Adapting to heatwaves and coastal flooding

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Key messages

- With an expected increase in the incidence of heatwaves and heat-related deaths, adaptation options are required that may include developing early warning systems to reach all citizens, preparation of the health system and hospital emergency departments, encouragement of behavioural changes to reduce exposure to heat stress, and better designed homes.
- Australia's built environment suffers from heatwaves on very hot days. Adaptation options include applying 'cool cities' concepts to reducing urban heat islands, increasing the resilience of cities to heat-related failures through upgraded engineering design standards, the use of less heat-sensitive materials in key infrastructure, better maintenance routines, emergency response plans that foster adaptability through collaboration across agencies and scales, and management of peak demand loading on the electricity grid.
- With increasing exposure of Australian property and infrastructure to coastal flooding in various ways along the Australian coastline, adapting to coastal inundation represents a case for thinking nationally or regionally, but analysing and acting locally.
- Options for adaptation to coastal flooding include retrofitting existing developed areas or building beach defences, changing building codes, planning and design standards to accommodate extreme and unpredictable conditions, converting current land uses to those less sensitive to flooding, encouraging house insurance rates that send a clear signal about the advisability of living in flood-prone areas, and developing effective early warning systems and evacuation pathways for extreme events.
- Early precautionary action may involve significant benefits in lives saved and property protected, fewer costs and sacrifices, and some new opportunities.

Heatwaves and coastal flooding are two impacts of climate change likely to be experienced by very large numbers of Australians during coming decades. Although it remains difficult to attribute an individual weather event directly to the effects of global warming, the nation is nevertheless likely to experience an increase in the number of days where daytime temperatures rise above 35ºC and in the frequency and seriousness of coastal flooding events as the global climate changes.[1]

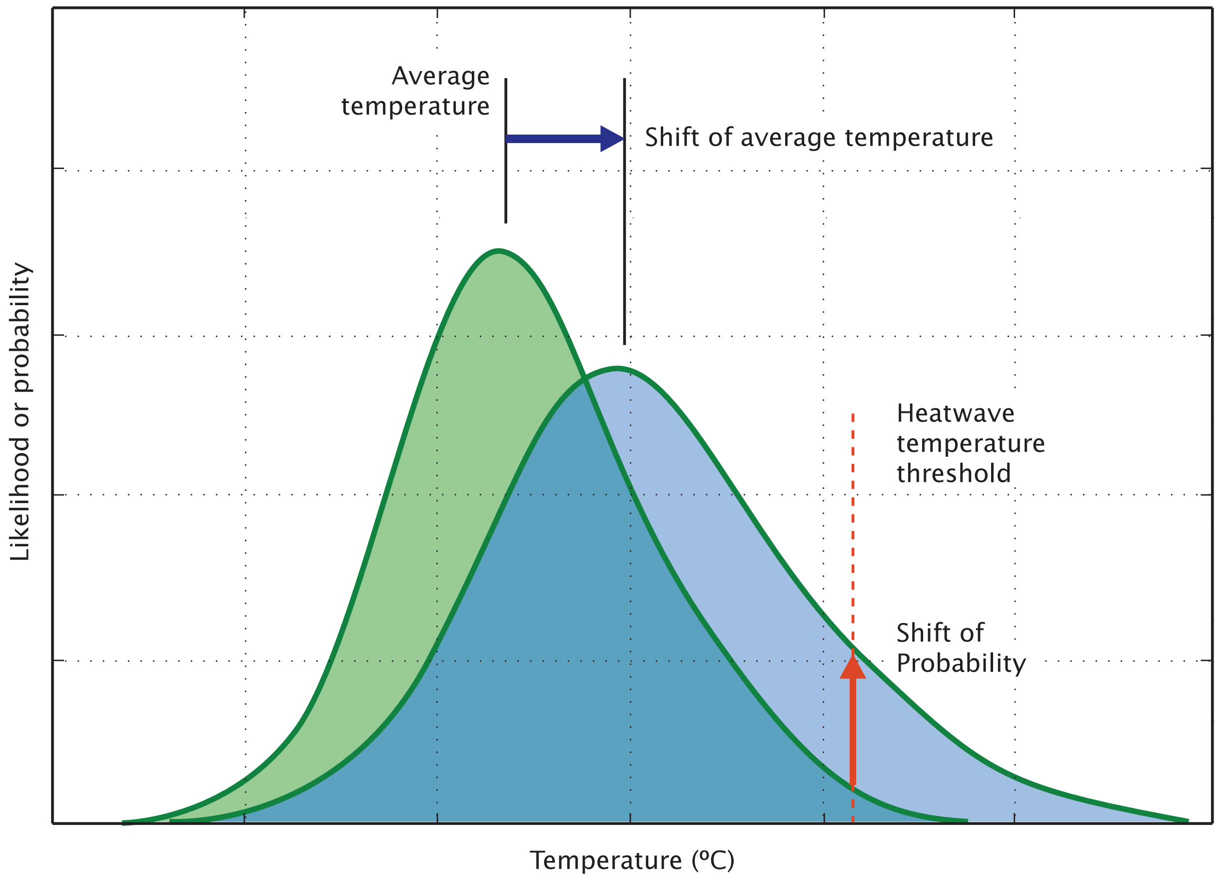
The fact that more Australians are exposed to these impacts is not, however, due to climate change alone. It is also significantly attributable to our rapid population growth, which has meant that more people now live in flood-prone areas – while our cities, with fewer green areas, are also becoming hotter places in which to live as they become more heavily built-up. It is also a part of who we are: many Australians prefer to live on the coast, in cities and, increasingly, in the tropics and subtropics.

Our exposure to future heatwaves and floods is thus likely to arise from a convergence of climate change with strong population growth, personal preferences, and planning that fails to take account of these issues.

Heatwaves

A heatwave is an event where temperatures are so high they pose a serious risk to individual health, as well as to public and private infrastructure. In Australia, heatwave conditions are often defined as periods in which daytime maximum temperatures are above a key threshold, usually 35ºC.

Australia has already experienced five of its hottest years in the last decade. As our climate warms in step with the global climate, average local temperatures will also increase across the continent, raising the likelihood of more days exceeding 35ºC, as Figure 6.1 shows. Based on the typical meteorological year weather (i.e. typical annual weather and long-term average at a given location based on historical observations) in Melbourne,[2] the number of days with daily maximum temperature above 35ºC is likely to more than double with a global temperature increase of 2ºC. The trend is summarised in Figure 6.2, which also includes Sydney and Brisbane.



▲ ***Figure 6.1**: A conceptual illustration of the increase in likelihood of higher daily maximum temperatures in response to the shift of average temperature.*

Meanwhile, under the IPCC's high emission (or A1FI) scenario,[3] which the world is tracking, the incidence of very hot days in major capital cities can be expected to increase substantially by 2030 and 2070. Data in Chapter 3 suggest, for example, that residents of Adelaide and Melbourne may experience twice as many very hot days in 2070, while residents of Darwin could find 35ºC days occurring for up to two-thirds of their year.[4]

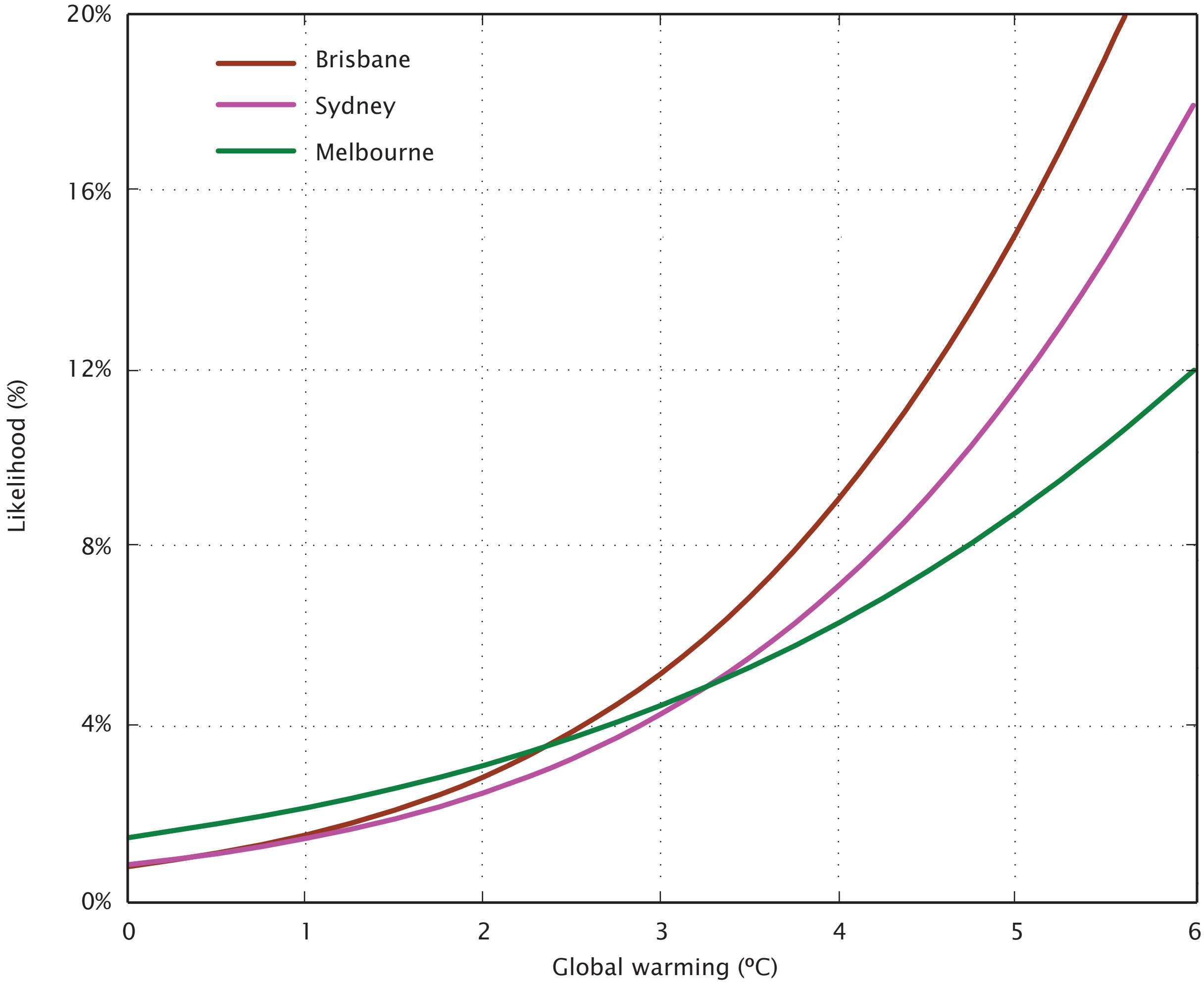


__Figure 6.2__: Likelihood of yearly occurrence of daily maximum temperature greater than 35ºC, based on typical meteorological year weather.[2]

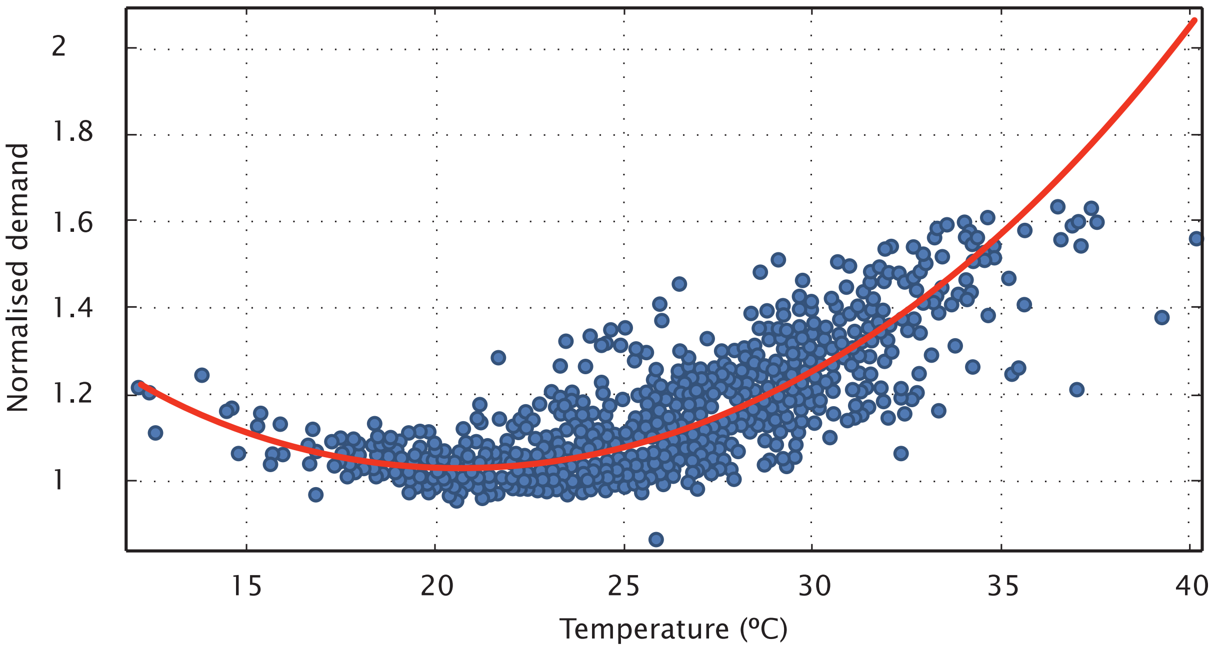
In health, the most publicised impact is the increase in premature deaths that occurs during a severe hot spell. The numbers of these fatalities can be considerable: the southern Australian heatwave of 1938 is estimated to have claimed 438 lives, while that of January 2009 led to 374 deaths, even in the age of air-conditioning (and not including the 173 bushfire deaths in February 2009), as recorded in the disaster database managed by the Attorney-General's Department, Australia. The people most vulnerable to heat stress include infants, the aged, people with chronic ill-health, those who are overweight, and the socially disadvantaged such as those on low incomes. People living in the urban environment have a relatively greater exposure to heat stress because of the urban heat island effect that may increase mortality. However, the time lag before heat stress affects the health of individuals makes accurate assessment of mortality difficult. During the heatwave peak, health-care and emergency services can be overstretched. Health effects also play out in the wider economy, not only in medical costs but also in the form of disruption to services due to absence from work.

Adaptation may include:

- reshaping health-care services to developing early warning systems to reach all citizens (with a social network back-up for those most at risk)
- preparation of the health system and hospital emergency departments, and improvements in maintenance programs for essential services
- encouragement of behavioural changes by the public to reduce exposure to heat stress
- retrofitting of old houses with better insulation
- development of emergency response plans for heatwaves in all regions.

Australia's infrastructure also suffers from heatwaves on very hot days, an example being the failure of Victoria's rail network due to buckled rails in 2009. Poorly cooled or ventilated buildings may become temporarily uninhabitable without air-conditioning. Entire communities and their infrastructure may find themselves at increased risk from bushfires. These factors, too, considerably increase the economic impact of heatwaves. Adaptation options include applying 'cool cities' concepts to reducing urban heat islands, increasing the resilience of cities to heat-related failures through upgraded engineering design standards, the use of less heat-sensitive materials in key infrastructure, better maintenance routines, and emergency response plans that foster adaptability through collaboration across agencies and scales.

One of the greatest impacts of heatwaves is on energy supply, with the massive demand for air-conditioning leading to failures in the electricity transmission network and blackouts. In general, Australia's high peak demand for electricity tends to occur during hot spells in summer (Figure 6.3). The frequency of high peak demand will increase in response to rising global temperatures. For example, it may triple for residential housing as the Earth warms by 2ºC.[5] A key adaptation will be the management of peak demand loading on the grid, as well as in the home and workplace, to avoid disruptions to supply. If peak demand is not reduced through the better design of buildings and suburbs, centralised energy supply systems will struggle to cope with the increased demands deriving from climate change. Renewable energy and storage may be used to reduce peak demand and dependence on grid electricity, but designing cooler buildings and cities is equally important.



▲ ***Figure 6.3***: *The impact of temperature on energy demand in South-East Queensland between 3.00 and 3.30 pm (normalised so that the average across the year equals 1).*

The economic costs of heatwaves extend beyond infrastructure damage and premature deaths. Illness and transport disruptions cause loss of human productivity, while crop and horticulture damage reduces agricultural productivity. Because most of the global warming that will occur in the next few decades is now built into the Earth's system because of historical and current greenhouse gas emissions, and is largely unavoidable, the likelihood of more heatwaves makes it very clear that Australians face considerable adaptation challenges now – in our daily lives, in how we build our homes, plan our cities, go about our work, and take care of our health. All of us will be exposed to the effects of increasing heatwaves. Research underlines that it is both sensible and economically far more cost-effective to start planning and to take action as soon as possible in order to minimise the effects.

Australians, wherever they live, have adapted to periods of very hot conditions – with varying degrees of success – by designing their houses, clothing, diets, and work patterns to suit. So the adaptations that lie ahead in the coming decades are less likely to come as a shock, will often make good sense, and will frequently involve win–win outcomes, such as the creation of new jobs in a more sustainable economy.

Coastal inundation

Today, coastal inundation is caused by storm surges, which usually occur when low-pressure weather systems, cyclones, or storm winds combine with high tides to drive sea water onshore and swamp areas normally regarded as dry land. Minor inundation can also result from large king tide events. Over the next few decades, the risk of coastal inundation is expected to increase owing to sea-level rise and potential increases in storm intensity and frequency driven by the changing climate. Continuing growth in our coastal populations means that more Australians, their property, and infrastructure will be exposed.[6] Minimising these risks calls for a strategic approach that involves governments, industries, communities, and individuals working together to come up with practical and affordable solutions.

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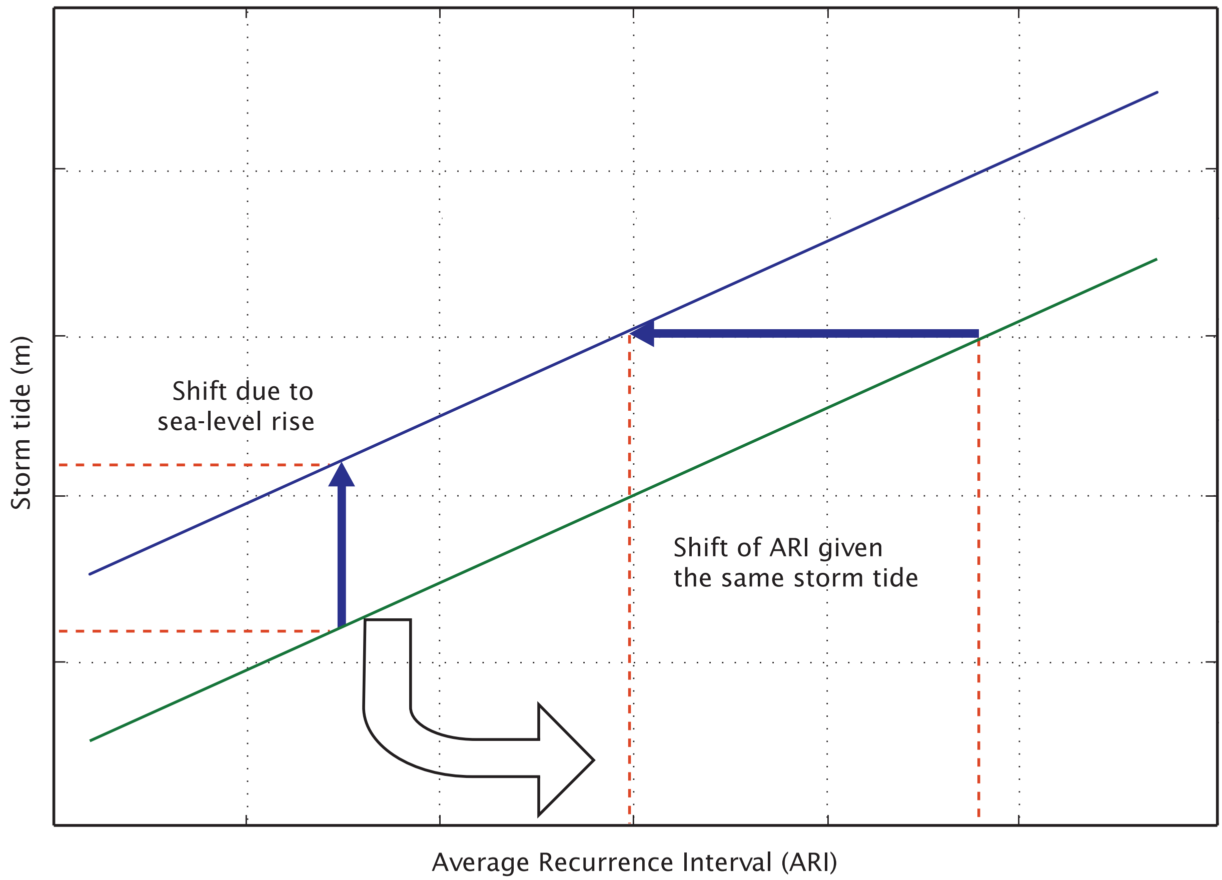
Sea level is projected to rise by 20–80 cm above 1990 values by 2100; however, larger estimates that take ice sheet melting into account cannot be excluded – a study for the Netherlands Government suggested a high end value for sea-level rise of 110 cm by 2100 (see Chapter 1). Higher sea levels will likely increase the occurrence of coastal flood events. Storm surges due to extreme weather events are likely to become more intense and frequent, with a current 1-in-100-year[7] inundation event occurring nearly twice as frequently by 2030 and many times more often by the latter part of the century, because of sea-level rise. This is illustrated by Figure 6.4, which shows that sea-level rise will lead to more frequent extreme flooding events. Although rare, such events can lead to large loss of life, as was the case in 1899 when 400 people died as a result of a cyclonic storm surge in Bathurst Bay, Queensland.



▲ ***Figure 6.4****: A conceptual illustration of the reduction of average recurrence interval of the same height of storm tide due to sea-level rise*

The Australian Government report *Climate change risks to Australia's coasts*[6] (see Chapter 4), found that, out of 711 000 existing residential buildings close to the sea, between 157 000 and 247 600 properties were potentially exposed to flooding with a sea-level rise of 1.1 m. Furthermore, nearly 39 000 buildings located within 110 m of 'soft' shorelines would be at risk from accelerated erosion due to sea-level rise and changing climate conditions. If all these buildings were destroyed, the cost of replacing them was estimated at AU$41–63 billion. Besides homes, 258 police, fire and ambulance stations, five power stations or sub stations, 75 hospitals and health centres, 41 landfill sites, three water treatment plants, and 11 emergency services facilities would also all be at risk, being located within 200 m of the sea shore. Essential services such as electricity generation and wastewater management would be also at risk from flooding, erosion, the intrusion of sea water into coastal freshwater systems and drainage systems, and increased corrosion. Almost all of our existing coastal buildings and infrastructure were constructed under planning rules that did not factor in the impacts of climate change, though state governments are now taking account of sea-level rise through their planning policies. Just as the building codes and rules for Darwin changed in the wake of Cyclone Tracy, so they should now be re-assessed for each region and locality in Australia to take account of climate change.

It is important to note that risks from coastal flooding are not uniform. They vary all along the Australian coastline, affected by local climate, topography of both the land and seabed, rainfall in local catchments leading to riverine and estuarine flooding co-incident with storm surge, tidal characteristics and demography, buildings and other infrastructure in the affected zone, as well as local adaptive capacity. This makes adapting to coastal inundation a clear case for thinking nationally or regionally, but analysing and acting locally.

To illustrate the extent of the risk and what must be done to minimise it, CSIRO has completed a study of inundation in South-East Queensland.[8] This provides a model for the type of issues and options that coastal communities around the continent will need to consider. It found that the current storm surge events will occur more frequently on average as a result of sea-level rise, as shown in Table 6.1. The current 1-in-100-year storm surge event, for example, would occur about every 61 years with a sea-level rise of 20 cm, and every 9 years with a sea-level rise of 1 m – that is, it will be more than 10 times more frequent. Currently about 230 000 southern Queenslanders are at risk from a 1-in-100-year storm surge. However, population growth will interact with climate change and the number of people at risk could rise to 400 000. The cost of dealing with such events would increase from AU$1.12 to AU$1.97 billion (Table 6.2).

Table 6.1: Average recurrence interval (years) in relation to different levels of sea-level rise for inundation events in South-East Queensland that currently have recurrence intervals of 50, 100, 500, or 1000 years

Current events	0.2 m sea-level rise	0.4 m sea-level rise	0.6 m sea-level rise	0.8 m sea-level rise	1.0 m sea-level rise
1-in-50	31	19	12	7	4
1-in-100	61	38	23	14	9
1-in-500	306	188	115	70	43
1-in-1000	613	375	230	141	86

Table 6.2: Estimate of people and homes exposed to major flooding events in South-East Queensland

	Scenario 1 Today	Scenario 2 No adaptation, 2030	Scenario 3 Adaptation, 2030
Population	Today's population	2030 population	With no population growth in vulnerable locations
Buildings	Today's buildings	2030 buildings	With no building growth in vulnerable locations
Storm tide	2.5 m	2.7 m (2030)	2.7 m (2030)
Exposed populations	230 000	400 000	250 000
Exposed residential buildings	35 000	62 000	40 000
Costs ($bn)	1.12	1.97	1.28

This study shows there are considerable benefits from taking early, proactive adaptation measures to limit the possible damage from storm tide events, such as to:

- retrofit existing developed areas with structures designed to reduce flood risk or enable water to subside quickly, protect key infrastructure from minor flooding, and build beach defences where it is economic and advisable to do so (recognising they will eventually be overwhelmed).
- change design standards for new buildings within existing developed areas so they are more able to withstand periodic inundation, e.g. minimum floor heights above sea level, flood-tolerant lower floors, and demountable homes that are easily moved.
- encourage house insurance rates that send a clear signal about the advisability of living in flood-prone areas.
- introduce building codes that allow for extreme events. These could even prevent or discourage new developments in at-risk areas. Convert current land uses to those less sensitive to occasional flooding (e.g. parks and recreational areas).
- develop nationally consistent planning principles that ensure higher levels of government support and build capacity in local government for protecting local communities. Develop more flexible local and regional planning to accommodate extreme and unpredictable conditions.
- develop effective early warning systems and evacuation pathways for extreme events.

The benefits of successful adaptation are substantial. In the case of South-East Queensland, as summarised in Table 6.2, if nothing is done then the number of people at risk of a major (2.7 m by 2030) flood event will grow from 230 000 today, to 400 000 in 2030. Preventing new at-risk developments would protect about 150 000 people and save AU$0.7 billion in a major storm event by 2030. Retrofitting or reclaiming flood-prone land on top of this would protect 170 000 people and save AU$0.9 billion in a major event affecting South-East Queensland in 2030.

Conclusion

Australians' options in adapting to heatwaves and floods can be either proactive or reactive. They usually involve all levels of society, from the individual to the local community and local government, to regional, state and federal governments. As illustrated by the case of South-East Queensland, early precautionary action will almost always involve significant benefits in lives saved and property protected, as well as fewer costs and sacrifices. This action will also open up new opportunities, such as the colder parts of Australia decreasing their energy use for heating, new industries, technologies, and jobs arising out of climate adaptation, and a leadership role for Australia in global adaptation to heatwaves and coastal inundation.

Further reading

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