Z. J. (2020). The real estate risk fix: Residential insurance-linked securitization in the Florida metropolis. *Environment and Planning A: Economy and Space*, 52(6), 1131-1149. <https://doi.org/10.1177/0308518x19896579>
- Taylor, Z. J., & Weinkle, J. L. (2020). The risksapes of re/insurance. *Cambridge Journal of Regions, Economy and Society*, 13(2), 405-422.
- Trounson, A. (2020). *Too many eggs in the property wealth basket*. The University of Melbourne. <https://pursuit.unimelb.edu.au/articles/too-many-eggs-in-the-property-wealth-basket>
- United States Census Bureau. (2023). *Profiles*. <https://data.census.gov/profile/>
- Unnava, V. (2020). *Understanding Parametric Triggers in Catastrophe Insurance*. Yale School of Management. . <https://som.yale.edu/blog/understanding-parametric-triggers-in-catastrophe-insurance>
- World Meteorological Organization. (2021). *WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019)* No. 1267. https://library.wmo.int/doc_num.php?explnum_id=10989
- World Meteorological Organization. (2023). *Economic costs of weather-related disasters soars but early warnings save lives*. <https://public.wmo.int/en/media/press-release/economic-costs-of-weather-related-disasters-soars-early-warnings-save-lives>
- You, X., & Kousky, C. (2023). Improving Household and Community Disaster Recovery: Evidence on the Role of Insurance. *EDF Economics Discussion Paper Series*, 23(01). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4365715

Figures

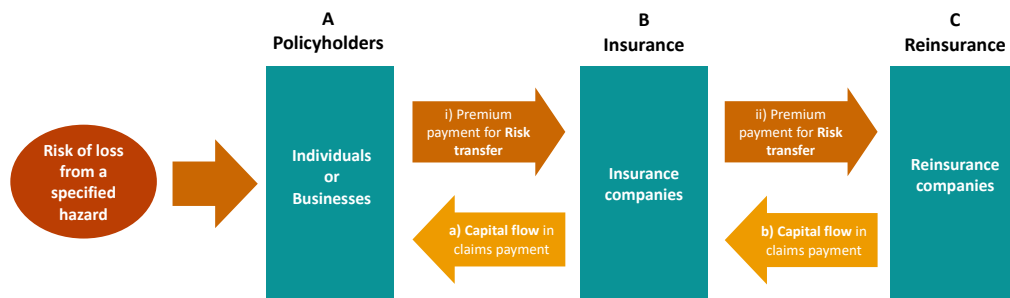


Figure 1 Insurance Risk Transfer Process (adapted from Jarzabkowski et al, 2023)

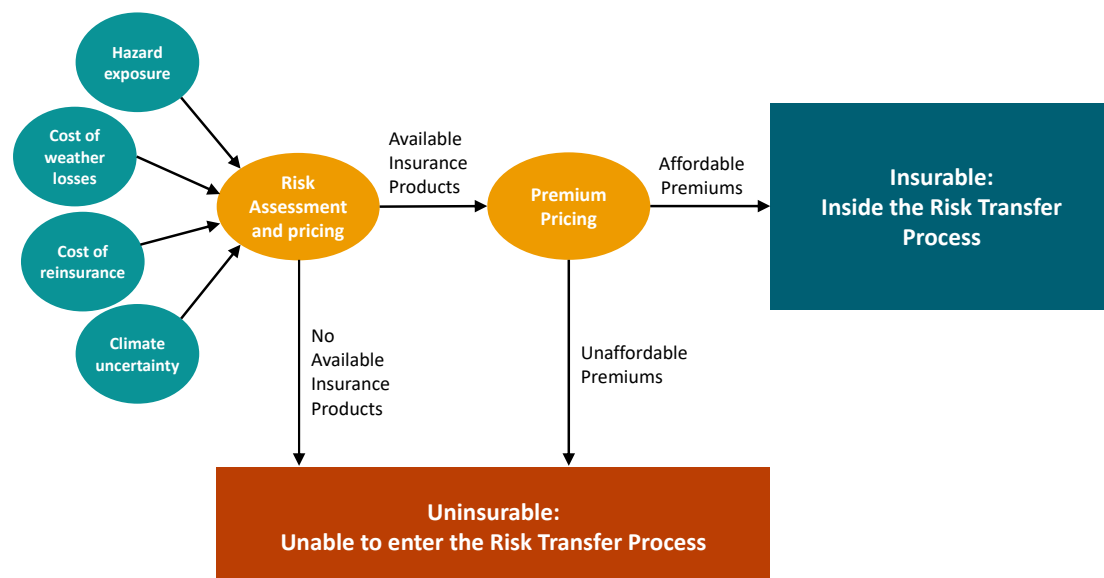


Figure 2: Factors influencing premium pricing and consequences for insurability⁶.

⁶ While the definition for unaffordable premiums may vary, the definition of a price exceeding four weeks of gross family income proposed by Paddam et al. (2023) is deemed reasonable.

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