A Climate Risk Report

Scoping Climate Change Risk for MBRC

August 2009

Climate Risk

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Disclaimer:

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Climate Risk supports a constructive dialogue about the ideas and concepts contained herein.

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Lauren Bowra

Lauren works in the Brisbane office working on Local Government, Regional Planning and ICT sectors. Lauren holds a double degree in Environmental Planning and Environmental Law. Lauren's passion for climate change adaptation has seen her undertake her honors research studying the role of insurance in main streaming climate change adaptation. Lauren's recent studies at Griffith University include climate change law and climate change planning policy.

Executive Summary

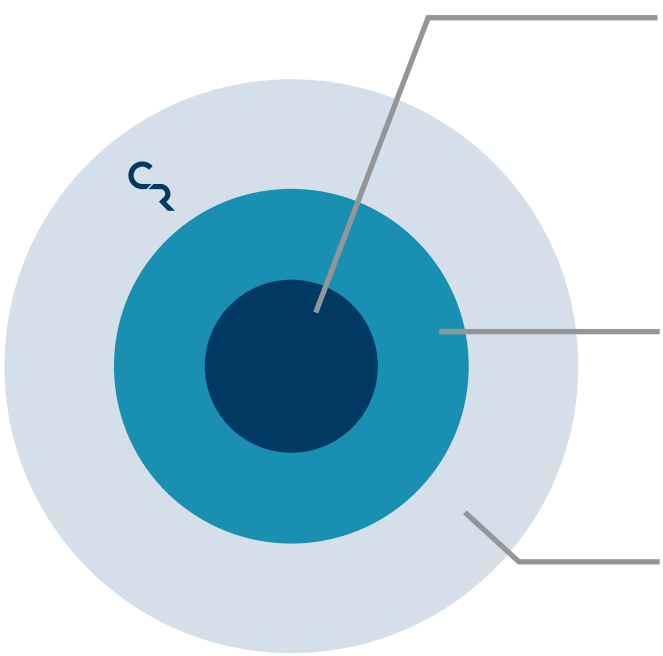
The scientific consensus is that climate change is real, it is affecting society now and if left unchecked will cause immense socio-economic and environmental impact (Garnaut 2008). Climate is very relevant to Moreton Bay Regional Council. The most recent edition of the Intergovernmental Panel on Climate Change (IPCC) highlights that the South East Queensland (SEQ) Region's unchecked development and rapid growth "is projected to exacerbate risks from sea-level rise and increases in the severity and frequency of storms and coastal flooding by 2050" (IPCC 2007, p.509).

The main findings of this report highlight that Moreton Bay Regional Council (MBRC) is exposed and vulnerable to many projected impacts from climate change. In this report, we highlight that MBRC's risks stem from primary, secondary and tertiary hazards (Figure i); the exposure to those hazards; and council's vulnerability should the hazards materialize.

> "Council will need to make challenging decisions regarding the cost-benefit of early, mid and late term adaptation options."

Primary hazards

The scoping risk assessment highlights that MBRC (or parts ofMBRC) is exposed to all of the main primary climate change hazards, including sea level rise, storm surge, precipitation change, heat waves, flooding and extreme weather



Primary Hazards (direct physical effects) examples:

1. Temperature
2. Precipitation
3. Drought
4. Wind
5. Fire weather (increased bushfire conditions)
6. Sea-level rise
7. Severe weather (e.g. hail and lightning)

Secondary Hazards (regulatory) examples:

1. Hazards from planning regulation
2. Carbon constraints and markets
3. Building and infrastructure standards
4. Insurance industry regulatory change

Tertiary Hazards (social response) examples:

1. Changing demographics
2. Population shift
3. Changing consumer spending patterns
4. Changing energy use

Figure i. Primary, secondary and tertiary climate change hazards discussed in this report.

events. This will have a material impact on Council because of the exposure of its assets and the exposure and vulnerability of much of the community it represents. The required adaptation actions will introduce short-medium term increased operational costs. Failure to adapt will result in ongoing long term economic challenges.

Secondary Hazards

This report also shows that Council is significantly exposed to and vulnerable to secondary risks, such as regulatory and policy changes, and changes to insurer expectations. The most pressing secondary hazards stem from the Commonwealth's Carbon Pollution Reduction Scheme (CPRS), the Queensland Government's Planning Reform (including the South East Queensland Regional Plan 2011-2031), and any insurance related change. Each of these will add increased compliance related strains on Council and may present potential legal ramifications. The CPRS will also ultimately result in increased operational costs until Council finds viable alternatives to fossil fuel based costs.

Tertiary Hazards

The MBRC region is highly vulnerable to decisions which the community and businesses make in response to climate change. These actions include building design and quality, business location, air-conditioner use, changing consumer patterns and population shift to and from the region. These actions have the potential to alter the demographic of the region and either increase or decrease Council's ability to foster a resilient community.

Economic Ramifications

Each of the sectors of Council and the community are exposed in various ways, but all these risks present significant economic challenges for Moreton Bay Regional Council, which include:.

- Increased insurance costs – Insurers no longer wish to shoulder the increased cost associated with climate change. It is anticipated that insurers will use a range of incentives (including increased premium costs or withdrawal) to reduce Council's climate change related risks. ,

- Increased operational costs – Primary, secondary and tertiary hazards present an array of increased costs for Council. In the short term Council will require additional resources to ensure compliance to new standards and regulations as well as cost associated with upgrading assets and services required to deal with the change. Increased costs may also arise from increased damage and cleanup costs associated with extreme weather events.

> The Moreton Bay Region is highly vulnerable to decisions which the community and businesses make in response to climate change.

- Increased energy costs - Council spends a considerable portion of its budget on energy. Emissions trading will be implemented within two years and the cost of carbon will continue to increase substantially over the coming decades. Until Council reduces its dependence on fossil fuels a carbon constrained economy will see significant increases in its energy related costs. MBRC operation expenditure may increase by over $5 million per annum and $17 million within the first few years of carbon trading.

- Potential litigation –Legal costs often present challenges for councils. It is envisioned that climate change and associated strategies may lead to increased planning challenges and potential tort-based litigation. As the science surrounding climate change strengthens there will be increasing pressure on Council to make appropriate decisions on the type and location of development.

Adaptation challenges

Council will need to make challenging decisions regarding the cost-benefit of early, mid and late term adaptation options. Increased insurance, energy and maintenance costs are virtually certain, placing strains on Council's ability to provide other adaptive measures to support community (e.g. increased public transport provisions). Increased maintenance and operational costs will likely run into millions of dollars (and even more if tort based litigation occurs). Even with appropriate adaptation, expenses will increase due to climate change, although evidence suggests that these can be reduced substantially.

It is our view that if additional resources for climate change are not embedded into the existing Council budget Council will either,

a) Ultimately become less financially viable as it attempts reactionary short term measures, or

b) Require increased resources from its ratepayers and/or State and Commonwealth funding.

> MBRC operation expenditure may increase by over $5 million per annum and $17 million within the first few years of carbon trading.

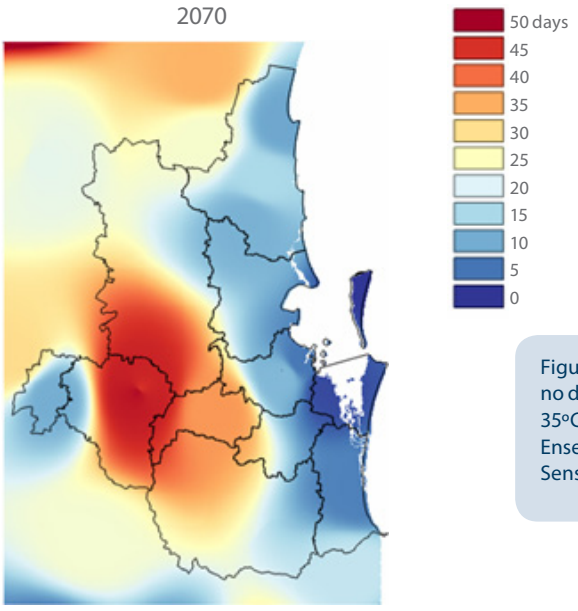


Figure ii. 2070 Average no days max temp > 35°C (annually) A1FI, Ensemble, Medium Sensitivity .

Next steps

Although climate change presents significant challenges for MBRC there are many opportunities that can be utilized to reduce these risks. These actions, which have a range of ancillary benefits include:

1. Develop a climate change working group with supporting resources
2. Add climate risks to the council risk register
3. Undertake detailed assessment of high priority risk
4. Engage with insurers to discuss risk management and cover
5. Embed climate change into the corporate plan and planning scheme
6. Increase and maintain adaptive capacity
7. Make representation to state and federal government for areas where Council has responsibility
8. Be prepared to set a precedent by challenging development on adaptation principles
9. Identify potential cocktail effects from multiple coincident impacts
10. Explore public / private partnerships towards economic resilience
11. Raise community awareness of risks and support for adaptive measures by Council
12. Focus on identifying sources to help fund the required adaptation

> Until Council reduces its dependence on fossil fuels a carbon constrained economy will see significant increases in its energy related costs.

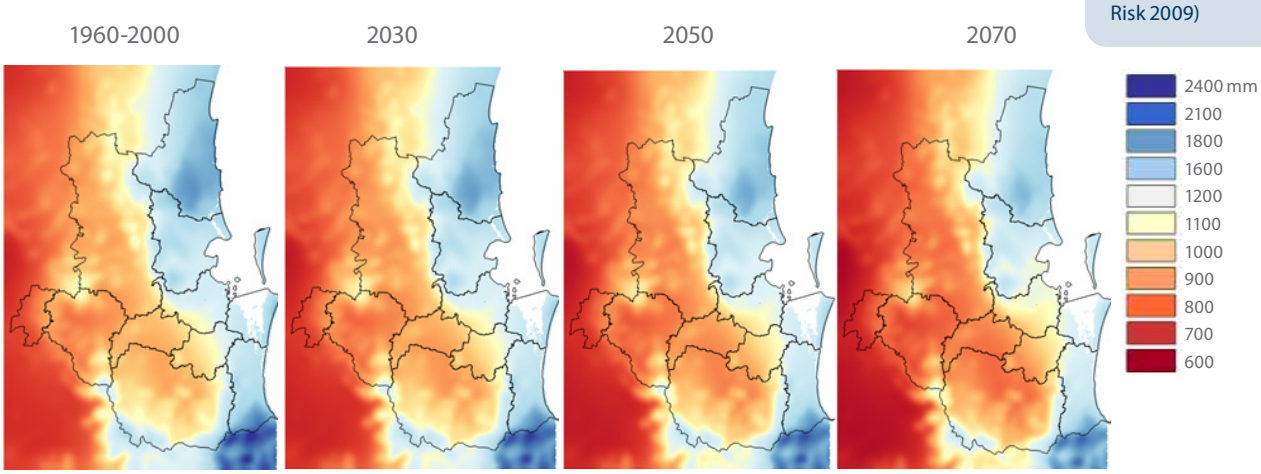


Figure iii. Mean number of days with precipitation of less than 1 mm (annually) A1FI, Ensemble, Medium Sensitivity. (CLIMSystems & Climate Risk 2009)

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1 Introduction

"Climate change will impact future city spatial patterns, growth, and development"

(World Bank 2008, p.5)

The scientific concern is that climate change is real, it is affecting society now and if left unchecked will cause immense socio-economic and environmental impacts (Garnaut 2008). The most recent edition of the Intergovernmental Panel on Climate Change (IPCC) adaptation report highlights that the South East Queensland (SEQ) Region's unchecked development and rapid growth "is projected to exacerbate risks from sea-level rise and increases in the severity and frequency of storms and coastal flooding by 2050" (IPCC 2007, p.509). This view on SEQ's vulnerability has been recently supported by the Garnaut Review, which highlights that tens of billions of dollars worth of assets and services in SEQ are exposed to severe weather events (Garnaut 2008).

The Queensland Government has recently acknowledged these climate change risks and are undertaking policy and regulatory changes to consider climate change mitigation and adaptation.

As will be discussed in this report, the State and Commonwealth response to climate change also presents an array of regulatory risks to Local Governments, who are at the forefront of climate change management strategies but often lack resources and capacity to implement them.

The aim of this report is to provide a scoping assessment of the potential climate change specific risks facing Moreton Bay Regional Council (MBRC). This report also presents a range of adaptation option pathways for MBRC to help foster a climate resilient community.

Scope

This report was commissioned by MBRC to raise the awareness of potential climate change risks for the Council and the community it represents. In particular, Climate Risk Pty Ltd was asked to focus on the exposure to:

Council Operations

- Potential Operational Impacts – how will climate change impact on the Council's operational activities
- Potential Litigation[1] – what is the level of liability that may occur from climate change; and
- Planning – what implications will climate change have for planning decisions

Community Exposure

- Economic – what business and industry sectors will be exposed to

1 It is important to note that Climate Risk Pty Ltd cannot offer legal advice and that the discussion on potential litigation will derive from a broad literature review of existing views surrounding potential litigation risk. We have access to a broad range of papers that have discussed legal exposure for Councils in Queensland.

climate change impacts in the region

- Community - assess the risk and impact to the region's residents from climate change

Environment

- What are the potential impacts of climate change on the environment – biodiversity, weeds, water availability

Insurance

- What is the potential impact on insurance premiums for Council and community

Costs

- Identify the potential costs of climate change for the above themes

Limitations

All information in this discussion paper is drawn from credible sources in the public domain and internal analysis. However, all existing climate change science has an element of uncertainty regarding regional impacts.

This report provides an initial assessment of the type and significance of risks to MBRC. It is not a detailed examination of the Council's specific risks and vulnerabilities and cannot be used as the basis of any financial or legal decisions.

2 Climate Change Overview

There is now overwhelming evidence that global average temperatures are increasing as a result of anthropogenic interference of the earth's climatic system (Stern 2006; Pittock 2005; Stefan 2006). The latest data reveals a clear trend in the rate of carbon emissions across the globe, which is contributing significantly to global warming. Data released by the Global Carbon Project (2008) shows that since 2000 anthropogenic CO_2 emissions have grown at a rate four times faster than during the previous decade and are exceeding the worst case scenario projected by the IPCC's long term scenarios.

The Earth's global temperature has warmed significantly over the past 100 years (IPCC 2007). On average the world is currently 0.74°C warmer than what is was a century ago (IPCC 2007) (Figure 1). Furthermore the rate of change has not been uniform across the globe, with the northern latitudes seeing much more warming than other regions. Evidence that increase in the earth's global temperatures is already affecting terrestrial biological systems is mounting, with changes being recorded in numerous scientific publications and international reports (IPCC 2007; Rosenzweig et al. 2008). The fourth assessment report by the IPCC Working Group II has warned that the consequences of climate change, including sea level rise and increased frequency and intensity of weather events, will result in 'adverse effects on human and natural systems' (IPCC 2007, p. 52).

Current international negotiations are attempting to reduce greenhouse gas emissions to a level that is significantly below the 1990 levels (up to 80% by 2050). However, latest data suggest that CO_2 emissions are growing faster than ever, mainly as a result of increased wealth, the rapid economic growth experienced by China and India and the declining efficiency of the world's natural carbon sinks (Global Climate

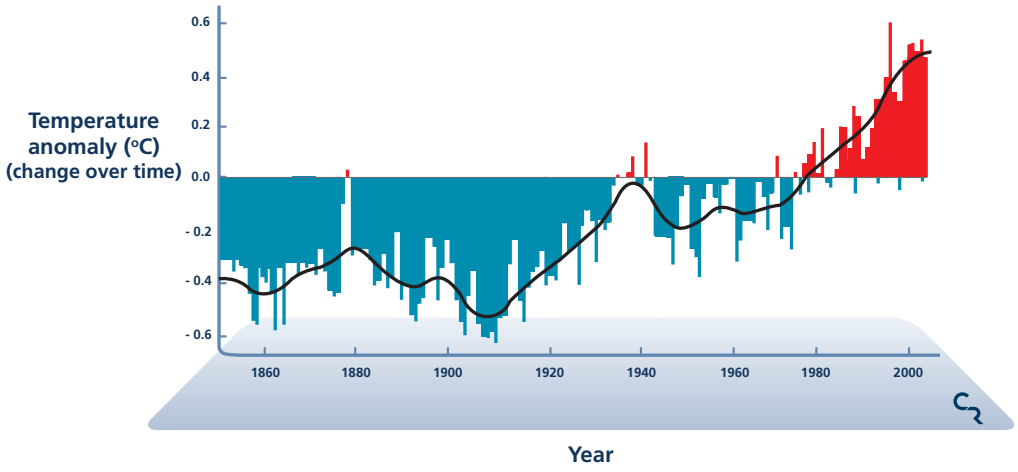


Figure 1. Temperature anomaly from pre-industrial times. This graph highlights that the Earth has experienced a significant increase in average temperature since the 1990s.

project 2008; Canadell et al. 2007).

Regardless of existing efforts to curb greenhouse gas emissions by countries which are signatories to the Kyoto Protocol, it is now widely accepted that global world temperatures will continue to rise for the remainder of this century at least. This is because we still have the locked in impacts, due to the existing carbon loading in the atmosphere. Latest projections by the IPCC suggest that average global temperatures will increase by approximately 1.8°C and 4.4°C by 2100 (IPCC 2007). However James Hansen the director of the NASA Goddard Institute for Space Studies believe that these projections are conservative and that global temperatures can rise by up to 6°C by the end of the century (Hansen et al. in press; IEA 2008)[2].

Although these figures may not seem significant, an increase of only 2°C can have devastating consequences. As shown by Garnaut (2008, p.139) 1.8°C - 2.3°C warming may mean 10%-17% of the world's species becoming extinct and a 19% - 40% likelihood of irreversible melting of the Greenland Ice Sheet (leading to significant sea level rise). An increase of 1.5°C - 2.5°C is also likely to have negative impacts on ecosystems services (e.g. water and food supply), and have serious consequences for human and animal health (IPCC 2007, p.26). Some argue that 2°C of average warming leads to the beginnings of "runaway" climate change, where positive feedback mechanisms are triggered (such as the drying of the Amazon Rainforest or melting of permafrost), leading to the higher end of climate change projections (i.e. 6°C increase of 1990 levels and 2 metres sea level rise by 2100)(Hansen et al. 2008).

Strategies to deal with climate change generally consist of two elements: adaptation and mitigation (Pittock 2005, p.7). The IPCC defines adaptation as an 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (Metz et al. 2001, p.708).

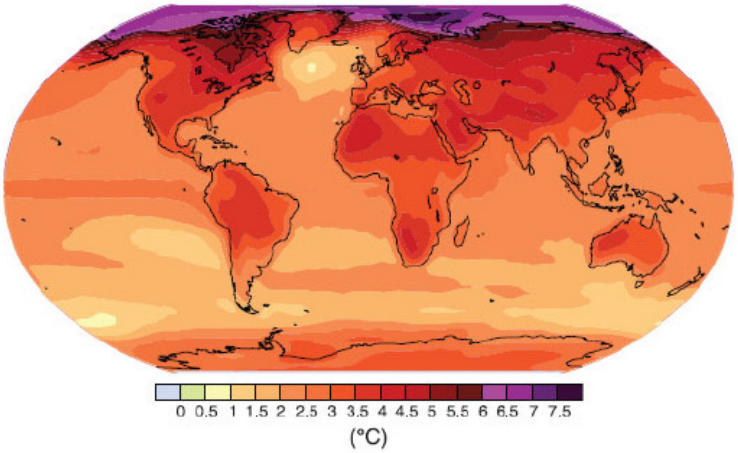


Figure 2. Projected surface warming for end of 21st Century (IPCC 2007); temperatures are relative to the period 1980-1999.

2 Hansen et al. (in press) and Rind (2008) argue that standard climate models (including the widely used Charney Sensitivity model) do not consider significant factors such as changes in glaciation and vegetation and the ability of oceans to absorb CO_2, which diminishes as sea water temperature rises.

This definition is expanded on by Adger, et al. (2005) who state that 'adaptation can involve both building adaptive capacity … and implementing adaptation decisions' (p.77).

Mitigation is defined by the IPCC (Metz et al. 2001, p. 716) as 'an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.'

In a summary for the IPCC Banuri et al. (2001, p.52) advocate that adaptation and mitigation need to be considered together in any climate change response. The connection between adaptation and mitigation is often overlooked. Environmental lag time means that climate change is already here and that we have to adapt to current and future changes that are already locked in. Mitigation strategies attempt to reduce the severity of the impacts and ensure that any climatic change occurs within our capacity to adapt (Pittock 2005).

Although international discussions are underway with the objective to contain average global warming, the global greenhouse emissions continue to rise. This pattern is projected to continue without a concerted global effort to contain emissions growth (Figure 3).

Climate Change in Australia

Australia is vulnerable to a changing climate. The past century has seen Australia experience an average warming of 0.7°C and a significant reduction in coastal precipitation (Preston & Jones 2006). This warming trend is set to continue with predictions that by 2030 average Australian temperatures could increase from 0.4°C - 2°C above 1990 temperatures and 1°C - 6°C by 2070 (Preston & Jones 2006). According to the Australian Department of Climate Change, climate change will place considerable strain on Australia's coastal communities including sea level rise and increased storm surges, changes to marine and coastal biodiversity and changes to fisheries (Voice et al. 2006, p.2).

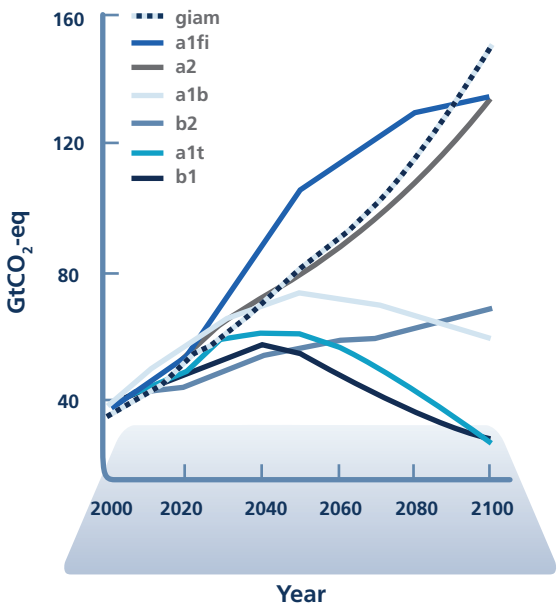


Figure 3. Recent ABARE modelling shows that current emission rates (GIAM) are outpacing previous IPCC projections.

Climate Change in SEQ

"Queensland's coastal settlements are anticipated to suffer extreme infrastructure impacts from increased storm surge and localised flash flooding."

(Garnaut 2008, p.126)

SEQ is one of Australia's fastest growing regions with a population set to increase by over one million over the next twenty years (QDLGPSR 2005) from its current level of 2.7 million. The natural and built environment is under considerable pressure to cater for the increasing population. The changing climate is and will continue to increase this pressure, whilst decreasing the region's resilience. There are potentially several important effects of climate change in SEQ including reduced water quality and availability; vegetation loss; increased weed invasion; threats to grazing; impacts on the pasture and forestry industry; and a broad range of effects arising from heat stress. A more detailed description of SEQ climate change variables is included in chapter four (see Figures 5,6 and 7 for SEQ projections).

South East Queensland

Brisbane	Increase in annual temperature (°C)	Number of days >35 °C
Present		1.0
2030 average (mid emissions)	1.0 (0.7 - 1.4)	2 (1 - 2)
2070 average (low emissions)	1.6 (1.1 - 2.3)	3 (2 - 4)
2070 average (high emissions)	3.1 (2.1 - 4.4)	6 (4 - 14)

Figure 4. Recent science suggests that South East Queensland will experience significant challenges from climate change (Q.OCC 2008).

- Marked drying trend since 1950s
- Potential for more significant increases in inundation as a result of storm surges due to higher mean sea level and more intense weather systems
- Increase in 1-in-100-year storm tide events projected to be 0.45 m along the Sunshine Coast, mostly due to sea-level rise
- Less water available in future for cities, industries, agriculture and natural ecosystems
- Number of days over 35 °C expected to increase in future, potentially affecting peak energy demand
- Less frost damage to crops and higher wheat yields but lower wheat quality
- Increased pest and disease risk

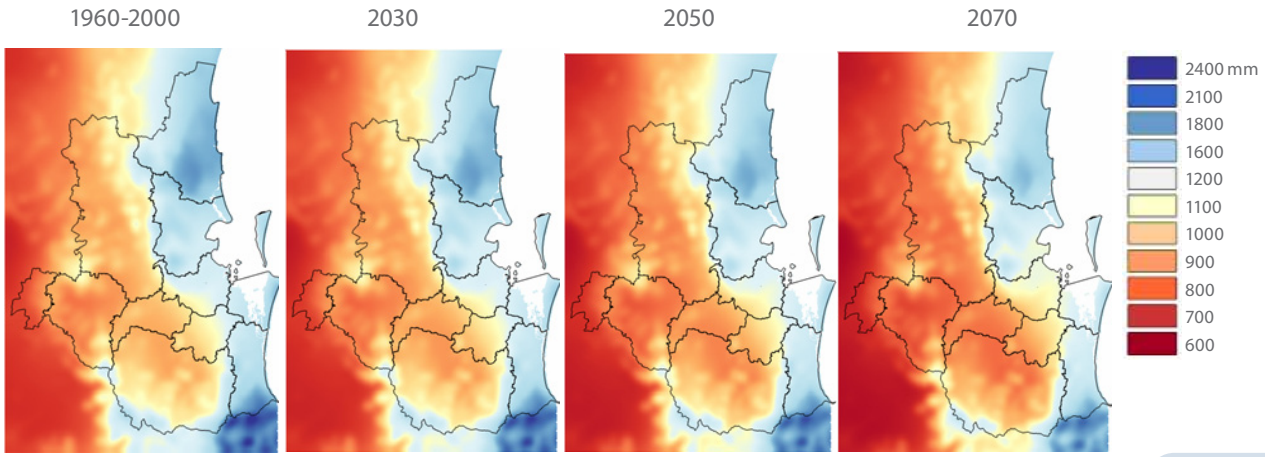


Figure 5. Mean Precipitation - Annual (mm) A1FI, Ensemble, Medium Sensitivity. (CLIMSystems & Climate Risk 2009)

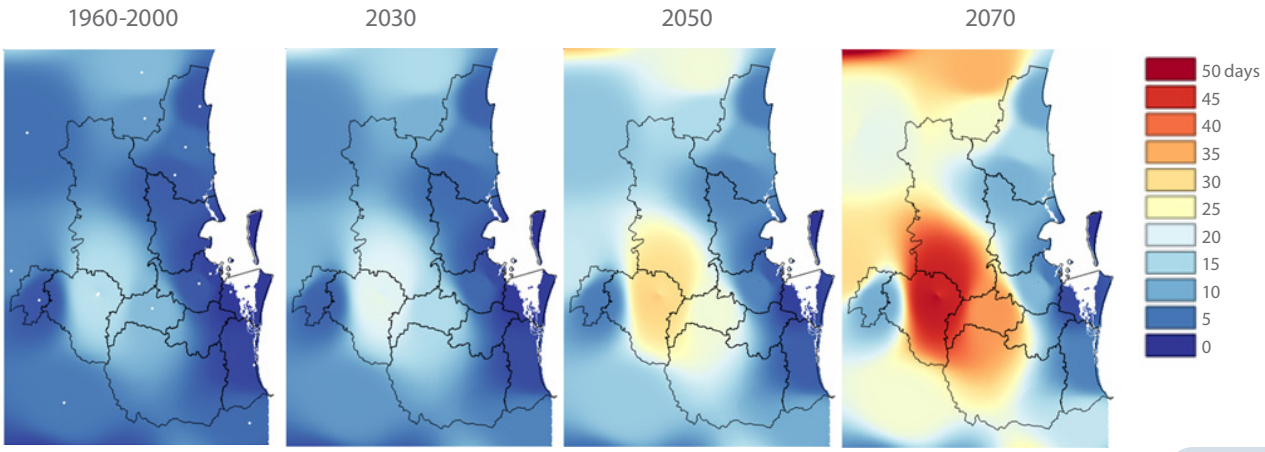


Figure 6. Average no .days max temp > 35°C (annually) A1FI, Ensemble, Medium Sensitivity. (CLIMSystems & Climate Risk 2009)

3 Methodology

The methods used in this report follow an amalgamation of risk frameworks that are used throughout Australia and abroad. The framework of this report focuses on the three main elements of risk, as defined by Crichton (1999) in the 'Risk Triangle' which is a useful starting point to build the framework for this report (Figure 8). The risk triangle has a robust recognition in a broad range of sectors including insurance, disaster management (Geosciences Australia 2007) and urban adaptation (Rolf & Crichton 2006). The risk triangle shows that the degree of risk is a function of three elements; Hazard, Exposure and Vulnerability. The size on the risk depends on the extent of these three components and without all, the risk does not exist. This framework's simplicity lends itself to both simple scoping of emergent risks as well as a more comprehensive drilling down into each of the elements as time, resources and data become more available.

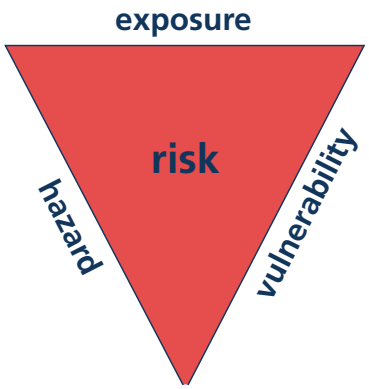


Figure 8. Crichton's Risk Triangle (Crichton 1999).

THE RISK TRIANGLE

1. Risk is a potential loss, the occurrence, or the size of which, is uncertain.
2. Risk depends on hazard, vulnerability and exposure. If any one of those elements is missing, there is no risk.
3. Hazard refers to the frequency and severity of an event or the severity of a source of danger that may cause a loss (e.g. storm surge).
4. Exposure is the accumulated value and proximity of the subject matter (e.g. number and value of houses within a storm surge risk zone).
5. Vulnerability measures the extent to which the subject matter could be affected by the hazard (e.g. height of buildings from the ground level).
6. Subject matter is the life or health of people or animals, or the property, data, or environmental assets that are under consideration. (adapted from Crichton 2001, p.244)

The Risk Triangle model is used by Climate Risk Pty Ltd with its insurance clients and provides a simple way of examining a complex issue. The diagram below provides a framework of the methods and inputs used to identify a scoping assessment of MBRC's climate change risks.

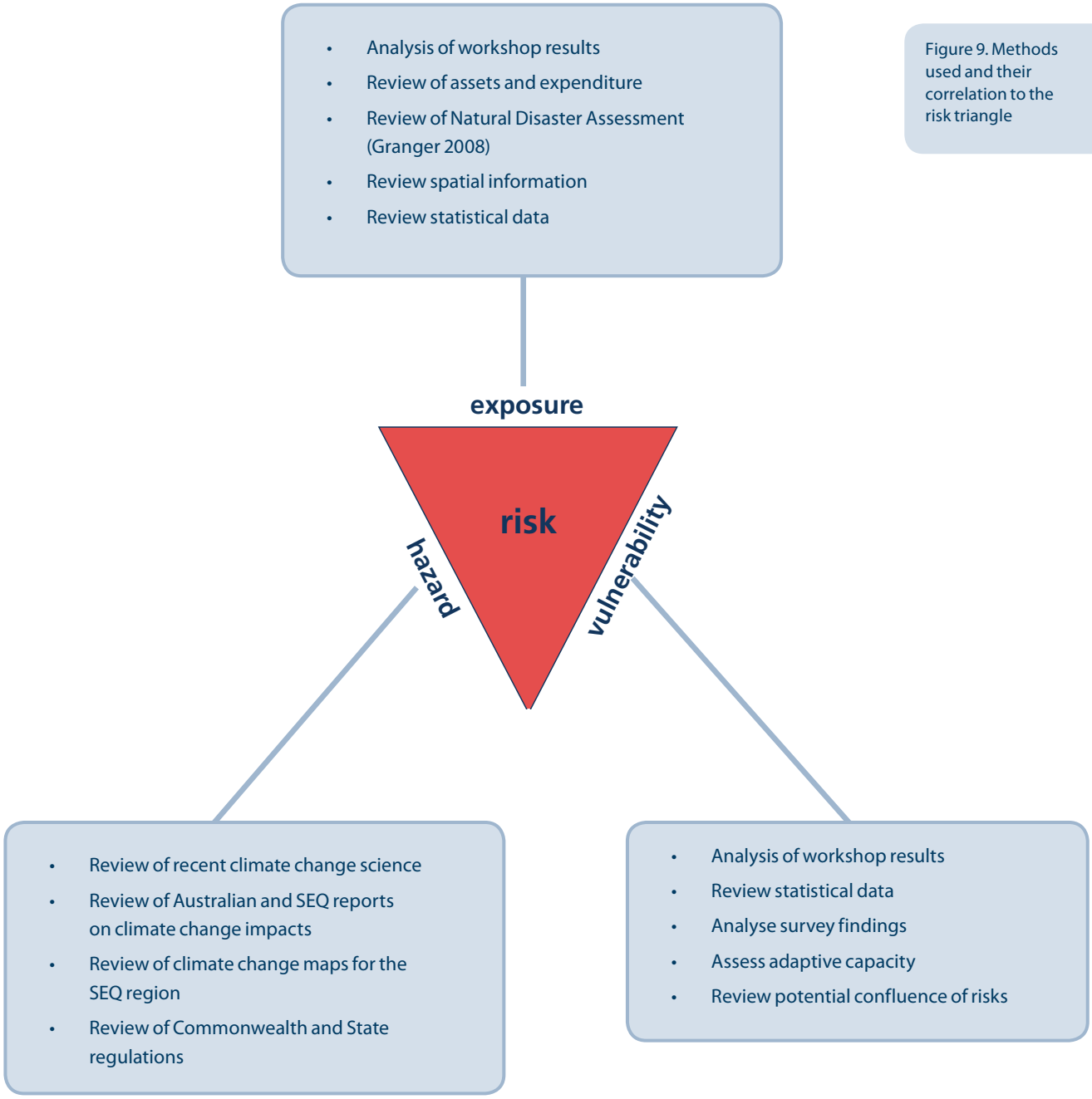


Figure 9. Methods used and their correlation to the risk triangle

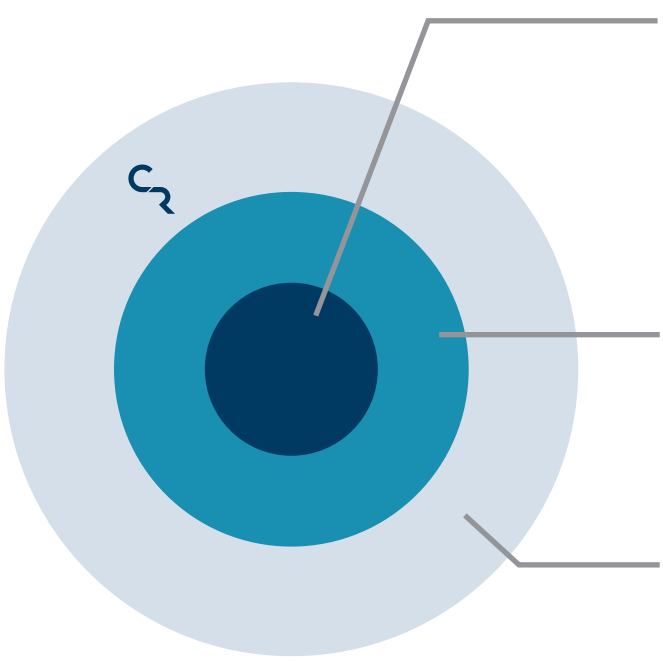
4 Hazards

For this report a hazard is identified as "a climate-change related event, series of events or variation, or an action in response to these, which has the potential to result in a material economic, social or environmental loss" (Climate Risk 2008).

For further clarification we present the climate change hazards in three distinct themes of impacts; primary, secondary and tertiary which are explained in detail below (Figure 10).

To identify primary climate change hazards specialists utilise projections from Global Circulation Models (GCM). Although the science behind climate change projections is improving there is still a range of uncertainty. There are twenty GCMs that are used throughout the world and each of these have their own strengths and weaknesses for climate change variables and spatial coverage. Further uncertainties arrive when the GCMs are downscaled to the regional level. However, as long as the uncertainties are recognised GCMs provide a useful exploration into the possible future climate change scenarios.

Projections of climate change beyond 2030 are highly dependent on the global emissions pathway. At present the world's emissions growth is about 3.0% per year. This is well above the A1FI (IPCC worst case) scenario of



Primary Hazards (direct physical effects) examples:
1. Temperature
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7. Severe weather (e.g. hail and lightning)

Secondary Hazards (regulatory) examples:
1. Hazards from industry regulation
2. Carbon constraints and markets
3. Hazard mapping
4. Building and infrastructure standards
5. Insurance industry regulatory change

Tertiary Hazards (social response) examples:
1. Changing consumer demographics
2. Changing consumer geographical distribution
3. Changing consumer spending patterns

Figure 10. Primary, secondary and tertiary climate change hazards discussed in this report.

2.5%. According to Garnaut (2008), the emissions trajectory for what he describes as the Platinum Age is projected to see global emissions increase by 3.1% per year. As most current models follow the A2 scenario (of 2% growth per annum) the IPCC worst case scenario is looking more like being the new best case scenario.

Primary Hazards

Heat

In general the climate of South East Queensland (SEQ) is expected to become hotter and drier. It is also expected that SEQ will experience an increase in the number of days over 35°C with less cold nights. By 2030 the average annual temperature in SEQ may increase by 0.3°C - 1.6°C on 1990 levels (Cai et al. 2005, Hennessy et al. 2006). As shown below, this increase can manifest itself in a range of ways.

Heatwave

Probably the most significant temperature related hazard is the change in return rate of extreme heat days (or heatwaves). The definition of a heatwave differs across the globe, but generally it "can be defined as a prolonged period of excessive heat. The difficulty in defining a heat wave in Australia has been in establishing an appropriate heat index with an acceptable event threshold and duration, and relating it to the climatology of the area under investigation" (BoM 2008). Heatwaves have caused more fatalities than any other natural hazard in Australia (Granger & Haye 2000). In

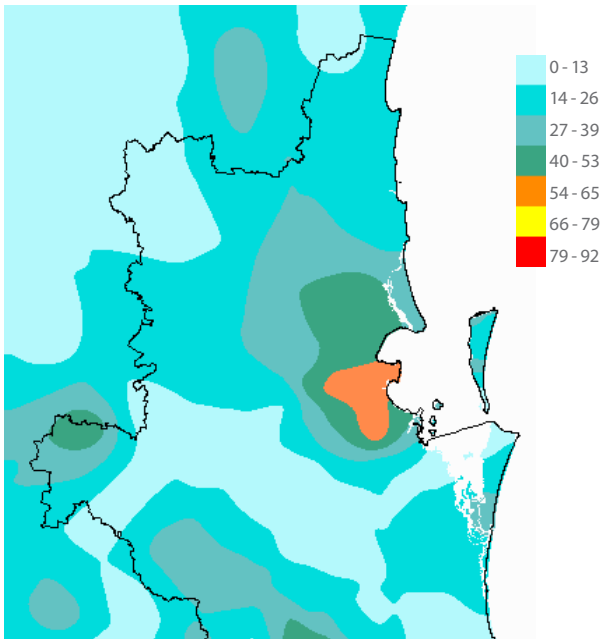


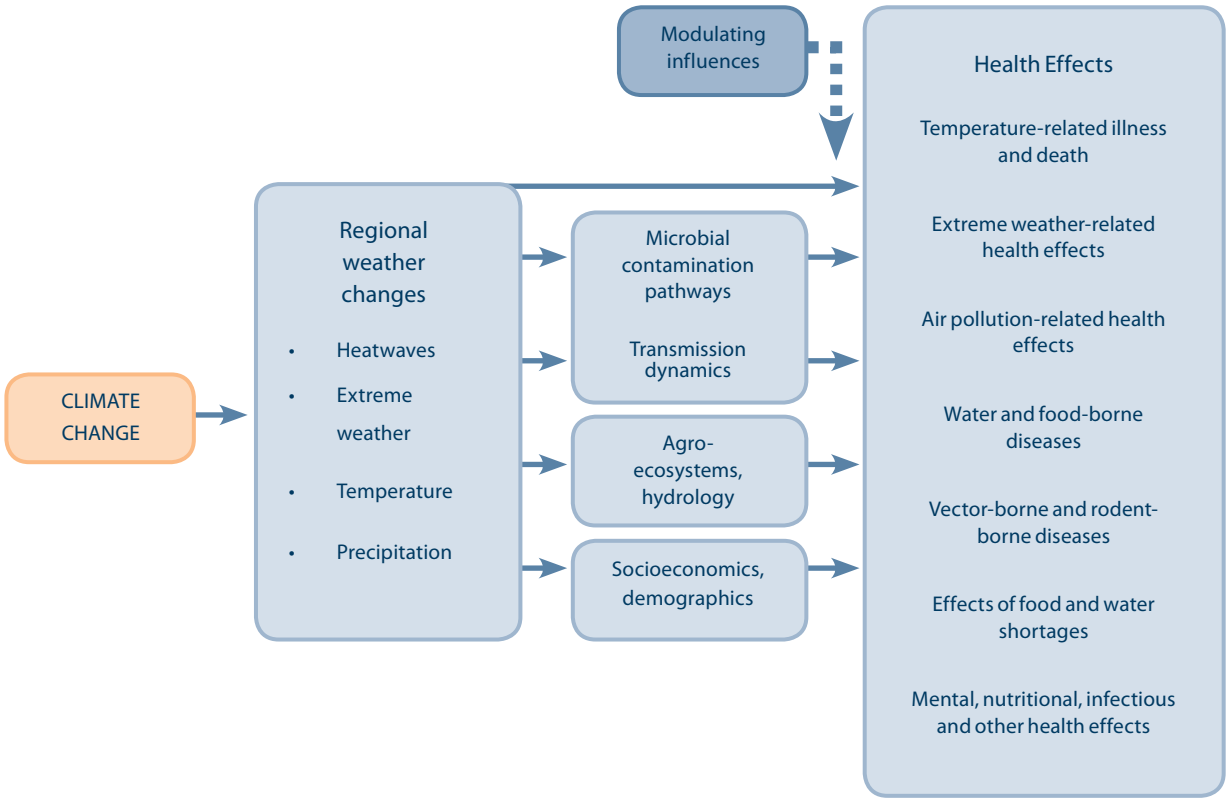
Figure 11. Map highlighting a projected number of days over 35°C in 2070 (using SRES A1FI scenario and an ensemble of GCMs). The MBRC area is projected to experience up to 40 days over 35°C during this period (CLIMsystems and Climate Risk 2008).

SEQ, historical evidence suggests that the average recurrence interval (ARI) for heatwaves is 5-6 years:

Using a threshold for temperature that is within the top 5% of daily maximum temperatures for a continuous three-day period in the South-East Queensland area, at least 18 heat wave events have been identified since 1899. (Granger & Hayne 2000, p10.4)

This return rate may decrease (i.e. heatwaves may occur more often) with the onset of climate change. Recent science suggests that increased global average temperatures may lead to "more intense, longer lasting, and/ or more frequent" heatwaves (Meehl & Tabaldi 2004, p.994). Heatwaves can have serious human health ramifications, especially on the elderly and infirm. They can also place considerable strain on infrastructure, energy supply as well as increase livestock and crop losses (Granger & Hayne 2000) (Figure 12).

Figure 12. Influences and effects of climate change on human health (McMichael 2003)



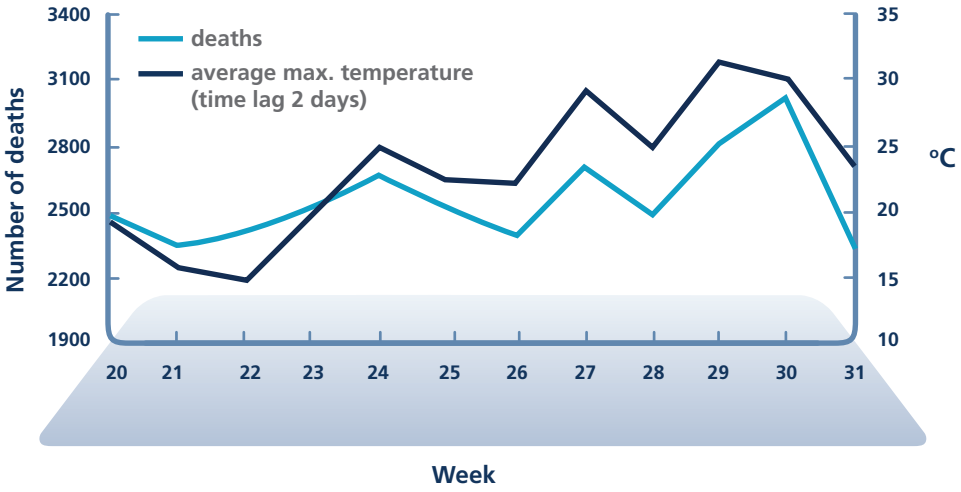


Figure 13. Graph showing the correlation between a heatwave in the Netherlands and number of recorded deaths (Munich Re 2007).

Bushfire

It is well documented that increased temperatures are associated with increased bushfire danger (William et al. 2001; Hennessey et al. 2007; Pitman et al. 2007). A recent Australian study predicted that under A2 emissions scenario there could be a 100% increase in bushfire and grassland fires. The authors note the SEQ region as being particularly "worrisome"(Pitman et al. 2007, p.397). The increasing popularity of rural residential living, as well as the preservation of natural areas within urban developments in SEQ, poses an increasing level of risk (Granger et al. 2003).

In the US, bush fire models show that if there is a significant increase of CO_2 in the earth's atmosphere, resultant impacts would include decreased fire containment, increased area at risk of burning, increased costs for containment and, ultimately, increased economic losses (Mills 2002; Westerling & Bryant 2008) (Figure 14). Consequently, the negative social outcomes that may follow include loss of property, damage to forests and wildlife, loss of life, loss of tourism, increased erosion due to watershed damage, respiratory health problems, and a greater likelihood of business disruption (Epstein & Mills 2006).

Human Health

Temperature can also impact on the health of humans. Increases in temperature, especially during heatwaves, increase the incidence of food and water borne illness. This comes from quicker spoilage of food (McMichael et al. 2006), decreased treatability of the water supply (Soh et al. 2008) and changes in the "distribution and activity of flies, cockroaches, and rodents" (IPCC 2001). As shown by the IPCC (2001) "climate plays a dominant role in determining the distribution and abundance of insects and tick species".

For the SEQ region it is anticipated that increased temperatures may lead to a shift in the range of disease harbouring mosquitoes (e.g. Ross River fever) (Lyth 2005).

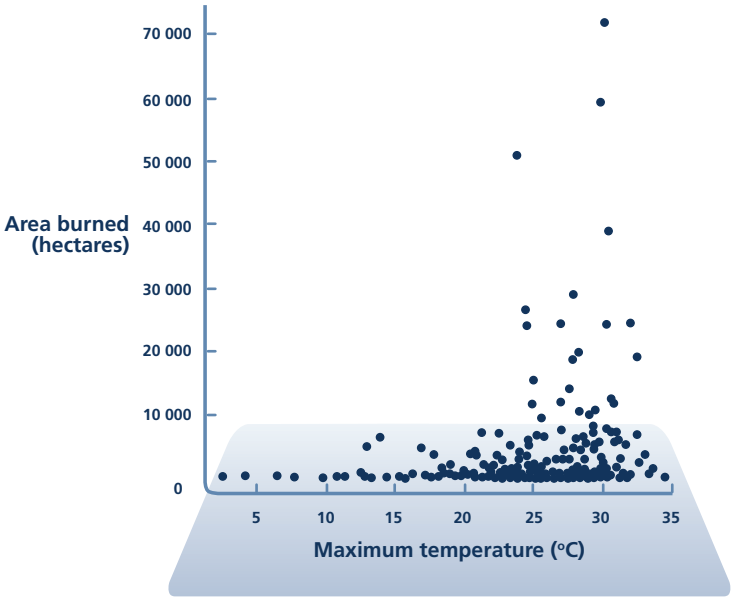


Figure 14. Correlation between large wildfires in California and neighbouring states and average monthly maximum temperature, 1980-99 (Westerling and Bryant 2008).

Ground Level Ozone

Of particular concern in the urban environment are potential challenges resulting from increased ozone levels. According to the Royal Society (2008) 'ground-level ozone is a serious pollutant that affects human health, reduces crop yields and damages natural ecosystems'. There is a strong correlation between ground level ozone and temperatures above 32°C (IPCC 2001). As ground level ozone is a significant pollutant in Australia, any increases in temperature may see an increase in the associated health effects (Horton & McMichael 2003).

Urban Heat Island

At the local level some areas of the built environment contribute to the 'urban heat island' effect. The urban heat island (UHI) effect is a phenomenon whereby the design (i.e. through consolidation and removal of the natural environment) and increased impervious surfaces of the built environment absorb and reflect more radiant energy than its surrounding environment (Kolokotroni & Giridharan 2008). This leads to increased temperatures (compared to surrounding environs) in the urban zone (Figure 15).

The implications of the UHI effect can lead to increased rates of human heat stress and death (Devi 2006), reduced productivity, increased water use (Guhathakurta & Gober 2008), increased energy use from air conditioners (Santamouris et al. 2007), as well as a potential exacerbation of the other heat issues described above. According to the IPCC (2007) heat related deaths in Brisbane for those over 65 years of age could more than double (from 1115 per year to 2300).

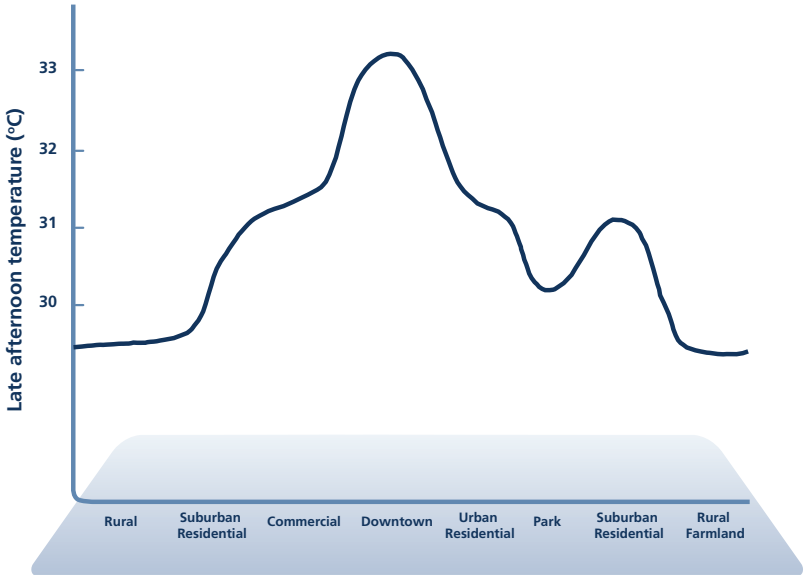


Figure 15. An indicative example of the temperature differences between an urban area and its surrounding environment.

Killer Heatwaves (Europe 2003)

In August 2003 Europe experienced the warmest weather on record with temperatures up to 14°C above the average maximum temperature for ten consecutive days. More than 30,000 deaths are associated with the European heatwave, more than half of those in France. The heatwave highlights the vulnerability of the elderly and infirm to the impacts of above average maximum temperatures, with up to 80% of those who perished being over 75 years of age (Trigo et al 2005). The flow on effects of the heatwave was substantial with morgues and funeral parlours having to hire temporary staff and refrigerated buildings to manage the increased rate of deaths (Dorozynski 2003). The heatwave also was responsible for over US$12 billion in insured crop losses and over $US 1 billion in damage caused by bushfires (Schär & Jendritzky 2004). As Australia (and many parts of Moreton Bay) have an increasingly aging population, local councils will need to consider how the plan for anticipated increased frequency of heatwaves in our urban environment.

Roads

Extreme and increased average temperatures also place a considerable strain on the built environment. For roads, increased temperatures during summer can prematurely crack the road surface and damage its water proofing. It is important to note however that road maintenance issues can also improve for regions in northern and temperate climates (Cechet 2007), due to less freeze-thaw events (IPCC 1997).

Natural Environment

The Australian Government Department of Climate Change noted that rising temperatures have impacted Australian ecosystems and biodiversity. While some changes have been observed- including more frequent and intense coral bleaching and changes in species distribution, abundance, phenology and physiology- the impacts are hard to measure due to the complex interactions between species and the lack of comprehensive species documentation (CSIRO 2007; Hughes 2003).

Agriculture and Forestry

These temperature impacts on the natural environment also have large ramifications on agriculture and forestry. While it is possible for forestry to see better productivity (e.g. from increased CO_2) and be used for greenhouse gas abatement and local temperature control (Aussenac 2000),

it is also sensitive to a range of heat related impacts, especially seedlings (DeYoe 1986). Other risks include increased number in pests, reduced water availability and bushfire risks. Similarly agriculture is exposed to heat through exposure to drought, reduced water availability and heat stress on equipment and livestock.

Sea Level Rise

Sea level rise is perhaps the most widely acknowledged climate change variable, especially in the media. The majority of sea level rise comes from the thermal expansion of the ocean as the global average temperatures increase as well as melting glaciers and polar ice sheets (IPCC 2007). Since 1900 the sea level has risen by 19cm (Hennesy 2007). At present sea levels are rising at approximately 3.1cm per decade (3.1mm per year), this has increased from the 1.8mm rate in the 1960s (Figure 12). The predictions of total future sea level rise range from 30cm to 2m by the end of the century (IPCC 2007), with current science anticipating the that the probable range is between 80cm and 2m (Pfeffer et al. 2008) (Figure 16). A sea level rise of a few centimetres will have significant impacts of the natural and built environment, especially in low lying coastal regions.

Increased sea levels can have ecological impacts (e.g. through changing stream flow); economic impacts (e.g. through altered distribution of fisheries); and social impacts (e.g. through loss of sandy beaches) (Voice et al. 2006). Furthermore sea level rise is expected to increase coastal flooding events, so that "events that currently occur roughly once every 50 years might occur as frequently as once or more per decade" (Church et al. 2006).

These factors are important because analysis indicates that coastal inundation is 50-100 times that of the predicted sea level rise, i.e. for every 1m of sea level increase, the sea may claim up to 100 metres of the foreshore (not including event based erosion). Hence based on the less extreme IPCC sea level rise projections the current predicted sea level rise of 3-30 cm by 2040 and 9 -88 cm by 2100 (IPCC 2007) could see the unprotected coastal foreshore retreat between 1.5 m - 30 m and 4.5 m – 88 m respectively.

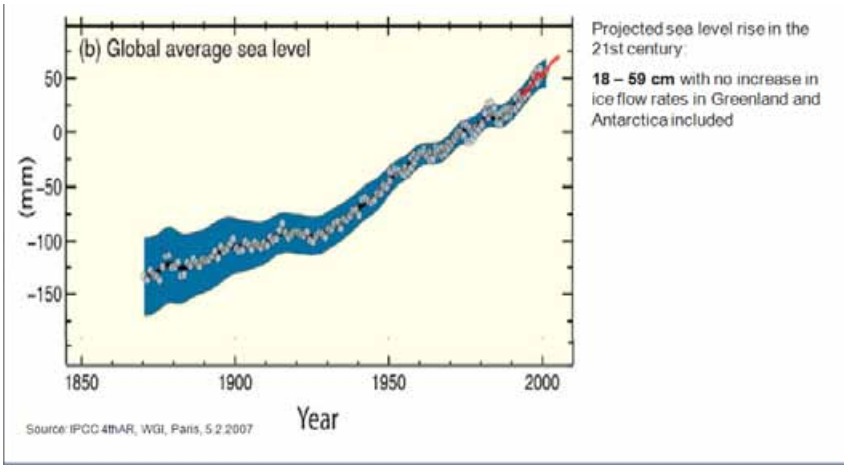


Figure 16. Sea level rise since the mid 19th Century (IPCC 2007).

Storms / Extreme Weather

Storms, also known as extreme weather events, are a common occurrence in the Australian environment. According to the Bureau of Meteorology (BoM 2008) "each year, on average, severe thunderstorms are responsible for more damage (as measured by insurance costs) than tropical cyclones, earthquakes, floods or bushfires". In light of recent science it is anticipated that the intensity of these storms will increase with a warming of Australian average temperatures. The resultant impacts would likely include an increase in disruption to key services such as electricity and transport, increased damage to infrastructure, higher accident rates including road and aviation sectors, and increased outbreaks of post-event disease and water-borne diseases from extreme rainfall (Department of Climate Change 2008). Lightning strikes are also predicted to increase under climate change by a factor of 1.4 for every degree increase in atmospheric temperature (Mills 2005).

A recent report that in SEQ "hail risk (hail-days per year) is projected to increase in south-eastern Queensland by up to two days per year by 2030 and four days per year by 2070" (Queensland Department of Climate Change 2008). Hail damage is responsible for some of Australia's largest single event insurance claims and as highlighted by the Insurance Council of Australia hailstorm are represent the highest percentage of weather events (Figure 17).

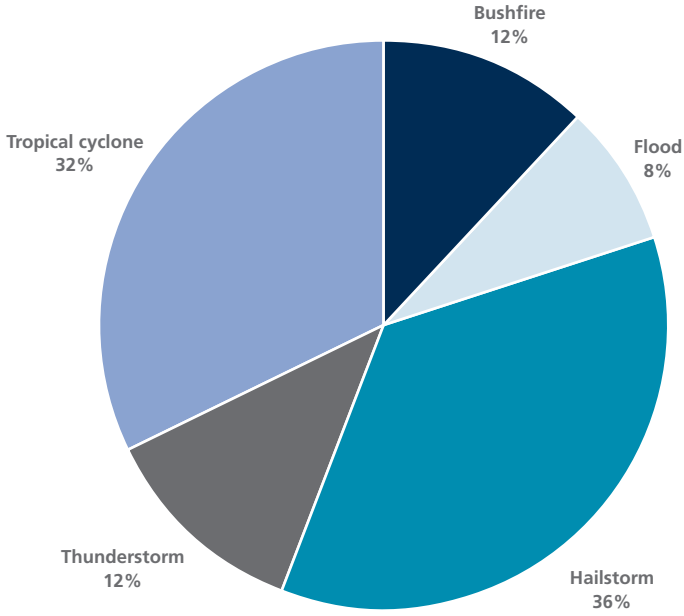


Figure 17. Percentage of Australian insurance claims from natural disasters (ICA 2007)

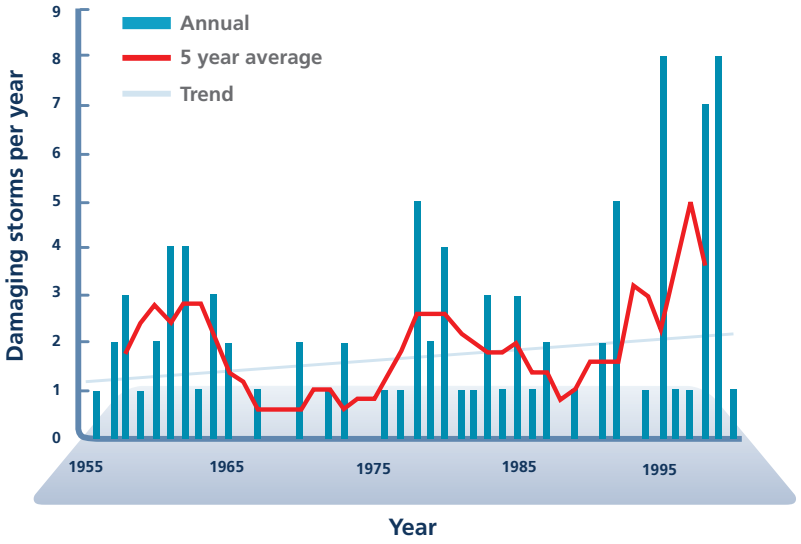


Figure 18. Graph showing the increase occurrence of damaging storms.

Current Australian science predicts that climate change will see a southerly movement of cyclones, as well as an increase in their intensity. As shown by Leslie et al (2007, p.179) (Figure 19) it is projected that there will be an increased in the number of intense tropical cyclones along the Australian east coast with increasing numbers and severity of impacts over southeast Queensland and the NSW northern coast. As shown by the recent Garnaut Review if a category 3 cyclone was to hit the Gold Coast the damage to houses, businesses, infrastructure and repercussions to the national economy may be in the order of $25 billion (Garnaut 2008). According to Munich Re (2007) there has been a marked increase in the number of global windstorm catastrophes (Figure 20).

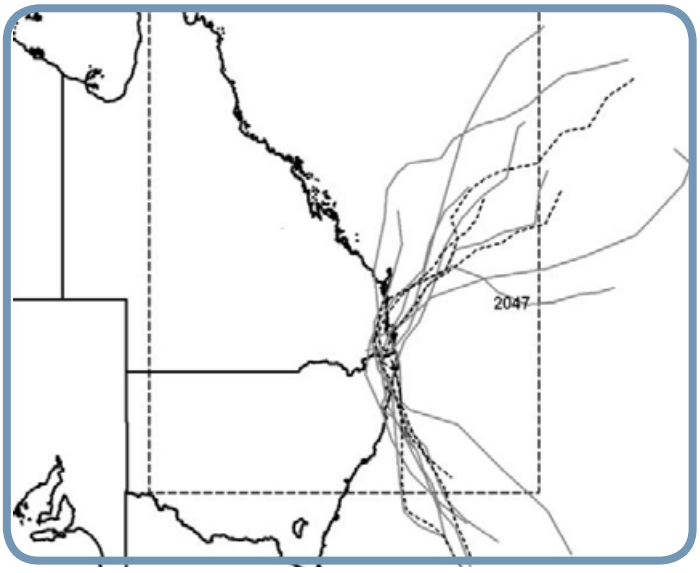


Figure 19. A selection of model tropical cyclone tracks for the period 2000-2050. The dashed lines are the control model tropical cyclone tracks, the full grey lines are the enhanced greenhouse gas model tracks (Leslie et al. 2007).

Queensland is exposed to numerous tropical cyclones per year - for more information on historical cyclone tracks visit www.bom.gov.au

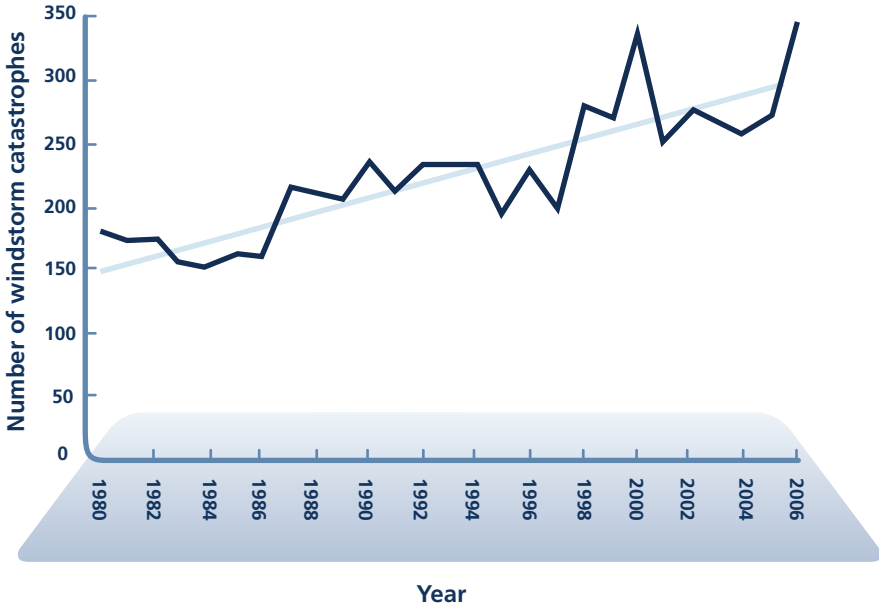


Figure 20. Trend highlighting the increased occurrence of damaging windstorms over the past three decades (Munich Re 2003).

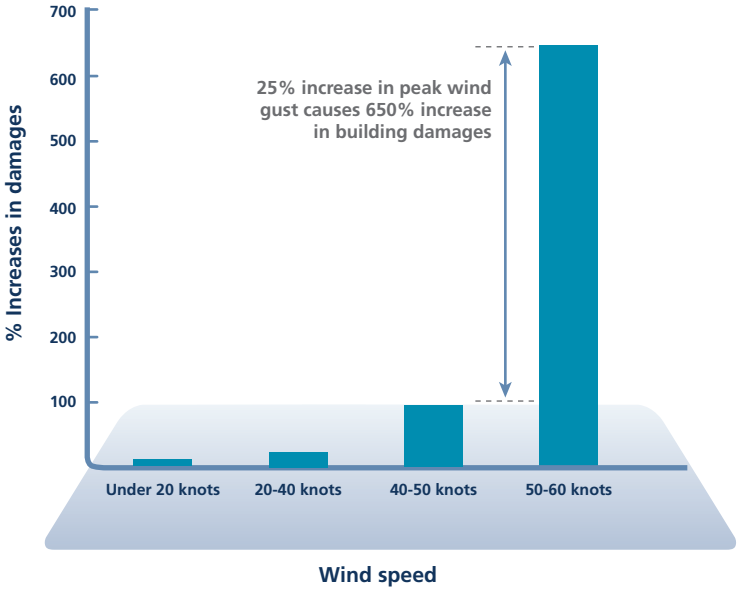
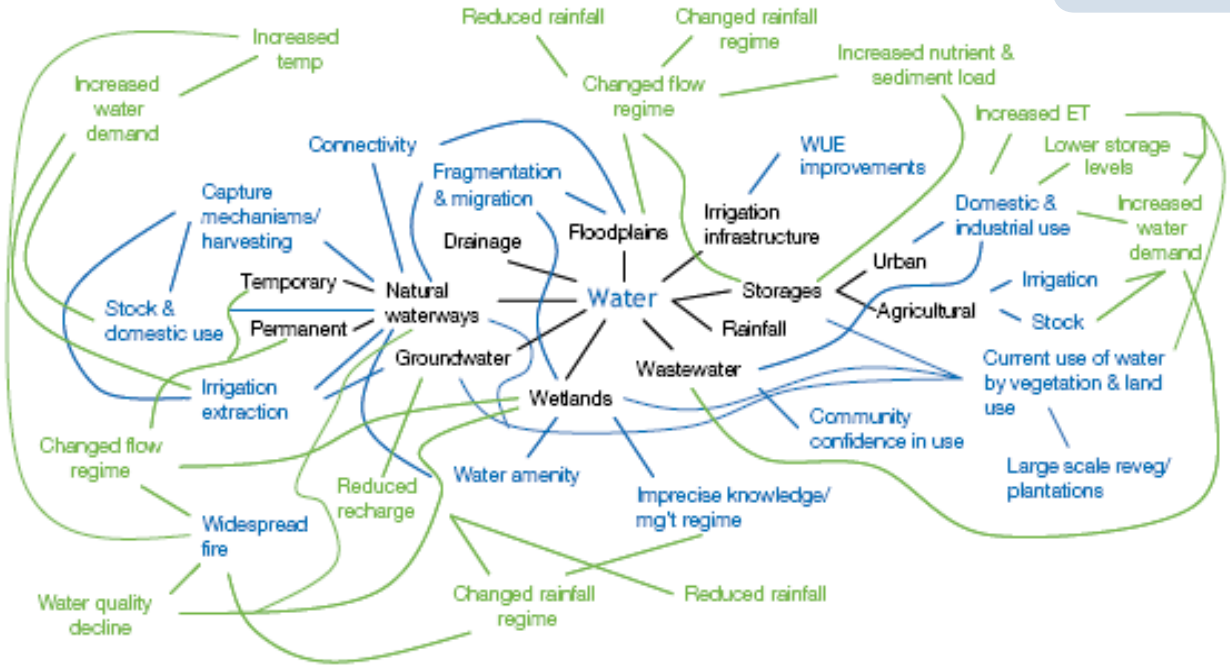


Figure 21. Graph highlighting the nonlinear correlation between peak wind speeds and insurance losses (Hawker 2007).

Precipitation

Australia is a dry continent. Any changes in precipitation are significant for human settlements and agriculture. According to the CSIRO, it is anticipated that South East Queensland will experience an increase in the number of days between rainfall events and more intense downfalls when they occur. Reduced rainfall, or number days between rainfalls can increase costs and maintenance in the built environment due to drying of soils affecting the foundations built infrastructure, through to reduced water affordability for agriculture and environmental flows (Figure 22).

Figure 22. The range of drivers (exacerbated by climate change) that place pressure on Australian water resources (Source DCC 2008).



Flooding

With intense rainfall comes flood. Global flood catastrophes have increased over the past three decades (Figure 23) and it is predicted to continue (especially with the onset of sea level rise and increased urban development). As shown by Hennesey et al (2006) a 25% increase in the duration of a 30 minute rainfall event can see a 1 in 100 year flood event becoming a 1 in 17 year event.

Over the past 40 years (since records were collected) the MBRC region has experienced five significant periods of flooding. According to the Bureau of Meteorology (BoM 2008) 'significant

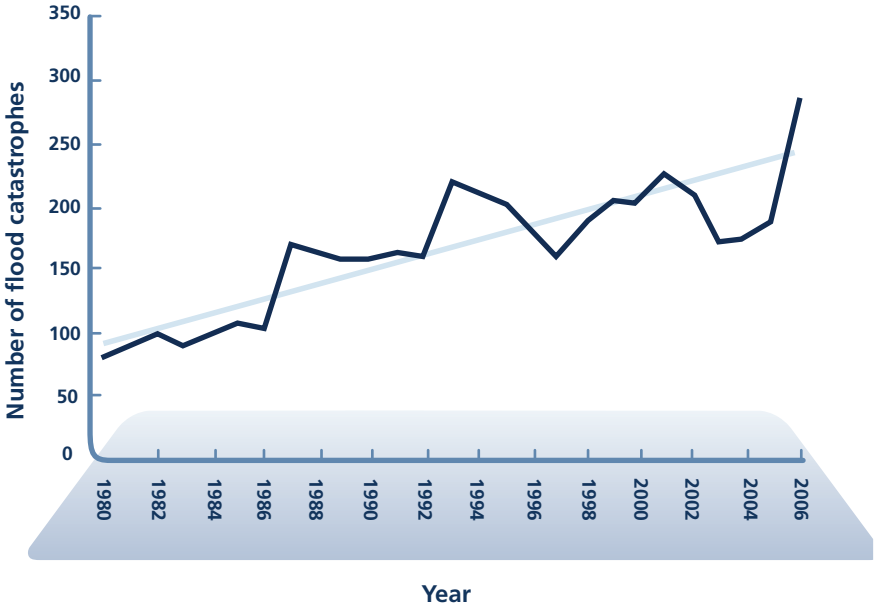


Figure 23. Global flood catastrophes have increased over the past three decades.

flood events with major flooding were reported in 1967, 1972, 1974, 1989 and 1991' (Figures 24 and 25). In particular the low lying regions of the Caboolture District in MBRC are sensitive to flood According to a recent study of natural disaster risk in Caboolture the region faces considerable flood risk with 'at least 110 sq km of the Shire exposed to inundation at the 100 year ARI flood level, at least 55.5 sq km of which is in the Caboolture River and 46.3 sq km in the Stanley River catchments' (Institute for International Development 2007, p.6).

Figure 24. South Pine at Drapper Crossing Flood Peaks (BoM 2008).

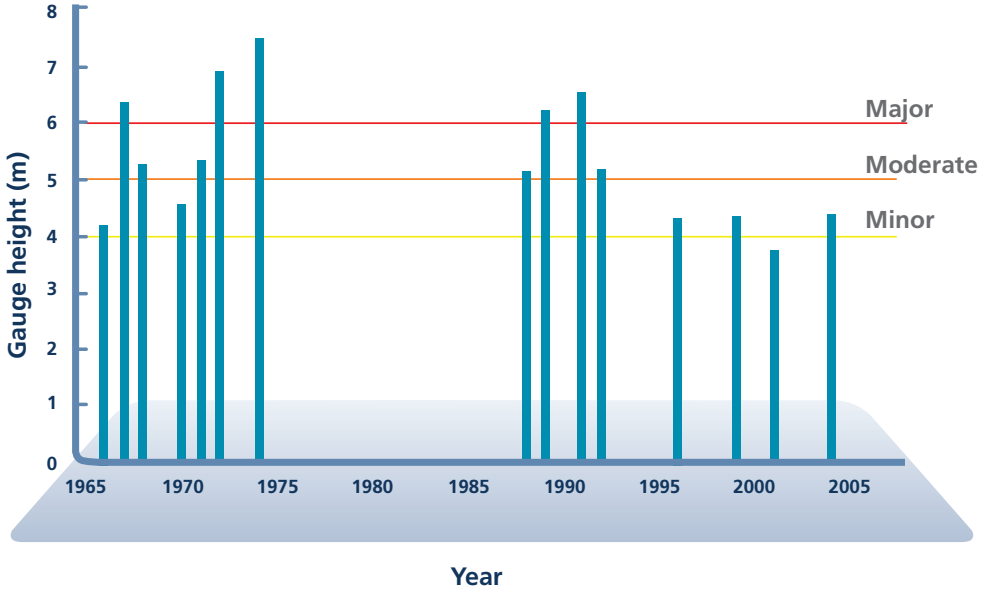
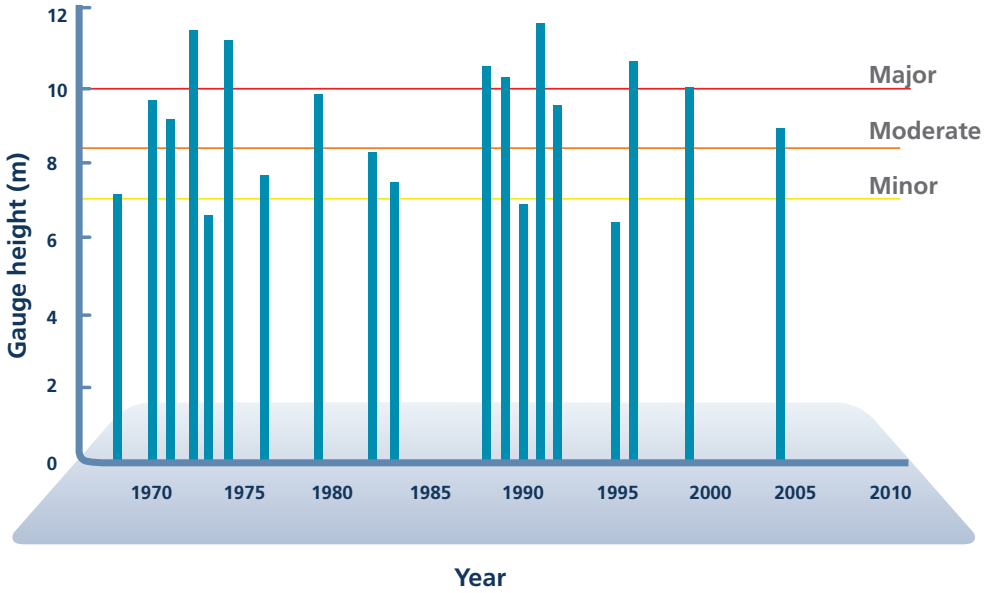


Figure 24 and Figure 25. These graphs show that the MBRC region has experienced numerous major and moderate floods over the past 40 years (BoM 2008).

Figure 25. Caboolture River Flood Peaks (BoM 2008).



Secondary Hazards

Federal and State climate change policies and regulations are being created at a rapid rate. In the past year the following significant Federal and State policies and regulations have been created and/or amended with respect to climate change:

Commonwealth

- National Greenhouse and Energy Reporting Act 2007 – this act is designed to support the collection, reporting and auditing of data by GHG polluters over a pre-define threshold. It is still ambiguous where Local Governments sit within this act.

- Mandatory Renewable Energy Target 20 (MRET20) – Commonwealth's commitment for 20% renewable energy by 2020 (45,000 GW hours per year).

- Carbon Pollution Reduction Scheme (CPRS) – This is the Australian emissions trading scheme. Companies who emit over a predetermined threshold will have to purchase the right to pollute. These permits will be auctioned and can be trading nationally.

Queensland Government

- ClimateSmart 2050 – 'establishes Queensland's long term climate change goals and provides a platform for the Government, community and industry to move to a low carbon future. It includes initiatives in: energy, industry, community, planning and building, primary industries, transport, adaptation, and government leadership' (Queensland Government 2008).

- ClimateSmart Adaptation Plan – 'Queensland's plan for increasing our resilience to the potential impacts of climate change. Under the plan, government and business are required to consider the potential effects of climate change when they make decisions about: water planning and services, agriculture, human settlement, natural environment and landscape, emergency services and human health, tourism, business and industry, finance and insurance' (Queensland Government 2008).

- SEQ Regional Plan Review 2009-2031 – The latest review of the SEQRP has been brought forward, and it has been widely reported that there will be a heavy focus on climate change mitigation and adaptation.

- SEQ Infrastructure Plan – Infrastructure plan supports the SEQRP review, will also consider climate change mitigation and adaptation.

- Planning Reform – there is a suite of anticipated changes to many of Queensland's planning instruments. The reform agenda includes standardising planning schemes

and undertaking a risk-assessment approach to development applications. It is envisaged that many of the reforms will embed climate change mitigation and adaptation.

These new policies and policy changes present a range of risks for Local Councils in three main areas:

1. Compliance - The enormity and speed of climate change specific policies create a substantial workload and cost for local governments to collate synthesise and implement. Choosing to focus on one policy over another (e.g. mitigation over adaptation) may see competition of resources and some measures being implemented more thoroughly than others.

2. Staffing challenges - there is a dearth of local government professionals (such as planners and engineers) and those with climate change specific skills are even scarcer. As all councils will be responding to climate change policies simultaneously the cost of obtaining these key staff will increase substantially.

3. Regulatory Risks - changing policies also means changing regulatory risks from failure to comply, litigation and planning challenges (this will be discussed below in further detail).

The Queensland Government has attempted to embed adaptation to climate change in a number of regulations and policies. At present there is a review of the South East Queensland Regional Plan (SEQRP), where it is anticipated that it will become the main mechanism for climate change adaptation in the region.

The current SEQRP provides some limited guidance to councils in regards to climate change adaptation. These include the following climate change specific directions to:

2.3.4 Assess the impact of potential climate change in preparing planning schemes and land use strategies.

2.3.5 Raise community awareness, knowledge and understanding of air quality, greenhouse gas emissions and climate change impacts.

2.4.4 Ensure use and management of the coast provides for natural fluctuations in coastal processes, including storm tide inundation, climate change and sea level rise.

Carbon Constraints

The Commonwealth Government is committed to implementing a system to reduce national greenhouse emissions under the Carbon Pollution Reduction Scheme (CPRS) (currently scheduled for 2011). This trading scheme is a market based mechanism which aims to reduce carbon pollution by creating a cap on total national greenhouse gas emissions across a wide range of

economic sectors. The CPRS program presents two main challenges for Local Governments. Firstly, there is the cost associated with recording and auditing the emissions (although those councils who are already members of the Cities for Climate Protection program may already be somewhat prepared).

The biggest challenge to Local Governments and particularly MBRC from a carbon pollution scheme arises from increased costs associated with fleet and plant fuel, cost of bitumen, and cost of energy and electricity supply for the services that it provides to the community. Although the Commonwealth has indicated that there will be no net increase in transport fuel costs for the next 3 years, it is possible that it will rise after a transition time. Even a few cents a litre can increase the Councils fuel bill substantially. With oil vulnerability on the horizon the problem is exacerbated with the community, who already feel the strain of increased fuel prices, with limited access to public transport services and facilities.

The cost of emissions under a CPRS scheme will be decided by the market, but there are various estimates for costs. In the short term, the Garnaut review has suggested starting with a fixed price of $20/tCO-e for an initial transitional period. Thereafter the cost of carbon will depend upon on the trajectory of emission cuts as set out by the government.

Plausible Future Emission Levels

There are several important challenges presented to Council in preparing itself for changes which may be at or even beyond the regulatory horizon. In the short term emission policies will be driven by political considerations including election commitments, international negotiations and the influence of impacted groups.

In the medium and long term it is worth remembering that the objectives of carbon constraints are the avoidance of 'dangerous' levels of climate change. The European Union has defined dangerous levels of climate change as greater that 2°C above pre-industrial levels. This figure is based on the risk of unlocking significant positive feed-backs in the global climate systems which will lead to irreversible or 'run-away' climate change.

Australia will tend to be a 'target taker' of agreements which are established by larger economic blocks and enforced through trade access or sanction. If Australia was required to take Barack Obama's anticipated 80% national emission cuts by 2050, it would equate (on a per capita basis) to 83% cuts in Australia. The European Union's position based on avoiding the 2°C warming requires an Australian emission cut of the order 90% by 2050. The implementation of national and international targets will depend on the participation of developing countries like India and China. Whatever the targets are for 2050, there is little doubt

that they will be deep and will change the face of the international economy if climate change is effectively addressed.

The following diagrams show the impacts of three emission targets in Australia by sector, a 60% cut consistent with the Commonwealth Governments current goal, a reduction consistent with the new US target (83% cuts) and a cut consistent with the EU position (90%+ reduction).

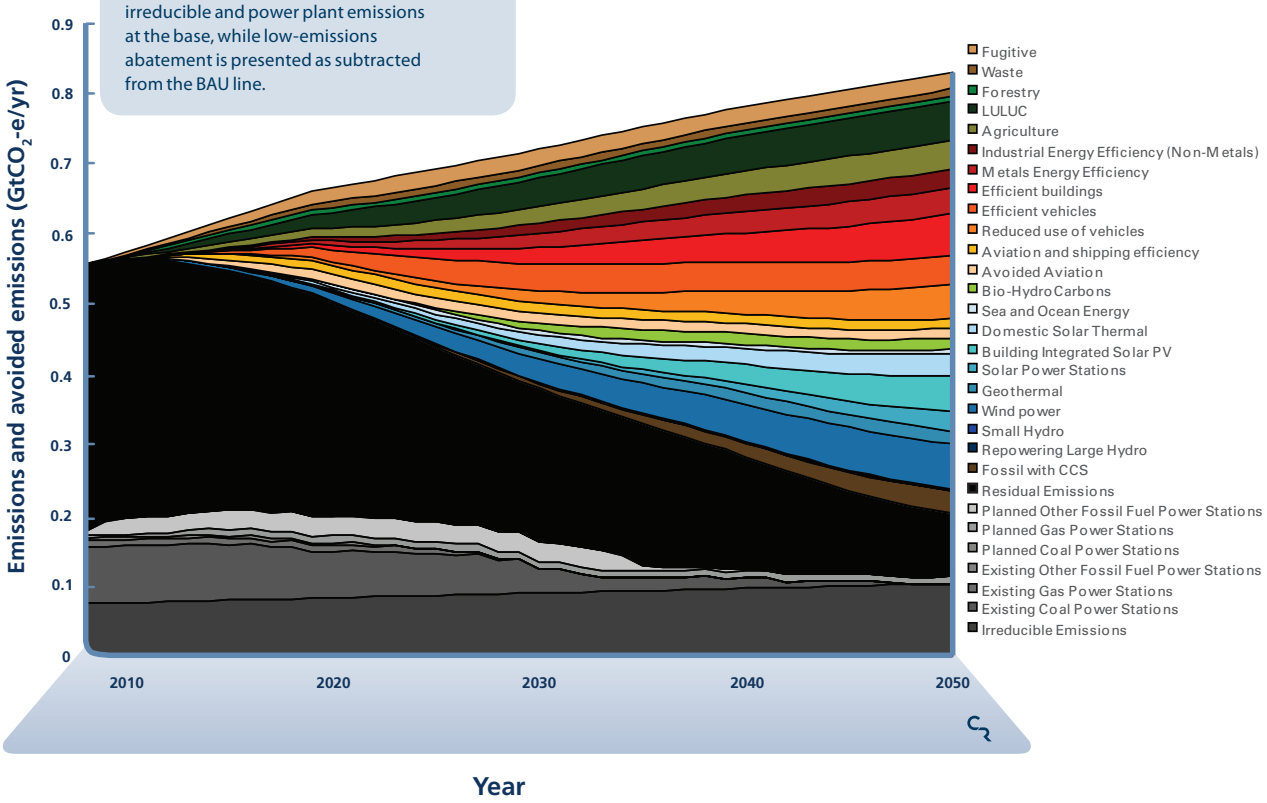


Figure 26. Emissions profile of the Rudd Government scenario showing irreducible and power plant emissions at the base, while low-emissions abatement is presented as subtracted from the BAU line.

Figure 27. Emissions profile of the US equivalent scenario showing irreducible and power plant emissions at the base, while low-emissions abatement is presented as subtracted from the BAU line.

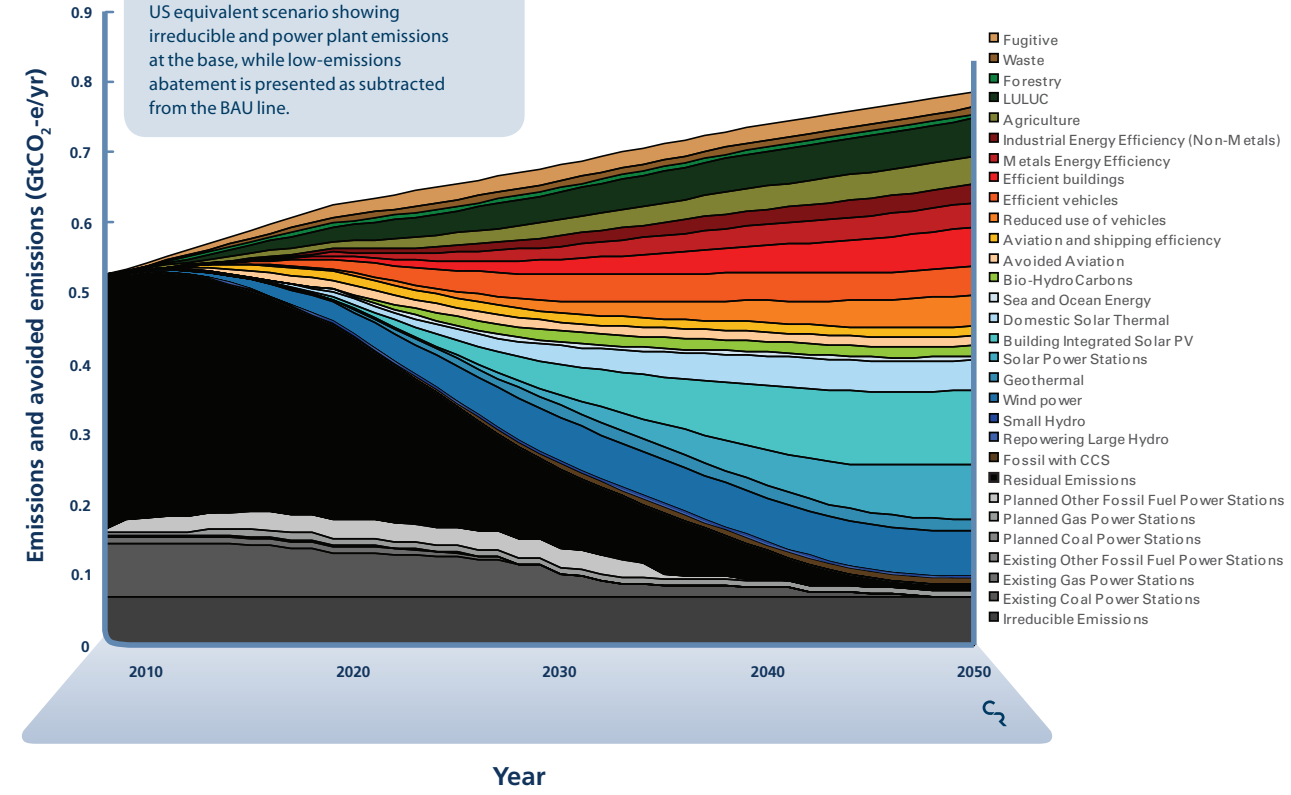
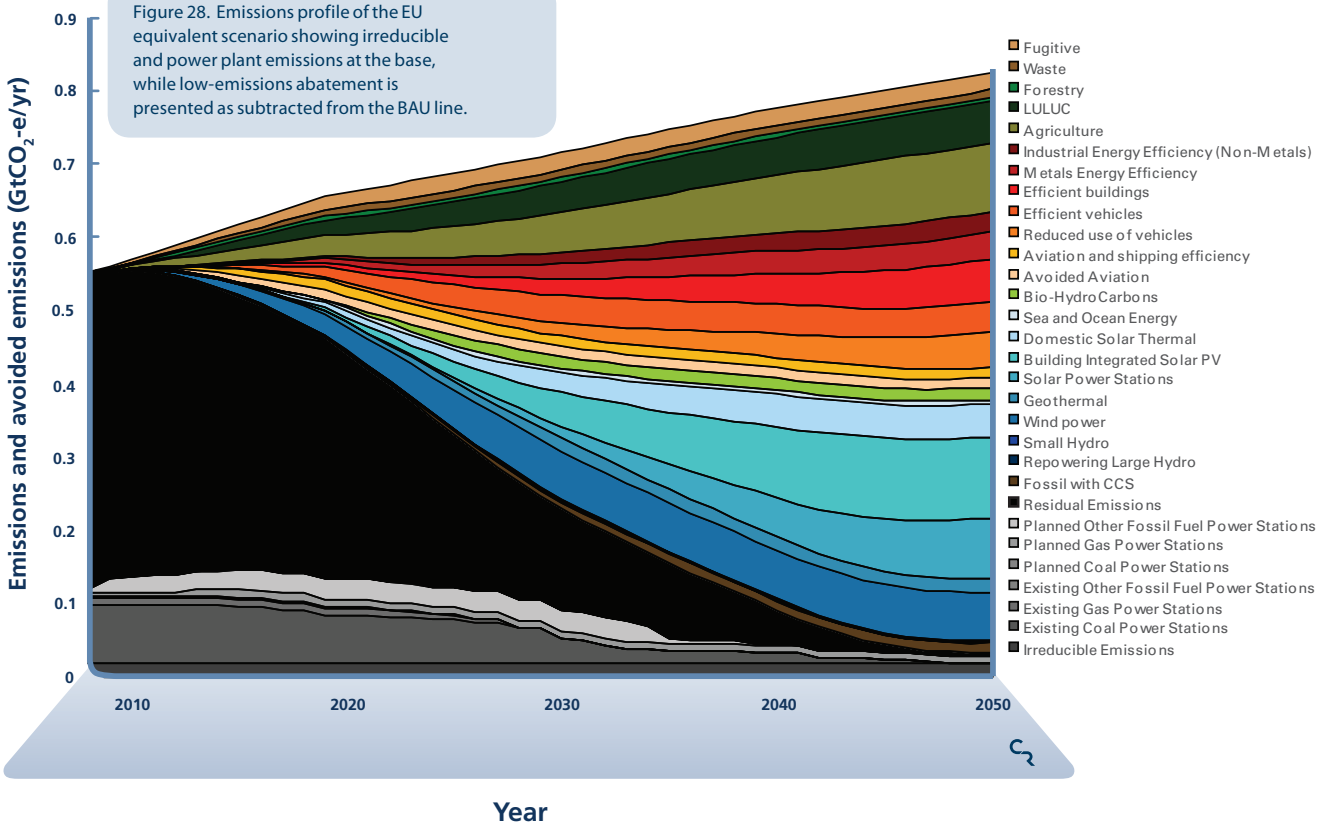


Figure 28. Emissions profile of the EU equivalent scenario showing irreducible and power plant emissions at the base, while low-emissions abatement is presented as subtracted from the BAU line.



Moreton Bay Regional Council - Operational Expenditure and CPRS

The following discussion uses the Moreton Bay Regional Council Financial Budget 2008/2009 data to highlight areas where there may be potential increases in operation costs from climate change and associated strategies.

Operational Costs and the Carbon Pollution Reduction Scheme

According to the Australian Local Government Association the proposed Carbon Pollution Reduction Scheme (CPRS) will increase Australian Local Government operational costs significantly.

It is estimated that a CPRS at a carbon price of $20 per tonne may raise council operational costs by 1.8%. However, the impact would not be uniform across all councils. The cost burden in some council areas could be significantly higher depending upon the council's mix of services, policy decisions and financial circumstances. (ALGA 2008)

If this percentage is realised for Moreton[3] then it equates to an increase of between $5.5 million – $6.2 million annually (see Table 1). Over three years this equates to more that $17 million that a) may not have been budgeted for and b) may compete with other operational budgets and affect their funding for resilience.

Table 1. CPRS impact on annual operational expenditure (assumes that Council has not considered CPRS in budget and that CPRS impacts realised from 2010/2011 financial year with a price of $20 per tonne of carbon - based on Garnaut 's prediction).

*Note that while recent discussions place the starting carbon price at $10 per tonne recent Australian Treasury (2008) modelling estimates the price of carbon up to $57 per tonne by 2020.

Budget Forecast Year	Projected	1.8%	Total (projected + CPRS)
2008/2009	$ 391,861,107	-	$ 391,861,107
2009/2010	$ 410,909,931	-	$ 410,909,931
2010/2011	$ 308,643,197	$ 5,555,578	$ 314,198,775
2011/2012	$ 328,519,899	$ 5,913,358	$ 334,433,257
2012/2013	$ 348,667,371	$ 6,276,013	$ 354,943,384

These increases in costs do not include changes to insurance pricing, adaptation retrofitting or increased post event emergency response and clean up. Of concern is that by 2020 Australian Treasury modelling shows that the price of carbon could be as high as $49.00 (based on a 15% reduction of GHG emissions). Without changes to Council assets, operational behaviour and sources of energy, a price of $49.00 per tonne could pose significant problems. Council may have limited options than to pass the increased costs on to ratepayers and developers.

The above discussion was limited to the price of carbon. However climate change is likely to contribute to an array of other increased operation costs. The following table (Table 2) describes potential climate change impacts for each cost centre.

3 This assumption is based on MBRC having not considered CPRS in operation costing – assumption has arisen as there are no publically available documentation which states CPRS has been considered in future budgets.

Table 2. Anticipated climate change impacts on expenditure by cost centre.

Cost Centre	Anticipated climate change impacts on expenditure	Comments
Executive	uncertain	
Councillors	increase	Potential increase in councillors and officers insurance
Corporate Governance	uncertain	
Legal Services	increase	Potential increase in planning challenges and tort based litigation
Procurement	uncertain	There may be pressure for council to purchase more parcels of land for environmental easements. Council may need to purchase land that is less exposed to climate change hazards such as storm surge
Corporate Services	uncertain	
Financial Services	increase	Possible initial expenditure increase from changes to financial and insurance reporting methods
Information and Technology Services	uncertain	Potential increased electricity costs associated with CPRS
Customer Services	uncertain	Potential increased frustration from residents having to meet new regulatory requirements
Media Marketing & Communications	uncertain	Increased demand to communicate new regulatory changes, energy efficiency and resilience education
Human Resources	uncertain	Potential increased costs associated with staff training and OHS requirements
Library Services	increase	Increased costs of books (from increased transportation and production costs), possible increased electricity, asset maintenance and insurance costs
Property Services	uncertain	

Table 2. Continued

Cost Centre	Anticipated climate change impacts on expenditure	Comments
Planning and Development	increase	Initial increase in costs associated with embedding climate change in new planning scheme and training strategic and development assessment planning officers and engineers. Potential increased strategic land acquisitions required.
Transport Infrastructure	increase	Increase demand for public transport services, increased road maintenance costs. Costs associated with changes for transport model to consider CPRS.
Disaster Management	increase	Increased number and intensity of extreme weather events
Waste Management	increase	Increased costs associated with GHG management and transportation.
Moreton Bay Water	increase	Increased maintenance costs
Plant and Fleet	increase	Increased fuel costs (CPRS) and initial capital expenditure to transition to low carbon fleet and plant
Parks and Recreation	increase	Increased maintenance costs associated with low precipitation and post storm clean up
Canals	increase	Increased maintenance and operational costs
Marine Infrastructure	increase	Increased costs associated with sand replenishment and Lyngbya clean up. Potential increased maintenance costs of marine infrastructure
Council facilities	increase	Increased maintenance and retrofit costs
Compliance	uncertain	
Arts and Culture	uncertain	
Community Services	uncertain	

Direct Impacts on Council

There are several areas of change that we believe will impact directly upon council services, both negative and positive, these include:

1. Reductions in emissions from household, commercial and industrial waste.
2. Increases in vehicle efficiency
3. A transfer of some transport from car to public transport
4. Building efficiency
5. Across the board de-carbonisation of energy in fuels and power - requiring widespread renewable energy development
6. New infrastructure

Indirect impacts for Council

There will also be positive and negative impacts that will indirectly affect council though the impacts on individual and businesses in the area. Important impacts may include

1. Stabilisation of aviation levels and increases in costs
2. Modification to agricultural practices - especially livestock which is particularly sensitive to carbon trading
3. Significant reduction in land clearing
4. Increases in renewable energy developments of various kinds.

It is possible that some of these changes will provide opportunities for inward investment if properly managed. However within the context of risk, the most important hazards to council arise from regulatory risks:

1. Long term building standards – buildings have very long life-spans and therefore effectively lock in performance over many decades. There is an emerging tension between existing building standards which are designed for past performance requirements and the climate science which implies quite different performance standards .
2. Planning and zoning for future development - planning for a change to increase public transport use, and increase development of renewable energy assets is required in the short term. For example national biomass requirement may need to ensure the highly productive land is not committed to building or industrial development. Areas of potentially high wind energy resource need to ensure that urban development is not too close due to noise levels prohibiting use of the land for wind farming. There may also be the need to consider easements for infrastructure such on-shore and off-shore transmission lines, CO_2 pipelines and increase gas pipeline capacity.
3. Economic disruption - Wide ranging

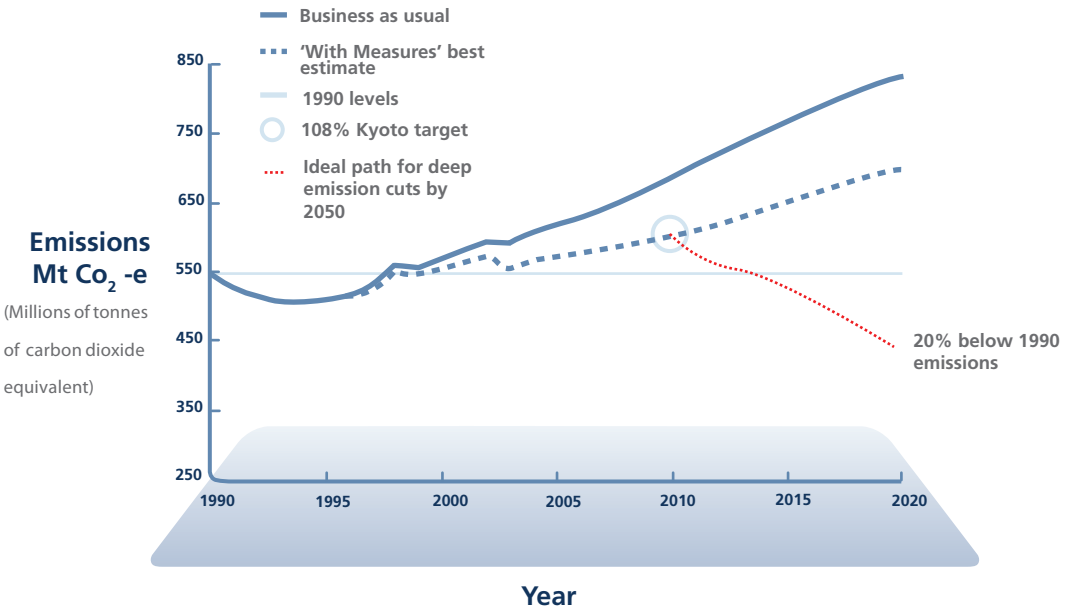


Figure 29. This graph shows that if Australia is to meet internationally recognised abatement there would need to be a significant paradigm shift from its business as usual, including carbon constraints and renewable energy targets.

economic changes with some sectors benefiting and others being adversely affected or undergoing transitions such as re-tooling, re-skilling or relocation.

Litigation

As shown by recent publications (England 2007; McDonald 2008) climate change presents a legal minefield for Local Governments. Legal threats come from issues surrounding failure to abate (causation of greenhouse gases); failure to adapt to the known impacts; mal-adaptation to the known impacts and pressure from developers and community groups surrounding climate change mitigation and adaptation requirements (or lack of) for new developments.

To a certain extent, the Civil Liabilities Act, 2004 offers some protection to Councils, although as shown by England (2007) recent international and national reports and attention on climate change make it difficult for Local Governments to deny that they were not aware of climate change risks.

A recent ruling in the Supreme Court of South Australia (Northcape Properties Pty Ltd v District of Yorke Peninsula [2008] SASC 57) has highlighted that climate change is, and will continue to be, a contentious issue for developers and councils. In this case, a development was rejected by the District Council of Yorke Peninsular due to its failing to consider anticipated sea level rise. This was a view supported by the Supreme Court Judge who agreed that the foreshore could recede by up to 40m by 2100. This has served as a wake up call for both developers and councils.

Although the council won the above case the process of gathering supportive information and legal costs can be an expensive risk for Local Governments to take. Councils face difficult decisions surrounding the costs and benefits of such action. It could be argued that if the council did not challenge the development, then they could face action in years to come by property owners seeking redress from council for allowing development to occur in an "at risk" area.

There is also a risk of litigation from businesses and residents if risks are hidden from public view.

Anecdotal evidence suggests that some councils in Australia may be holding on to the findings of risk assessments. This presents a significant risk in itself, and may negate some of the protections that Queensland Governments have under the Civil Liabilities Act, 2004. It may be in the interest of Council to divulge all known climate change risks to its residents and businesses to increase the chances of volenti non fit injuria defence being used under the Civil Liabilities Act, 2004[4]. Climate Risk Pty Ltd recommends that MBRC seeks legal counsel to further consider these issues when determining the public availability of climate change risks in the government area[5] (see Appendix II for a more detailed assessment of Civil Liabilities Act).

Box 2. Potential Council Litigation

Dr England from Griffith University describes some of the potential legal risks for councils:

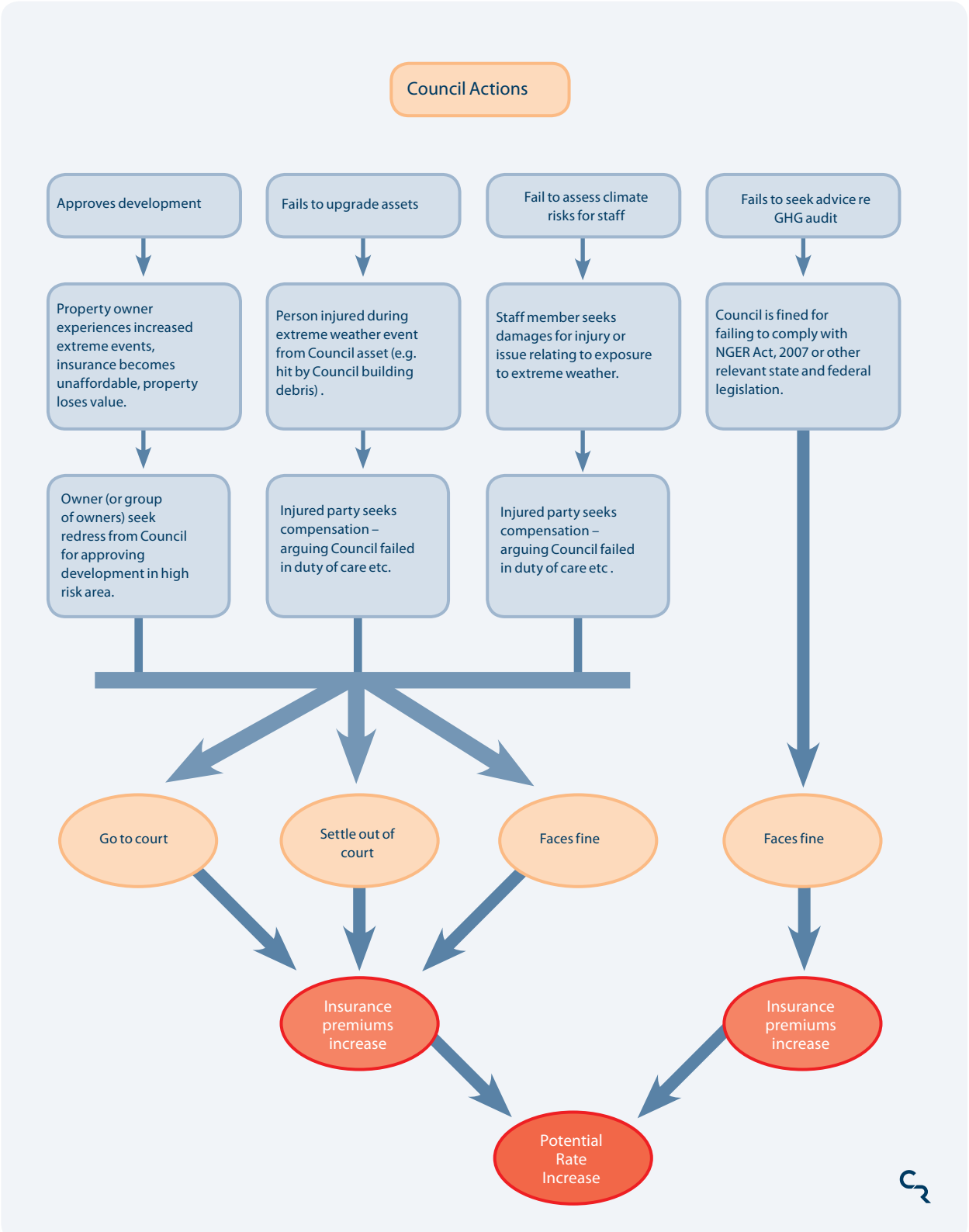
" It's not hard to envisage the type of law suits [from climate change] that may eventuate or increase in incidence. These may challenge:

- The appropriateness of development approvals in flood prone, coastal zone or at risk areas
- The adequacy of building standards to withstand extreme weather events - as their area of activity expands and their frequency increases
- Responsibility for erosion, landslides etc, resulting from extreme weather events
- The adequacy of emergency procedures when more frequently put to the test
- Failure to undertake disease prevention programmes
- Failure to preserve 'public' natural assets in the face of climate change – if and when the technology becomes available." (England 2006 p. 4)

4 "The Latin phrase volenti non fit injuria or volenti for short is a long standing legal maxim that when translated means "to a willing person, no injury can be done". It means that a person who knowingly and willingly puts himself or herself in danger cannot sue for the resulting injuries as they have voluntarily assumed the risk" (McGuire & Stevens 2007, p. 1).

5 Climate Risk Pty Ltd is not able to give legal advice and suggests Council seeks legal counsel to further consider these issues.

Figure 30. Possible decisions that lead to legal action and/or fines and link to potential increased insurance premiums.



Insurance

Australian and international insurers are feeling the impacts from climate change. The growth in claims from climate related events has increased significantly over the past decade and insurers are seeking ways to contain this unsustainable rate of increase (Figure 31). There are three significant threats that insurers face from Local Governments.

1. Regulatory exposure – Local Governments are at the forefront of land use planning and play a significant role in the development approval process. Local Governments in SEQ are experiencing a major strain on resources with an increase in development applications. Councils are often restrained from rejecting development applications for a number of reasons. These include: time and resources to challenge in court, planning staff without appropriate knowledge and/or political support. However these planning decisions have the potential to increase their exposure to climate change, or conversely decrease insurance policy holders should they determine the area to be too high a risk.

2. Tort based litigation (see previous section). Councils and their staff have a range of insurance for public liability and indemnity issues. As shown in the previous section tort based litigation is possible, increasing the insurance sector to potentially unidentified risks.

3. Occupational health and safety claims from staff or the community injured by Council assets which were not built or maintained to a standard which considers climate change risks.

Insurers ultimately have three options to spread their growing risks, and these have serious consequences for Councils and the communities which they support:

1. Cease insuring high risk areas or activities;
2. Increase premiums; and/or
3. Work with clients to minimise risks and losses.

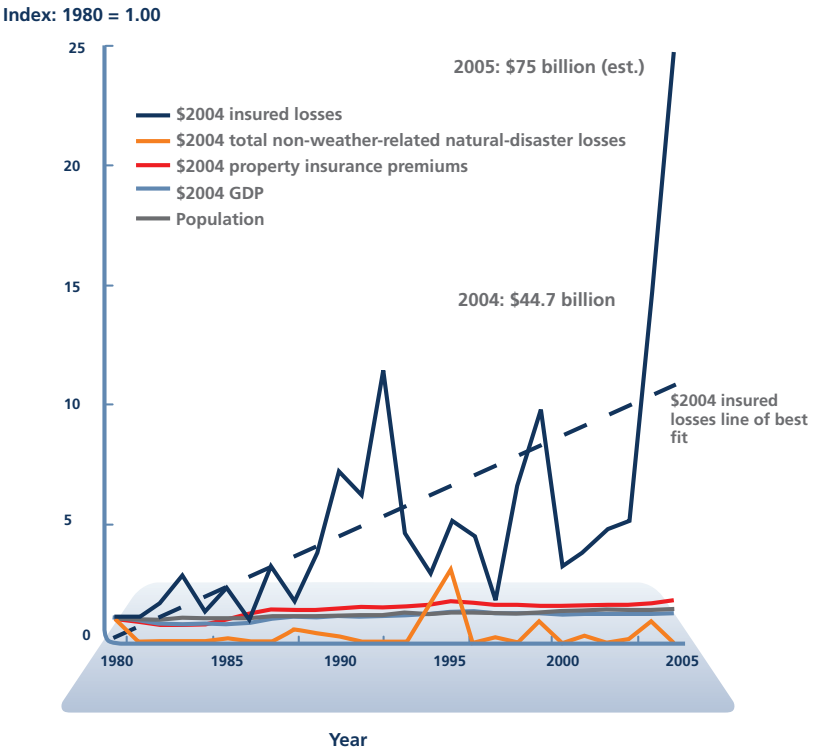


Figure 31. Insured weather-related losses are rising faster than premiums, population or gross domestic product. Data exclude health and life insurance premiums and losses (Mills 2005)

Tertiary Hazards

Tertiary hazards are those which result from adaptations by the community or businesses to deal with climate change. There are innumerable possibilities and as such they are difficult to predict. They include real estate fluctuations, demographic and behavioural changes, as well as changes in infrastructure location and specification and the advent and implementation of new technology. Even more complex is the issue of cocktail effects; those that are a combination of climate change and other systemic risks, such as market downturns and pandemic.

In Australia, the tragedy of the Black Saturday fires in Victoria on Saturday 7th February 2009, coupled with major flood events in North Queensland, demonstrated the severe impacts extreme weather events can have from an insurance perspective. It is inevitable that the general public's ability to "donate" to help the uninsured will reduce as such events in one form or another become more common. This may tend to shift the focus for relief even more to the local government structure

Current oil price volatility combined with increased mortgage and rent stress exacerbates those already vulnerable to climate change impacts. The pressures from increased cost of living may see some opting out of insurance. These are the types of choices that people make as a result of climate change but which are consequential for Council. If a serious climatic event does occur and people have foregone insurance or are underinsured then Council will have to deal with a population that has very little resources left to rebuild their lives (as happened in New Orleans with Hurricane Katrina).

Some of the social movement and demographic hazards are also about relative changes and perception. If one place is seen as being more resilient than another the population may be more prepared to buy home and settle there. Maintaining a balance demographic is a challenge for many local governments in the face of climate change.

5 Exposure

MBRC's exposure to the climate change impacts and associated strategies is presented by a scoping examination of potential impacts across each of the following sectors:

- Asset Planning and Delivery
- Asset Maintenance and Construction
- Community and Cultural Services
- Strategic Planning and Development
- Environment and Local Laws
- Office of the CEO
- Corporate Services

The results stem from a scoping analysis of Council documents, spatial information and relevant demographic and statistical data.

Asset Planning and Delivery

The planning and delivery of assets can be a difficult process under uncertain conditions and requires sound strategic foresight. The onset of climate change will no doubt exacerbate this challenge. Council is undergoing a rapid transformation (both from the amalgamations and the projected population growth), which is placing significant development pressures on the region.

The planned assets designed to support the delivery of Council's services will need to consider the anticipated climate change impacts. At present, Council has more than $3 billion worth of property plant and equipment (Moreton Bay Regional Council 2008).

For buildings there may be an increased cost from design and materials to ensure the building is both compliant with energy efficiency regulations as well as being resilient from the physical impacts of climate change. Council may also need to re-consider whether parcels of land that have been reserved for new Council buildings are in an area which is vulnerable to physical impacts. The planned location of plant and other equipment which may support emergency management services should also consider the balance between proximity to areas at risk and exposure to the risk. Furthermore, Council may also find that assets which are poorly designed and located now may see associated increased insurance costs in the future, or in the worst case an uninsurable asset.

Both a carbon-constrained environment and strains on electricity lines during peak periods will place challenges to the deliverability of Council services. As such Council may need to investigate ways of ensuring future energy security.

In summary it is anticipated that the types of risks that the Asset Planning and Delivery sector would need to consider are described in the table below.

Table 3. Summary of Risks for Asset Planning & Delivery.

Asset	Climate Change Issue	Description
Council Buildings	Proximity to "at risk" areas – e.g. coastal zones, bushfire prone areas, sea level rise, storm surge and increased frequency and intensity of extreme events	Possible loss or damage to physical assets from climate impacts Design for physical impacts (e.g. longer dryer periods with more intense rainfall events – leading to changing stormwater runoff requirements and protection from foundation and building cracking)
	Changes to State and Federal building code standards and planning policies	Stranded assets (no longer viable for development) Staged design process – to plan in line with changing climate change projections Old assets may need retrofitting to align with national carbon reduction targets and requirements.
	Energy security and increased cooling requirements for buildings	Building design Creation of renewable energy systems for Council use
Council Land	Changes to State and Federal building code standards and planning policies	Regulatory restrictions may result in stranded assets (no longer viable for development) Loss of coastal land on the foreshore
	Proximity to "at risk" areas – e.g. coastal zones, bushfire prone areas	Possible loss or damage to physical assets from climate impacts
	Sea level rise and storm surge	Designing and possibly retrofitting coastal and inland flood defences (this is also relevant to protect community and business properties)

The consideration of the above will no doubt be a challenge for the planned asset and operational budget, as the need for these measures competes with other Council needs. As well as direct costs associated with the above, challenges for staff retention for those with skills to adapt to the above should also be considered a crucial element of Council's adaptive capacity.

Asset Maintenance and Construction

The climate change risks for asset maintenance and construction are include increased occupational health and safety risks as well as increased demand on Council budget. Firstly, an anticipated increase in heatwaves may see increased risks for maintenance and construction staff. In turn this may increase the number of days allocated to projects. The potential increase in exposure for staff to the physical impacts from climate change may also see changes in associated insurance requirements and costing. There is likely to be a cost involved in the re-training of maintenance staff around construction, installation and maintenance of new materials which have been used to adapt to climate change and reduce greenhouse gas emissions.

Some new technologies pose risks to the community and the environment. For example new Federal regulation will require that all incandescent bulbs are phased out by 2010 and replaced with energy efficient compact fluorescents. The most widely used replacement bulbs in offices contain methyl mercury (the most toxic form of mercury) and breakages of these bulbs may create challenges for OHS and disposal methods. Furthermore, once the entire community switches to these bulbs there may be risks associated with the disposal of these in landfill sites, exposing staff and the wider environment to methyl mercury. In the US States of California, Minnesota, Ohio, Illinois, Indiana, Michigan, and Wisconsin it is illegal to treat light bulbs that contain mercury as general waste, and special requirements must be followed (USEPA 2008).

It is anticipated that the types of risks that the Asset Maintenance and Construction sector would need to consider are summarised in Table 3.

Table 4. Summary of Risks for Asset Maintenance & Construction.

Issue	Climate Change Issue	Description
Maintenance of Council Assets	Proximity to "at risk" areas – e.g. coastal zones, bushfire prone areas, sea level rise, storm surge and increased frequency and intensity of extreme events	Increased maintenance costs and schedules may be required from exacerbated wear and tear due to climate change impacts. Changing insurance charges – or potential loss of insurability
	Wind Storms	Roofing, increase in maintenance, power line damage, park and equipment damage, run-off events – erosion, accessibility (e.g. trees on road), insurance availability and premiums.*
	Marine impacts	Nutrients from run-off, increased temperatures result in Lyngbya (algae bloom – heat causes breakage and distribution) – clean-up costs and equipment (taken to the dump), impacts on tourism, erosion of sand.
	Drought	Operations affected particularly with dust, electricity prices – asset design and cost, water efficiency (water restrictions), loss of opportunity to plant trees and maintain existing ones.*
	Changes to State and Federal building code standards and planning policies	Old assets may need retrofitting to align with national carbon reduction targets and requirements. Staff may need re-training to implement the new requirements and maintain their currency on technological developments (e.g. staff maintenance of solar PV cells) Changing building codes/standards, insurance, design, generalised standards that are not applicable to localised conditions.* Regulatory mapping may result in a decrease in useable land, changes in habitat, sewage infrastructure inundated, as well as roads (e.g. already happening at Bribie).*

Table 4. Continued - Summary of Risks for Asset Maintenance & Construction.

Issue	Climate Change Issue	Description
	Flooding	Roads and Bridges, backing up of stormwater systems, Beachmere, Deception Bay (lower socio-economic area), erosion, sedimentation in canal developments (continually cleaning out), Bribie Island isolation, depot assets and fleet, accessibility to equipment, King John area, leaching, lock gates at Bribie Island (electric power).*
	Uptake of low emissions vehicles	Staff may need re-training - or Council may need to outsource maintenance. Possible increase of associated costs.
Occupational Health and Safety	Exposure to climate change impacts	Council may see a decrease in the number of days available to undertake outside maintenance due to risks such as increased days over critical temperatures.

* denotes issues raised in the workshops

Community and Cultural Services

Recent State projections of MBRC shows that by the time many of the projected climate change impacts materialise (in 2030) there will be approximately an extra 150,000 people in the region. The Australian Bureau of Statistics (ABS), as well as the Department of Infrastructure and Planning (DIP), have provided the following statistics and projections for the MBRC's population:

- The resident population of MBRC (data from Caboolture, Redcliffe & Pine Rivers Shire census) at the time of the 2006 Census was 332,737 people (PIFU 2007)

- By 2026, the estimated population of MBRC will be 488,602 (PIFU 2007).

Many homes on the MBRC coast are currently exposed to sea level rise and storm surge (over 1000 in Caboolture District alone). Under a business as usual development this exposure could increase substantially as current development on the coast continues.

The recent drought and subsequent water restrictions shows that the South East Queensland Area has a vulnerable water supply. Current climate change projections see a reduced rainfall and increase evapotranspiration rates, raising water security concerns. Current adaptation strategies which allow for rainwater tanks do not facilitate rainwater tank size that would be required under these conditions (i.e. people buy the cheapest tank (i.e.1,000 - 2,000 litres) so their payments above the rebates are minimal – however when examining the anticipated days between rainfall events people would require water tanks with storage capacity of 30,000 litres).

The recent announcement of an emissions trading scheme shows that the Federal government is committed to a carbon constrained economy. While some may see this is as necessary step greenhouse gas abatement there will have social and economic implications.

As shown by recent Griffith University modelling (Dodson and Sipe 2008) parts of the Moreton Bay Region is considered to be very highly vulnerable to the combination of increased oil and mortgage costs. Many suburbs in the Moreton Bay Region have been identified as experiencing mortgage and rental stress due to the general increased cost of living and increased housing demand (Moreton Bay Regional Council 2008). Recently released modelling on emissions targets suggests that a CPRS will correlate to between 17% and 28% increase in electricity charges (Commonwealth Treasury 2008; Garnaut 2008). Although it is envisaged that this would be supported by some compensatory measures, those in the lower socio-economic cohort will no doubt feel the pressure of an unsupported carbon constrained economy (Figure 27).

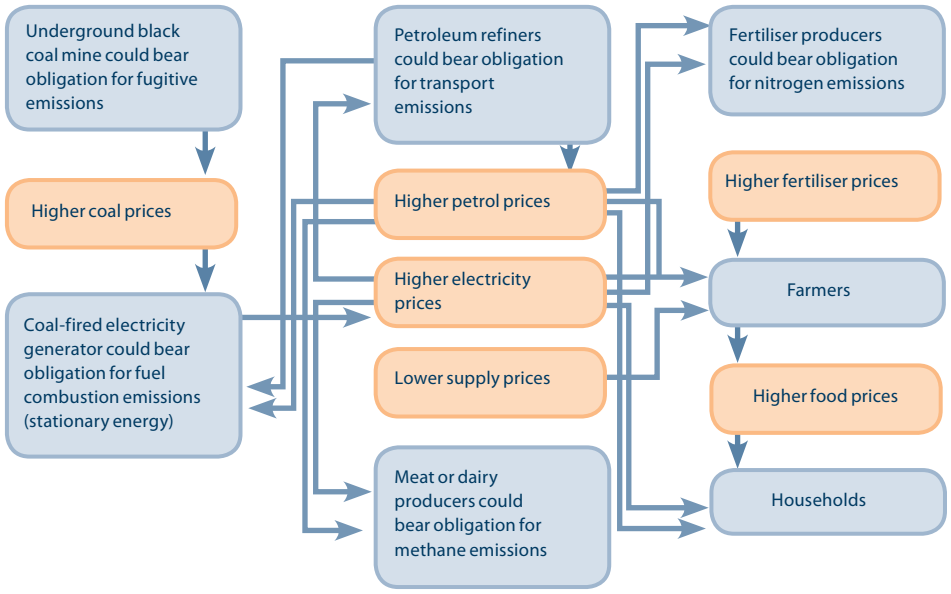


Figure 27. Garnaut's description of how carbon constrained economy may impact on the cost of living for householders (Garnaut 2008).

Table 5. Summary of Risks for Community & Cultural Services.

Issue	Climate Change Issue	Description
Community health	Heatwaves and extreme weather events	Heatwaves have the potential to impact on the health of Council's aging population, especially in areas under financial pressure such as Bribie Island. Impacts come from heat stress, reduced sleep and dehydration. Heatwaves may increase the potential for food spoilage, leading to food borne illnesses.
	Average warming, precipitation change	Changes in range and distribution of mosquitoes which carry vector borne illnesses
	Various	Increased health impacts will see an increased demand or competition for health services – may see changes in priorities and longer waiting lists.
Community wellbeing	Carbon Pollution Reduction Scheme	General increased cost of living, possible isolation, difficulty in getting to work and community services
	Economic impact of extreme events	Extreme events will have significant impacts on the community – especially those uninsured and under insured.
	Extreme weather and events	Potential for disruption for events such as the Woodford Folk Festival.
	Increased temperatures and reduced water availability	Parks and sports grounds may degrade and be of limited use to the community
Population shift	Various	If adaptation measures are not implemented MBRC may be seen as an area exposed to climate change impacts causing population shift or reducing immigration into the area and potential reduction in property values.
Community infrastructure	Carbon constrained economy	A carbon trading scheme may see an increased need for the provision of good quality public transport
Community economy	Insurance and regulatory change	Increased insurance or unavailable insurance may have serious ramifications for homeowners who lose value in their assets

Strategic Planning and Development

Strategic Planning and Development plays a crucial role in facilitating reductions in the community and Council risks. The department's role of ensuring reasonable compliance with legislation and regulation across the Council region provides it with a significant opportunity to either increase or decrease the community's resilience to climate change. A recent report commissioned by Council highlighted that the Caboolture District is already exposed and vulnerable to a range of natural disaster risks such as heatwaves, cyclones and extreme weather and many of these will be exacerbated by climate change and misaligned urban growth. The planning and development sector will have to consider a broad range of climate change impacts. The strategic planning sector will need to consider if areas identified in its Local Growth Management Strategy are exposed to the physical impacts of climate change (e.g. storm surge, sea level rise, heatwaves etc).

Although this process is time consuming and potentially resource intensive it plays an important role in the region's exposure to the risks. Risks associated with these decisions include planning challenges, potential litigation surrounding decisions made and inputs used, and an increased need for staff to have or have access to the appropriate level of climate change knowledge. There is currently a dearth of planners and engineers in Australia (especially those with climate change skill sets), and as such Council will have to consider how it ensures that staff with these attributes are embedded into the strategic planning and development sector.

Development assessment is the coalface of risk reduction. Development assessment officers and planners have a challenging role in facilitating the implementation of local and regional desired environmental outcomes. It is critical that staff at this level have an understanding of a range of climate change issues in order to validate climate change considerations proposed in development applications.

In summary, the challenges that climate change presents to the strategic development and planning department highlight an increased need to consider:

- Increased pressure on current infrastructure
- Regulatory changes
- Methods to assess climate change impacts on proposed developments
- Changing competition between land uses - e.g. land for renewable energy vs urban development
- Demographic changes

Table 6. Summary of Risks for Strategic Planning & Development.

Issue	Climate Change Issue	Description
Future Plans	Changes to State and Federal building code standards and planning policies	Changes to planning schemes, past local area plans may be in at risk areas. Carbon constrained economy may see increase need for planning for consolidation, walkable communities, transit orientated developments (TOD). Potential challenges between mitigation and adaptation challenges (e.g. TOD may decrease transport emissions but exacerbated urban heat island phenomenon). Need to assess what the changing demographics and economic base is and identify if they are vulnerable to climate change impacts and associated strategies. A revision of earlier strategic plans (including land banking releases) will be required to evaluate them against climate change impacts discussed in this report
	Proximity to "at risk" areas – e.g. coastal zones, bushfire prone areas, sea level rise, storm surge and increased frequency and intensity of extreme events	Reviews of current and future location of settlements may be needed. Council may need to identify engineering remedies as well as potential planned retreat of some at risk areas.
Development Assessments	Changes to State and Federal building code standards and planning policies	Staff training to understand new regulations and policies. Possible increase in Planning and Environment Court challenges around adaptation design, climate models used etc. Possible initial increase in DA backlog as staff familiarise themselves with new policies and regulations. Challenges in identifying infrastructure charges associated with climate change impacts.

Moreton Bay Water

Changes in rainfall and temperature will have significant impacts on the water supply - for quality , quantity, infrastructure creation and maintenance, and cost of energy associated with water distribution.

This report does not explore these in detail and as such it is recommended that an in depth review of climate change and Moreton Bay Water be undertaken.

Environment and Local Laws

Climate change is set to exacerbate the challenges that the natural environment already faces from the urban development, agriculture and weeds. The key challenges of climate change will be through increases in temperature, increase in sea levels, extreme weather events and elevated CO_2 in the atmosphere and oceans.

The impacts of theses events will result in

- Changes in the range of species distribution, include pest weeds, pest animals and disease
- Loss of species (plant and animal) and damage to ecosystems through either inundation or drought
- Loss of ecosystems
- Changes to rivers i.e. changes to sediment and nutrient dynamics, eutrophication

These keys challenges will also have a significant impact on the public health and well being of our community. They will be seen through:

- Decrease in the gross value of agricultural production
- Potential food spoilage leading to food bourne illness
- Changes in the range and distribution of mosquitoes which carry vector bourne diseases
- Increase in the demand for health services due to new and yet unknown communicable diseases, subsequent health effects from heat stress, and poor quality food.

In a recent study, Low (2007) acknowledges that 'the full spectrum of impacts remains very uncertain due to the large number of possible interactions under different carbon dioxide scenarios' (Low 2007, p. 4). This statement implies that there are some flow-on impacts that cannot be fully predicted due to the complexity of inter- and intra-species interactions with the natural environment.

Numerous studies have investigated the potential physical and ecosystem effects of climate change in a more generic fashion, albeit, not identifying specific species, but looking at the overall impacts associated with a range of climatic influences on the natural environment. The findings of such studies can be extrapolated and used in the context of this report. The table below, adapted from the Australian Government Department of Climate Change, provides a list of these impacts.

Table 7. Summary of Risks for Environment & Local Laws.

Climate Change Challenge	Issue	Implications for MBRC
Increase in temperature	• Southward species migration can result in changes in range of weeds, other invasive species and pests and diseases. Such trend has the potential to significantly impact agricultural production. • Mismatching of life-cycle interactions between species (predator-prey; plant-herbivore; pathogen-host; pollinators-flowering plants) leading to species declines and extinctions • Changes in distribution and abundance of species • Species loss • Reduced capacity for recovery of natural areas following wild fire and other disturbance regimes. an increased degree of eutrophication and greater frequency of algal blooms • Coastal and inland wetlands would be adversely affected by temperature increases • Both existing and potential new plant and animal pests could become established more widely, even with a slight increase in temperature	The gross annual value of agricultural production (crops and livestock) is considerable. For the Caboolture region is estimated at $83.2 Million[6], with agriculture being the third most significant industry.
Sea level rise	• Increased inundation of coastal wetlands and lowlands • Loss of estuarine, coastal species and communities • Increased intrusion of salt water vegetation into freshwater ecosystems in coastal areas • Coastal erosion is likely to be accelerated where it is already occurring and erosion may become a problem over time in coastal areas that are presently either stable or are advancing	Threat to coastal foreshore's scenic amenity with potential tourism ramifications. Loss of species and damage to ecosystem services.
Increase in sea surface temperature	• Pole ward species migration • Increased algal blooms • Decrease in coastal montane cloud forests • Changes in species distribution and ecosystem composition	Changes in the sea surface temperature may see a movement of fish species impacting on commercial and recreational fishing. Changes in jellyfish abundance may have potential ramifications for tourism and local recreation.

6 http://qrsis.oesr.qld.gov.au/reports/rwservlet

Table 7. Continued - Summary of Risks for Environment & Local Laws.

Climate Change Challenge	Issue	Implications for MBRC
Altered rainfall and runoff pattern	• Altered river flow and changes to sediment and nutrient dynamics • Altered lowland flood risk • Loss of wetlands and associated biodiversity • Loss of migratory birds dependent on wetlands and streams • Disruption to stream, estuarine, wetland food webs due to reduced supply of nutrients • Drying of ecosystems leading to loss of species and changes in community composition • Invasion of woody shrubs into drying landscapes • Increased incidence of eutrophication of streams, lakes and estuaries • Changes in species distribution and ecosystem composition	Threat to scenic amenity with potential tourism ramifications. Loss of species and damage to ecosystem services.
Altered frequency of extreme weather events	• Mass mortality when climate thresholds are exceeded during extreme events • Changes in species competitive interactions and species and community composition • Changes in range of invasive species	Loss of species and damage to ecosystem services.
Elevated CO_2 in the atmosphere and ocean	• Increased ocean acidification • Increased erosion of coral reefs due to ocean acidification and decreased rates of calcification • Increased disruption to food chains (e.g. Southern Ocean) • Changes in photosynthesis, respiration, growth and tissue composition in plants • Decreased nitrogen content in vegetation • Increased invasion of woody shrubs into arid and semi-arid rangelands • Impaired movement and function of high oxygen demand fauna (e.g. squid, fish) • Changes to plant-insect prey relations due to decreased nitrogen content in vegetation • Changes in species distribution and ecosystem composition	Impact on grazing industry. Impacts on fisheries.

Office of the CEO

The Office of the CEO plays an integral role in the sustainability of Council and the community it represents. The office of the CEO manages governance, fleet, waste, legal and major projects. As this sector is responsible for a large amount of greenhouse gas emissions (especially with fleet and waste) it is particularly vulnerable to secondary hazards.

Climate change is threatening the insurer's bottom line. As such there is a risk that they will increase insurance costs for those who continue to avoid adaptive behaviour.

Councillors and officers may be more exposed to tort based litigation for failing to adequately consider climate change in decision making – leading to increased councillor and officers insurance rates.

Summary of climate change related challenges include:

- Carbon permit costs
- Energy costs
- Building costs
- Litigation
- Insurability

It is important to note that the Office of the CEO provides the mandate to the whole Council to address climate change or not. A failure to provide such guidance is coming under scrutiny in the private sector (CDP 2008) and can be expected to apply in the public sector in equal measure. Therefore the role and responsibility of councillors and senior managers in the face of climate change is a fundamental adaptive step.

Table 8. Summary of Risks for Office of the CEO.

Issue	Climate Change Issue	Description
Fleet (including operational equipment)	Transition to fuel efficient non fossil fuel vehicles (e.g. biofuels)	Initial increased cost to buy new fleet and equipment (can also be done via a phase out process) Staff may need re-training - or Council may need to outsource maintenance. Possible increase of associated costs.
	Extreme weather	Council fleet and plant may suffer damage from extreme weather events (e.g. hail)
Local businesses	Emissions trading	Staff will need to be skilled in CPRS in order to help provide advice to local businesses Emissions trading and exposure to primary hazards may reduce the attractiveness of the area for new businesses.
	Extreme weather	Increased costs for SMEs risk education, and support programs post disaster
Waste	Extreme weather	Possible leaching Possible disruption temporary disruption to community waste collection and operation of landfill sites
	Emissions trading	Increased costs associated with possible recording and auditing of GHG emissions recording. Increased costs associated with energy costs (without adaptive measures)
	Energy saving light bulbs	Increased costs associated with containing mercury from discarded light bulbs
Insurance	Increased insurance costs	Increased insurance or at worst removal of some insurance products (including councillors and officers insurance and asset insurance)

Corporate Services

The Corporate Services Directorate covers the management of human resources, finance, information technologies and public affairs. All of these elements are vulnerable to climate change. As the Corporate sector provides the necessary framework for the functioning of Council it is imperative that climate change is duly acknowledged.

Furthermore climate change and associated strategies will have serious implications for some industries, such as tourism, agriculture and a range of small-medium enterprises (SMEs). As was discussed earlier the majority of SMEs do not recover from extreme events, potentially decreasing the area's resilience to further climate change challenges. It is therefore critical that Council identify and support local businesses that may not be aware on the broad range of risks. Other hazards which are of concern are described in the following table.

Summary of climate change related challenges include:

- Staff Occupational Health and Safety
- Staff training
- Leakage of climate change trained staff
- Identification of the priorities and managing budget with competing needs

Table 9. Summary of Risks for Corporate Services.

Issue	Climate Change Issue	Description
Occupational health and safety	Increased exposure	Climate change presents a range of new hazards as well as exacerbates existing risks (e.g. more heatwave days). Council needs to investigate and amend OHS policies accordingly.
Staff Knowledge	Initial cost of staff training and leakage of skilled staff	Climate change skilled staff are in strong demand. Council needs to review resources and processes to retain these valuable staff. Council will need to ensure that staff are across climate change and the ever-changing climate related regulatory response (e.g. CPRS and Planning Reform)
Competing needs	Competing budget constraints	Risk that competing budget constraints reduce the available resources for climate change adaptation strategies. Council need to identify win-win and high priority actions.

6 Vulnerability

Before starting it is worth considering what we mean by vulnerability in the context of a Local Government. As shown earlier a risk is a confluence of the hazards, the exposure to those hazards and a vulnerability to those hazards. Therefore, vulnerability for Local Governments is anything that would represent a material impact to Council if impacted (directly or indirectly) by a climate related hazard.

By way of example we may identify that coastal flooding will be a hazard that affects the locality. We may also identify that there are people in the region who may be adversely affected by these floods. Clearly the people affected are vulnerable, but how is council? In this case council might be vulnerable if it has been unable to maintain road access during a 'foreseeable' flood or if there has been damage to property built in high risk areas which council approved. Both of these could lead to legal action which in turn would have a material affect on councils financial standing. Indirectly such events could lead to a loss property value in the region or a loss of population which may undermine the rate base and size of the local economy.

Council's vulnerability to climate change can be expressed in a number of ways:

1. Responsibilities of Council
2. Council's asset values and operational and maintenance costs
3. Economic and demographic balance of its population
4. The resilience of the local economy
5. The ability for Council to limit increasing climate exposed development (including State led development)
6. Delivery of Services – Staff Capacity
7. The capacity for Council to implement adaptive change

Responsibilities of Council

A major vulnerability for council are the areas for which it is legally responsible (i.e. for the the provision of services which may be affected by climate change hazards).

The previous chapter on exposure worked through the various 'business units' of Council to consider what exposure might be relevant. The vulnerability occurs if these areas of potential impact are not, or cannot, be adapted. In these incidences the council may be held responsible for losses which were in principle foreseeable and avoidable. The consequences of such a failure may range from a loss of public confidence through to legal action against Council or its directors and officers.

Some of the key areas of responsibility which were identified as being exposed

to climate change hazards were:

1. Development assessment standards – Especially in areas which may be exposed to greater levels of flooding due to climate change or built to inadequate standards for future impacts (e.g. wind and heat).

2. Roads and access – Especially the ability to get people to and from vulnerable locations during flooding events.

3. Storm water – Existing storm water management may be inadequate leading to greater levels of flooding.

4. Environmental management – Including weed control and waste water management under adverse/ flooding conditions

5. Emission liability – Greenhouse gas emissions from municipal waste management facilities and other operations.

6. Health and safety – Including staff and public e.g. playgrounds become dangerously hard after very dry period.

Council's Assets and Operational Costs

All aspects of climate change will place a strain on the financial viability of Council. It is possible that Council has assets which may become stranded (e.g. through regulatory mapping and / or insurability).

Council will need to make challenging decisions regarding the cost-benefit of early, mid and late term adaptation options. Increased insurance, energy and maintenance costs are virtually certain, placing strains on Council's ability to provide other adaptive measures to support community (e.g. increased public transport provisions). Increased maintenance and operational costs will likely run into millions of dollars (and even more if tort based litigation occurs). Even with appropriate adaptation, expenses will increase due to climate change, although evidence suggests that these can be reduced substantially with good management.

> "Increased insurance, energy and maintenance costs are virtually certain"

There are clearly cost implications as resources will have to be found to:

a) Upgrade the capital stock and systems to be climate resilient

b) Cover high operational and maintenance costs

c) Cover higher insurance costs and potential liabilities

Some of this additional income may need to come from the rate base or from state or federal Government investment in adaptation.

Community Demographic and Socio-Economic Structure

The Council is affected by demographics and socio-economic structure in many different ways. These include:

- The cost of providing services to the elderly

- The availability of affordable labour for the local economy
- The availability of skilled labour for the local economy
- The presence of economically highly active people e.g. 30s and 40s
- Sufficient numbers of children to support playgrounds, sports facilities and child services

The ageing of the population and/or the presence of pockets of disadvantage are already pressing issues for Local Governments across Australia. But there is the possibility that climate change can affect these both positively and negatively, and Council may have a role in affecting the outcome.

Much of the current community is vulnerable to current climate change risks and associated strategies especially those in isolated communities such as Bribie Island. Due to the projected population increase for 2026, and without adequate adaptation measures, the numbers at risk could increase. This is especially so with the projected aging population (see Figure 32) . As discussed earlier MBRC is vulnerable to heatwave events (days over 35).

There is of course the prospect that may people retiring may chose to go to southern states in Australia seeking a cooler climate. This could be beneficial to some extent, but it may mean the what is lost are the aging wealthy who are mobile (and able to pay for private services) and those who remain are less wealthy and more dependent upon council services.

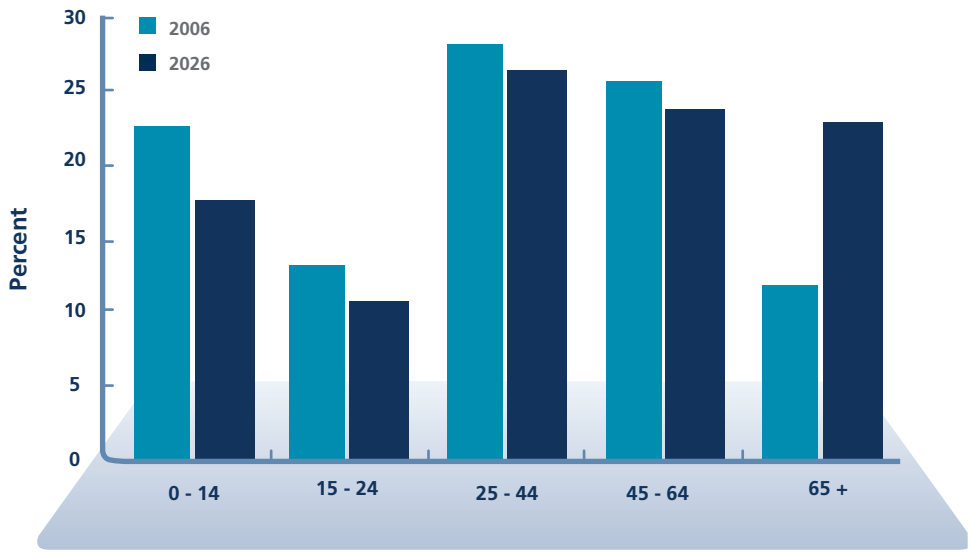


Figure 32. MBRC has an ageing population with 25% of the population anticipated to be over 65 by 2026 (PIFU 2008).

A balanced demographic is essential for the maintenance of health economy. This means that businesses need to be resilient which we discuss below. Also to be attractive to an active and mobile workforce there needs to be a high level of Council support and services. An especially important group will be young families, which wish to buy safe and secure housing and have access to health and child care services. This group will be in great demand in coming years and Councils will have to work hard with local business to secure their presence. Climate change impacts which may undermine the confidence of this group to invest in the area will be especially damaging for the local economy and therefore the Council.

The Resilience of the Local Economy

The literature indicates that a large proportion of small medium enterprises (SMEs) do not survive a major interruption to business (Climate Risk & Zurich GI 2008). If businesses in the Moreton area are more exposed to weather related hazards than neighbouring areas the ramifications for MBRC's economy could be devastating.

So the vulnerability of the region's economy depends on the exposure and associated actions by taken by the key industries. These can be informed by Council to provide guidance on adaptive actions and strategies. For example Climate Risk is developing climate change training and products for Small and Medium Size Enterprises with the global insurer Zurich.

Developmental Controls

Residential, commercial or industrial developments which occurred pre-1990 could arguably be considered to have been built before climate change science was sound enough to inform proper decision making. This building stock is essentially inherited and those who own these building (including Council) may have also inherited a climate change risk. Few developments since 1990 have made provision for climate change impacts, though the information to say there was a risk became increasingly available and in due course some owners may seek redress (some may argue that this is especially so in the past few years).

The opportunity from now on is to ensure that development does not occur in locations which are knowingly exposed to climate change. Put simply this needless expansion of an exposure can be implemented through planning controls.

The current collection of MBRC Planning Schemes do very little to encourage climate change adaptation or discourage exposure to climate change impacts. If the proposed new planning scheme also fails to address resilient communities then the long term vulnerability of the community will be increased.

Due to a range of factors (like State intervention) it may be beyond the control of Council to prevent development in highly exposed areas.

Delivery of Services - Staff capacity

Although council has a small number of staff members who are adequately skilled to deal with climate change issues, soon to be released regulations will see these staff under considerable strain. There is increasing demand for workers with climate change skills and Council is now competing against other councils and the private sector for the procurement of these staff.

More generally, climate change will affect all staff in different ways from staff dealing with the elderly having to manage more heat stress, road workers dealing with more flooding, Councillors having adaptive decisions challenged by developers and so on. Staff who are well equipped to deal with new challenges are likely to stay; if they become overly strained they may leave.

Council Capacity to Deliver Adaptive Change

Council can be a leader or a follower. Leading will inevitability risk community and commercial resistance, overcoming which will need a program of education and engagement. Therefore it could be argued that it is better to wait until the community and private sector are more aware and open to these changes. However, the problem we identify is that waiting will lead to increased exposure through development in inappropriate areas and an ongoing loss of capacity as people may move to other areas they see are 'safer', retire to more comfortable locations or as staff and internal capacity are lost in council as climate enhanced strains take their toll.

If Council does decide to take a lead on climate change then there are issues surrounding resources, capacity and authority to deliver climate adaptive change. These include:

- Adequate budgets
- Suitably trained staff
- State government decisions

These will be essential in the delivery of an adaptation plan. These needs are discussed in greater detail in the following chapter.

In Focus: Bribie Island

A scoping assessment of climate change risks and Council information highlights that there is an area within Caboolture district that is of particular concern. Bribie Island has seen rapid population growth in recent years, and has been particularly attractive for the older population. Recent ABS data shows that almost 50% of the current population is aged over 55 and almost 25% are aged over 65. Bribie Island is geographically isolated, and its single entry and exit point reduces emergency exit and entry points during extreme flooding. When looking at the current and projected climate Bribie Island stands out as a significant challenge.

Climate issues that pose significant threats to Bribie Island residents and council include:

- Bush fire risk - over 8% of buildings in medium risk zone (IID 2007)
- Storm surge and sea level rise - 63% of residential properties are in the storm tide zone (IID 2007).
- High exposure to heat waves (CLIMsystems & Climate Risk 2008).
- Low socio-economic cohort (22% of households earn less than $400 per week and relatively high unemployment of over 7%) (IID 2007).
- Carbon constrained economy – Resident's isolation, low car ownership, poor public transport, low income levels and aging population exacerbate risks associated with a carbon constrained future.
- Wind – has high to very high exposure to wind.

Recent research shows that Bribie has the highest community vulnerability risk rating in Caboolture (IID 2007). Furthermore some of Bribie Island's critical emergency services infrastructure (such as SES sheds and a fire station) are located in a medium bushfire hazard zone (IID 2007). As discussed earlier in the report climate change may exacerbate bushfire risks, potentially resulting in some medium zone areas being upgraded to a high risk zone.

In Focus: Redcliffe Peninsula

Redcliffe is situated on a peninsula within the Moreton Bay Region, and is currently home to approximately 55,000 people (Redcliffe City Council 2008, p.5). This figure is expected to grow to approximately 57,500 and 66,200 people by 2026 (based on low and high projections) (PIFU 2008).

Currently, Redcliffe has the highest proportion of persons aged 65 and over in South East Queensland (Qld Government 2006, p.4). This trend is expected to continue into the future, with ABS data projecting an increase from18.9% in 2001 to 30.3% in 2021 (ABS 2001).

The Redcliffe peninsular encompasses a total area of 37square kilometres, of which 22km comprise of a coast line. The peninsular contains seven suburbs including: Redcliffe, Clontarf, Scarborough, Woody Point, Rothwell, Kippa-Ring and Margate. Five of these suburbs are located along the coast line, featuring many residential properties and infrastructure in close proximity to the foreshore.

Particular risks:

- Heat and health implications

The peninsular has the highest proportion of aging population in South East Queensland. This segment of the population is particularly vulnerable to extreme weather conditions (such as heatwaves). Furthermore, according to a report published by the Commonwealth Government in 2007, the prevalence of asthma is markedly higher in Redcliffe compare to Brisbane and other parts of Australia.

- Sea-level rise, storm surges and flooding

According to Professor Ian Low (2009), Redcliffe is particularly vulnerable to floods and storm surges. The high risk to Redcliffe stems from it being 'a low-lying area with no preparation areas like rocky foreshores to stop the sea level'. Storm surges have the potential to severely damage coastal infrastructure. The Houghton Highway bridge, for example, has been declared by the Queensland Government Department of Main Roads as 'one of the very few bridges in Australia which would be affected by a storm surge' , and has been redesigned and constructed to withstand a 1-in- 2000 year storm event.

Sea level rising and storm surge modelling, undertaken by Childs et al. (1988), indicate that under a worst case scenario, many areas along the western perimeters of Redcliffe City are at risk. These areas comprise a range of land uses, including: open space, canal estate, airfield, industrial and residential. The total size of area at risk from sea level rise has been estimated at 867ha for a 4.12 m event and 631 ha for 2.82 m event (Childs et al.1988, p.665). (Table #). However, these estimates are dated and could indeed be higher. The Storm Tide Hazard Study, which is currently

being finalised, will provide a detailed coverage of these areas that will be inundated. Any areas being identified at being at greater risk may see reduced desirability (i.e. reduced re-sale value) and/ or reduced insurability. Climate Risk Pty Ltd anticipate that regardless of the Storm Tide Hazard Study, insurers will be undertaking their own assessments of the area.

Primary use	Area at 4.12 m		Area at 2.82 m	
	ha	%	ha	%
Commercial (net)	4	0.1	2	0.2
All residential (net)				
• canal estate	26	3.0	26	4.1
• other	104	11.9	33	5.2
Industrial land	11	1.3	11	1.7
Airfield	98	11.3	98	15.6
Golf course and Open space	136	15.8	98	15.6
Parks	122	14.0	104	16.6
Undeveloped parcels	325	37.5	240	38.1
Miscellaneous (incl. roads, beaches)	41	4.8	19	3.0
Total	867	99.8	631	100.1

Preliminary estimates of land affected by sea-level rise at Redcliffe. Source: Childs et al. 1988, p.665.

The zoning plan for Redcliffe City reveals that largest proportion of the coastal areas was designated for "comprehensive development", with the remaining areas comprising mainly of residential areas with some park and recreation facilities. Foreshore development and associated infrastructure- including: buildings, parks and tourist facilities, jetties, stormwater drains, roads, and powerlines- is particular vulnerable to severe weather events and flooding. The existing canal developments at Kippa-ring areas and Newport water are at particular risk from flooding and associated erosion (Childs et al. 1987).

Property Value - in recent years, the value of waterfront properties in Redcliffe has reached record high. Figures show that the suburbs of Scarborough, Redcliffe and some areas of Woody Point experienced valuation rises of between 40% and 70% and some waterfront properties rose by up to 90% between 1999-2004 (Redcliffe City Council, n.d). While this can be perceived as a positive development, the vulnerability of these properties to climate change related damage and insurance costs cannot be ignored.

In Focus: Woodford & Surrounding Area

As an inland, rural community of approximately 5,000 residents (Queensland Government 2008b), Woodford and surrounding areas face a different set of climate risks than the coastal and more densely populated areas of Moreton Bay Regional Council.

The area is 'predominately rural, with some recent residential and rural residential growth' (profile id, 2009). The region is known for its diverse natural environment, and strong agricultural production (MBRC 2009a; MBRC 2009e). Woodford and the surrounding Caboolture region have always faced the climatic extremes of South East Queensland (SEQ). These conditions are expected to become more extreme and frequent under climate change.

Climate change risks that pose significant threats to residents of Woodford and surrounding areas and Council include:

- Bushfire

The natural forests around Woodford are composed primarily of fire tolerant plants, indicating a history of bushfire (Institute for International Development 2007). The hinterland, including the large forested area in and around Woodford, will be susceptible to increasing frequency and intensity of bushfires. Although the prevalence of fire-tolerant flora species suggests a level of ecosystem resiliency to fire, the risk to life, agricultural areas, and property is expected to increase. Furthermore there is a considerable amount of commercial forestry which is also exposed.

- Flooding

The Caboolture area has a history of serious floods, with 110 sq km of the former Shire susceptible to 1:100 year flood levels (Institute for International Development 2007: pp6-7). The Third Assessment Report of the Intergovernmental Panel on Climate Change notes that 'precipitation extremes are expected to increase more than the mean, and the intensity of precipitation events are projected to increase. The frequency of extreme precipitation events is projected to increase almost everywhere' (Abbs, McInnes and Rafter, 2007, p9). Woodford has been susceptible to flooding in the past (Australian Government 2008), and the impacts of increased rainfall intensity may lead to more frequent flood events in the area.

- Landslides

The D'Aguilar Range near Woodford has a history of landslides triggered by rainfall events (Institute for International Development 2007: p7). With the increased rainfall and flooding events discussed above, the risk of landslides may increase should rainfall increase.

- Cyclones

The Caboolture area has been affected by tropical cyclones, winter cyclones, and thunderstorms in the past (Institute for International Development 2007: p5). Severe storms and east coast lows are the most common natural area in SEQ, including Woodford (MBRC 2009d).

- Heatwaves

Although hinterland areas above 100m are less likely to be affected by heatwaves, low lying, inland areas such as the Woodford township can experience the most severe heatwave impacts (Institute for International Development 2007: p13). Climate change is expected to significantly increase the frequency of heatwave events (Institute for International Development 2007: p15). Increased temperature brings a number of flow-on effects. For Woodford, an area that relies primarily on tank water, one of these impacts may include an infestation of disease vectors - uncovered tanks, often located close to homes, provide a breeding area for mosquitoes (MBRC 2009f). Heatwaves can also have considerable impacts on agricultural crops, the health of livestock and farm machinery.

- Drought

It is predicted that the climatic system will become less predictable – oscillating between the El Nino and La Nina cycles. This will make it difficult for agricultural producers in Woodford to estimate their water availability and their choice of crops / livestock. With much of the Woodford area having been drought declared this decade any future reduction in water availability will have considerable impacts on the economic viability and land values in the region.

- Housing, economics and transport

Woodford is relatively isolated with little public transport, which creates a reliance on private motor vehicles. Caboolture is the closest larger centre with the main access to Brisbane and the Sunshine Coast is via the Bruce Highway (M1). The closest rail service is at Caboolture (MBRC 2009e). With a significant proportion of Woodford households earning less than $649 per week (gross), residents are vulnerable to increased isolation from critical infrastructure and employment as petrol prices rise due to carbon constraints. At the 2006 Census, 38.5% of the Woodford area's population was purchasing their homes, compared to only 32.8% in SEQ (profile id 2009). This higher rate of mortgages may put this low socio-economic cohort at further risk due to mortgage stress. In addition, the Woodford region has a significantly higher percentage of residents who live in 'caravans, cabins and houseboats' than SEQ – at 9.8%. (profile id 2009). These transient dwellings are at high risk of damage in extreme weather events.

- Planned retreat

Other areas of the Moreton Bay Region are facing increased risk of inundation and flooding, and inland areas such as Woodford may experience an influx of "evacuees" from these areas as the risks to life and property become untenable. Those who sought a 'sea-change' on the coast may turn to a 'tree-change' instead.

- Regional attractions and assets

The Woodford Folk Festival brings over 90,000 visitors to the region every year - visitors who have, in recent years, experienced heavy rain, mud, hot temperatures and the risk of heatstroke. An unusually severe storm or heatwave during the festival may also put pressure on emergency services during a holiday period ie. 20,000 people on one site on one day. As the weather events become more extreme, the festival may be moved to a different season.

The region has key agricultural and tourism-based economic assets. Rich farm lands dominate the region, including strawberries, bananas, pineapples, pawpaw and avocados (MBRC 2009a; MBRC 2009e). In addition, the region has a diverse natural environment due to its location at the 'Macleay-Macpherson Overlap, where the Torresian and Bassian biological distributions come together' bringing both subtropical and temperature native ecosystems together (MBRC 2009b). Climate change affects agriculture and biodiversity through changing the habitat and growing conditions (e.g. temperature, rainfall). Additionally, existing weed threats including lantana and exotic pine and grass species, may further invade the area taking advantage of conditions which native or rural species cannot (MBRC 2009c). Tourism, the natural environment and agricultural viability of the region are all under threat from climate change (MBRC 2009c).

In Focus: Narangba Industrial Estate

The Narangba Industrial Estate (NIE) was "developed in the 1960s to provide for the needs of noxious and hazardous industries, which are generally difficult to locate, but which provide essential goods and services" (Queensland Health 2008). However, as the region's population has grown, along with the estate's growth, there has been a gradual encroachment of exposure of risks to the surrounding population and environment. As the NIE is an area with a range of toxic hazards, which could be triggered by or exacerbated by climate change, there is the possibility for a confluence of the risks. Although there is limited publicly available information the most pressing issues associated with climate change may include:

- Increased ground level ozone. A recent EPA report has highlighted that the area emits considerable levels of small particulates (e.g. pm10). Combined with an increased number of extreme heat days, as is projected, this has the potential for increased occurrence of ground level ozone (IPCC 2001). Ground level ozone is of particular concern as it is linked with a range of respiratory illnesses and (Horton & McMichael 2003).

- Extreme weather and increased chance of pollution. Extreme weather presents risks for the local waterways and community. The Binary Industries fire of 2005 (where an intense fire resulted in the distribution of contaminants across residential areas) highlights the potential severity of impacts when things go wrong on the NEI. According to a recent study, the area of Narangba had a moderate wind risk (IDD 2007). Although, it is anticipated that buildings in the NIE are build to above standard levels, it is reasonable to consider that some of these (particularly the older structures) may not have been designed to withstand the full force of a category five cyclone.

For the Narangba Industrial Estate it is the potential consequences, not likelihood which makes it an area of concern. Should extreme weather events force damage the noxious industries in the region there is a potential for impacts on health and the environment. Furthermore, the NIE is an important economic provider for the Moreton Bay Region, employing hundreds of people. As such, the recommendations of Climate Risk Pty Ltd that a detailed climate change risk assessment of the area be undertaken.

In Focus: Samford Valley

The Samford Valley is a key location for regional, environment-based tourism and also provides a location for rural-residential living which remains close to the urban centre of Brisbane with a distincy character of many small villages (MBRC 2009). Although its distinct character is derived from these factors, they strongly contribute to the area's risk under climate change and a carbon-constrained economy.

Climate change risks that pose significant threats to the Samford Valley, particularly the communities of Mt Nebo and Mt Glorious, include:

- Access

Parts of the Samford Valley area, such as Mt Nebo and Mt Glorious, are linked by a steep, curving and narrow road along the D'Aguilar Range (BCC n.d.). In extreme weather events, emergency access to or evacuation from these areas, is often difficult, and at times impossible. Under a carbon-constrained economy, the cost of travel to and from these peri-urban areas is likely to increase significantly.

- Bushfire Risk

The region is at particular risk of bushfire. Risk to the community is exacerbated by isolated, rural residential homes and areas difficult to access. Factors contributing to high bushfire risk in the area include –

  - Vegetation types in the area, including Eucalypt spp, Melaleuca spp, Banksia and Wallum heath, have an extremely high heat yield, leading to more intense fires, which are more damaging to buildings and infrastructure and produce more airborne embers likely to start spot fires (Landmarc Ltd 2003).
  - Pine Rivers Shire (pre-amalgamation) identified Laceys Creek, Samsonsvale, Mt Nebo as areas of high bushfire hazard (Landmarc Ltd 2003).
  - Mt Nebo is a high-risk area due to the presence of dry sclerophyll forest and the direction of prevailing winds (gloriousnebo 2008). The community is susceptible to high damage as homes are often surrounded by vegetation, serviced by electric-pumped tank water (low levels of supply and at-risk of fault due to black-out), and isolated from efficient access.
  - The increase of lightning due to greater extreme weather.
  - There are flow-on impacts of fire including – the contamination through ash and debris fall and increased erosion, of key water supplies in the area of Lake Kurwongbah and Lake Samsonvale (Landmarc Ltd 2003).

- Water Supply

Climate change will bring an increase in extreme conditions in relation to rainfall. Firstly, an increase in the number of days between rainfall events (a decrease in frequency of rainfall), and secondly, more intense downfalls when they occur (an increase in intensity) (Abbs, McInnes & Rafter, 2007). Therefore these changes will include more extreme periods of drought. The Institute of Sustainable Resources (QUT ISR 2008) notes that 'the status of water supply within the valley is important. Most of the valley is reliant upon rainfall tank storage and groundwater'.

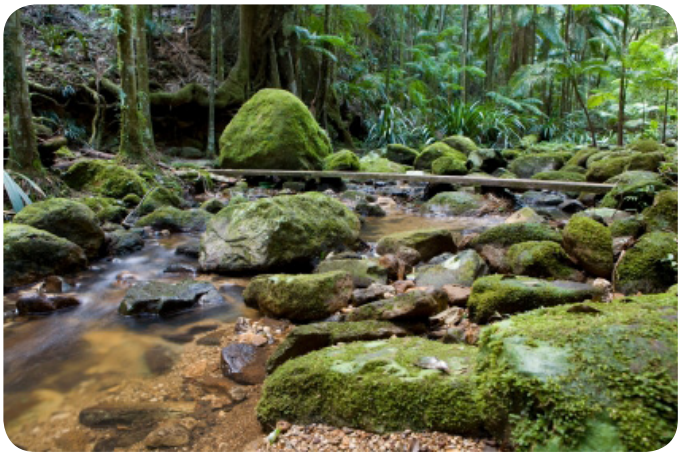
Water supply for Samford Valley and surrounding mountain communities may become significantly strained under climate change. Combined with a continually increasing population (profile id 2009), a dependency on electric-pumps for tank water – which can fail under the blackout conditions increasing under climate change – and a greater need for water supplies for bushfire conditions, this is a potentially disastrous situation.

- Food Supply

Mt Glorious and Mt Nebo residents travel to larger centres in order to access main food supplies. If access routes are cut-off during extreme weather, food supplies are at risk (gloriousnebo 2008).

- Waste Collection

Mt Glorious has no council waste collection system. In an extreme weather event, the removal of damaged infrastructure and vegetation will be difficult, particularly due to the small, windy access routes.



7 Adaptation Options

This chapter highlights a range of adaptation actions that will contribute towards a more resilient community and Council. Two case studies of climate change adaptation options (Melbourne and Chicago) are presented at the conclusion of this chapter to provide examples of strategies implemented by other local governments.

There are a range of options which Council can take to adapt to climate change and associated strategies. These include:

1. Develop and foster a climate change working group with supporting resources
2. Add climate risks to the council risk register
3. Undertake detailed assessment of high priority risk
4. Engage with insurers to discuss risk management and cover
5. Embed climate change into corporate plan and planning scheme
6. Increase and maintain adaptive capacity
7. Make representation to state and federal government for areas where Council has responsibility
8. Be prepared to set a precedent by challenging development on adaptation principles
9. Identify potential cocktail effects from multiple coincident impacts
10. Explore public / private partnerships towards economic resilience
11. Raise community awareness of risks and support for adaptive measures by Council
12. Focus on identifying sources to help fund the required adaptation

A more detailed description of each of the recommendations is presented below:

1. Develop a climate change working group and supporting resources

Climate change presents significant challenges to the Moreton Bay Regional Council. At present there are few staff focussed on climate change, as well as other sustainability issues. As such it may be prudent to further increase the level of knowledge of decision makers about climate change and establish climate change working groups to ensure that each sector of Council is represented in any climate change strategy. Furthermore, the seriousness of the issue combined with the opportunity of a new corporate plan and planning scheme, highlights the benefits of short – mid- term resource

allocation to enable a concentrated strategy to be developed in line with the new plan and planning scheme. A climate change working group would be a fitting group to identify the priorities for action.

2. Add climate risks to the council risk register

By placing climate change specific risks on the risk register, Council can ensure that the awareness of those are heightened and considered frequently. Most risks are familiar (e.g. flooding, heatwave etc), but it is the severity and frequency that will increase under climate change. Therefore the management of some of these risks is not something new but builds on the existing risks.

3. Undertake detailed risk assessment of high priority risks

The current project was a scoping study to examine the various climate change risks and associated strategies presented to Moreton Bay Regional Council. Therefore it would be prudent to widen the scope of the current project to consider detailed impacts on each of Council's sectors.

If resource constraints limit the timing of this process, Climate Risk suggests that at the very least Council examines the risks assessment with a working group to establish priorities for adaptation and/or further research. During this process an identification of win-win options would be useful and may provide economies of scale (e.g. climate change strategies which have ancillary benefits to other council challenges). As there are many synergies and cross border dependences, it would also be advantageous to undertake a scoping review of climate change strategies being undertaken by neighbouring councils.

4. Work closely with your insurer

Insurers will play a crucial role in mainstreaming climate change adaptation. Council activities have the potential to either increase or decrease the insurability of residents and businesses. It is recommended that Council examine ways of working together with insurers to share and reduce the potential risks.

5. Embed climate change into corporate plan and planning scheme

It was noted in the senior management and councillor workshop that the corporate plan should incorporate the challenges and opportunities presented by climate change. By incorporating climate change into the planning scheme and corporate plan council could better capture the economies of scale, ensure that synergies between mitigation and adaptation are balanced and embed climate change issues into mechanisms with mid to long term milestones. Planning schemes also ensure that the risk is better shared between developers and the Council.

6. Increase and maintain adaptive capacity

Council is already facing challenges from staffing constraints (especially

with planners and engineers). Climate change is a relatively new issue for Council and Universities have only just begun to incorporate climate change into a range of degrees. As such new graduates (and existing staff) with climate change skill sets will be highly desirable. Council will need to embed climate change knowledge within its existing staff and encourage employment for those with new skills sets.

7. Representation to State and Federal government

As shown in this report, both Queensland and Commonwealth Governments will soon be introducing policies and regulation which may have considerable impact on the community and Council operations, as well as Council's own climate change strategies. It is therefore imperative that Council come to terms with how these will impact on their community and operational performance and undertake appropriate lobbying to ensure that all tiers of government understand the opportunities and constraints facing local governments. An example of this is with the soon to be released SEQ Regional Planning Review, due for public comments in late 2008.

8. Be prepared to set a precedent by challenging development on adaptation principles

Part of the challenge at present is that there have been no precedents in the Queensland Planning and Environment Court which supports Council decisions to place requirements on developers. There is a strong scientific body of evidence (which has been supported by interstate judicial decisions) for Council to challenge a development which increases the community's exposure to the projected impacts of climate change.

9. Identify potential cocktail effects

The risks from climate change do not occur in isolation. Other systemic challenges, such as the US sub-prime market collapse, oil vulnerability and pandemic health risks, are impacted by and can be exacerbated by climate change. When identifying the climate change challenges and opportunities it is of utmost importance that they are considered in the context of other risks.

10. Explore public / private partnerships

There is the potential for Council to utilise forward thinking private enterprises as a way to help mainstream adaptation. For instance, Council may develop a relationship with a telecommunications service provider to help support ICT hubs.

11. Raise community awareness

Ultimately the community will be dealing with the risks from climate change. As such it is important to ensure that they have a grasp of the issue and understand and support Council efforts to adapt. A meeting with key community groups and businesses may provide a valuable insight as to how each of these groups are (or are not) dealing with the issue.

Climate Change Adaptation Case Studies

Melbourne, Australia (Climate Change Task Force 2008)

In August 2007, a Climate Change Taskforce was established to consider the impacts of anthropogenic climate change on the city of Melbourne and identify opportunities for mitigation and adaptation. Following an assessment process of opportunities, three key areas for adaptation were identified. These are: buildings, social equity and urban resilience:

Buildings

Increasing building resilience to the impacts of climate change such as heatwaves and extreme weather events has been identified as a key adaptation opportunity for Melbourne. Melbourne recognises the potential for expanding the Building Code of Australia (BCA) and increasing the awareness of sustainable building design among local communities, businesses and government, the Taskforce is advocating for:

- Mandatory standards for the construction of new buildings and the sustainable retrofit of existing commercial and residential properties;
- An awareness campaign and education program to explain building retrofitting;
- The provision of financial incentives to encourage the uptake of building retrofits, possibly in the form of rebates and tax deductions;
- The instalment of meters and monitoring systems in existing buildings to audit energy use and assess opportunities for improvement; and
- The provision of a broad-scale guidance and decision-support program for tenants and building owners to facilitate the inclusion of retrofit measures.

Social equity

Financial hardship is expected to increase in light of carbon pricing and rising petrol prices. Considering the low adaptive capacity of lower income households, the Taskforce has identified the following opportunities:

- Restrict low income households' vulnerability to heat stress and extreme cold weather; and

- Increase support for low income renters by conducting a round table with private rental investors, superannuation funds, real estate agents, body corporate and community organisations to discuss measures for adaptation e.g. installing rainwater tanks or solar hot water systems, and providing low or zero interest 'green' loans and incentives.

Urban resilience

Similar to most Australian cities, urban development in Melbourne has resulted in heat islands that are approximately 1-2°C warmer than surrounding areas. Corresponding increases in the potential for flooding and inundation of stormwater drainage systems due to more paved surfaces, means that managing and planning 'green' urban areas is a key adaptation opportunity for the city. The taskforce has recommended the following actions to limit the UHI effect and improve flood management:

- Incorporate vegetative roofs into building standards and promote the use of 'green' roof credits; and

- Modify planning and zoning requirements to include mandatory standards for more 'green' space. Identifying potential or existing areas using GIS mapping is expected to be the first step in implementing this option.

Chicago (Prazen, ed. 2008)

In late 2006, a Climate Change Taskforce was established to identify cost-effective mitigation and adaptation measures for the City of Chicago. Working closely with MWH, an engineering consultancy, a number of strategies for adaptation have been identified: reduce vulnerability to extreme heat events, reduce vulnerability to extreme precipitation events, reduce vulnerability of buildings, infrastructure, and equipment to extreme climate conditions, and reduce vulnerability to ecosystem degradation. Recommendations are discussed in more detail below.

Reduce vulnerability to extreme heat events

In order to reduce the vulnerability of human populations to extreme heat events, MWH has suggested the following actions:

- Prepare for extreme heat events by continuously improving emergency response plans, encouraging neighbours to 'check up' on each other, opening up more 'cooling centres', and ensuring that employees and tenants have adequate information about heatwaves;

- Mange the UHI effect by identifying 'hotspots' within the city, encouraging tree planting and community participation, and developing and sharing best practices with other organisations; and

- Increase ozone response activities by supporting public transit discount days and offering benefits to employees who travel to work in this way.

Reduce vulnerability to extreme precipitation events

The combined (sanitary and stormwater) sewer system in Chicago was built over one hundred years ago and can only handle up to a two-year storm event. With the predicted increase in intensity of rainfall from climate change, MWH has recognised the following actions as key priority areas for the city:

1. Incorporate projected climate conditions into watershed studies and hydrological planning requirements;

2. Conduct a stormwater management study to assess the capacity of the current system to cope with the impacts associated with climate change;

3. Conduct adequate testing

of distributed solutions (e.g. permeable paving and 'green' roofs) to reduce vulnerability to storms, as well as long-term planning studies; and

4. Collaborate with municipal agencies to develop a stormwater management plan to address future climatic conditions.

Reduce vulnerability of buildings infrastructure, and equipment to extreme climate conditions

If buildings are to maintain their structural stability and level of service, MWH recommend the following adaptation options: undertake a power vulnerability study in the case of hot summers and long heatwaves, distribute current energy sources to ensure critical services remain on-line during extreme heat events, and switch to renewable energy to meet increased demand; manage fleet vulnerability by purchasing vehicles with a high heat tolerance and change maintenance schedules to take account of increased stress; and incorporate climate change impacts into plans for new developments and building renovations.

Improving the resilience of natural ecosystems in the Chicago area has been identified as a key adaptation measure for assuring continual diversity and species protection. MWH has recommended the following actions:

- Encourage businesses and property owners to participate in preserving native species and investments in 'green' migratory pathways;
- Disseminate new plant lists to identify hazardous zones and influence landscape design;
- Ensure proper maintenance and protection of trees on public land;
- Adapt current wetland management practices to future impacts of climate change; and
- Encourage farmers to adjust planting and harvesting dates, plant more tolerant varieties, switch to warmer season crops, and invest more capital in crop storage or livestock facilities.

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APPENDIX 1

Workshops

The risk assessment project included two separate workshops. The first was a brief (2 hour) workshop with corporate managers and councillors. In this workshop the participants explored the potential ramifications of regulatory change, in particular the review of the South East Queensland Regional Plan, due for release mid-2009. This workshop followed Crichton's risk triangle and the Climate Risk Resilience Diamond.

The scenario explored in this workshop focussed on the South East Queensland Regional Plan releasing climate change maps that defined areas in South East Queensland (SEQ) which were sensitive to climate change (i.e. areas that face exacerbated risk from storm surge). A transcript of workshop findings are presented below.

The main findings of the workshop identified that Council is vulnerable to the State Governments actions. Council believed that it did have the ability to help create a more resilient community, but did not have the power (e.g. Council could restrict development to reduce the risks and this decision could end up being overturned or compromised by the State Government who may approve or guide development into that area). Some workshop participants expressed that Council has a medium vulnerability to climate change due to its population, coastal areas and existing infrastructure.

Workshop participants imagined that if there were negative repercussions from climate change maps included into the regional plan, then responsibility for compensation would ultimately rest with the State as Local Governments sit under their jurisdiction.

APPENDIX 2

Some fauna species vulnerable to Climate Change in SEQ

Brisbane semi-slug (Fastosarion virens) – Gympie
Morose woodland snail (Meridolum morosum) - Brisbane
Fraser's banded snail (Sphaerospira fraseri) – Cooloola
Illidge's ant-blue butterfly (Acridopsis illidgei) – Mary River
Swamp crayfish (Tenuibranchiurus glypticus) – Woodgate
Marjorie's hardyhead (Craterocephalus marjoriae) – Burnett River
Striped gudgeon (Gobiomorphus australis) – Woodgate
Crimson-spotted rainbowfish (Melanotaenia duboulayi) – Burnett River
Wallum froglet (Crinia tinnula) - Cooloola
Green-thighed frog (Litoria brevipalmata) – S.E. Qld
Bleating treefrog (Litoria dentata) – S.E. Qld
Elf skink (Erotoscincus graciloides) – Fraser Island
Bell miner (Manorina melanophrys) – Gympie region
Smudgee (Angophora woodsiana) – Noosa River area
Angle-stemmed myrtle (Gossia gonoclada) - Brisbane
Silky oak (Grevillea robusta) – Gympie

Source: Low 2007, p.10.

Some flora species most vulnerable to climate change (based upon their northern limits)

Low Vulnerability	Northern Limit
Grey Mangrove (Avicennia marina) Spotted Gum (Corymbia citriodora)* Pink bloodwood (C. intermedia) Moreton Bay Ash (C. tesselaris) Brown Bloodwood (E. trachyphloia) White mahogany (Eucalyptus. acmenoides) Narrow-leaved ironbark (E.crebra) Gum-topped Box (E. moluccana) Forest Red Gum (E. tereticornis) Paperbark (Melaleuca quinquenervia)	Malaysia North Queensland Cape York New Guinea Atherton Cooktown Cooktown Atherton Tableland New Guinea New Guinea
Intermediate Vulnerability	**Northern Limit**
Broad-leaved Ironbark (E. fibrosa) Grey Gum (E. major) Grey Gum (E. propinqua) Swamp mahogany (E. robusta)	NW of Rockhampton Blackdown Tab., Carnarvon Gorge Gympie, Blackdown Tableland Yeppoon
High Vulnerability	**Northern Limit**
White mahogany (E. carnea) Red Bloodwood (E. gummifera) Tallowwood (E. microcorys) Grey Ironbark (E. siderophloia) Scribbly Gum (E. racemosa) Narrow-leaved red gum (E. seeana)	Gympie Almost Maryborough Maryborough Near Bundaberg Bundaberg Landsborough






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