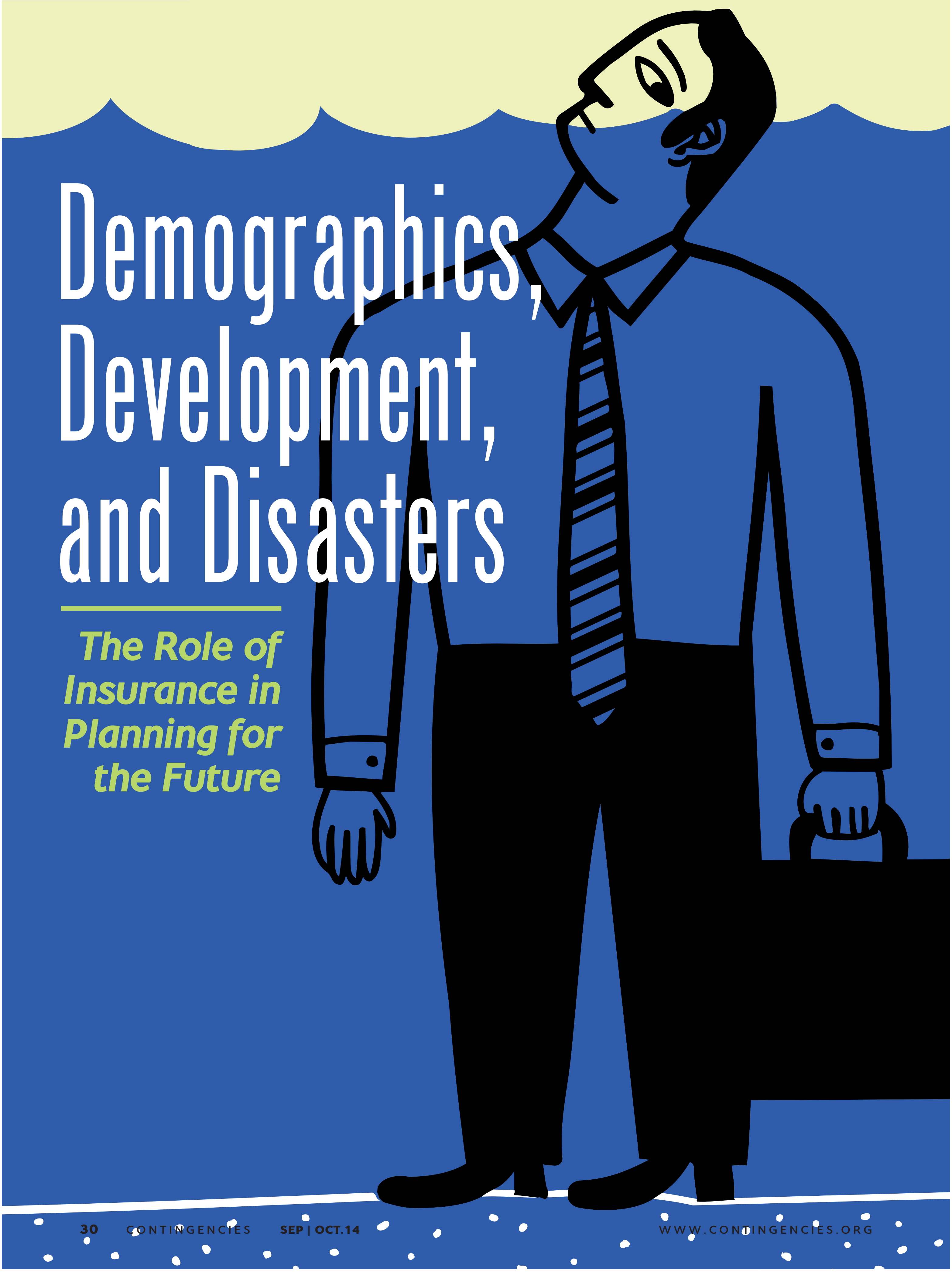
Demographics, Development, and Disasters

The Role of Insurance in Planning for the Future



The insurance industry has a vital role to play in helping societies adapt to climate change or future demographic shifts.

By Rade Musulin

I WAS RECENTLY PART OF A GROUP OF RESEARCHERS that prepared a report for the National Climate Change Adaptation Research Facility (NCCARF, sponsored by the Australian government) on how the insurance system can assist with climate change adaptation. When we were asked to consider the insurance system's role in climate change adaptation (see note on Page 33), our answer was expected to be quick and obvious. The insurance system would deploy its underwriting expertise to identify locations subject to flooding (or other climate-related perils) and take appropriate actions: lowering coverage, increasing prices, or some combination of the two.

With the proper incentives for climate change adaptation in place, the problem would correct itself.

In fact, these underwriting actions are unlikely to solve the problems. One of the insurance industry's most important tools is charging for risk, so that risk is factored into economic decisions and overall losses are reduced. Unless that economic signal is sent before construction, however, its value is seriously diminished. At the same time, addressing something like flood risk is more complicated than simply charging people with elevated flood risk a high premium. The difficulty is that in many cases the "problem" of high flood risk is only "discovered" after someone (often a voter) has invested a large sum of money into building on the property. And frequently, someone else (who might have been on the local government council in a prior period when the flood-prone area was opened to development) generated a good deal of tax revenue from the construction.

The insurance system faces a conundrum in such circumstances. If insurers charge risk-based premiums, the coverage often is unaffordable to those who need it. This leads to calls to form government pools, which either can compel low-risk policyholders to subsidize high-risk ones or hold premiums low without a current subsidy, fail to build adequate financial reserves, and (often) run deficits to be repaid with revenue bonds. A frequent side effect of such efforts to make insurance "affordable" is even more development in high-risk zones and larger losses in the long term.

Aside from affordability, the key reason that the insurance system is ill-equipped to use its pricing and underwriting tools to address climate change adaptation is the imbalance in the time horizon for insurance pricing and that of climate change. Insurance prices are usually adjusted annually to forecast the cost of risk over the life of the policy (usually one year). In order to send significant price signals to the market regarding climate change, however, the time horizon must be decades rather than years. This means that the annual view of pricing used in the insurance industry effectively precludes its use as a vehicle for climate change adaptation.

Instead, insurance risk-pricing tools would be more useful at the level of public policy development, analyzing the optimal level of investment in mitigation and/or land-use planning.

Economic Development and the Nature of Losses

As the world achieves a more advanced level of economic development in coming decades, the issue of dealing with the *economic* consequences of natural disasters will become more critical. Severe loss of life and injury have been an issue for millennia, but in the developed world this issue has been mitigated by a plethora of methods, including stronger building codes (and their enforcement), improved meteorological tools (such as satellites), vastly more powerful computer models of tropical cyclones, and improved understanding of geologic processes such as plate tectonics. As death tolls have declined, economic losses have become a dominant issue.

This implies that economic development will lead to better disaster mitigation techniques, reducing injuries and loss of life. Economic effects will become more pronounced, reflecting higher levels of economic integration and the tendency of more affluent citizens to demand compensation for material losses and replacement of damaged property. But does it necessarily follow that the economic effects of natural disasters of the magnitude recently observed are optimal when balancing potential investments in loss mitigation against expected reductions in losses from natural disasters?

Taking the question a step further, are governments even asking the right set of questions and using proper analytical tools to understand the answer? Generally speaking, today's building codes have been developed with a focus on single-building structural integrity, life safety, and cost, all viewed from today's perspective over the design life of a building.

This process may lead to an inappropriate investment in loss mitigation because of two simple facts. First, the size of the community affected by a disaster has an effect on the cost of rebuilding (often described as "demand surge" or "post-loss amplification"). Second, the type of damage a structure may be exposed to can change, from either the climate or other peril-related issues.

I will discuss two specific factors: demographic shifts and climate change, but these are examples of broader consequences of the way we are looking at land-use planning and building code development in an unpredictably changing world.

I would note one final concept. Almost imperceptibly, global society has become mind-numbingly complex, an issue that cuts to the heart of enterprise risk management (ERM) skills that the actuarial profession has identified as a core capability. Almost every product we use involves an intricate supply chain involving scores or hundreds of providers. Disruptions to that supply chain, of which there have been many recent examples, add an order of magnitude to the difficulty of understanding how we should prepare building stock constructed today for the hazards it may face decades ahead.

Climate Change Now

The abstract of 2013 findings presented to NCCARF (see note on Page 33) states:

> The economic and insured costs of natural disasters due to extreme weather—tropical cyclones, floods, bushfires and storms—are rising in concert with growing concentrations of population and wealth in disaster-prone regions. A contribution to these rising costs has not yet been attributed to anthropogenic climate change, although such a contribution cannot be ruled out…
>
> Extreme events are, by definition, rare, and so detecting a signal of climate change in volatile time series of economic losses faces a challenging signal-to-noise problem. This situation is unlikely to change any time soon and so, in the absence of scientific clarity, decision-making in relation to climate change adaptation to extreme weather events of the types considered here, will of necessity take place in an "environment" of uncertainty and ignorance; this reality strengthens the case for expanding disaster risk reduction as part of any climate change adaptation policy.
>
> … The peer-reviewed scientific literature shows that the rising costs of natural disasters from extreme weather is mainly explained by growing concentrations of population and wealth in disaster-prone regions, although a climate change contribution cannot be ruled out. At least in the case of U.S. tropical cyclone, recent studies suggest that we may be several decades to centuries away from being able to detect with high statistical confidence an anthropogenic climate change signal in the losses. Given such long and uncertain time frames, policy-making in relation to climate change adaptation will of necessity take place in an environment of uncertainty and ignorance; this reality strengthens the case for encouraging adaptation to the current climate.

The final paragraph argues strongly for a stochastic, rather than a deterministic, view of possible future states. When we construct a building today, we do not know what type of or how many buildings may surround it in 50 years, nor can we be certain that today's climate conditions will still prevail. While not offering a perfect solution, a stochastic framework can consider a *range* of future states with associated probabilities, allowing us to consider a wider array of potential hazards.

It surprises many that some of the most striking cases of anthropogenic changes in insurance-loss patterns have nothing to do with anthropogenic global warming (AGW). Little credible evidence exists that AGW is having a measurable effect on insurance losses in the short term. However, human activity is clearly having an impact on the Earth, and various public policy initiatives are affecting the types of risks that are insured. For these reasons, it is important that insurers pay careful attention to the consequences of human activity, regardless of their position on AGW. Further, insurance concepts may provide us with a way to understand AGW risks from an economic perspective.

To illustrate this point, consider two examples:

Human Activity and Flood Risk

Discussion of exposure to flood losses in coastal areas often focuses on the role of sea level rise and how that can increase the impact of tidal floods and storm surge. The driver in coastal flooding is the relative difference in elevation between land and sea. This can be changed by human activities that lead to land subsidence, which is triggered by compaction of soil, groundwater extraction, and construction of heavy buildings in cities.

A recent World Bank study in Bangkok forecast a total sea level rise by 2050 of 32.3 cm (roughly 12.7 inches), of which 20 cm (nearly 8 inches) is from land subsidence. Flood losses in 2050 could be 4.25 times today's losses, with 70 percent of the increase attributable to land subsidence alone.

Another aspect of flooding is the role of increased precipitation intensity. Land use and land cover changes have the potential to influence the intensity and frequency of floods by affecting peak flow (typically by decreasing seepage) and time to peak (typically by increasing runoff speed). It is therefore possible that a 50-year flood from 20 years ago could be a 25-year flood today because of human-induced land use and land cover changes.

Human Activity and Fire Risk

Fire is another natural hazard that may be affected by the potential impact of global temperature rise on rain and wind patterns. As with flooding, there are other anthropogenic factors at work. For example, where we build, the type of trees we plant, the vegetation we introduce, how we manage fires, etc., are all known to have an effect on fire potential. Additional factors that affect fire risks are logging practices to clear forest land, contested ownership of land, unemployment, and social unrest.

Clearly, climate change is indeed happening around us every day as humans erect buildings, divert water flow, or engage in deforestation. None of these effects requires taking a position on AGW.

The Cancellation Conundrum

Many readers can cite instances of insurance policies being canceled or non-renewed during periods of high uncertainty about expected loss costs, particularly if regulators place a burden of proof on insurers to justify price increases (as is the case in Florida).

I would suggest, however, looking at a different type of cancellation. Similar to the effect of noise-canceling headphones, changes in climate metrics such as temperature or precipitation can have multiple effects that either amplify or dampen drivers of loss activity caused by natural disasters.

Advocates for aggressive action to curb AGW often fall into

Statement of Scope

In this article, the term "demographic shifts" is used as shorthand for a number of drivers of losses from natural disasters, including population growth, wealth accumulation, shifts in the location of property (e.g., inland vs. coastal), and the occupancy of property (e.g., single-family homes vs. apartment blocks).

I am deliberately avoiding taking positions on a number of controversial issues involving climate change or the appropriate degree of investment in loss mitigation for a range of other perils. Instead, I am looking at how the insurance system could respond to an identified potential increase in global natural disasters—the cause of which I will not hypothesize on, or discuss—in light of evolving global economic conditions.

My goal is to encourage an evolution in the way we think about loss mitigation, particularly in the developing world, in three fundamental ways:

- Incorporating a community perspective in addition to the current focus on the integrity of the individual structure.
- Recognizing that incorporating community thinking into the determination of the optimal decision on building practices requires thinking through future changes in exposure (e.g., the number and/or type of buildings surrounding a structure during its design lifetime) or shifts in the hazards affecting the structure (e.g., climate change, deforestation, or land issues such as sinkholes). This requires moving away from a static view of risk based on present conditions.
- Introducing stochastic practices, transforming the tools we use to evaluate the appropriate investment in loss mitigation from their current emphasis on life safety in a single structure to include community resilience and advance planning for a range of future scenarios.

Note: This article in part summarizes findings presented to the National Climate Change Adaptation Research Facility (NCCARF, sponsored by the Australian government) on how the insurance system can assist with climate change adaptation. The study had three main parts:

- A summary of peer-reviewed literature on whether climate change signals are clearly detectable in insurance losses;
- A review of various disaster pools around the world that may become involved in funding climate change mitigation;
- A discussion of how the insurance system more generally can support climate change mitigation efforts.

The full study is available online at **http://www.nccarf.edu.au/publications/market-based-mechanisms-climate-adaptation**.

the trap of assuming that any significant change in key climate measures, such as documented increases in global average temperatures, will lead to greater destruction from natural disasters. Aside from sea level rise, however, changing climate metrics can just as easily decrease natural disaster losses as increase them. And in many cases, a climate driver can trigger offsetting changes that cancel one another out.

Consider hurricane activity in the North Atlantic basin. The drivers of hurricane activity are highly complicated and far beyond my scope here, so I am just offering an illustrative exercise rather than a scientifically rigorous one.

On one hand, rising water temperatures can increase evaporation, thus feeding the thunderstorm activity that is a key driver of hurricane formation. On the other hand, rising air temperatures have been associated with the desertification of the Sahel region in western Africa, reducing thunderstorm activity in the Cape Verde region of the eastern Atlantic Ocean by increasing large, dry air masses. Whether these opposing forces increase or decrease the likelihood of major hurricane formation is unimportant here; what is important is to recognize that climate processes are highly complicated. Compounding the issue is a tendency for these processes to be nonlinear: A small change in input can trigger a large effect on output.

Competitors or Partners?

The economic effects of natural disasters can be addressed in many ways, including government aid or payments by an insurance system. Government aid often appears in the form of post-event appropriations. These fail to provide pre-funding for losses, do not send proper economic signals for loss mitigation, may lack clarity about distribution of funds, and can create significant difficulties with government budgets. An insurance system offers a mechanism to overcome these problems by charging premiums reflecting risk, distributing benefits according to contracts, and pre-funding losses through accumulated premiums and reinsurance. Insurance has the added benefit of being able to draw upon resources external to the local economy.

But private-sector insurance solutions are not without issues. Accounting rules preclude private insurers from spreading losses across time as governments can do through debt repaid with bonds. This eliminates a tool sometimes used by governments to address affordability issues associated with pre-funding losses. Also, private markets generally seek out and destroy subsidies through competition, pricing, and the consequences of adverse selection. For the most part, this is beneficial for economic efficiency and loss minimization. But it often leads to issues with coverage affordability or no insurance if coverage is dropped due to cost considerations.

Most advanced economies rely on the insurance system to fund a significant portion of natural-disaster losses and to diversify the risk throughout the economy. In turn, insurance systems use reinsurance to spread the risk of very large disasters throughout the global financial system. Regions represent different-size exposures to the reinsurance system, affecting the level of funding required and its cost. Major factors driving a region's exposure include the nature of natural perils, the quality of construction, the size of the population in harm's way, wealth, and the level of insurance penetration.

Regions that have the greatest potential for insured loss pay significantly higher margins for reinsurance (the difference between expected loss recoveries and total cost of coverage). In 2014, Florida is a peak zone, while China is not, reflecting the relative size of potential insured losses in Florida and China. Reinsurance costs in Florida are high, while those in China are relatively low. This is not due to an absence of severe disasters in China, but rather to the relatively low level of insurance penetration in China and the high level of penetration and wealth in Florida. As China continues its economic development in coming decades, however, demographic forces, including increasing wealth, urbanization, and greater insurance penetration, will place considerable upward pressure on risk-transfer costs, with potentially significant social and economic consequences.

Lessons From Florida

The power of demographics in driving the cost of natural disasters is clearly seen in the history of Florida, which in one generation went from a largely undeveloped agricultural state to one of the world's peak zones for natural catastrophes. Four key elements drove this transformation: high exposure to loss, lack of sophisticated actuarial tools to measure risk in past decades when construction occurred, rapid development in a period of increasing wealth, and inadequate investment in loss mitigation.

Because a large proportion of land-falling hurricanes in the United States (including the most severe) strike there, Florida has a high exposure to loss. The state has a long coastline and is very flat, offering little protection against storms.

In the decades before Hurricane Andrew in 1992, actuaries lacked the tools to properly measure and price for risk. In 1992, a U.S. rating bureau, the Insurance Service Office, calculated rates indicating approximately $80 million in catastrophe premiums for the entire Florida domestic property market annually. Current modeled estimates of the needed revenue based on 1992 exposure levels are at least 10 to 20 times that amount, demonstrating severe problems with the tools used to measure loss exposure in that period.

This illustrates how major errors can be made in forecasts, as well as the impact new technology can have on the perception of risk. The primary effect of limited tools and data in the 1980s was a significant underestimation of risk. This led insurers to offer more coverage than they could support, with overly generous terms and inadequate prices. This contributed to rapid development and inadequate investment in loss mitigation.

According to the U.S. Census Bureau, Florida's overall population increased 367 percent between 1950 and 1990, from 2.8

million to 12.9 million. The growth was not uniform, with much of it occurring near Fort Lauderdale and Miami, the most catastrophe-prone part of the state. This period was also one of rapid wealth accumulation as the U.S. posted stunning economic growth following World War II. In 40 years, the value of property exposed to severe hurricanes exploded. This was also a period of below-average hurricane activity due to the well-established Atlantic Multi-Decadal Oscillation. Consumers, government, and insurers were lulled into a false sense of security.

The final element of Florida's climb to peak zone status was an inadequate investment in loss mitigation. There were few economic incentives for doing so because inexpensive insurance provided generous benefits. A study by the Insurance Institute for Property Loss Reduction following Hurricane Andrew found that homes built after 1980 were three times as likely to have been rendered uninhabitable by the winds up to 97 mph generated by Andrew as those built before 1980 (10 percent vs. 33 percent).

The extent of economic and demographic pressures on Florida can be seen by looking at the Great Miami Hurricane of 1926. During the subsequent 80 years, inflation increased by 830 percent, per capita wealth increased 480 percent, and population in the area increased 3,500 percent. The same event in 2006 would have generated economic losses of almost $150 billion, which is consistent with the estimates of catastrophe models after adjusting to an insured-loss basis. Instead, while the 1926 hurricane caused local disruption, it had relatively little effect on the national economy or the global insurance system.

Florida experienced severe hurricane activity in 1992, 2004, and 2005, resulting in massive disruption of the insurance market, political agitation by consumers, and government intervention. Property insurance issues dominated the 2006 campaign for governor and the legislature. Recent years have seen continued turmoil, including widespread public anger at government officials, the inability of a state catastrophe fund to honor its capacity commitments, insurers leaving the market, litigation over rate increases, and insurer insolvencies. Also, predictions of high hurricane activity failed to materialize, which may have the effect of reducing pressure for the type of public policy actions needed to avert future disaster. Florida is an excellent case study of what can happen when an area prone to severe natural disasters experiences rapid population growth during a period of economic wealth creation.

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The Next Florida

Parts of Asia—China in particular—exhibit many of the factors that led to problems in Florida. Economic development has increased per capita wealth. Population is shifting from widely distributed farms in rural areas to more concentrated cities, many in areas prone to natural disasters. China, for example, is pushing ahead with a sweeping plan to move 250 million rural residents over the next dozen years into newly constructed towns and cities—a pattern that is repeated on a smaller scale all across Asia.

Much of Asia has an additional factor: a low level of insurance penetration. Currently, the proportion of economic losses from natural disasters covered by insurance is small, as is evidenced by the very low insured loss from the Sichuan Earthquake in China. This allows Chinese insurance companies to secure relatively low reinsurance rates on the global market because Chinese insured risk can be pooled with that of many other places. If the level of insurance coverage increases significantly in coming decades, potential Chinese insured losses will increase dramatically, particularly when this effect is combined with urbanization and economic growth. These factors will place upward pressure on risk financing costs.

Research in the United States has shown that increases in insured losses over many decades can be explained by adjusting for changes in population and economic conditions. Various global organizations provide forecasts to 2050 of demographic variables such as population and real gross domestic product (GDP). These forecasts reveal that:

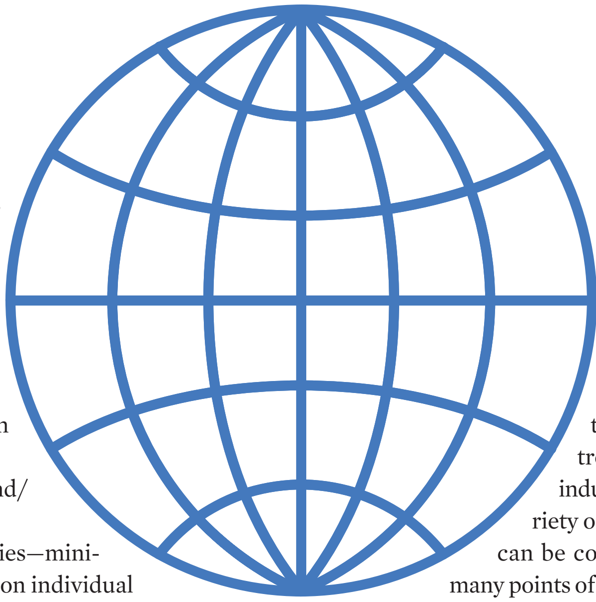
- Economic growth and population change are forecast to vary significantly by country over the next 40 years.
- Insurance penetration is currently very low in a number of developing countries; if this changes significantly, it will drive a large change in insured losses.
- Losses are related to these factors, and thus the risk diversification picture will change over time.
- New peak zones will emerge.
- The cost of financing risk will be affected, as it was in Florida.

It is important to note that if insurance penetration increases, insurance costs will grow much faster than GDP.

Loss Mitigation

Perhaps the most significant implication of the impact that demographic trends will have on insurance costs involves the investment in loss mitigation.

Traditionally, building codes have been focused on life safety and/or protection of property in single buildings based on current demographics (or climate conditions). Standards have been developed by engineers, often with relatively little focus on the economic value of mitigation activities in a macroeconomic sense. While building codes are concerned with the structure's



resistance to loss over its lifetime, the issue generally is considered an engineering problem. Few, if any, codes explicitly consider both the current and future cost of risk financing as an economic problem.

There are three lenses through which loss mitigation activities can be viewed:

- Life Safety—preventing injury and/or death.
- Protection of Individual Properties—minimizing the potential for damage on individual structures, such as an ability to withstand x m/s wind at a location. The focuses include structural integrity and degree of loss.
- Management of Overall Economic Impact—focusing on damage to the economy and community resilience, which implies that the size of the potential loss in an area should affect the wind engineering standard at a location, and further that the potential of future losses in an area is reflected in the appropriate standard today. Put simply, risk must be considered across both space and time.

To see how an economic mitigation standard could be developed, assume that the economic value of mitigation is equal to the present value of expected savings in insurance costs over the life of the building. Then assume that:

- Insurance costs are a function of expected loss, operating expenses, and a "risk load" to allow for needed profit and the cost of risk transfer.
- Expected loss and expenses can be estimated over time by adjusting tools like catastrophe models.
- Risk load is affected by overall risk concentration.
- Large risk concentrations carry a higher risk load.

It follows that insurance cost is a function of potential losses to both the individual building *and those around it*. Further, the economic value of mitigation must reflect the expected cost of risk transfer over the lifetime of the building, which will change as the diversification profile changes over time. This has significant implications for mitigation planning in countries like China. Additional mitigation investments are required for areas of high potential future growth, because of population or wealth or both. Had people been thinking this way in Florida in the 1960s, it is likely that the problems of the 1990s could have been reduced.

Future Climate Change

It is key to remember that the ultimate cost of building-code and land-use decisions should not be based on a static view of today's situation, but on a holistic view of the future building stock under a range of future conditions. Of course, no one can know with any degree of certainty what the population density or wealth of a community will be in 50 years. But it is entirely possible to build a range of such scenarios, which can be expressed stochastically.

Using exactly the same logic, one can envision a range of future climate scenarios that range from those of the global warming skeptics to those urging urgent action. Catastrophe models used by the insurance industry can be tweaked to simulate a variety of future climate scenarios, and these can be combined into a model that reflects many points of view with appropriate probabilities.

Software used to develop insurer economic capital models could be applied to simulate a range of future states reflecting various demographic, climate, and land-use outcomes. By incorporating pricing techniques that reflect both expected losses and risk load, it would be possible to test various loss-mitigation strategies that address a range of future states. Such an exercise would help public policy planners properly balance costs and expected financial benefits in search of the optimal investment in loss mitigation.

Will History Repeat Itself?

The trends I discuss in this article will affect insurers, reinsurers, and governments. Insurers will see the cost of financing risk change over time because of large-scale demographic forces. If they operate in territories that move toward peak status, scrutiny will increase from reinsurers, governments, and rating agencies. They will have to adapt, but the requisite changes may take time to implement. Examples include information technology systems, information collection, internal controls, and pricing. Reinsurers and capital markets will need to provide significantly more capacity and focus underwriting attention on emerging markets. Governments will need to rethink their approach to building codes and loss mitigation. Mitigation strategies take a long time to implement, and their benefits can be slow to materialize.

While certain actors in the public policy arena may oppose stricter building codes for selfish economic reasons, the public backlash against leaders who are seen as having failed to prepare for problems can be unpleasant, as many in Florida have learned.

Take a moment to consider what locations globally exhibit several of the following factors:

- Significant catastrophe exposure (including flood);
- Potential for rapid population growth;
- Forecast of strong GDP/wealth growth in coming decades;
- Limited/incomplete modeling coverage (i.e., for flood);
- Missing data, such as detailed flood elevation maps or construction coding;
- Developing building codes and/or unclear understanding of current stock's condition;

- Low insurance penetration;
- A possibility of increased natural disaster activity due to climate change (rising sea levels are almost a certainty).

These are the type of problems that led to the difficulties in Florida. With the number of places in the world that have the same factors, insurers, reinsurers, and public policy planners must pay careful attention to trends and plan for possible changes before they occur.

Will history repeat itself? New technologies exist, such as catastrophe models, satellites, and the Internet, which should allow for better management of future insurance hot spots. Public policy planners can study the history of places like Florida to learn from others' mistakes. Regardless, China faces significant changes in coming decades, and thinking of the future today can improve the odds of avoiding adverse outcomes tomorrow.

When my colleagues and I were asked to write a paper for the NCCARF on the topic of how the insurance system could contribute to climate change adaptation, the expected answer was to provide premium incentives to build structures better able to withstand climate change.

When we examined the problem, it quickly became apparent that premium adjustments on insurance policies offered for one-year policy terms could not possibly provide proper incentives for loss mitigation against threats that might emerge over decades. But this did not lead us to conclude that the insurance system had no role to play in helping to support climate change adaptation or future demographic shifts. Quite the contrary, we realized that the insurance industry had a great deal to contribute by studying the nature of losses, the potential roles of public and private insurance systems, our experience in Florida, expected demographic change in Asia, and powerful tools already available in the insurance industry. □

RADE MUSULIN, a member of the Academy and an associate of the Casualty Actuarial Society, is chief operating officer of Aon Benfield Analytics Asia Pacific, based in Sydney, Australia. He has written extensively on public policy issues surrounding the funding of large natural disasters.

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