**Feehan Consulting**

Feehan Consulting
84 Balaclava Rd
Shepparton Vic 3630

Phone 0358 313 6180
Mobile 0437 354 088
el pfeehan@mcmedia.com.au

# Climate Change Discussion Paper – Summary

## Goulburn Broken Catchment Management Authority

Final

18 October 2007

This is a "short" version of a longer, more detailed paper. This paper attempts to provide a high level summary of the information in the longer paper. In turn, the longer paper is only a summary of information and ideas gleaned from many different sources. Both papers can be used as pointers to key information sources.

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# 1. Introduction

The purpose of this paper is to

- Provide background information about greenhouse gases and climate change
- Discuss greenhouse and climate change related issues relevant to the Goulburn Broken catchment
- To propose a course of action to be implemented by the CMA and relevant stakeholders to respond to greenhouse gas and climate change and especially improve the adaptive capacity of the catchment.

**Long Term Goal -**

The long term goal of this Framework is to increase the adaptive capacity of the Goulburn Broken catchment and reduce the risks of climate change impacts.

# 2. Situation Statement

## 2.1. The Greenhouse Effect and Climate Change

The Intergovernmental Panel on Climate Change (IPCC), which advises the United Nations, is responsible for providing the international community with authoritative advice on scientific, technical and economic issues relating to climate change. The IPCC's Fourth Assessment Report (2007) (Hennessy 2007) concluded that climate change has accelerated in recent decades, and that most of the warming over the past 50 years is attributable to the increase in greenhouse gas emissions from human activities.

Moreover, scientists predict that temperatures will continue to rise in the 21st century.

Climate change has the potential to adversely affect our environment, our communities and our economy unless we take action now - to reduce our greenhouse gas emissions, and prepare for the impacts of climate change.

The natural greenhouse effect warms the planet and allows humans to live on the Earth. For millions of years, water vapour, carbon dioxide, methane and other greenhouse gases have occurred naturally, heating the atmosphere and making Earth habitable.

The Victorian Government through its "*Environment SustainabilityAction Statement"* (2006) has accepted that climate change is occurring.

| **Recommendation:** – accept climate change is occurring – move on to adapting to it |
|---|

***I say the debate is over.***

***We know the science.***

***We see the threat.***

***And the time for action is now.***

…Arnold Schwarzenegger. Governor State of California.

## 2.2. Greenhouse gases

Water vapour is the most common greenhouse gas. However, several other greenhouse gases contribute to human-induced climate change. The major contributors are:

- Carbon dioxide ($CO_2$)
- Methane ($CH_4$)
- Nitrous oxide ($N_20$)

For purposes of measurement, all greenhouse gases are converted to a common unit, called $CO_2$ equivalent ($CO_2e$) (Table 1)

| **Gas** | **GWP (Global Warming Potential)** |
|---|---|
| Carbon dioxide ($CO_2$) | 1 |
| Methane ($CH_4$) | 21 |
| Nitrous oxide ($NO_2$) | 310 |
| $CF_4$ | 6,500 |
| $C_2F_6$ | 9,200 |
| HFC-23 | 11,700 |
| $SF_6$ | 23,900 |

• Table 1 Global warming potential of some greenhouse gases.

## 2.3. Victorian Greenhouse Gas Inventory

Greenhouse gas inventories present data on emissions of a range of greenhouse gases, and on the removal of these gases from the atmosphere by 'sinks'. The

emissions and removals recorded in these inventories relate to human activity. Table 2 summarises Victorian emissions.

| Gas | 2005 emissions (kt) | CO2-equivalent (kt) |
|---|---|---|
| **CO2** | 98,416 | 98,416 |
| **CH4** | 827 | 17,372 |
| **N2O** | 16 | 4,904 |
| **HFCs** | NR | NR |
| **PFCs** | NR | NR |
| **SF6** | 0.005 | 128.8 |
| **Total CO2-e** | | 121,873 |

NR = not reported (commercial in confidence)

• Table 2 Estimates of Victorian emissions of various greenhouse gases

**Recommendation:** – for our purposes only need to focus on $CO_2$, $CH_4$, $N_2O$ for mitigation activities

**Recommendation:** - Seek to have net greenhouse emissions by sector figures available on a regional basis.

## 2.4. Greenhouse gases from agriculture

Primary industries are significant emitters of greenhouse gases. Agriculture, including land clearing, is the third largest contributor to Victoria's total greenhouse gas emissions. Therefore, this sector has an important role to play in reducing Victoria's emissions.

The two main greenhouse gas emissions produced from the agricultural sector are:

**Nitrous oxide ($N_2O$)** from soils:

**Methane ($CH_4$)** gas from ruminants:

Both nitrous oxide and methane are more potent greenhouse gases than carbon dioxide. One unit of methane has a global warming potential equivalent to 21 units of CO2, and one unit of nitrous oxide is equivalent to 310 units of CO2.

**Recommendation:** – seek development of Goulburn Broken GHG inventory

**Recommendation:** – determine contribution of Agriculture as a regional source of GHG to aid in resource management planning

## 3. Climate Change Strategies

There are a number of relevant climate change strategies at State, Federal and International levels.

## 4. International

These include the Kyoto Protocol and the IPCC.

### 4.1. National Greenhouse Strategy

The *National Greenhouse Strategy* - Strategic Framework for Advancing Australia's Greenhouse Response (AGO 1998), A progress report was produced in 2000.

### 4.2. Victorian Greenhouse Strategy

The Victorian Greenhouse Strategy (DNR 2002; DSE 2005)) has six action areas:

- Positioning Victoria's economy for a low carbon future
- Communities shaping their future through action on abatement and adaptation
- Transforming urban areas for sustainability
- Adapting to climate change
- Reducing net emissions from land management in rural Victoria
- Government leadership.

**Recommendation:** – the CMA and this Strategy will contribute to a number of these areas.

The State has produced a Consultation Paper on "Adapting to Climate Change".

### 4.3. COAG - National Adaptation Framework

This Framework was adopted in 2007 and has two priority areas for potential action:

- *Building understanding and adaptive capacity*.
- *Reducing vulnerability in key sectors and regions*.

### 4.4. National Biodiversity and Climate Change Action Plan 2004-2007

This Strategy, published in 2004, (NHMMC 2004)outlines a national strategic approach to protect Australia's biodiversity from the impacts of climate change

## 5. Features of the Catchment and its Vulnerability to Climate Change

Situated in northern Victoria and part of the Murray Darling Basin, the Goulburn Broken catchment comprises the catchments of the Goulburn and Broken Rivers and a small part of the Murray Valley. The catchment covers 2,391,544 hectares, or 10.5% of the State. Some 185,000 people live in the catchment providing an employment pool of 65,000. Of these 17,000 are employed in

agriculture and associated industries. The Goulburn Broken is particularly vulnerable to climate change as a result of it generating and using large amounts of water.

Key features of the catchment that will impact on its vulnerability to climate change include:

- Large areas of intensive agriculture, reliant on regular supplies of irrigation water, with a large infrastructure to store and deliver water
- The catchment is a producer of large quantities of high quality water, used within, and downstream of, the catchment for a wide range of purposes. The Goulburn Broken catchment produces 11% of the Murray Darling Basin stream flow from less than 2% of the land area. It also imports water into the catchment from the Murray River and exports water to adjacent catchments for irrigation, urban, and stock and domestic supply.
- Within the Goulburn Broken catchment there is a total of 1,818 wetlands (>1 hectare) covering an area of 82,181 hectares. The Barmah-Millewa Forest wetland is the region's most significant wetland and is listed under the Ramsar Convention as a wetland of international importance and listed on the Register of National Estate.
- Approximately 2,200 species of native vascular plants and 430 species of native vertebrate animals have been recorded in the Goulburn Broken catchment.
- Approximately 28% of the catchment is Public Land covering a range of reservation types supporting some of Victoria's most valuable forest industries, National and State Parks and alpine resorts. Most of the remaining native vegetation is on public land.
- The region supports a hierarchy of economic assets ranging from primary assets of farm production, irrigation and drainage infrastructure, through to food processing, transport, retail, tourism and recreation assets.
- The Goulburn Broken catchment is widely regarded as the "food bowl" of Australia.
- The catchment's gross value of production from agriculture, horticulture, forestry and aquaculture production and processing is nearly $3.0 billion per annum. The catchment as a whole produces approximately $7.8 billion across all sectors of its economy.
- Over the past five years, capital investment in food processing was $630 million. The existing assets are being added to at an investment rate of about $100 million each year (or $ 1 billion over 10 years).
- Social assets of the Goulburn Broken catchment include the abilities, knowledge and skills of each resident as well as the capacity of communities throughout the catchment.

# 6. Climate Change Scenarios

## 6.1. Introduction

Modeling the effects of climate change in Australia is mostly done by CSIRO. It usesa number of different models driven by greenhouse gas emission scenarios to predict the likely changes to climate.

A number of climate change scenarios have been produced for planning purposes. These have been produced at a range of scales and at different times. Essentially, the scenarios and assessment of impacts are similar, and only the North east results are reproduced here.

## 6.2. North East Greenhouse Alliance

The North East Greenhouse Alliance (NEGHA) has recently released a new report (NEGA 2007) on the community's understanding of climate change, the likely impacts of these changes and the capacity of the regional community to adapt. As part of this process CSIRO was asked to update the climate scenarios (Hennessy 2006). Given the proximity of the North east region to the Goulburn Broken and the similarity of previous assessments it seems sensible to use their assessment of impacts for Goulburn Broken purposes. The 2007 North East assessment is slightly more extreme than the Goulburn Broken 2004 assessment.

The North East scenarios and assessment of impacts are shown in the figures below (Table 3):

| Season | 2030 | 2070 |
|---|---|---|
| **Spring** | Warmer by 0.3 to 1.6°C<br>Rainfall decrease likely (+3 to – 15%) | Warmer by 0.8 to 5.0°C<br>Rainfall decreases likely (+10 to -40%) |
| **Summer** | Warmer by 0.3 to 2.0 °C<br>Rainfall change uncertain (±15%) | Warmer by 0.8 to 6.0°C<br>Rainfall change uncertain (±40%) |
| **Autumn** | Warmer by 0.3 to 1.6°C<br>Rainfall change uncertain (±10%) | Warmer by 0.8 to 5.0°C<br>Rainfall change uncertain (±25%) |
| **Winter** | Warmer by 0.2 to 1.4°C<br>Rainfall decrease likely (+3 to -10%) | Warmer by 0.7 to 4.3°C<br>Rainfall decrease likely (+10 to -25%) |

- Table 3 Seasonal temperature and rainfall projections for north-eastern Victoria. Source (Suppiah 2004)

CSIRO projections for north- eastern Victoria were based on the results of 12 climate models that had good simulations of observed average patterns of temperature, rainfall and atmospheric pressure over south-eastern Australia. Warmer and drier conditions are likely, with more heatwaves, fires, droughts and rain storms, fewer frosts and less snow.

Climate changes likely for north-eastern Victoria are shown in Table 4.

| Variable | Changes |
|---|---|
| **Temperature** | • Annual warming of 0.3 to 1.6°C by 2030 and 0.8 to 5.0°C by 2070<br>• Daytime maximum temperatures and nighttime minimum temperatures are likely to rise at a similar rate<br>• Warming is likely to be greater in spring and summer<br>• 10-60% increase in the number of hot summer days (35°C) by 2030 and a 20-300% increase by 2070 on the plains. Rate of increase will be greater in the mountains<br>• 0-50% reduction in the number of frost days by 2030 and a 50-100% decrease by 2070 |
| **Rainfall** | • Annual rainfall decrease are likely (changes of +3% to -10% by 2030 and +10 to -25% by 2070)<br>• Extreme daily rainfall events are likely to become more intense. |
| **snow** | • Area with at least 1 day snow cover per year likely to be reduced 10-40% by 2030 with 22-85% by 2050<br>• Area with at least 60 days snow cover shrinks 18-60% by 2020 and 38-96% by 2050<br>• At Mt Hotham, peak snow depth declines 10-505 by 2020 and 25-95% by 2050 |
| **Drought** | • Droughts are likely to become longer and more frequent, particularly in winter-spring<br>• Rainfall deficiencies that currently occur once every 5 winter springs may occur once every 3-5 years by 2030 and once every 2-3 years by 2070<br>• Due to hotter conditions droughts are also more likely to become more intense |
| **Fire** | • 10-40% increase in the frequency of days with extreme fire-weather risk by 2020, and 20-120% increase by 2050<br>• 4-25% increase in the frequency of days with very hogh and extreme fire-weather risk by 2020, and 15-70% increase by 2050 |
| **The climate of Wangaratta** | • A 1°C warming and a 5-10% rainfall decrease (a moderate scenario for 2030) would make the climate of Wangaratta more like the current climate of Corowa. |

• Table 4 Climate variables and likely changes due to climate change by 2030 and 2070

### 6.2.1. Potential Impacts

For small increases in greenhouse gas concentrations and low levels of global warming (up to 1C above the 1990 level), both positive and negative impacts are projected. For large increase in gas concentrations and high levels of global warming, natural and human systems are more likely to move beyond coping thresholds. Very few studies have been undertaken to assess risks posed by climate change for north-eastern Victoria. The available literature indicates:

- Annual average flow in north-eastern Victorian rivers is likely to decline 0-25% by 2030 and 5-505 by 2070, with the most likely outcome being a significant decrease
- Dryland grazing and broad acre cropping in north eastern Victoria are likely to benefit from higher $CO_2$, but this may be offset by the effects of higher temperatures and reduced rainfall
- Higher temperatures will reduce the amount of winter chilling which is important for setting fruit and it may become necessary to consider alternative varieties and management options. Reductions in water available for irrigation will also impact on horticultural activities.
- In the Rutherglen and Glenrowan regions, grape quality could decline by 7-24% by 2030, and 12-70% by 2050. The gross returns could be decreased by 2-12% by 2030 and 4-58% by 2050
- Productivity of exotic softwood and native hardwood plantations is likely to be increased by $CO_2$ fertilization effects, although the amount of increase will be limited by projected increases in temperature, reductions in rainfall, increased bushfires, changes in pests and by feedbacks such as nutrient recycling
- For infrastructure, design criteria for extreme events are likely to be exceeded more frequently. Increased damage is likely for buildings, transport structures, energy services, telecommunications and water services
- The need for increased cooling in summer is also likely to increase peak energy demand, while the energy demand for winter is likely to fall
- The number of heat related deaths is likely to rise
- Warmer temperatures may also assist the spread of disease, including vector-borne diseases such as Murray Valley Encephalitis and food borne infections such as salmonella
- Ski tourism and alpine ecosystems are likely to be affected by reduced snow cover and duration. By 2020, there is likely to be 5-40 fewer days of snow cover per year, a rise in the snow line of 30-165 metres, and a reduction in the total snow covered area of 10-40%.

**Recommendation:** for planning purposes adopt the North east climate scenario and assessment of impacts and use the upper ranges e.g. the worst-case scenario for planning.

# 7. Implications of Scenarios for Goulburn Broken Assets

## 7.1. Water Resources

(Jones 2005) provides estimated ranges of changes in mean annual runoff for all major Victorian catchments in 2030 and 2070 as a result of climate change.

In summary the report suggests that in 2030, the most favourable outcome is a change in mean annual runoff of 0% to -20% occurring in catchments in the east and south of the state (East Gippsland shows a small chance of an increase) and, at worst, the possible change ranges from -5% to -45% in the west of the state.

**For planning purposes the 2030 Wettest and 2030 Driest can be considered as indicative of best and worst case scenarios, respectively.**

### 7.1.1. Reduced Water Quality

Water quality may also be impacted by climate change, including, water temperature, carbon dioxide concentration, the number and types of organisms, transportation of water sediment and chemicals, and the volume of water flow. Decreases in stream flow, impacts on coastal underground water and wetlands, and increased salinity will be critical issues for water supply and management as well as natural resource management..

### 7.1.2. Changed Flood Frequency

Increases in extreme rainfall events are projected for many regions, although the impacts are spatially variable. Increased extreme rainfall events are likely to result in more flash flooding, strains on sewerage and drainage systems, and challenges for emergency services.

### 7.1.3. Catchment Salt and Water Balance

(Zhang 2005) assessed the impact of climate change on catchment salt and water balances for selected catchments in Victoria. The study clearly demonstrates that climate change poses significant challenges for NRM. Relatively modest changes in rainfall and temperature can lead to significant reductions in water and salt yield and increases in end of valley salt concentrations.

**Recommendation:** – CMA planning frameworks need to consider climate change eg Salinity, River Health, Wetland, Environmental Flow, Water Quality Management Plans

## 7.2. Biodiversity

It is probable that climate change is already affecting Victoria's plants and animals, but further research is needed to better identify the effects of climate change on biodiversity. Many of Victoria's ecosystems have a limited ability to adapt to climate change. Those restricted to small geographic areas, or unable to migrate fast enough to keep pace with shifting climatic zones, will be particularly vulnerable. However, some ecosystems and species will be advantaged or unaffected by climate change.

Ecosystems and species will respond directly to changing climate conditions, but at the same time will have to cope with and adapt to other climate-induced changes in land use and changes in pests and diseases, particularly invasions by introduced species.

## 7.3. River Health Implications

Sam Lake (Monash University) in a presentation on "Climate Change and freshwater ecosystems in south-eastern Australia" discussed possible river health implications of climate change. A large range of impacts are possible.

### 7.4. Forests

Forests are an important part of Australia's landscape and provide many benefits to society. They provide habitat for animals and plants, and are important for protecting our water and soil resources. They also supply the resource base for one of Australia's largest manufacturing industries, providing wood for housing, furniture and paper products, and making a significant contribution to employment and export earnings for Australia.

The projected changes in Australia's climate are expected to affect forests in a number of different ways.

### 7.5. Land

Information on land impacts is hard to come by. However climate change impacts on land will be related to impacts of floods, droughts, changing land use, agriculture and biodiversity.

### 7.6. Pests and Weeds

There's not much around on weeds but an Ensis study, reported in Farming Ahead March 2007, suggests:

- Climate change will alter the climatic limits that will eventually constrain the range of weed species
- Increasing temperatures might allow some "sleeper" weeds to become invasive
- Climate models can predict the likely impacts of climate change on the future distribution and relative abundance of weeds
- Predictions could change as climate models improve or if global greenhouse emissions patterns change.

### 7.7. Agriculture

Predicting the likely impacts of climate change on agriculture is difficult due to the complexity of interactions between climate and the environment. The impacts of climate change on crops and animals may be influenced by a range of factors, including their tolerance to increased maximum and minimum temperatures, moisture availability and tolerance of water stress, changes in exposure to pests, impacts of storms, and elevated concentrations of carbon dioxide. In addition to the direct impacts of climate change on agriculture, there is the possibility of indirect effects based on social and economic impacts as regional and international markets and consumer demands respond relatively rapidly to climate change.

Identified areas of risk for the region include:

- dryland grazing and broad-acre cropping are likely to benefit from higher carbon dioxide concentrations, but these gains may be offset by the effect of higher temperatures. An overall negative impact on production is more likely if substantial rainfall decreases accompany the warming
- irrigated agriculture is very significant in the region and includes cropping, dairy and horticulture. Likely reductions in overall water resources will reduce water volumes available for irrigation while at the same time higher temperatures and evaporation rates may increase crop requirements for water. These impacts will increase the need for more efficient use of water

- higher temperatures will also reduce winter chilling which is important for some fruit trees for fruit setting and it may become necessary to consider low chill varieties and alternative management options
- viticulture in the region will be affected by possible reductions in grape quality due to higher temperatures, however, there may be opportunities for new varieties better adapted to warmer climates
- warmer temperatures will also increase risk of heat stress in dairy cattle, reducing milk production, unless management measures such as shade sheds and other cooling measures are adopted.

### 7.8. Alpine Areas and Snow Conditions

Some important areas of the Victorian Alps lie within the southern areas of the region. Australian alpine ecosystems and species are highly adapted to their environment and are extremely sensitive to changes in climate. Decreasing snow cover, increasing risk of fire and invasion by weeds and other species will also have an impact. Species whose habitat is located in the highest elevations and the coldest environments will have nowhere to retreat to as the climate warms, and will therefore be threatened with extinction.

The alpine resorts of Mt Buller, Mt Stirling and Lake Mountain are key economic drivers for both surrounding communities and Victoria as a whole. While climate change will have the greatest impact on lower elevation resorts, CSIRO research estimates that with some increased artificial snow making, Mt Buller will be able to maintain skiing conditions to at least 2020.

### 7.9. Fire Weather

An increase in fire-weather risk is likely at most sites in 2020 and 2050, including the average number of days when the FFDI rating is very high or extreme. The combined frequencies of days with very high and extreme FFDI ratings are likely to increase 4-25% by 2020 and 15-70% by 2050.

| |
|---|
| Implications for catchment – more fires like 2006/07 – catchment and biodiversity impacts |

### 7.10. Other Issues

There is a range of other potential impacts of climate change, however many of these are not of direct, immediate relevance to CMA activities. These issues include:

#### 7.10.1. Communities

A wide range of direct and indirect climate change impacts may affect Victorian communities. Flooding and rising sea levels, heatwaves, water shortages, increased frequency and intensity of storms, greater air pollution and higher urban temperatures pose the greatest potential threats.

Climate change may have wide-ranging effects on human health. There is concern over the direct effects of higher summer temperatures and heatwaves; increased risk of respiratory problems; water quality issues for drinking water; and the risk of increased rates of food- and water-borne disease.

Climate change is perhaps the greatest scientific commincation challenges for this decade.

### 7.10.2. Recommendation: CMA relies on communities to implement RCS program – need to assess impact of climate change on this relationship. Settlements and Infrastructure - Impacts of Climate Change

The impacts of climate change on settlements and infrastructure are likely to be widespread. Key sectors likely to be affected include energy and water supply, health infrastructure and services, transport, building, food industry, and tourism.

There is a need for planners, builders and key industry sectors to consider the impact of climate change when planning for the future. In particular, as the occurrence of hotter temperatures, bushfires, floods, drought and storms increase, so too will the pressure on key infrastructure assets.

**Recommendation:** – review implications for CMA floodplain management; disaster management; waterway incident response roles

## 7.11. Surprises

The possibility of surprises (ie impacts or changes that are unexpected or occur more quickly than anticipated) needs to be factored into planning. For example:

- Climate change may occur more rapidly than expected
- Natural systems may respond more quickly and in ways that are not anticipated
- Physical, social and biological systems may have thresholds that we are not aware of, or have not been accurately factored into current impact assessments.

Systems thinking rather than silo thinking will also be useful.

**Recommendation**: Strategic and planning approaches must be flexible enough to cope with unseen "surprises"

## 7.12. Summary

- Regional risks to water are reasonably well understood. (Northern SWSS is also addressing this). However it is not apparent that implications of other risks are well understood, yet.
- Implications of climate change risks are being built into the thinking of a number of programs – Irrigation Futures learnings will be useful
- Could do some regional case studies to get a better feel for implications of risks, vulnerabilities and adaptation strategies. For example – biodiversity impacts
- There are a lot of potential risks – need to focus on the ones that are most relevant to the CMA.

# 8. Opportunities Associated with Climate Change

## 8.1. Biosequestration and Carbon Brokering

*Biosequestration – a carbon off-set option usually associated with forestry*

*Carbon brokering – provision of a carbon offset service*

If a national emissions trading scheme emerges in which bio-sequestration projects are eligible for offsetting carbon emissions, then there will be a demand for suitable revegetation and reafforestation projects across Australia. There is already such a demand in NSW through GGAS (Greenhouse Gas Abatement Schemes).

(Campbell 2007) reviewed opportunities for Catchment Management Authorities (CMAs) to facilitate biosequestration investment into revegetation projects that meet the priorities of their regional catchment strategies (RCS). CMAs could become carbon off set service providers. He concluded that while different options will suit different CMAs in different circumstances, the overall conclusion is that CMAs should hasten carefully, if not slowly, as this new market evolves.

**Recommendation:** – CMA needs to be involved but not leading in this field. Engage with carbon brokers with the aim of helping to achieve Regional goals. Adopt Campbell's advice and hasten carefully, if not slowly, as this new market evolves. Adopt a brokering or facilitation role rather than a "doing" role.

## 8.2. Agriculture

There is a number of opportunities for agriculture to both increase the quantity of carbon it sequesters (captures), and reduce greenhouse gas emissions. Action to reduce greenhouse gas emissions can also have a number of other benefits.

# 9. What Are We Going To Do?

## 9.1. Approaches

There are two approaches to dealing with climate change. The first is to do nothing, the second involves activities to reduce emissions (mitigation). The third involves adapting to climate change. The last two approaches can be underpinned by research and knowledge generation but can be implemented on a "best-bet" basis immediately.

This paper is focused on adapting to climate change. The CMA is not in a position to promote wide scale mitigation activities within the catchment, which are more in the realm of industry and regional groups such as the Goulburn Valley Waste Management Group and the proposed Goulburn Broken Greenhouse Alliance Group. The CMA can, and will, support GHG reduction activities of its own operations and others within the catchment.

**Recommendation:** – CMA adopt the policy position – focus on adapting to climate change, and support greenhouse gas mitigation at the catchment level.

## 9.2. Adapting to Climate Change

Some useful concepts to be considered in approaches to living with climate change include:

- Vulnerability
- Risk Management
- Resilience
- Adaptation

**Recommendation:** – develop and implement processes to enhance the region's resilience, adaptability and transformability – Wolfenden et al (2007) provides pointers; as well as the AGO (2006) and the Irrigation futures project.; and see Section below on adaptation planning

## 9.3. Adaptation Planning

Adaptation planning involves judgements about the best strategy in the face of uncertainty about future climate change.

Adapting to climate change impacts is a complex task. We are at an early stage in understanding likely impacts and options for dealing with them. However, there are steps businesses, governments and the community can take now to prepare for climate change in the future.

- Plan early
- Be systematic and strategic
- Use the best information
- Be flexible

An adaptation strategy will aim to increase the resilience of human and natural systems to possible changes in climate conditions where this is likely to be feasible and cost effective, and takes account of the social dimensions of distributing losses. It is a framework for managing future climate risk. It offers the potential of reducing future economic, social, and environmental costs as well as protecting life.

**Recommendation:** – GBCMA needs an adaptation strategy – which will be part of a regional adaptation strategy – this document can be considered as Version 1 of the GB Adaptation to Climate Change Strategy. The Goulburn Broken Adaptation Strategy will involve further development of approaches outlined in Wolfenden, the AGO, the Irrigation futures project and other relevant sources.

## 9.4. Victorian Climate Change Adaptation Program

One component of the Victorian Climate Cchange Adaptation Program involves projects being run by the Department of Primary Industries ensure that Victorian agricultural and rural communities can respond effectively to climate change. Staff at ISIA are involved in some aspects of these projects. They also contribute to the Agriculture Adaptation to Climate Change Program in DPI.

### 9.5. Other Regional Attributes Required

A range of other attributes and behaviors will need to be displayed to ensure the region manages and adapts to climate change as best it can. These attributes and behaviors will include:

- Coordination, leadership, linkages
- Collaboration
- Positioning
- Partnership approaches
- Priority setting (Priority setting will be undertaken in a risk management framework – see section above.)
- Flexibility
- Shared responsibilities
- Consultation and engagement
- Knowledge sharing

**Recommendation:** – CMA can promote desirable regional behaviors

### 9.6. Relevant Groups, Projects and Leamings

A number of relevant groups, projects and learnings exist that can be adapted or adopted for CMA purposes. Some of these include

- Goulburn Broken Greenhouse Alliance
- Dryland Landscape Strategy
- Goulburn Broken Irrigation Futures (IF) Project
- Strategic Approaches

  At least two other regions (North East and Westernport) have already produced regional strategies to respond to climate change issues. A North Central Case Study also provides useful approaches.

GBCMA can consider many of these actions in its own strategy, or alternatively promote their implementation by others (eg Goulburn Broken Greenhouse Alliance).

# 10. The Goulburn Broken CMA Strategic Approach to Climate Change

*(This section picks up all Recommendations, or spirit of Recommendations, in previous Sections).*

## 10.1. The Strategy

Put as simply as possible a suggested strategic approach to climate change can be outlined as:

The long term goal of this Framework is to increase the adaptive capacity of the Goulburn Broken catchment and reduce the risks of climate change impacts.

- Acknowledge that climate change is occurring (the debate has moved past "is it occurring" and "what are its causes"), and the impacts, over time, will be serious. There are major implications for the region's water resources, biodiversity, agricultural industries, infrastructure and communities. The CMA will support implementation of relevant climate change Strategies.

- The main game is climate change adaptation.

- CMA Programs and planning frameworks must address climate change impacts and incorporate adaptation to climate change into operational plans and reporting processes. Strategic and planning approaches must be flexible enough to cope with unseen "surprises".

- Adopt, for planning purposes, the North East climate scenario and assessment of impacts. The 2030 Wettest and 2030 Driest are indicative of best and worst case scenarios, respectively. (An updated Goulburn Broken assessment may become available later in the year.)

- Development of a Goulburn Broken Greenhouse Alliance is supported as an approach to encouraging measures to reduce greenhouse gas emissions.

- Work towards understanding the impacts and vulnerability of the catchment to climate change. Risk management approaches will be used to help determine and manage the main issues.

- Develop and use adaptation strategies to enhance the region's resilience, adaptability and transformability and to encourage desirable attributes and behaviors. This paper is Version 1 of the Adaptation Strategy.

- Develop close links with climate change researchers, the Australian Centre for Climate Change Adaptation and the Victorian Climate change Adaptation Program and with state and federal government greenhouse policy units.

- Learn from studies undertaken in other areas (especially North East and West Gippsland) and also the Irrigation Futures project. Don't try to reinvent the wheel

- The CMA's role in floodplain management, disaster and waterway incident management will be challenged (ie it probably needs beefing up).

- Be involved, but not leading, development of carbon brokering and biosequestration opportunities. Engage with carbon brokers with the aim of helping to achieve Regional goals. Adopt Campbell's advice and hasten carefully, if not slowly, as this new market evolves. Adopt a brokering or facilitation role rather than a "doing"

- Support regional GHG abatement initiatives and the development of a regional GHG inventory, including understanding agriculture's contribution. For our purposes only need to focus on $CO_2$, $CH_4$, $N_2O$ for mitigation activities.

## 10.2. Implementation of Strategy

Strategy implementation will occur across all CMA programs and will be the responsibility of all program managers.

Strategy implementation needs to strongly coordinated and integrated.

There needs to a "climate change face" within the CMA to provide

- Coordination
- Integration
- Liaison with relevant projects, organization within, and external to, the region
- Scanning for issues and opportunities

Resourcing (funding and person) needs to be made available.

Actions to implement this strategic approach are listed in the following table (Table 5).

| Strategy Element | What has to be done to implement this | Priority/Timeframe |
|---|---|---|
| The long term goal of this Framework is to increase the adaptive capacity of the Goulburn Broken catchment and reduce the risks of climate change impacts. | • Consultation with ICs – ie discuss this document with ICs<br>• Board to adopt Policy position | • High/Immediate |
| Acknowledge that climate change is occurring (the debate has moved past "is it occurring" and "what are its causes"), and the impacts, over time, will be serious. There are major implications for the region's water resources, biodiversity, agricultural industries, infrastructure and communities. The CMA will support implementation of relevant climate change Strategies. | • Consultation with ICs<br>• Board to adopt Policy position | • Very high/Immediate |
| The main game is climate change adaptation. | • Consultation with ICs<br>• Board to adopt Policy position | • Very high/Immediate |
| CMA Programs and planning frameworks must address climate change impacts and incorporate adaptation to climate change into operational plans and reporting processes. Strategic and planning approaches must be flexible enough to cope with unseen "surprises". | • Undertake gap analysis (underway)<br>• Then modify strategies as appropriate | • Very high/Immediate |
| Adopt, for planning purposes, the North East climate scenario and assessment of impacts. The 2030 Wettest and 2030 Driest are indicative of best and worst case scenarios, respectively. (An updated Goulburn Broken assessment may become available later in the year.) | • Consultation with ICs<br>• Board to adopt Policy position<br>• Review scenarios as new or updated information becomes | • High/Immediate |

| | | |
|---|---|---|
| | available | |
| Development of a Goulburn Broken Greenhouse Alliance is supported as a mechanism for encouraging the reducing of Greenhouse gas emissions. | • Board and Management support formation of Alliance and work to ensure this occurs<br>• Work with Alliance to develop and implement regional mitigation and adaptation strategies | • Very high/Short term |
| Work towards understanding the impacts and vulnerability of the catchment to climate change. Risk management approaches will be used to help determine and manage the main issues. | • Risk management approaches – management policy.<br>• Watching brief on research projects – develop a process to review projects and assess their relevance to the catchment<br>• Undertake vulnerability and risk analysis at a range of scales within catchment (this document probably provides this at a broad scale; more detailed analysis may be required at a sector/industry or sub catchment scale) | • Very High/Medium term |
| Develop and use adaptation strategies to enhance the region's resilience, adaptability and transformability and to encourage desirable attributes and behaviors. This paper is Version 1 of the Adaptation Strategy. | • Develop and implement processes based on Wolfenden and Irrigation Futures and any other relevant ones. | • High/Short – Medium but will run over a long period |

| | | |
|---|---|---|
| | • Will need resources to drive this process – people and dollars | |
| Develop close links with climate change researchers, the Australian Centre for Climate Change Adaptation,the Victorian Climate Change Adaptation Program and state and commonwealth climate change policy units. | • develop a process to review projects and assess their relevance to the catchment.<br>• Will need resources to drive this process – people and dollars | • High/Short term – but will run over a long period |
| Learn from studies undertaken in other areas (especially North East and West Gippsland) and also the Irrigation Futures project. Don't try to reinvent the wheel | • Management policy position<br>The Irrigation Futures project is probably the closest thing we currently have to an adaptation strategy. It should be possible to utlise some of their outcomes and processes to streamline the development of a Goulburn Broken climate Change Adaptation Strategy.<br>• | • Very high/immediate |
| The CMA's role in floodplain management, disaster and waterway incident management will be challenged (ie it probably needs beefing up). | • Develop position after review of gap analysis | • High/Medium |

| | | |
|---|---|---|
| Be involved, but not leading, development of carbon brokering and biosequestration opportunities. Engage with carbon brokers with the aim of helping to achieve Regional goals. Adopt Campbell's advice and hasten carefully, if not slowly, as this new market evolves. Adopt a brockering or facilitation role rather than a "doing" | • Consultation with ICs<br>• Board to adopt Policy position<br>• Put in place mechanism or procedures; Will need resources to drive this process – people and dollars | • Moderate/Medium term |
| Support regional GHG abatement initiatives and the development of a regional GHG inventory, including understanding agriculture's contribution. For our purposes only need to focus on $CO_2$, $CH_4$, $N_2O$ for mitigation activities. | • Implement with Goulburn Valley Greenhouse Alliance.<br>• Undertake CMA GHG production audit | • Moderate/Short term (CMA Audit can be done relatively quickly) |

**Table 5 Suggested Actions to Implement Strategic Approach**

## 11. Relevant Current Research Activities

There are a large number of relevant climate change and greenhouse research programs and projects underway. These include:

- Greenhouse Action in Regional Australia Program
- CRC for Greenhouse Accounting
- Vic Department of Primary Industries
- Greenhouse in Agriculture Project
- CSIRO - Water for a Healthy Country Flagship
- CSIRO Climate Adaptation Flagship
- Biodiversity Research activities

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| | |
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