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The impact of climate change on insuring flood risk

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Abstract

"The potential consequences of climate change are profound, particularly on people in the less developed countries. The question is therefore not whether climate change is happening, but what to do about it. The answer lies in a double strategy. We need to reduce emissions of greenhouse gases, which will mean altering how we live and do business. We also need to realistically assess the implications of the changes that are already upon us and adapt accordingly."
(United Nations Environment Programme (UNEP, 2007))

This paper focuses on the second part of the 'double strategy', in particular on the implications of floods and how we can adapt. The US National Academy of Sciences has stated that the Earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with accelerated global warming during the past two decades. It expected that such climate change will lead to rising sea levels and increased storm activity and greater rain intensity. Each of these factors will raise the risk of floods and the potential cost of the associated flood damage.

Flood cover is a particularly topical subject both in Australia and overseas. In June 2007, New South Wales experienced severe storms, which resulted in substantial property damage, including flood damage. Around a month later, the UK also experienced widespread flooding and the USA is still recovering from the impact of Hurricane Katrina in 2005.

Each of these countries currently has a different approach to the provision of insurance cover for flood damage to property. Our paper will set out the current approach adopted by insurers across the world and provide a discussion of the benefits and drawbacks of each of these approaches.

Our paper will draw together consideration of types of flooding, ways to counter flood risk and the availability of flood insurance, as well likely future changes to flood experience.

We will use this information to present key focus points for insurers in Australia regarding their current approach to the provision of flood cover for insuring property.

Key words: Flood, storm, climate change, property, insurance, frequency, severity

1 Introduction

Globally, the economic cost of extreme weather and flood catastrophes is severe, and if it rises owing to climate change, it will hit poorest nations the hardest. From 1971 to 1995, floods affected more than 1.5 billion people, or 100 million a year; of those, 318,000 people were killed and more than 81 million left homeless. Additionally, the number of major flood disasters has risen relentlessly over recent time. There were six in the 1950s; seven in the 1960s; eight in 1970s; eighteen in the 1980s; and twenty six in the 1990s.

Flooding affects more people on an annual basis than any other form of natural disaster, so why is flood insurance cover not readily available in many areas across the globe?

This paper attempts to answer this question by considering:

- the background to the concept of climate change caused by global warming
- types of flooding
- ways to counter the risk of flood
- responsibilities for minimising flood risk
- whether floods are an insurable risk
- how floods are measured
- how flood insurance cover varies across the globe.

We also focus on potential changes to flood risk in Australia owing to climate change, covering:

- how changes in flood risk occur
- the economic cost of flood risk
- the observed increasing number of floods
- the insurance of flood risk.

We conclude with the progress of nationally consistent flood mapping and a minimum standard definition of flood, and the appropriate actions that should be rapidly progressed by key players to respond to increasing flood risk.

2 Background on climate change

The possibility that mankind could be responsible for global warming was first noted in 1896 by a Swedish scientist Svante Arrhenius. Arrhenius concluded that as humanity burned fossil fuels such as coal, which added carbon dioxide gas to the Earth's atmosphere, the planet's average temperature would rise.

In the 1930s it was realised that the USA and North Atlantic region had warmed significantly during the previous half-century. Scientists believed that this was just a part of a natural cycle, with unknown causes. A lone voice, the amateur scientist, G.S. Callendar, insisted that greenhouse warming was on the way.

In the 1950s, Callendar's claims provoked a few scientists to look into the question of global warming. This was made possible by a significant increase in government funding, especially from military agencies that had Cold War concerns about the weather and the seas. The new studies showed that carbon dioxide could indeed build up in the atmosphere and should bring warming. Measurements confirmed this by 1961, showing that the level of the gas was rising year by year. A 1967 calculation suggested that average temperatures might rise by a few degrees within the next century. Groups of scientists that reviewed the issue saw no need for any immediate actions, although they did draw official attention to the need for a greater research effort.

Since the 1970s international panels of scientists have warned that the world should take active steps to cut greenhouse gas emissions. The scientists' claims about climate change first caught wide public attention in the summer of 1988 which at that time was the hottest summer on record.

Over the last 20 years climate change has become an increasingly high profile issue both from a social and economic viewpoint. It’s not only the scientists and environmentalists who are concerned about climate change. Governments, politicians and the general public are also taking an interest in climate change. Many countries have signed up to global protocols, such as the Kyoto Treaty or are implementing national initiatives to reduce the output of greenhouse gases and carbon trading schemes are becoming increasingly popular.

Australia has enormous potential to suffer from impending climate change. More than 80% of its population resides within 50 km of the coast with increasing concentrations in regions already vulnerable to weather hazards (CSIRO, 2002). We believe that flooding is the most common and most costly natural disaster and that this is the main reason why the number of natural catastrophes costing more than $10m has been increasing since 1967.

3 Types of Flooding

Flooding can take many different forms and the majority of flood occurrences can be classified according to the types described below:

River flooding

If the volume of water flowing into the river systems exceeds the capacity of the channels, river flooding will occur. Some floods occur seasonally when winter or spring rains, coupled with melting snows, fill river basins with too much water, too quickly. Unexpected heavy or prolonged rainfall can also produce river flooding. Rainfall saturates the soil, and as a result, an increased proportion of the rain falling flows straight into the watercourses and in turn into tributaries and then the main river channels.

Examples of river flooding were observed in NSW in June 2007 and across many areas in the UK in July 2007.

Figure 3.1 - Flooding at Ross on Wye, UK

(BBC News website)

Storm Surge

Storm surge is caused by a combination of storm systems and high tides. Storm force winds drive seawater against the coast. When this is coupled with high tides and large waves, huge quantities of water amass along the coastline and can result in large areas of land being flooded. The damage caused by storm surge can be exacerbated by the failure of flood defence mechanisms, such as dikes and levees, which are often erected along large water channels to allow the adjacent land to be used for housing or agricultural purposes.

One of the worst cases of storm surge experienced occurred in Europe in 1953. The worst affected areas were the East coast of England and The Netherlands. The floods caused extensive property damage and over 1,800 people perished. More recently flooding due to storm surge was seen in the USA in 2005 when Hurricane Katrina caused flooding across a wide area, particularly in New Orleans where levees failed.

Figure 3.2 - Satellite photograph of Hurricane Katrina

(NOAA Satellite and Information Service)

Tsunami

Coastal flooding can also be produced by tsunamis. These are waves produced by earthquakes or volcanic activity on the seabed. Such activity can trigger extremely fast moving waves, which reach shore in the form of enormous breakers.

A recent devastating example occurred on 26 December 2004. A magnitude 9.3 earthquake ripped apart the seafloor off the coast of north western Sumatra. This earthquake set off a devastating tsunami that travelled thousands of kilometres across the Indian Ocean. It took the lives of more than 200,000 people in countries as far apart as Indonesia, the Maldives, Sri Lanka and Somalia and caused extensive property damage.

Flash flood

A flash flood can occur anywhere and is the most frequent type of flood. It is caused by very high intensity rainfall over a period of several hours. Under these conditions, the ground is unable to absorb a high proportion of the rain falling and the water simply runs off along the surface. As land is converted from rural to urban usage, it loses its ability to absorb rainfall. Urbanisation can increase water runoff to two to six times above what would be expected to occur on natural terrain. During periods of urban flash flooding, streets can become swift moving rivers, while basements can become death traps as they fill with water and sewer systems can overload bringing health risks.

By way of example, in the USA Texas is currently suffering its wettest year for more than 100 years. During 2007, 40 people have died there in flash flooding incidents. This equals the record high set in 1989.

Groundwater

When the groundwater level is relatively close to the surface, changes in rainfall patterns over a long period of time, extreme rainfall over a short period of time and/or seepage from nearby watercourses can raise the water table. A rise in the water table can lead to basements being damaged by water seepage and the destabilization of building foundations.

Dam burst

Large water reservoirs are created by building dams and put the areas lying below them at risk of flooding should a failure of a dam occur. The failure of a dam can occur as a result of high intensity rainfall, landslides, subsidence or defects in the structure's design. It should be noted that most failures occur during the construction phase or shortly afterward and therefore the risk of flooding declines significantly a few years after a dam becomes operational.

For example, in February 2005 five villages were washed away and over 70 people lost their lives when the two year old Shadikor dam burst near Pasni in Pakistan. Another such occurrence was in March 2005 when torrential rains and melting snow caused the Band-e-Sultan dam, which was three years old, burst in south-eastern Afghanistan killing at least six people and causing widespread devastation. Thousands of hectares of land were washed away and hundreds of homes and shops were destroyed.

Mudflow

Mudflows or mudslides are caused by heavy rain saturating loose soil on a slope leading to a combination of landslide and flood. Mudflows often occur in combination with flash floods or river flooding. A "lahar" is the name given to a mudflow which occurs on a volcano. Heavy rainfall can result in the ash from a recent eruption being transported downhill as a mudflow.

One of the best known examples of a mudflow occurred in Switzerland in 1987 as a result of heavy storms. Numerous mudflows occurred throughout the Alps causing hundreds of millions of dollars of damage.

Ice Jam

Floating ice can accumulate at a natural or man-made obstruction and ice build ups, called ice jams, can temporarily stop the flow of water. When such ice barriers break up flood waves can be triggered causing flooding downstream. Losses are often avoided as modern technology allows ice jams to be broken up artificially before water accumulates to dangerous levels.

4 Countering the risk of flood

If global warming leads to rising sea levels and increased storm activity, it follows that it has the potential to increase both the frequency and severity of many of the types of flooding mentioned in the Section 3. As a result, it is increasingly important to resolve the issues relating to flood insurance.

Although often a flood can be assigned to a single event type as described in Section 3, on many occasions a combination of flood types and other natural hazards such as hurricanes, hailstorms and earthquakes may have occurred. In these circumstances, problems with insurance cover can arise if some occurrences are covered, but others are not.

This paper focuses on the impact of climate change on insuring flood risk, but it is worth bearing in mind that insurance is just one way of dealing with the risk of flooding. There are a wide range of other methods that can be used to minimise the risk of flood. The most common of these methods are described below, with details of the bodies responsible for minimising flood risk.

4.1 Methods of minimising flood risk

Avoiding development in areas at risk

This is the simplest method that can be adopted for reducing flood risk. It involves avoiding the settlement of areas at high risk of flood. While it does not reduce the flood risk for existing development, it can be used to minimise flood risk for new areas of development.

There are various reasons why this is not the best or most practical method to adopt. Settlement of river plains is attractive. The land is often well suitable for agricultural or commercial use and can provide a desirable location for dwellings. There is a ready supply of water and the river system can be used for transportation purposes.

It is interesting to note that despite extensive flooding during the summer of 2007, the UK government has not ruled out using flood plains under plans to build three million new homes by 2020.

Modifying construction and design

Modern technology allows the construction and modification of buildings such that they have a greater capacity to withstand inundation by water:

- modified construction techniques can be used to minimise flood impact for new constructions
- existing properties can be relatively easily and inexpensively upgraded to resist flood damage and be more quickly habitable after a flood event.

A good example of property modification is the flood proofing of a house which had been flooded several times. The property was made almost "flood resistant" by an insurance company and a council in the UK during 2005. Norwich Union and Norfolk County Council pioneered new protection measures against flood damage. The measures taken included the installation of flood gates and one-way valves to prevent sewage build-up. The main kitchen appliances were raised on plinths and MDF kitchen units were replaced with steel alternatives. Tiles were also installed to replace carpets and the walls and skirting were replastered up to one meter above floor level to limit the dampness seeping into walls.

Norwich Union estimated that by putting in flood-proof solutions, which typically cost between £10,000 and £30,000 per property, the cost of repairs in the event of a flood could be reduced from about £49,000 to as little as £8,500 and the time it takes for a property to become habitable again could be halved.

Flood barriers

Flood barriers include the use of dams, dykes and levees and other systems for preventing water inundation. Relief watercourses and improved drainage and sewage systems are other type of flood protection measures that can be taken.

The Thames Flood Barrier, which was opened in 1984, is London's primary defence against flooding. The final cost of building the barrier was approximately £535 million (valued at £1300m at 2001 prices). Central government met 75% of the approved costs and ratepayers were responsible for the remainder.

The barrier gates are closed when high tides and or storm surge threaten flooding in the Thames. Up until 1990, the number of barrier closures was one to two per year on average. Since 1990, the number of barrier closures has increased to an average of about four per year. In 2003 the Barrier was closed on 14 consecutive tides.

Early warning systems

Losses from flood can be reduced if early warning systems are implemented, allowing movable property to be taken to safer locations before flooding occurs.

An example of an early warning system is the Tsunami Warning System (TWS) in the Pacific, established in 1965, comprises of 26 participating international Member States and has the functions of monitoring seismological and tidal stations throughout the Pacific Basin to evaluate potentially tsunami generating earthquakes and disseminating tsunami warning information. The Pacific Tsunami Warning Centre (PTWC) is the operational centre of the Pacific TWS, located near Honolulu, Hawaii. PTWC provides tsunami warning information to national authorities in the Pacific Basin.

Insurance

Insurance is a very important method of dealing with the costs of flooding. This method is explored in more detail in later sections of this paper.

4.2 Responsibilities for minimising flood risk

Responsibility for implementing the various methods of minimising flood risk described in Section 4.1 lies with four main groups, namely:

- the Government or State
- insurance regulators
- insurance and reinsurance companies
- individual property owners.

To achieve an optimum risk reduction strategy all these groups must play a part. Ideally, the responsibilities would be as follows:

Government/State

The main responsibilities of the Government or State are to invest in flood prevention measures and early warning systems, disseminate appropriate information and provide an economic safety net for the population who suffer losses.

It is also the responsibility of the Government or State to design and enforce building regulations or standards for the construction of new properties and repair to flood affected properties.

Insurance regulators

The insurance regulators are responsible for ensuring that insurers are supervised such that their commitments to policyholders have a high probability of being fulfilled.

It is the regulators' responsibility to monitor flood insurance pricing and provision of cover.

Insurance and reinsurance companies

Insurers and reinsurers can provide flood cover. They have a responsibility to ensure that flood insurance is appropriately priced to reflect flood risk and flood protection measures taken by the policyholders. Insurers also have a responsibility to encouraged and helped policyholders to protect their property by taking appropriate flood prevention measures both before and after a flood claim occurs.

David Smith the CEO of Zurich Australia was quoted in August 2007 as saying

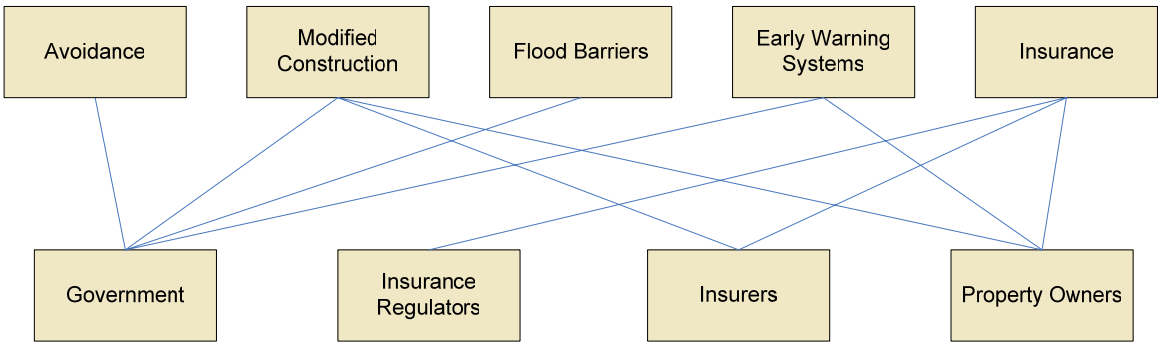
"The community will, and I believe already is, increasingly looking to insurers – and rightly so – to play a greater role in restoring their clients to their pre-disaster position. Traditionally the general insurance industry has congratulated itself on handing over a cheque – paying the claim is where we saw our obligation ending. With the strong likelihood of major disasters through global warming this is no longer enough."

Individual property owners

Each property owner has responsibilities to ensure that they have the appropriate insurance cover where it is available, to protect their property in order to minimise the risk of flood and act appropriately in response to early warning systems.

The diagram below illustrates the distribution of responsibilities:

Figure 4.1 – Distribution of responsibilities for flood risk



5 Flood insurance cover

Insurance coverage for flood damage to property varies around the world. In this section, we discuss whether floods are an insurable risk, how floods are measured and how flood insurance cover varies in Australia, the UK and the USA. In Appendix B, flood insurance cover worldwide is summarised.

5.1 Are floods an insurable risk?

To understand whether a risk is insurable we must consider the basic principles of insurance. In "Floods – an insurable risk?", 1998 Swiss Re give consideration to this very question by looking at the six key principles of insurance as defined by Gruss.

These six principles, along with commentary on their relevance to flood insurance are as follows:

- **Mutuality**

  A large number of people who are at risk must combine to form a risk community.

  The proportion of property at risk from serious flooding in most countries is small, typically less than 1%. As a result the size of the community at risk and requiring flood insurance is often considered too small to allow an economic solution to the provision of flood insurance. However, a co-operative approach can be taken where all household insurance policies include flood cover. Then insurers can include a higher premium for those properties at increased risk of flooding, but incorporate a subsidy as a result of spreading the expected cost of flood risk across a large number of policyholders.

  Importantly, if as a result of climate change, the proportion of the population at risk of flooding increases, it will make insurance a more and more viable option.

- **Need**

  When the anticipated event occurs, it must place the insured in a condition of financial need.

  Despite the proportion of property at risk being small, there is a very real need for flood insurance as flooding often causes considerable damage.

- **Accessibility**

  The expected loss burden must be assessable in order for a viable insurance system to operate.

  Small scale floods occur reasonably frequently and statistical analysis of the resulting losses is possible. However it is more difficult to assess catastrophe losses associated with flood. Statistics are often unreliable, the frequency of loss is relatively low and

accurate up-to-date flood maps are not always available. If extensive flood mapping is undertaken, such as in the UK, the risk becomes well understood.

- **Randomness**

  The time at which the anticipated event occurs must not be predictable and the occurrence must be independent of the will of the insured.

  Flood occurrences are generally accepted to be independent of the will of the insured and some degree of randomness occurs in flood losses, particularly when considering the less frequent catastrophe losses. Some natural occurrences are predictable; for example El Niño is known to occur every 3 to 7 years and the force of any event can be predicted to some extent by analysing sea surface temperatures.

- **Economic viability**

  The community of insured people must be able to cover its future loss related financial needs on a planned basis.

  When a flood occurs in an area of high population density, the resulting losses can be enormous and it is possible that the economic viability of a region is threatened.

  In the UK, an agreement that exists between the government and insurers to allow the provision of insurance to be economically viable as a result of the minimisation of flood risk through government implement strategies.

- **Similarity of threat**

  The insured community must be exposed to the same threat and the occurrence of the anticipated event must give rise to the need for funds in the same way for all concerned.

  As discussed in Section 3, flooding can occur as a result of a wide variety of different events. However similarity of threat exists to the extent that all losses occur as a result of water damage.

We agree with Swiss Re's conclusion that the three principles which are the most serious potential barriers to creating a viable flood insurance system are mutuality, accessibility and economic viability.

Despite these apparent barriers, we believe that flood is an insurable risk. A few countries do have a flood insurance system that works well, but many more have systems that provide only limited or no insurance cover.

This situation is likely to remain unchanged as long as flood insurance is only an issue for those at risk of suffering losses and the premiums of a small number of policyholders have to cover all losses. For a viable insurance system to be established the government/state and insurance industries need to work together to:

- highlight threat of flood and increase risk awareness
- promote a co-operative approach to spreading risk between those at high risk and those at almost no risk.

We believe that climate change has the potential to influence the provision of flood insurance, as the population at risk increases and that insurance will be seen as more viable solution to dealing with the effects of flood risk.

5.2 Measuring floods

A flood event criterion commonly used in flood risk assessments is the 100 year ARI or the 1% AEP, where the Average Recurrence Interval (ARI) and the Annual Exceedance Probability (AEP) are defined by the Australian Government Bureau of Meteorology (BOM) as:

ARI "*the average, or expected, number of years between exceedances of a given rainfall total accumulated over a given duration"*

AEP "*the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year*."

With ARI expressed in years, a conversion table can be created from the following relationship:

$$AEP = 1 - \exp\left(\frac{-1}{ARI}\right)$$

Table 5.1 – Conversion table for flood measurements

ARI (years)	1	2	5	10	20	50	100
AEP	0.632	0.393	0.181	0.095	0.049	0.020	0.010

It can be seen that ARIs of greater than 10 years are very closely approximated by the reciprocal of the AEP.

The BOM provides the following example of statements which are equivalent:

- rainfall totalling 159mm falling in 3 hours at the Darwin Regional Office has a 1% probability of being equalled or exceeded in any one year (AEP terminology)

- rainfall totalling 159mm in 3 hours has an average recurrence interval of 100 years (ARI terminology).

These statistics can be used to estimate the risk associated with occurrence of floods within the design life of a structure.

Implicit in most analyses of flood risk is the assumption that the general climatic conditions do not vary and that evidence of the past is a reliable indicator of potential future conditions and flood events. The recent publicity regarding the influence of climate change indicates that this assumption may not be valid and that potential climatic changes may need to be incorporated into future flood risk assessment. However, at present there is no strong evidence to justify the inclusion of potential changes in assessments of flood risk and it is not possible to quantify the magnitude of potential climatic and streamflow changes. This situation may change in the future.

The risk of flooding may also change over time due to changing development conditions within a catchment. One of the most dramatic potential changes to a catchment is urbanisation of part, or all, of the area. As discussed earlier urbanisation generally increases the volume of runoff, flood peaks and flow velocities while decreasing the delay between the storm event and related flood. On the other hand, measures such as farm dam construction and soil conservation measures may reduce the flood risk by reducing or diverting the flood flows.

The flood risk at any specific location is, therefore, not a constant risk, but rather a risk that varies with time as both climate and development within a catchment change.

5.3 Insurance cover in Australia

This section will start with a summary of the flood insurance system in Australia and then provide some additional detail on the June 2007 flooding in New South Wales.

5.3.1 Flood insurance system in Australia

Approximately $1,500 billion of Australia's wealth is locked up in homes, commercial buildings, ports and other physical assets (ABS, 2002). This is equivalent to nine times the current national budget or twice our gross domestic product. The insurance industry currently underwrites the risk to the bulk of these assets from weather events, but climate change is threatening its ability to do so as effectively in the future. Therefore, the effect to Australia from climate change is quickly becoming a social, economic and political issue.

Generally Australian insurance contracts cover damage caused by "rainwater" where "rainwater" means:

"rain falling naturally from the sky including rainwater run-off over the surface of the land and including rainwater overflowing from stormwater drains and channels."

This definition does not, on the face of it, cover many of the types of flooding described in Section 4 above. Most notably flooding from river flooding or storm surge are not covered by this definition.

In Australia the law states that insurance companies are required to tell household and commercial policyholders whether or not they are prepared to cover the policyholders' property against flood damage and this must be done before a policy is taken out or renewed.

If such notification is not provided then the insurance company must pay for flood damage. This is called Standard Cover.

In Australia, flood cover is typically excluded from personal building and contents insurance contracts, but may be provided as part of a commercial property insurance policy. One common definition of flood used in Australian insurance contracts is:

"the inundation of normally dry land by water escaping or released from the normal confines of any natural watercourse or lake (whether or not altered or modified) or of any reservoir, channel, canal or dam."

The IAG Sustainability Report 2005 summarised the issues in Australia as follows:

The lack of affordable and consistent flood insurance is one of the biggest issues facing Australian communities. It's a challenge that we have begun tackling but it is one that is fraught with complexity. Although the issue poses a significant reputation risk to insurers, we believe it is a whole-of-society issue affecting local communities, governments and insurers.
In the past, flood insurance has not been provided for one simple reason - insurers have not been able to determine the flood risk to individual homes. Understanding this risk is essential to be able to set a premium.

Unlike car insurance, where risk can be determined by such factors as car make and model, there is no commonly collected information for properties that can help insurers assess risk. Each home's risk is determined by its individual location relative to a flood plain. Until recently, data technology was not available to cost-effectively develop flood risk models.

The annual cost of insuring a home against flood would vary significantly depending on its location - from virtually nil to thousands of dollars.

There is no cover for all types of flood because of difficulty in providing affordable premiums when the risk of flood is known to be high - there comes a point where enough premium simply could not be charged to cover the cost of claims without being prohibitively expensive, forcing up the cost of insurance for all other customers.

Our most recent assessment puts 160,000 Australian homes at risk of a one-in-100 year flood. Some homes lie in places where the flood frequency could be higher than one-in-20 years. We have concerns over the fact that approval was given for the construction of these homes in the first place. However, as they now exist, community-minded insurers such as ourselves, must look to how to provide affordable flood cover to their residents.

The basis of all Australian flood risk assessment is data. Streamflow data, collected primarily by Statutory Authorities and meteorological data, collected by the Bureau of Meteorology. These data benefit many parts of society and, in the area of flood risk assessment, they are essential for the determination of the flood risk. Lately there has been a reduction in data collection programs thereby reducing the quantity of data available for assessment of flood risk. To assist the assessment of flood risk, we believe that data collection should be increased, not decreased, so that appropriate information is available to assess the flood risk of individual properties.

5.3.2 NSW floods 2007

The 2007 storms started on Friday 8 June 2007 and caused extensive flooding, damage and loss of life in the Hunter Region and the Central Coast in New South Wales in Australia.

Ten deaths occurred at the height of the storms on the 8 and 9 June. Rainfall exceeded 300 mm in the Hunter region and 200 mm in parts of the Central Coast and Sydney. New South Wales Premier Morris Iemma declared a natural disaster for the affected areas. Nearly 6,000 State Emergency Service volunteers, including crews from across New South Wales, ACT and Victoria worked in the area and responded to over 10,000 calls for assistance. At one point, more than 105,000 homes were without power.

A bulk carrier, the MV Pasha Bulker, was beached at Nobbys Beach at Newcastle after it failed to follow a warning to move out to sea to escape the approaching storm. In Sydney, ferry services were cancelled for two days as gale-force winds produced swells up to five metres and Cremorne Point wharf collapsed.

On the evening of Sunday 10 June, approximately 4,000 residents in the Hunter Valley including residents of central Maitland, South Maitland and Lorn were forced to evacuate their homes in anticipation that the Hunter River would breach its levee. Evacuation centres were set up at East Maitland and Maitland High School. However by the morning of the 11 June the flood water had peaked without breaking the levee bank.

In a media release made on 25 July 2007 the Insurance Council of Australia stated that the total number of insurance claims received by the general insurance industry as a result of the storms in NSW on 8-11 June was 63,000 and that the total cost of the claims was estimated to top $750 million. This estimate represents a significant injection of funds by insurers back into the effected regional economy in the Newcastle, Hunter and Central Coast regions.

The Chief Executive of the Insurance Council of Australia, Kerrie Kelly was quoted as saying:

“When the current claims figures are broken down it is clear that the most affected by the storms are householders with 65% of the claims relating to residential property. The next largest related to commercial property accounting for 19% of claims, then vehicles at 12% and a smaller group including rural, marine and industrial at around 4% of total claims to date.”

“Early estimates based upon applications for government relief are that 1 in 5 people affected by this storm event had no insurance cover at all. This initial assessment of non-insurance in NSW resonates with research commissioned by the Insurance Council of Australia that shows 26% of all NSW households do not have any form of home and contents insurance,”

The Insurance Council expects claim costs to continue to increase over the coming months as the more complex commercial and industrial claims are finalised.

The 2007 storm and flood is considered to be the second most destructive in Hunter Valley history after the 1955 Hunter Valley floods.

Figure 5.1 - Floodwaters cut a Central Coast road in the June 2007 flood

(NSW SES)

5.4 Insurance cover in the UK

This section will start with a summary of the flood insurance system in the UK and then provide some additional detail on the July 2007 flooding across England.

5.4.1 Flood insurance system in the UK

In the UK household insurance includes flood cover. The Association of British Insurers (ABI) members have agreed on three categories of insurance provision, based on the annual statistical chance of flooding in a given area and local flood defence investment plans:

- low where the chance of flooding each year is 0.5% (1 in 200) or less
- moderate where the chance of flooding each year is between 0.5% (1 in 200) and 1.3% (1 in 75)
- significant where the chance of flooding each year is greater than 1.3% (1 in 75).

In Low and Moderate areas, ABI members offer flood cover in the normal way on buildings and contents policies to homeowners and small businesses. In Significant areas where no improvements in permanent defences are planned or feasible, insurers will not guarantee to provide cover in all cases.

However, where there is a history of flooding insurers use their best efforts to work with policyholders to establish on a case-by-case basis, what action they, the Environment Agency and the Local Authority can take to enable cover to be continued. This may include, for example, temporary barriers which are deployed prior to flooding or measures that homeowners can take to reduce damage such as removable household flood products which homeowners can buy and fit themselves to protect their property or construction materials to reduce damage if the house is flooded.

In contrast to Australia, most household insurance policies include flood cover in the UK. The main reason that flood cover is available in the UK is an agreement between the government and insurers exists. The insurers will continue to provide cover on the understanding that the government will implement strategies such as those described in Section 4.2 to minimise flood risk.

In 2000 insurers warned the UK government that they not provide cover for property in flood prone areas unless flood defences were improved and building protection made more efficient and effective. A two year plan was agreed, but is remains an issue.

5.4.2 July 2007 floods

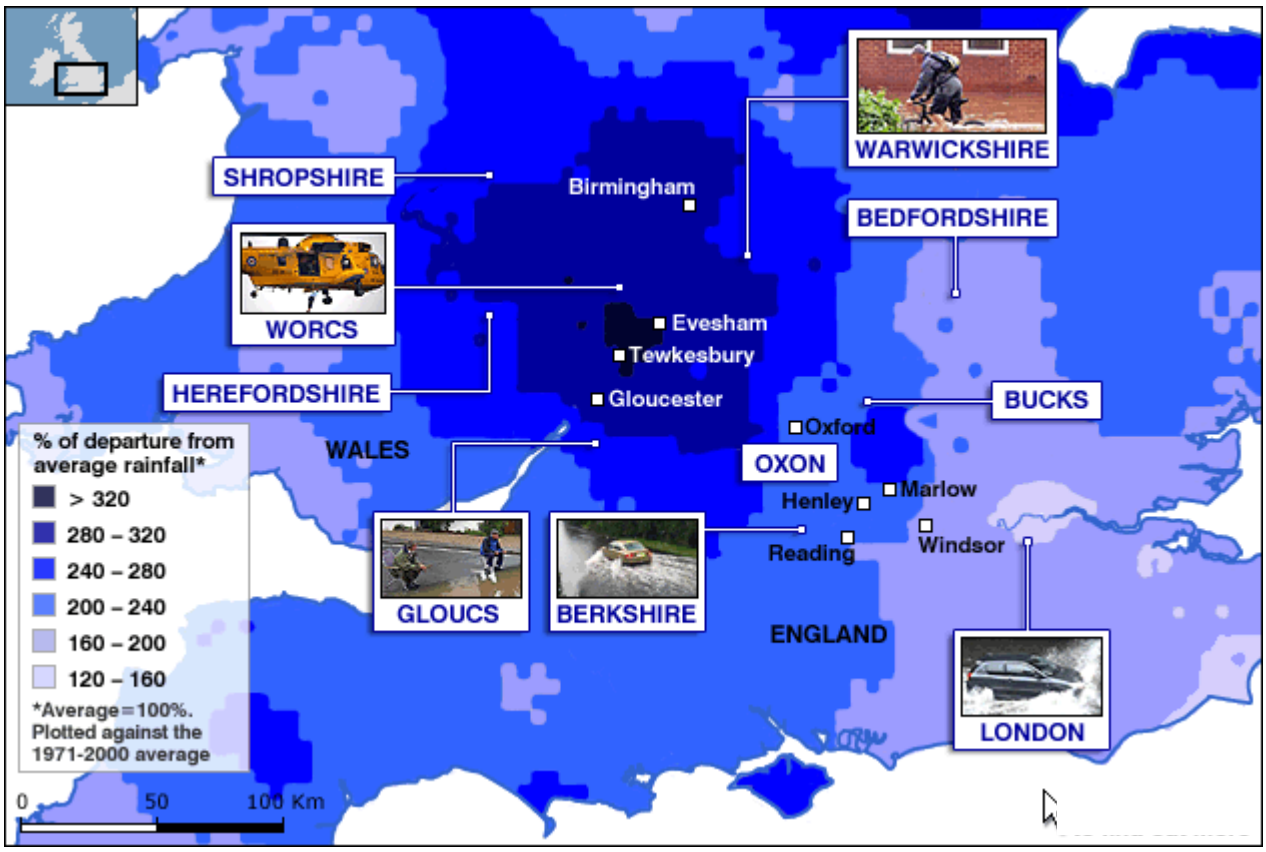
Following widespread flooding which caused about £3bn worth of damage in July 2007 the ABI has proposed that the UK government needs to do more to protect against floods. The BBC has reported that in a letter to Environment Secretary, the ABI raised concerns that even normal rainfall could lead to further widespread flooding.

While the ABI has welcomed plans to bolster the UK's flood defences, it also wants a review of how to solve the problem. According to the ABI, the UK government needs to spend £150m more on flood defences than it has already earmarked, since some defences will have been put under great pressure in recent events and will need to be checked and possibly strengthened, and some drains and watercourses were blocked due to inadequate maintenance. This led to some flooding taking place in areas not identified as being at risk. The ABI believes that an urgent review is needed of how best to maintain urban and rural drainage that should include whether expenditure is adequate, and how to co-ordinate better modelling of flood risk and planning of alleviation measures.

It is interesting to note that in the aftermath of the UK’s worst floods for many years, the government has not ruled out using flood plains under plans to build three million new homes by 2020.

Following the 2007 floods, the UK government has formally applied to the European Commission for money to help deal with the floods crisis which hit parts of England. The government has lodged an application for support under the European Union Solidarity Fund (EUSF) for coping with natural disasters. The likely EUSF donation has been put at between £60m and £125m. The EUSF is particularly aimed at helping countries cope with the uninsurable costs of natural disasters, such as cleaning up and restoring infrastructure. The minimum cost of damage has to be above £2.2bn before an application can be considered.

Figure 5.2 - Level of precipitation observed in the UK during July 2007



(BBC News website)

5.5 Insurance cover in the USA

This section will start with a summary of the flood insurance system in the USA and then provide some additional detail on Hurricane Katrina, which hit the southern states of America in 2005.

5.5.1 Flood insurance system in the USA

In the USA, flood damage is excluded under homeowner policies. The National Flood Insurance Program (NFIP) provides flood cover via the Federal Insurance Administration (FIA). Flood insurance is administered through insurance companies, but these companies do not accept any of the risk. No mortgage lenders that are federally insured or financed can lend money on a property in a flood plain zone unless the property is covered by flood insurance.

Flood insurance in the USA covers "*direct physical losses by flood and losses resulting from flood-related erosion caused by waves or currents of water exceeding anticipated cyclical levels and accompanied by a severe storm, flash flood, abnormal tide surge or a similar situation which results in flooding.*"

Buildings are covered for replacement cost, but coverage for personal possessions is available on an actual cash value basis only. Coverage for the contents of basements is limited. In 1993, 7,800 policies purchased at the last minute resulted in $48 million in claims against

only $625,000 in premiums. To prevent people putting off the purchase of coverage until waters are rising and flooding is inevitable, policyholders now have to wait 30 days before their policy takes effect.

The National Flood Insurance Act was amended in 1969 to provide coverage for mudslides. A further amendment in 1973 put constraints on the use of federal funds in flood plain areas unless the property was protected by flood insurance, a provision that was expected to make coverage in flood plains almost universal. However, because the initial mortgage on the property is frequently sold by the originating bank to another entity and flood cover, while required for initial financing, is not necessarily renewed each year, enforcement of this law has been poor.

The FIA pays losses in excess of premiums; sets the rates, coverage limitations and eligibility requirements; and designates flood plain areas. The NFIP is expected to be self-supporting (i.e. premiums are set at an actuarially sound level) in an average loss year, as reflected by past experience. In an extraordinary year, as Hurricane Katrina in 2005 demonstrated, losses can greatly exceed premiums. Hurricane Katrina losses and the percentage of flood damage that was uninsured have led to calls for a revamping of the entire flood program.

Flood plain maps are redrawn periodically in the USA. Increased development in and around flood plains can lead to changing run-off patterns and cause flooding in areas that were formerly not considered high risk. In addition, new technology enables flood mitigation programs to more accurately pinpoint areas vulnerable to flooding. Since the inception of the federal program, some 25 to 30 percent of all paid losses were for damage in areas not officially designated as flood-prone at the time of loss. A new report published by FEMA in 2007 suggests that development patterns should be changed to protect environmentally sensitive areas and that communities in the flood program should be encouraged or required to ban development in these locations.

More than 11 million USA homes are in what are deemed flood zones. Only about one in four homeowners who live in these areas purchase federal flood insurance from the NFIP. This low penetration rate is in part due to people underestimating the risk of flood. They tend to think the risk of flooding for structures in a flood zone is about the same as the risk of fire, when in fact it is much higher. According to a FEMA probability analysis, over the life of a 30 year mortgage, a property located in a special flood hazard area in a flood zone would have a 26 percent chance of being flooded, compared with a 1 percent chance of suffering a fire loss. The NFIP says that ninety percent of all natural disasters in the USA involve flooding.

5.5.2 Hurricane Katrina floods

Litigation surrounding Hurricane Katrina claims centres on two issues:

- who pays claims when a home is completely destroyed by a combination of water and wind? It is unclear whether it is the responsibility of any homeowners' insurance or any NFIP policy in place.

- can a distinction be made between flooding according to the cause? Natural events or human negligence such as a break in a levee attributed to poor design or engineering. Both could cause widespread flooding.

A federal appeals court in Louisiana has promised a decision on whether insurers are liable for flood damage when levees fail. In November 2006, a federal district court judge in New Orleans ruled that most flood damage exclusions in homeowners' insurance policies are ambiguous, because they fail to distinguish between flooding caused by natural events such as Hurricane Katrina and flooding caused by negligence.

When the language in insurance policies is ambiguous, it is usually construed in favour of the claimant. Insurers maintain that there is no ambiguity in the policies and that they clearly exclude flooding regardless of whether the cause of the flooding was the storm or negligence. The passage of flood insurance reform legislation through Congress is uncertain. Flood insurance reform bills were introduced in both houses of Congress in 2006. The House bill was passed but the Senate version was not. Similar legislation is being reintroduced in 2007.

The proposed reform would:

- cut costs by gradually eliminating the flood insurance subsidy for vacation and second homes as well as some commercial buildings constructed before the first flood insurance rate maps were drawn up
- maximum coverage limits under the program would be increased and more coverage options would be available
- raises penalties for mortgage lenders that do not enforce the law requiring flood insurance on properties in flood zones
- allow premium increases of up to 15 percent premium from the current 10 percent
- call for a study of expanding the scope of the program to cover properties in natural flood plains.

Insurers support reform of the flood insurance program, but some question whether the proposed increase in limits is enough. They would also like Congress to forgive the National Flood Insurance Program (NFIP) debt as 2006's Senate bill proposed, as well as reauthorize the program for a long term and, in an effort to shore up the NFIP, change FEMA procedures to ensure that disaster payments go to flood insurance policyholders before non-policyholders.

Uncertainty over the future of flood insurance reform is due to a proposal to add coverage for wind damage to the flood program and a provision that would require claims to be paid without regard to whether damage was due to wind or flooding.

Nationally, only 40 to 60 percent of those who are required to purchase flood insurance actually have policies in force. According to a Rand Corporation study conducted for the NFIP, nationwide about 49 percent of single family homes in special flood hazard areas (SFHAs) are covered by flood insurance. In the South and West the percentage is higher, about 60 percent. However, outside of the high-risk areas there is a steep drop off in coverage. Only about 1 percent of homeowners in non-SFHAs purchase it.

While the number of flood policies in force is growing, so are claims and although more people are buying flood insurance, the percentage is still dangerously low.

The study, "Availability and Affordability of Insurance Under Climate Change: A Growing Challenge for the U.S.", warns of larger financial losses in the years ahead if climate change trends continue and no actions are taken to face the challenge.

5.6 Summary of Australia, UK and USA

The table below summarises flood insurance cover available in Australia, the UK and the USA. Appendix B includes a summary additional for a variety of countries across the globe.

Table 5.2 – Flood insurance cover in Australia, the UK and the USA

Country	Flood Insurance
Australia	• Most private insurance companies do not provide flood cover for private households • Flood cover may be provided as part of a business contents insurance policy • Some state insurers provide flood cover for private households • Disaster aid compensation is paid from state funds with part reimbursement from the Commonwealth • Flood relief money is paid to local authorities for repairs to infrastructure and cases of personal hardship and emergencies • Insurance penetration is very low
UK	• Only private insurers provide flood cover – there is no state insurance • Cover is generally included in homeowners and household contents policies • Premium rates are broken down by postcode and are often high for storm/flood cover • Deductible are widespread but typically very low • Flooding due to dam burst is covered • Industrial cover includes business interruption • Insurance penetration is approx 95% for simple risks; 100% for industrial risks
USA	• The National Flood Insurance Program (NFIP) provides basic cover and is the only federal insurance scheme for national disasters • Additional cover is provided through private insurance companies • Insurance penetration for simple risks increased significantly after the Mississippi floods of 1993 as the sum insured jumped from USD 234 billion to 430 billion • Insurance penetration for industrial risks is high, although cover is often limited

(Floods – an insurable risk? Swiss Re 1998)

6 Changes in Australian flood risk

It is envisaged that there will be changes to flood risk in Australia owing to climate change. This section covers the ways in which climate change can affect flood risk, as well as the economic cost of flood in Australia. Subsequently, we discuss the observed increase in numbers of floods and the effect on insurance cover of flood risk.

6.1 How changes in flood risk occur

The effect of waves and currents

Any increased storminess would generate a more severe wave climate, i.e. larger waves would occur more frequently. Moreover, the principal direction of wave attack on the coast could also alter in response to changed patterns of storm generation. Increased coastal water levels would modify the shoaling, refraction and diffraction behaviour of waves as they move towards the shoreline.

The temperature of ocean and shelf currents is an important factor in storm generation and intensity. Where currents move close inshore they can also affect waterborne sediment transport and water quality. Changes to climatic zones and wind patterns could produce changes in ocean and shelf currents, which in turn could affect storm behaviour and sediment transport.

Shoreline position

If the climate change effect develops as postulated, the shoreline would move landwards because of two effects:

- inundation due to increased sea levels
- increased shoreline recession due to greater storminess, higher waves, increased sea levels and any changes to the direction of wave attack.

The second effect may be of far more significance than the first.

Bruun (1962) proposed a methodology to estimate coastal recession resulting from sea level rise. Gordon (1988) has suggested a tentative link between coastal recession in New South Wales over the past 40 years and increased sea levels over this period.

Sediment transport

Sediment transport falls into two categories:

- **Longshore Drift**
  Longshore drift is sensitive to long term changes in wave height and wave direction, both of which would be expected to be altered by climate change.

- **Onshore/Offshore Transport**
  The amount of sand removed from a beach and dune system depends upon a number of factors, the most important being the intensity and duration of storms. A possible increase in the severity and frequency of intense storm events associated with the postulated climate change effect would accelerate beach erosion.

Freshwater flooding

The severity of freshwater flooding may increase in some areas if greater intensities of rainfall eventuate. Areas may become prone to coastal inundation and freshwater flooding. The increased storm surge and wave setup at estuary and river entrances could also increase flood levels in the lower reaches of rivers.

6.2 Economic cost of flood

More than 80% of Australia's population resides within 50 km of the coast, concentrated in towns and cities along the coastal fringes of the east, south-east and south-west. Between 1991 and 1996, one quarter of Australia's total increase in population was concentrated within three kilometres of the coastline, predominantly within the "sun-belt" locations on the New South Wales and Queensland coast and in the south-west of Western Australia. This population growth means that the community's exposure to extreme events such as tropical cyclones, storm surges and flooding of rivers in deltas and other outflow regions, is growing rapidly.

Climate change may alter the severity of floods, though it is not yet possible to identify where this might occur. However, the potential impact of more severe droughts and floods can be examined.

Flood "return periods" (e.g. a 1-in-100 year flood) indicate the expected probability of a flood of a certain size, and are widely incorporated into land-use and development policies. Climate change may reduce the return period for floods. For example, the return period for a 1-in-100 year flood could be reduced to 1-in-25 years.

Table 6.1 below shows the results of a study of the economic cost of flood damage in the Hawkesbury Nepean river corridor in the west of Sydney. The study includes possible changes in future flood frequencies, although these estimates are highly preliminary. Nevertheless, the study shows that an increase in the magnitude of flood events would have significant economic costs through direct damage, for example, contact of flood waters with buildings and contents (CSIRO 1995).

Table 6.1 - Cost of direct flood damage, Hawkesbury-Nepean corridor

Current return period (years)	Future return period (years)	Residential damage ($m)	Commercial damage ($m)	Total damage ($m)
20	7	8.05	4.43	12.48
100	25	19.34	8.27	27.61
200	50	87.22	54.49	141.71
1,000	250	360.89	247.54	608.43
10,000	2,500	475.21	433.92	909.13

(Department of Environment & Climate Change NSW)

Floods are Australia's most common and most costly natural disaster type and, over the past three decades, the cost of all flooding in Australia has ranged between $2.5 and $4 billion per decade.

The overall cost of a flood is not simply made up of the personal, residential and commercial property damages. Other costs are incurred and can include the following:

- Emergency services
- Provision and distribution of supplies; including drinking water, food, clothing
- Repairs to infrastructure; including roads, bridges and flood defences
- Repairs to essentials services, including sewerage , water and electricity supplies
- Clean up costs
- Damage to business stock/supplies
- Business interruption costs; including lost revenue and wage costs

Areas at risk of flooding can be heavily populated. As mention is Section 2, more than 80% of Australia's population resides within 50 km of the coast with increasing concentrations in regions already vulnerable to weather hazards. Therefore, when a flood occurs a large number of people can be affected leading to high aggregate costs.

Flood loss can trigger claims on multiple insurance policies. This paper has discussed in detail insurance cover in respect to household and commercial property insurance, but flood can also give rise to claims on the following policies:

- Motor
- Theft
- Business interruption

6.3 Increasing number of floods

There is some evidence that the number of disasters per year, particularly floods and severe storms, is increasing as indicated in Figure 6.2. This is possibly due to any or all of:

- increased flooding owing to climate change
- better reporting in recent years
- increased population in vulnerable areas.

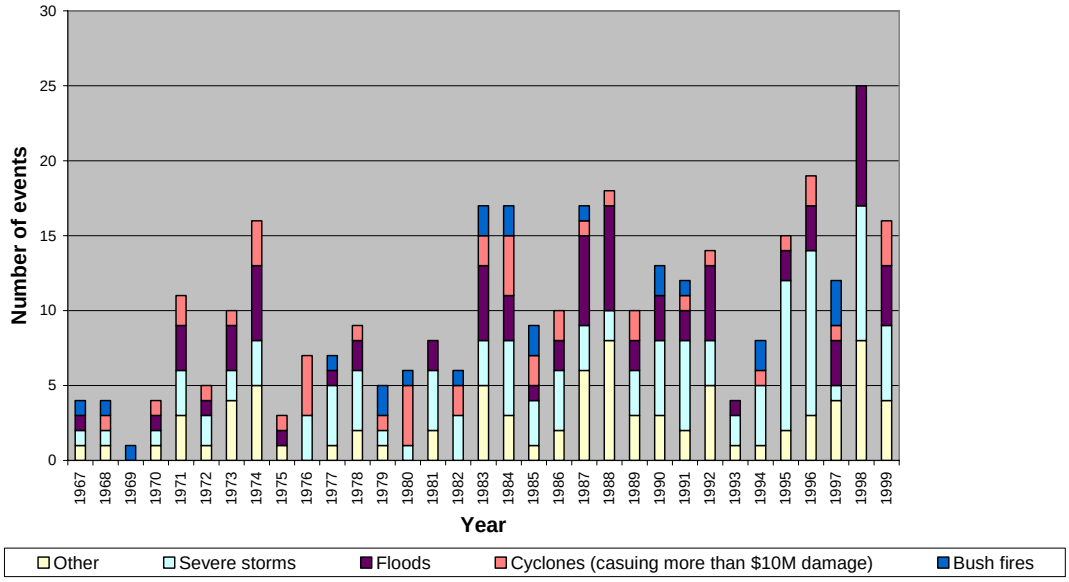
On average, the sea level in coastal Australia is rising. Globally, it is believed this observed rise has mostly been caused by the warming and therefore expansion of the ocean during the 20th century. There has also been a smaller contribution from the melting of ice caps and glaciers.

Global mean sea level is expected to rise by between 3 and 30 cm by 2040, and by between 9 and 88 cm by 2100. The range in the projections arises from uncertainties about future greenhouse gas concentrations and also scientific uncertainties regarding the magnitude of the various components.

Despite the large range of projections, this is perhaps one of the more confident projections of climate change science, in the sense that it is quite likely to occur. Nevertheless, its effects will only be noticed slowly. In contrast, most coastal damage due to elevated sea level is caused by extreme events, those rare floods or storms that increase the height of the sea and, when combined with wave action, erode the coastline in a short period of time. The interaction between chronic, incremental sea level rise and these acute events is important, as small changes in average conditions can lead to large changes in the frequency of extremes. Other local factors, such as land subsidence and geological processes, can also cause rapid sea level change in certain locations.

High rainfall associated with storms can cause flooding in coastal locations, leading to runoff events that may have an impact on coastal ecosystems. While there is substantial uncertainty regarding rainfall changes in a warmer world, it appears likely that the amount of rainfall per storm will increase, perhaps even if overall precipitation decreases at a location. Thus a combination of river flooding and high ocean levels seems more likely under a warmer climate. It is also likely that average streamflow in southern Australia will decrease due to reductions in rainfall and increases in evaporation due to higher temperatures, while streamflow in northern Australia is more likely to increase.

Figure 6.2 – Number of natural disasters in Australia, 1967 - 1999

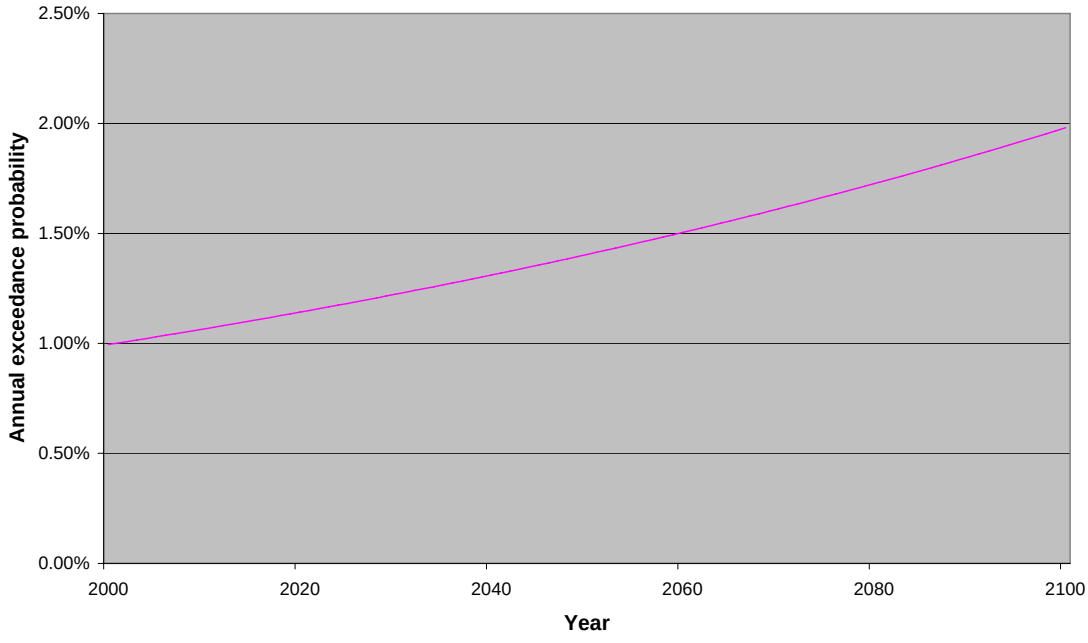


(Bureau of Transport and Regional Economics)

Increases in population in risk prone areas, combined with possible increases in storm intensities and rising sea levels, mean that the risks to life and property and cost of flood damage to the built environment and infrastructure will increase.

The graph below shows the projected increase in Annual Exceedance Probability (AEP), as described in Section 5.2, over the 100 year period from 2000 to 2100 for an area with an initial AEP of 1%.

Figure 7.2 – Projected increase in AEP



(Australian Government Bureau of Meteorology projection)

Increases in the intensity of the heaviest rainfall events would increase both flash flooding and the strains on water infrastructure such as sewerage and drainage systems, particularly in population centres.

More severe cyclones would increase the flood level associated with a 1-in-100 year flood in Cairns from the present height of 2.3 to 2.6 metres; a rise in sea level of 0.1 to 0.4 metres would result in the flood level increasing further to between 2.7 and 3.0 metres. This would result in flooding occurring over an area about twice that historically affected.

Over the past two years, half of the populated islands of the Torres Strait in far north Queensland have been hit by unprecedented flooding from surging king tides. The islanders can't prove that climate change is to blame for the tidal flooding or inexplicable shifts in the weather, but elders are baffled by what they are seeing. Although the flooding of the islands has gone largely unnoticed on mainland Australia, from 2008 it is set to become a globally reported issue.

According to the draft fourth Intergovernmental Panel on Climate Change report, written by the world's leading climate scientists and seen by the *Herald* before its official release in November 2007, the recent king tides exposed the need for better short-term coastal protection and long-term planning to potentially relocate up to half of the 4,000 people living on the islands.

Cut-off Lows, an intense low-pressure system that affects the east coast of Australia with flooding rains and damaging winds, have been shown to increase in intensity with climate change modelling studies (Katzfey and McInnes, 1996). In a separate study on flooding in the Hawkesbury/Nepean catchment, an area with an estimated 35,000 properties at risk from flooding (Gillespie et al, 2002), the return period for the 1-in-100-year flood event could be reduced to a 1-in-36-year event with the projected changes to climate (Schreider et al, 2000). This could increase average annual damages four-fold (Smith, 1998).

6.4 Insurance cover of flood risk

There are a number of factors the insurer must take into consideration before calculating an appropriate premium for flood risk. For example, when providing flood insurance for property, insurers must take into consideration various contributing factors, in order to assess the risk. These factors would include:

- location
- height of the land
- previous flooding in the area
- frequency of floods, severity of floods
- construction and design of the building
- various other factors.

The impact of climate change on insuring flood risk

Flood risk has become an escalating dilemma in terms of the provision of insurance cover. The insurance industry has had to manage flood risk at an accelerated rate, as flood risk is expected to increase in severity and frequency in the future:

*"The insurance industry will be the first to bear the cost of any increase in extreme weather events. It is likely to react by increasing premiums and expanding exclusions" (*Silver 2003)
"Unfortunately, global warming and the continued attraction of development in flat, low-lying, waterfront areas mean that the world's exposure to flood risk is increasing" (Fullalove 2003)

As a result insurance premiums will increase, as the volume and frequency of claims increase in the future. A trend of increasing premiums will not encourage individuals, industry and commerce to insure against such events.

7 Progress in Australia

Flood is a persistent risk in the Australian community that traditionally accounts for one third of natural hazard damage. As we have seen, there are several inundation risks captured by the term 'flood'. Community interest and focus on flooding has traditionally been restricted to rivers and creeks overflowing their banks due to long duration rainfall over large catchment areas. Flash flooding, a significant part of the residential flood risk, is produced by high intensity but short duration storms producing localised flooding conditions. Inundation risks related to storm surge and tsunamis are also flood risks faced, albeit to a lesser extent, by the Australian community.

In this section, we discuss the progress of nationally consistent flood mapping and the development of a minimum standard definition of flood.

7.1 Nationally consistent flood mapping

Development and maintenance of flood maps and how they impact upon the built environment is a role typically left to local government authorities and/or floodplain management authorities in each of the states.

In some instances there are highly accurate flood maps made available to the community and industry. Using these maps reasonable risk decisions can be made. In many other instances, no flood mapping is available, leaving a situation where local communities and insurers are unsure of the extent of the risk they face.

The general insurance industry is investigating the collective development of a national flood mapping tool. This tool will be employed by all insurers to test the risk applicable to an insured's property and enable the insurer to offer flood cover if the risk is within their own calibrated limits.

The development of flood maps will generate an environment where the predicted risk to all flood prone homes will be able to be understood, quantified and priced according to individual underwriting tastes. The insurance industry will also be in a position to work closely with government on those areas collectively identified as being at extreme peril and beyond the risk appetite of the insurance market. Such a mapping tool will also provide invaluable insight to government land use planners, emergency services, hydrologists and developers alike by accurately identifying on a national basis, to street address level, the known and predicted inundation risks to each community.

A key ingredient for the success of this project is the availability of and access to all current flood mapping and elevation data, in all its diverse forms. This information is currently held by government agencies. Government partnership with industry on this important initiative is therefore critical.

7.2 The Insurance Council's residential flood insurance project

In November 2006, following on from the considerable research and work undertaken by the general insurance industry on the issue of flood mitigation and management, the Insurance Council Board endorsed an approach for the industry to pursue a flood insurance framework. This framework will lead to residential flood coverage becoming available for nearly all households in Australia.

During 2006, the industry also reaffirmed its commitment to working in partnership with Governments to address the issues of flood mitigation and management. It was noted that flood remains a significant community issue that may worsen with the various inundation predictions arising from current climate change models. The Insurance Council believes a partnership approach with Government and the general insurance industry is needed to find ways in which community understanding of flood risk and its management can be increased. This includes flood insurance being made more widely available when the risk of flooding is reduced to an acceptable level through mitigation measures.

To reduce consumer confusion, in 2006 the general insurance industry has worked to develop a minimum standard definition of flood. It is envisaged that this standard definition of flood would be adopted, on a voluntary basis, by individual insurers and treated, by those who adopt it, as a minimum standard. i.e. Insurers would be free to offer coverage to a level above the standard definition, to the minimum standard, or as is the current situation not offer flood coverage at all.

The Australian Consumer and Competition Commission (ACCC) has advised industry that they need to consider for themselves any competition issues in relation to the application of the competition provisions of the *Trade Practices Act 1974* that may arise from their proposal to standardise definitions. A public interest authorisation process may be necessary.

The ACCC has made it clear to the Insurance Council that development of a standard definition for flood would be unlikely to raise concerns in itself, where insurers were otherwise able to continue to offer different levels of coverage, for example, should an insurer want to offer a different level of protection.

The general insurance industry also agreed on the need for the development of a consistent national flood mapping model, as discussed in Section 7.1. The primary obstacle to achieving greater market availability of residential flood cover, for the majority of households, is the ability for insurers to map, understand and price the risk.

8 Conclusions

Our conclusions are that there are particular actions for key players that should be progressed rapidly to appropriately respond to the increasing likelihood of severe flooding, as follows:

Governments

- foster and participate in public/private partnerships for risk spreading
- reduce disaster losses through improved planning and post-event response
- undertake a detailed assessment the government's overall financial exposure to changing patterns of weather disasters
- expand research on climate change and loss modelling
- issue climate change hazard maps
- take policy action to reduce greenhouse gas emissions.

Insurance Regulators

- review the "standards of insurability" to identify new challenges, domestically and overseas
- incorporate climate risks in solvency and consumer-impact analysis
- encourage insurers to collect and analyse more comprehensive data on weather related losses
- promote the practice of catastrophe modelling
- assess exposures of insurer investments and adequacy of capital and surplus to weather extremes
- explore the feasibility of developing a weather exposure questionnaire or survey
- identify and remove undue barriers to constructive insurer activities.

Insurers

- aim to improve loss data collection and enhance the actuarial analysis
- analyse the positive and negative implications of climate change on business, investments and customers, and share the results with shareholders
- promote and support advanced building codes, the "flood proof building" concept, and other construction tools to mitigate potential losses
- encourage policy holders to upgraded properties to resist flood damage
- engage in climate research and promote the use of scientific methods for enhanced climate modelling
- create an industry-driven activity improving on the climate change insurance working group that was briefly active in the mid-1990s
- lead by example in reducing their corporate climate footprint.
- encourage action to achieve reductions in greenhouse-gas emissions
- produce a minimum standard definition of flood
- develop a consistent national flood mapping model.

Property owners

- minimize disaster losses through upgrading properties to resist flood damage through the use of recognized pre-loss mitigation practices
- curb emissions that cause climate change, primarily by making cost-effective energy efficiency improvements and increasing the use of carbon-free energy sources.

Appendix A – Climate change

The Earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with accelerated warming during the past two decades. (US National Academy of Sciences)

There is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities. Human activities have altered the chemical composition of the atmosphere through the build-up of greenhouse gases—primarily carbon dioxide, methane, and nitrous oxide. The heat-trapping property of these gases is undisputed although uncertainties exist about exactly how earth's climate responds to them.

Energy from the sun drives the earth's weather and climate, and heats the earth's surface; in turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapour, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse.

Without this natural "greenhouse effect," temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems may arise when the atmospheric concentration of greenhouse gases increases.

Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulphate aerosols, a common air pollutant, cool the atmosphere by reflecting light back into space; however, sulphates are short-lived in the atmosphere and vary regionally.

Why are greenhouse gas concentrations increasing? Scientists believe that the combustion of fossil fuels and other human activities are the primary reason for the increased concentration of carbon dioxide. Plant respiration and the decomposition of organic matter release more than 10 times the CO_2 released by human activities; but these releases have generally been in balance during the centuries leading up to the industrial revolution with carbon dioxide absorbed by terrestrial vegetation and the oceans.

What has changed in the last few hundred years is the additional release of carbon dioxide by human activities. Fossil fuels burned to run cars and trucks, heat homes and businesses, and power factories are responsible for about 98% of USA carbon dioxide emissions, 24% of methane emissions, and 18% of nitrous oxide emissions. Increased agriculture, deforestation, landfills, industrial production, and mining also contribute a significant share of emissions. The USA emits about one-fifth of total global greenhouse gases.

Estimating future emissions is difficult, because it depends on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Appendix B - Worldwide summary

The table below summarises flood insurance cover available in a variety of countries across the globe:

Country	Flood Insurance
Australia	• Most private insurance companies do not provide flood cover for private households • Flood cover may be provided as part of a business contents insurance policy • Some state insurers provide flood cover for private households • Disaster aid compensation is paid from State funds with part reimbursement from the Commonwealth • Flood relief money is paid to local authorities for repairs to infrastructure and cases of personal hardship and emergencies • Insurance penetration is very low
UK	• Only private insurers provide flood cover – there is no state insurance • Cover is generally included in homeowners and household contents policies • Premium rates are broken down by postcode and are often high for storm/flood cover • Deductible are widespread but typically very low • Flooding due to dam burst is covered • Industrial cover includes business interruption • Insurance penetration is approx 95% for simple risks; 100% for industrial risks
USA	• The National Flood Insurance Program (NFIP) provides basic cover and is the only federal insurance scheme for national disasters. • Additional cover is provided through private insurance companies. • Insurance penetration for simple risks increased significantly after the Mississippi floods of 1993 as the sum insured jumped from USD 234 billion to 430 billion. • Insurance penetration for industrial risks is high, although cover is often limited.
Canada	• Cover is provided by private insurers. • Insurance penetration is low for simple/commercial risks and high for industrial risks.
Argentina	• Generally cover is provided by private insurance companies as a supplement to a fire policy. • Penetration is very low for simple risks and low for industrial risks.
Brazil	• Insurance cover is provided by private insurers; a state monopoly exists for reinsurance. • Insurance penetration is low for simple risks and moderately high for industrial risks.
Ecuador	• Insurance cover is provided by private insurers. • Insurance penetration is low for simple risks and moderate for industrial risks.
Belgium	• Most insurers exclude flood risk. • A state financed disaster fund was established in 1976 – payments from the fund are restricted to simple risks. • Insurance penetration is low.
Czech Republic	• Only private insurers; no state solutions. • Insurance penetration is around 15% for simple risks, 10% for commercial risks and 20-30% for Industrial risks.
France	• The insurance market is based entirely on private risk carriers, but is statutorily regulated. • The state also guarantees the main reinsurer – Caisse Centrale de Reassurance (CCR). • Extraordinary natural disasters are excluded from traditional reinsurance agreements. • 100% insurance penetration.
Germany	• Only private insurance companies, no state solutions. • In personal lines, insurance penetration is less than 10% for buildings, but is spread wider for contents. • For industrial risks, penetration is less than 10%.
Italy	• Private insurers only, no state solutions. • Insurance penetration is less than 5% for private households, up to 30% for commercial and small industrial risks and approximately 40-50% for large industrial risks.
Netherlands	• Primary insurers only provide some cover for industrial property risks. • Otherwise, cover is only available from foreign insurers and only for the insurance of foreign industrial companies' risks in the Netherlands. • Insurance penetration is virtually non-existent in personal lines and low in industrial business.
Poland	• Only private insurance companies, no state solutions. • Insurance penetration for personal and commercial property is under 25%, and around 50% for industry.

Portugal	• Private insurers; no state involvement. • Insurance penetration is high.
Spain	• Until 1991, natural perils cover was available only via a specific public corporation. • Since then, private insurers may offer this cover, but this is rarely taken up. • Insurance penetration is very high.
Switzerland	• Building is generally covered by state monopoly insurers. • A reinsurance mutual exists for major losses. • Contents and business interruption almost everywhere as well as building in some areas. • A mutual natural perils pool also exists. • Insurance penetration is practically 100%.
China	• Private insurers only; no state pool exists. • Insurance penetration is low for simple risks. • Industrial risks are high for foreign insurers, whereas many domestic companies have no insurance at all.
Indonesia	• Cover is offered by both private and state-owned insurance companies. • Insurance penetration is low for simple risks and high for large industrial risks.
Japan	• Cover is provided by private insurers only. • Over 40% of all households have cover. • Industrial risk insurance penetration is under 30%.
Philippines	• No state solutions, cover is provided by private insurance companies. • Generally, insurance penetration for property is low in simple risks and higher in industrial risks.
Taiwan	• Cover is provided by private insurance companies. • Insurance penetration is less than 1% for simple risks and under 10% for industrial risks.
Israel	• Private insurance companies offer flood cover in natural perils packages; there is no government involvement. • Insurance penetration is approximately 95% for residential property and over 90% for commercial/industrial property
South Africa	• Cover provided by private insurers, no state programmes for natural perils. • More than 75% of aggregated real estate is insured. • Industrial risks have a higher insurance penetration than simple risks/residential property.

(Floods – an insurable risk, Swiss Re 1998)

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