

# Best Practice in Incorporating Climate Change into Forest Management Planning

Rodney William Meynink, MBAC Consulting Group Pty. Ltd.



## Sustainable Forest Management Series

Department of Environment and Conservation

SFM Technical Report No.7

October 2008



Department of  
Environment and Conservation



Department of Environment and Conservation  
168 St Georges Terrace  
Perth WA 6000  
Tel: +61-8-6467 5000  
Fax: +61-8-6467 5562  
www.dec.wa.gov.au

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October 2008

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The report contains the opinion of MBAC Consulting Group Pty Ltd with regards climate change.

### **Acknowledgements**

MBAC Consulting Group Pty Ltd. MBAC Consulting Group Pty Ltd acknowledges substantial input from Chris Eastaugh (University of Lleida Spanish Catalonia) and input from Hans Drielsma (Forestry Tasmania), Rod Anderson (Victorian Department of Sustainability and Environment), Stefan Arndt (University of Melbourne), Barbara Sanders (SFNSW), Geoff Smith (SFNSW), Rodney Keenan (University of Melbourne) and Morgan Roche (SFNSW).

### **Reference details**

The recommended reference for this publication is: MBAC Consulting Group 2008, *Best Practice in Incorporating Climate Change into Forest Management Planning*, Department of Environment and Conservation, Sustainable Forest Management Series, SFM Technical Report No. 7.

*Cover photo:*        *Mature pine in Canada (British Columbia) affected by Mountain pine beetle (Dendroctonus ponderosae)*

### **Document control**

Commenced:        October 2008  
Effective from:    October 2008  
Custodian:        Director Sustainable Forest Management Division  
Approved By:      Director Sustainable Forest Management Division

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# 1 Abbreviations and acronyms

CDM	Clean Development Mechanism
CER	Certified Emission Reduction
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
E.	<i>Eucalyptus</i>
ERU	Emission Reduction Unit
ESFM	Ecologically Sustainable Forest Management
GGAS	Greenhouse Gas Abatement Scheme
IPART	Independent Panel and Regulatory Tribunal
IPCC	<i>Intergovernmental Panel on Climate Change</i>
IUFRO	International Union of Forest Research Organisations
JI	Joint Initiatives
MIS	Managed Investment Scheme
NGAC	NSW Greenhouse Gas Abatement Certificates
OFOF	Our Forests Our Future
P.	<i>Pinus</i>
PPM	parts per million
Q.	<i>Quercus</i>
Spp	species
TIMO	Timber Investment Management Organisation
UNFCCC	United Nations Framework Convention on Climate Change

## 2 Executive summary

There are many unanswered questions regarding climate change and forests, such as what are the impacts, how fast will this occur, how fast can species adapt, how should we plan, what needs to be done?

Observed changes in forests include changes in phenology (timing of cycles) and range change (examples from Europe, China, Japan, USA, Australia, Scandinavia, Siberia and Canada); changes in growth (Germany, the tropics and Australia); incidence of fire (Russia, Australia and California); incidence of pests (Alaska, Europe and British Columbia) and combined impacts (Australia).

To understand whether these are due to climate change, scientists turn to models. Models have improved significantly over the past two decades, although they depend on uncertain climate data and disturbance inputs. Accordingly, their outputs are estimates at best. Global and national modelling shows that ecological, economic and social disruptions are likely. Regional modelling is providing more detail. Example of regional models are provided for Western Australia (*The Indian Ocean Climate Initiative* or IOCI), Tasmania (climate driven change, plantation productivity and carbon modelling), Victoria (climate vulnerability and carbon modelling) and New South Wales (vulnerability and socioeconomic impacts as well as carbon modelling). Biome modelling has demonstrated that higher levels of carbon dioxide will increase plant growth, although the models cannot predict the impact of greater pestilence that could result (for example). The review suggests forest distributions are influenced more by extreme events (fire, pests, competition etc) than by small changes in climate. Modelling such events remains difficult. There is however agreement that rapidly changing climate will suit species that can spread quickly and are suited to a wide range of climatic conditions.

Models are also predicting economic impacts although given the uncertainty with climate models, meaningful economic modelling is difficult. Example models are provided, such as the Hamburg T106 model and the Urbana-Champaign climate model which show very different global timber production. They both can't be right. They can both be wrong. Markets can be expected to adapt to changing conditions, and thus ameliorate some of the effects of climate change on the forest industries. Social impacts will be job losses, changes in land tenure and social resilience and social adaptation.

In short, the impacts of climate change on forests are likely to be ecological, environmental and social although all assessments are with uncertainty.

Internationally, we are seeing more formal moves to maintain flexibility in forest environments, to best cope with unpredictable challenges such as climate change (Germany, Scandinavia, Finland, North America, Austria and France). Climates in Europe are expected to become warmer, and precipitation patterns are expected to change to generally drier summers, particularly in Mediterranean and Atlantic areas. Although forest productivity is expected to rise, increased and novel disturbances are expected to impact biodiversity and some commercial timber species (Europe and Australia).

There are many adaptation examples such as changing species compositions (France, Germany, Spain, Belgium, Belarus, Bulgaria, Austria, Slovenia, Czech Republic, Finland and Poland); extending natural reserve (Netherlands, Spain, Belgium, Poland, Sweden and Switzerland); focusing on forest health to improve resilience (Finland, Germany, Switzerland and Bulgaria); genetic adaptation (Sweden, France, Bulgaria and The Ukraine); improved fire regimes (Greece, Spain, France and Italy); quarantine and sanitary management (France, Finland, Czech Republic and Austria); new harvesting techniques (Finland and Sweden); promotion of reforestation of agricultural land (Latvia, Italy, Belarus, Slovenia, Lithuania, Denmark, Ireland and the United Kingdom) and promotion of wood products as building materials (France and Sweden); forest health and silvicultural practices such as thinning, fertilisation or irrigation (Finland and Australia); increasing genetic diversity (in both natural forests and in plantations) also a means of increasing resilience to pest attacks or inclement climate (Spain, Sweden); fire suppression (Europe and Australia); improved forest hygiene (Austria, France, Finland and the Czech Republic) and changed harvesting techniques (Finland).

In North America, there have been reports focusing on adaptation, such as changing species compositions (Canada and USA); design infrastructure for extreme events (USA and Australia); smoke pollution monitoring (USA); shorter rotation times (USA) and heavy thinning for Mountain Pine beetle (Canada and USA).

Mitigation and adaptation as they relate to climate change are becoming common themes throughout the forestry environment in Australia.

In NSW, mitigation response include the *NSW Greenhouse Gas Abatement Scheme* offsets of about 700 000 t CO<sub>2</sub>-e to date; improved methodology to account for carbon sequestration in plantations; *NSW Greenhouse Plan* - Incentives for implementation of mitigation measures; full cycle analysis of alternative forestry systems; research into bioenergy production from woody plants; improved carbon sequestration and soil carbon models; and the role of forest products (i.e. life cycle analysis) in carbon accounting. NSW adaptation responses include developing elite trees for economically viable plantations in low rainfall environments; development of sustainable production systems; increased atmospheric carbon dioxide on forest species; impacts of climate change on product quality, pests and diseases and minimising water loss.

In Victoria, mitigation responses include dealing with the impact of past fires and likely increasing fire danger - both central to Victoria's mitigation and adaptation programs; carbon sequestration using plantations and new estimates of baseline carbon stocks. Adaptation response includes mechanisms to deal with market failure (education, regulation, incentives and public investment); public consultation; implementation of environmental policies; utilisation of waste for biofuel (i.e. fuel substitution) and reducing fire risk in the forests.

For private plantation entities, mitigation and adaptation responses include carbon sequestration in plantations, utilisation of waste (residues) for biofuel; silvicultural change and geographical (spatial) diversification.

There is much we don't know. For example, accurate modelling of carbon storage in forests under different management regimes will need models designed specifically for regional conditions. Useful regional climate modelling for Australia will be impossible without a better understanding of El Nino phenomena. There is no Australian national framework for mitigation and adaptation issue. There is also little knowledge on the impacts of forest changes on climate change (so-called feedback impacts). The linkage between climate change and employment is also unknown.

A suggested trial including a possible role for government in Australia is the participation in the breeding of new tree varieties that are tolerant to a wider range of climatic conditions and the dissemination of the results. Trials of eucalypt production for high-value veneer products are also recommended. Non-production oriented trial recommendations include 'canary in a mineshaft' plots established on the edge or outside the natural range to give some advance warning of climate driven pressures, which provide data on how these species may fare under a new climate. Alternatively, 'pioneer' plots established at the opposite of the natural species' range as an indication of what species may be advantaged by new climate conditions.

Our recommendations are that the outputs from models need to be treated with caution. Despite the growing public awareness and profile of climate change in political debate there have been little scientific analysis of the impacts of climate change on Australian native forests and little evidence that forest managers are considering the potential impacts of climate change in management planning. The social effects of climate change are highly uncertain, and projects to strengthen community resilience and reduce vulnerability should be considered. A national forest framework for research, policy formulation and implementation should be established with all of the states contributing. There is also a strong need for research and development support for forests and climate change.

In terms of best practice, at present, adaptation responses are focusing on short to medium term timeframes, aimed at strengthening the resilience of forests and maximising diversity. Increased focus on fire suppression and pest resistance is common. In light of the uncertainties of future climate, maintaining flexibility in the forest is key. Considering that no one person or organisation can be expected to have 'the answer', maintaining management diversity (as well as ecological diversity) will help to spread risk, and give a greater chance of finding successful solutions. A key theme has been looking at ways to enhance the resilience of forests to adapt to climate change. Carbon modelling is becoming common as forest managers begin to better understand their baseline carbon state.

Globally and as a nation we probably need to get this right because, as they say, later will be too late. Climate change poses threats, but also the opportunity for us to regain our place in the public imagination as supporters of nature, rather than opponents.

## 3 Observed climate change in forests

### 3.1 Introduction

Evidence from paleoclimatological research indicates that major climatic changes, such as the rapid increase in temperatures at the end of the Younger Dryas<sup>1</sup> event 11 000 years ago<sup>2</sup>, can occur over the span of a few decades<sup>3</sup>. Studies of this period have shown that changes in species composition of plant communities can also occur rapidly. Globally, knowledge and experience regarding climate change and forest is rapidly changing and questions are now being asked, such as:

- What are the likely impacts of climate change on forests?
- What impacts ('feedback') do changes in forests have on climate change?
- How fast will change occur?
- How fast can species adapt to what could be rapid change?
- How should we plan for this?
- Has anyone planned for this?
- If so, how have they planned?
- Can we identify 'best practice'?
- What else needs to be done?

This report addresses some of these questions (refer Appendix 1 for Project Objectives and Scope of Works). Our starting point is to 'stratify' the issues into planted and native forests before considering change-dynamics in Europe, North America and Australia.

### 3.2 Native forests, plantations and climate change

There is greater clarity between climate change issues and planted forests (i.e. afforestation and reforestation) than with native forests. This is because we are mostly dealing with planted forests established specifically for bio- or carbon-sequestration purposes. This activity is the most tangible response to climate change simply because at this point, forests remain the only practical means to remove carbon dioxide from the atmosphere, store this for a considerable time<sup>4</sup> and do this at prices consistent with current estimates of potential greenhouse gas abatement policies<sup>5</sup>.

Native forests (and planted forests) are dynamic systems where change is to be expected. For established native forests, looking backwards at what has actually occurred and separating any observed changes into 'climate related' and 'non-climate related' is presently proving very difficult<sup>6</sup>. Looking forward and anticipating forest change in response to climate change and finding means to address climate change through forest management is an order of magnitude more difficult. As we shall see in this report, different models provide different 'answers'. This is probably the main reason few (if any) planners/agencies have implemented formal change in established forests specifically to respond to anticipated climate change. However, substantial research, consultation and framework developments have occurred in advance of adoption of findings. The major activities in native forests which are presented in terms of climate change are:

<sup>1</sup> The period is named after the alpine / tundra wildflower *Dryas octopetala*, which was found in ice cores in Greenland. The warming after this period is believed to have heralded the introduction of agriculture to Europe. The warming was c. 10° over a period of between 1 and 3-4 decades, depending on the 'science'.

<sup>2</sup> Believed to have occurred around 9620 BC.

<sup>3</sup> Post, E. (2003)

<sup>4</sup> Of course and not surprisingly, there is much debate about the suitability or otherwise of growing forests specifically to store carbon. While beyond the terms of reference for this project, a major counter-argument is that growing new forests on what was previously agricultural land simply displaces that agricultural production to somewhere else. In a globalised resulting greenhouse gas emissions simply to replace the 'lost' agricultural production. This is referred to as 'carbon-leakage' and is a major issue in the use of forests to mitigate word, food can be grown 'anywhere' and displacing agriculture in one location (i.e. in Australia) can result in lands being cleared elsewhere (i.e. in Brazil) with climate change.

<sup>5</sup> Sohngen, B. (2004) p1

<sup>6</sup> Many people spoken to for this report used the word "impossible" here.

- Fire management.
- Avoided deforestation.
- Utilisation of native forest residues for biofuel generation.
- Greater attention to forest health and pest/disease resistance.

Of course, it is significantly more complex than simply ‘established forests’ and ‘planted forests’ as there are complex relationships between management of both types of forests and modelling the interactions of these forests with agriculture, economics and population growth, for example.

The issue is one of forest dynamics:

- Are our forests changing in response to climate change?
- What changes have or may have occurred?

### 3.3 Observed phenology and range-changes

Evidence that climate change is affecting the world’s forests is accumulating.<sup>7</sup> The clearest of these are the detailed phenological<sup>8</sup> changes, such as the timing of budburst or the length of the period that deciduous trees retain their leaves. For example:

- Various reports have found that the growing season in Europe has lengthened by 11 to 20 days on average since 1960, and in many cases this can be clearly correlated with rising temperatures.<sup>9</sup>
- Similarly, extended growing seasons have been recorded in China, Japan, and the United States.<sup>10</sup>
- Ground-based studies are supported by satellite imagery, which shows an average lengthening of the growing season by 18 days in Eurasia and 12 days in North America.<sup>11</sup>
- In Australia, there is no direct evidence of phenological changes in Tasmanian forests that influences current management.<sup>12</sup>
- In Victoria, there is evidence of phenological change.<sup>13</sup> Climate change is expected to influence the ... timing of pollination and flowering.<sup>14</sup>
- In NSW, there is evidence of impacts of climate change on biodiversity, including effects on the physiology and distribution of species, and the timing of life-cycles - for example, flowering and fruiting times are changing.<sup>15</sup>

As many early researchers predicted, the range of many species is moving poleward, and to higher latitudes.<sup>16</sup>

- Treeline advancement northward has been recorded in Scandinavia, Siberia and Canada.
- Advancement to higher latitudes noted in the Urals, Scandinavia, the Carpathians, the European Alps and the Rocky Mountains.
- Vegetation thickening has also been evident in the Rocky Mountains, the Hudson Bay area and the Pyrenees.

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<sup>7</sup> Parmesan (2006) and Roberts (2008)

<sup>8</sup> Phenology is the study of the times of recurring natural phenomena.

<sup>9</sup> Menzel et al (2006)

<sup>10</sup> Reviewed by Linderholm (2006)

<sup>11</sup> Zhou et al (2001)

<sup>12</sup> Personal communications Hans Drielsma, Executive General Manager, Forestry Tasmania

<sup>13</sup> Personal communications Rod Anderson, Victorian Department of Sustainability and Environment (DSE)

<sup>14</sup> DSE (2008). Land and biodiversity at a time of climate change.

<sup>15</sup> NSW Inter-agency Biodiversity and Climate Change Impacts and Adaptation Working Group (2007). P21

<sup>16</sup> Reviewed by Eastaugh (2008)

Broad-scale ecosystem changes are becoming apparent in many regions, although it is sometimes difficult to attribute this solely to climate change.

- Some previously pine areas in Sweden are being colonised by birch (*Betula spp.*).<sup>17</sup>
- Siberian forests have been found to be retreating southwards (converting to grasslands) at a rate of 0.3 million hectares per year, as a result of increased human-induced fire frequency.<sup>18</sup>
- Afforestation in some European alpine areas may be attributable partly to recovery from middle-ages land clearing and subsequent heavy grazing until the early to mid 20th century.
- There have been no reports (from the people contacted for this report) of forest distribution changes in Australia.

### 3.4 Observed vegetation growth rates

In many parts of the world, increased vegetation growth rates have been recorded, which are largely attributable to warmer temperatures.<sup>19</sup> There are however several examples of reduced growth over recent years.

- Extreme summer aridity in 2003 has been responsible for tree crown damage and lowered growth in Germany.<sup>20</sup>
- Hotter dryer weather has been responsible for reduced growth in tropical forests.<sup>21</sup>
- Drought has had a significant impact on Australia's planted forests<sup>22</sup> (see later section).
- In Victoria, there have been some observed impacts in the Central Highlands forests on forest productivity. In modelling work, this has been extended to looking at 22 species for next 50 years.<sup>23</sup>

The relationship between climate change and these events cannot be determined with any precision.

### 3.5 Observed fires

An increase in fire frequency and intensity has been found in many regions.

- Seven of the nine years between 1998 and 2006 have been described as 'extreme' fire years in boreal Russia, and the area burned in the 1990s was reported to be 19 per cent greater than the 50 year average.<sup>24</sup>
- A study of the fire history of southeast Australia over the past 2800 years<sup>25</sup> described the fires of the last 35 years as 'unprecedented'.
- In Victoria, the drought/fire/flood cycle will likely be amplified.<sup>26</sup> Following two severe fire seasons (summers of 2007 and 2008), there have been some reports linking these fires to

<sup>17</sup> Berglund et al., (1996)

<sup>18</sup> Shvidenko and Goldammer (2001)

<sup>19</sup> Nemani et al (2003)

<sup>20</sup> BMELV (2006)

<sup>21</sup> Feeley et al (2007)

<sup>22</sup> Growth of some of southern Australia's blue gum forests has reportedly stagnated. In addition, conversion factors for green metric tonnes (gmt) to cubic metres is being lowered i.e. from 1.05 gmt/m<sup>3</sup> has been reduced to 1.00 gmt/m<sup>3</sup> – MBAC project work.

<sup>23</sup> Personal communications, Rod Anderson (DSE) and Nitschke, C. et al (2007). Results indicate that species are resilient, in terms of regeneration capacity, to predicted changes in climate over the short term (2010-2039) but that vulnerability increases significantly for climate projections from 2040 onwards. Model output suggested that a trigger point may be reached in the 2055 (2040-2069) period that will result in a loss of ecological resilience as species-specific thresholds are exceeded. By the period 2070-2100, 18 of 22 species were classified as extremely vulnerable. By this time, all species had the ability to regenerate above 1500 m in elevation but none could regenerate naturally following disturbance or harvesting below 400 m.

<sup>24</sup> Soja et al 2007

<sup>25</sup> Mooney and Maltby (2006)

<sup>26</sup> DSE (2008). Land and biodiversity at a time of climate change.

‘climate change’ (documents promised by DSE yet to receive). The impact on sustainable yield could be significant with some reports reducing this by up to 36per cent due to fire losses.<sup>27</sup>

- In California, the incidence of severe wildfire has been extensively reported.

### 3.6 Ecosystem health - observed pest incidence

Several forest pests have increased their range, and some infestations have been severe to catastrophic for some forest areas:

- The spruce beetle *Dendroctonus rufipennis* - normally has one life cycle every two years, but warmer conditions in the late 1990s allowed for annual cycles. Subsequent outbreaks caused 90per cent tree mortality on the Kenai Peninsula of Alaska.
- In Europe, the bark beetle *Ips typographus* has also been shown to have faster reproduction in a warming climate<sup>28</sup>, and has been responsible for massive losses of spruce in central Europe.
- Mountain pine beetle *Dendroctonus ponderosae* has caused huge damage to forests in north-western United States and south-western Canada. In British Columbia, Canada, substantial areas of mature pine are expected to be lost as a result of Mountain pine beetle (Figure 1). The impact on emissions is substantial.<sup>29</sup>



**Figure 1: Mature pine in British Columbia affected by Mountain pine beetle**

Photo acknowledgement<sup>30</sup>

In Australia for biological systems, climate change will affect:

- Physiology (individual organisms)
- Timing of life cycles (phenology)
- Shifts and changes in distribution (dispersal and shifts in geographic range)
- Potential for adaptation (rapid evolutionary change)

<sup>27</sup> From the present 597 000 m<sup>3</sup> sawlogs per year to around 380 000 m<sup>3</sup> per year.

<sup>28</sup> Okland et al 2007

<sup>29</sup> Kurtz, W. et al (2008). During outbreaks, the resulting widespread tree mortality reduces forest carbon uptake and increases future emissions from the decay of killed trees. The impacts of insects on forest carbon dynamics, however, are generally ignored in large-scale modelling analyses. The current outbreak in British Columbia, Canada, the researchers estimated that the cumulative impact of the beetle outbreak in the affected region during 2000–2020 will be 270 megatonnes (Mt) carbon (or 36 g carbon m<sup>-2</sup> yr<sup>-1</sup> on average over 374,000 km<sup>2</sup> of forest). This impact converted the forest from a small net carbon sink to a large net carbon source both during and immediately after the outbreak.

<sup>30</sup> Webbe, J. (2007).

In Victoria,

- There is a relationship between ecosystem health and resilience to change. The Victorian Government and its partner agencies in public land management have a formal role in maintaining the ecological integrity of land so that it continues to provide public-good services; providing equitable opportunities for appropriate use of public land, preventing negative offsite impacts and safeguarding assets of significance.
- Climate change will undoubtedly increase uncertainty and risk. It may allow some pest species to increase their population and extent, new or dormant pest plants and animals may emerge and it may reduce the distribution of some other pests.

The effects on individual organisms and populations cascade into changes in interactions among species. Changes in interactions further heighten extinction rates and shifts in geographic range. The ultimate outcomes are expected to be declines in biodiversity favouring weed and pest species (a few native, most introduced) at the expense of the rich variety that has occurred naturally across Australia.<sup>31</sup>

### 3.7 Combined impacts

In New South Wales, climate change is predicted to:

- Increase average temperatures in NSW by 0.7° to 6.4°C by 2070, with the greatest increase in the west of the state.
- Rainfall is likely to decrease everywhere other than the north-east.
- Projections suggest a reduction in frosts (though their severity may be increased) and an increased incidence of hot days, bushfire and intense storms.
- Drought frequency may increase, especially in winter and spring.
- Reduced rainfall will lead to an even greater reduction in runoff, increasing pressure on water resources.
- Plant growth may be enhanced by the 'CO<sub>2</sub> fertilisation effect' and increased water use efficiency (a direct effect on plant physiology of elevated atmospheric CO<sub>2</sub> concentration).
- Offsetting this, productivity increases will be limited by water and nutrient availability.
- The growth rate of forests may be increased, but the high risk of bushfire and possible increases in the impacts of pests and disease will threaten forest carbon stocks.

These then are some of the observations. Are they a result of climate change? Scientists invariably turn to modelling the environment in their desire to understand the observations, predict impacts and advise governments on suitable policies to best address the situations. This is then followed by public consultation, framework development and other programs long before changes in policy and then management plans occur.

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<sup>31</sup> Garnaut (2008) p182

## 4 Modelling to predicted change

Modelling is fundamental to any mitigation or adaptation strategy. However, models are at best approximations of natural systems and the imprecision of their outputs needs to be understood before decisions are made on their basis. There are two main types of models used in climate change and forestry. There are global/national models and there are regional models.

### 4.1 Global/national modelling

Forests around the world are widely expected to face significant pressures from climate change over the coming century. Increasing emissions are expected to have a severe and costly impact on agriculture, infrastructure, biodiversity and ecosystems in Australia.<sup>32</sup> Although the magnitude of the projected temperature rises and precipitation changes are still uncertain, modelling based on mean figures shows that ecological, economic and social disruptions are likely:

- Ecological effects range from phenological changes and extensions of growing seasons to widespread forest structural changes, species migrations and extinctions.
- Economic effects could be associated with an overall increase in global timber production (see Section 4.4), an increase in consumer surplus (lower prices) and an increase in producer surplus (increased profits). (The immediate question is how have the feedback mechanisms such as increase in pest populations been accommodated in such models?)
- Economic benefits may accrue to tropical regions where rainfall is more predictable at the expense of economic losses where rainfall is less predictable.
- Social effects will flow from ecological and economic effects and result from job losses and reduced community viability, for example. Already in parts of Australia (i.e. Gippsland), we have timber marginal-communities (i.e. reduced size), due to reduced wood availability from natural forests (due to closures for environmental/sustainability reasons).

The Intergovernmental Panel on Climate Change (IPCC) has produced scenario modelling using Global Circulation Models (GCM) which describe a rise in average global temperatures of between 2.0 – 4.5 degrees as ‘likely’, and a rise of less than 1.5 degrees as ‘very unlikely’<sup>33</sup>. They also concluded from their models that:

- Temperature rises are not expected to be consistent, but will vary across the globe.
- Most of the warming is expected in the northern Polar region whereas the higher latitudes of the Southern Ocean and the North Atlantic are expected to experience minimum warming.
- Heat waves may be more common and more intense, most notably in central Europe, western USA and East Asia.

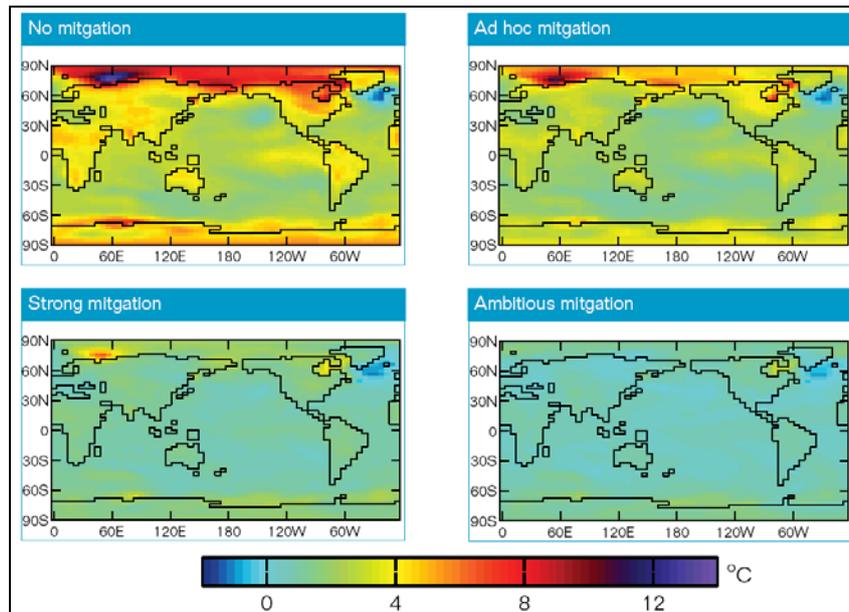
The predicted temperature changes with various mitigation targets are in Figure 2.<sup>34</sup> This figure introduces the Garnaut mitigation targets, immediately introducing scale and timing to the term (see Sections 5 (Europe), 6 (North America) and 7 (Australia) :

- No-mitigation
- Ad-hoc mitigation
- Strong mitigation
- Ambitious mitigation

<sup>32</sup> Garnaut (2008) p182

<sup>33</sup> IPCC (2007)

<sup>34</sup> Garnaut (2008) p 126. Temperature outcomes from the CSIRO Mk3L model (in Phipps 2006 not cited in this report)



**Figure 2: Predicted temperature changes under four mitigation-target scenarios**

- Precipitation is considered far more difficult to predict, but increases in the higher latitudes and the equatorial belt and decreases in the sub-tropical regions are generally considered most possible.
- Extreme rainfall events are likely to be more frequent, particularly in northern Europe and Australia. Drier summers are likely in mid-latitude areas such as the Mediterranean and Central America.
- Tropical cyclones may be less frequent, but those that do occur will be more intense.
- Storms with intense winds are likely to be larger and more common in central Europe and the North Atlantic.

The key observation is that impacts are not expected to be global. Rather, there will be regional differences. For example, warmer climates are overall expected to have a positive influence on the wood products industries, although some regions are predicted to benefit more than others and some regions may be disadvantaged.

Global Circulation Models suffer from being very complex but are still of coarse geographical resolution. These models are less precise when used for regional assessments, because most of our regional expectations are derived from modelling incorporating ecological, economic and social impacts.

## 4.2 Regional modelling

Regional climates in Global Circulation Models are often quite poorly resolved, particularly for precipitation. An increasingly common approach is to ‘nest’ regional climate models within global models.<sup>35</sup>

Regional climates in Australia and South America are strongly influenced by the El Nino – Southern Oscillation phenomena (ENSO). El Nino is not well understood, and there is no consistent evidence for how El Nino may change under a warmer global climate.<sup>36</sup>

<sup>35</sup> Schwierz et al. (2006)

<sup>36</sup> Meehl et al (2007)

The Australian modelling situation is:

- In Tasmania, Forestry Tasmania is involved in two externally funded<sup>37</sup> projects run by CSIRO. These involve modelling impacts of potential climate driven change scenarios on plantation productivity. The plantation productivity project has provided initial predictions for Tasmania and elsewhere in south-eastern and south-western Australia. Some eucalypt sites in south-western Western Australia are covered although there is no formal participation of any Western Australian agency. A biotic risk to plantations study has been funded by the Australian Greenhouse Office, now part of the Department of Climate Change.<sup>38</sup>
- In Victoria, DSE has identified that monitoring, research, development and science needs to provide information to underpin management and policies associated with unexpected change. In a Central Highlands Study<sup>39</sup> (referred to as ‘the climate vulnerability study’), the researchers used a mechanistic model<sup>40</sup> of forest regeneration and concluded that many forest tree species that currently dominate Victoria’s Central Highland region are vulnerable in their regeneration niche to future climate change due to their specific regeneration requirements, relatively narrow environmental distribution and the topographic characteristics of this region. DSE have provided additional funding to expand on the climate vulnerability study. See also footnote.
- Also in Victoria, climate change is seen as a long-term threatening process that scientific modelling indicates will magnify land and biodiversity decline. Climate change will also add to the inherent complexity of ecosystem functioning and make it more difficult to predict or fully understand how intervening in one part of a system may affect another.<sup>41</sup>
- Both Victoria (VicForests) and Tasmania (Forestry Tasmania) have undertaken carbon modelling of their native forest resource and native and plantation forest resource respectively, including above ground, below ground, soil and wood products in service modelling as a first step in obtaining broad estimates of the carbon environment (i.e. baseline).<sup>42</sup> This is addressed in the section on mitigation (i.e. better accounting for carbon in Section 7).
- In New South Wales, climate change modelling<sup>43</sup> has focused on:
  - Development of regional climate change models through downscaling of global climate projections.
  - Development of a Geographical Information System based framework for assessing the risk of climate change for primary production systems.
  - Vulnerability assessment of key systems to test the capacity for the coping range to be extended by proposed adaptation strategies.
  - Assessment of the socioeconomic impacts of climate change.
  - Development of decision support systems to assist primary industries in coping with enhanced climate variability.
- In Western Australia, The Indian Ocean Climate Initiative (IOCI) is a contributing partnership of WA State Agencies, CSIRO, the Bureau of Meteorology Research Centre (BMRC) and the WA Region of the Bureau of Meteorology to support informed decision making on climate variability and change in Western Australia. This broad based research confirmed that the risk of failed south-west winters (i.e. rainfall) was increased by climate change of the last quarter century.<sup>44</sup>

<sup>37</sup> These projects have been funded by Forest and Wood Products Australia.

<sup>38</sup> Personal communications Hans Drielsma, Executive General Manager, Forestry Tasmania

<sup>39</sup> Nitschke, C. et al (2007)

<sup>40</sup> A mechanistic model has a structure that explicitly represents an understanding of physical, chemical and/or biological processes (as opposed to an empirical model which is based on data). Mechanistic models are useful for inferring solutions outside of the domain that the initial data was collected and used to parameterize the mechanisms. From [http://www.epa.gov/ord/crem/library/CREMpercent20Modelingpercent20Glossarypercent2012\\_03.pdf](http://www.epa.gov/ord/crem/library/CREMpercent20Modelingpercent20Glossarypercent2012_03.pdf)

<sup>41</sup> DSE (2008). Land and biodiversity at a time of climate change.

<sup>42</sup> MBAC (2007a) and MBAC (2007b)

<sup>43</sup> Fairweather, H. and Cowie, A. (2007) pvii

<sup>44</sup> Ryan, B. and Hope, P. (2006).

## 4.3 Predicted ecological impacts

### 4.3.1 Biome modelling

Modelling and expert opinion in the early 1990s suggested that forests would grow faster, species would move upward and poleward, droughts and fires would be more common and novel insect and pathogen damage could be expected. Species distribution modelling commonly shows:

- Decreases in the areas of tundra, tundra/taiga and arid lands.
- Increases in grassland, tropical broadleaf forest and temperate mixed forests.

Models have improved significantly over the past two decades, and now incorporate elements of several model types (called hybrid models). Nevertheless, they still depend on uncertain climate data and disturbance inputs, and so model results should be considered to be scenarios or estimates at best.

### 4.3.2 Growth effects

Carbon dioxide effects on plants have been studied, and there is general agreement that higher levels of CO<sub>2</sub> will increase plant growth, and help water use efficiency. The magnitude of this effect is not known, and there is some suspicion that the effect may not be permanent. The effects may also be impacted by other factors, such as increased pest and disease activity.

### 4.3.3 Disturbance and succession regimes

A plant's range distribution is not generally determined by average temperatures, but by extremes, and by particular disturbance or succession regimes (fire, pest attacks, competition from other species etc.). Modelling of extreme events or disturbances is problematic, and at present the usual approach is to apply a degree of randomness to the models<sup>45</sup>, or to estimate probabilities.<sup>46</sup>

- A rapidly changing climate will suit species that can spread quickly and are suited to a wide range of climatic conditions.<sup>47</sup>
- Many invasive species have these traits, and an increase in weed problems is likely in many regions.

To the best of our knowledge, there have been no formal policy changes in other areas, such as Declared Rare flora & fauna, endemic & relictual (remnant) species, reserve location and design, maintenance of soil properties, water quality and quantity specifically driven by climate driven change concerns. Some minor management changes, although these have not been published to our knowledge. In our literature review for this project we were unable to locate any specific discussions of real proposals to address possible threats to these values. If policies regarding these concerns were developed, they would be the world best practice in this field. There were also lack of evidence that Europe has adopted a 'Montreal process' procedures in terms of climate change and forests, although they are being investigated.

## 4.4 Predicted economic impacts

Given the uncertainties in regional climate predictions, meaningful economic modelling is difficult. It is likely that new materials, new production systems and other factors will have at least as much effect as changed climate regimes<sup>48</sup>. Forest managers however are accustomed to thinking in timeframes beyond their own lifetimes, and the goal of producing cost-effective raw materials from forests is unchanged.

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<sup>45</sup> Seidl (2007)

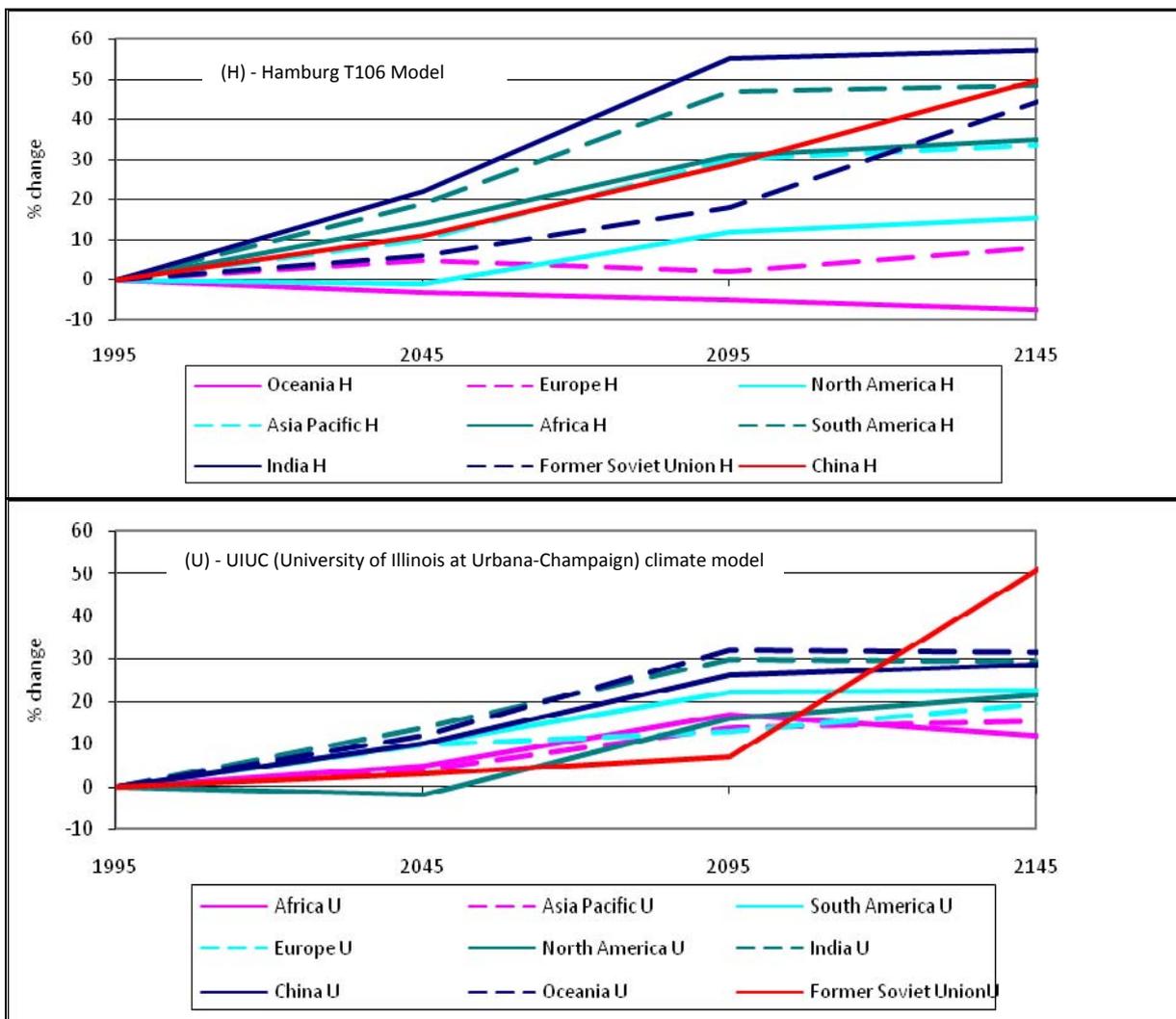
<sup>46</sup> Gonzales and Pukkala (2007)

<sup>47</sup> Dukes (2003)

<sup>48</sup> Miko Kirschbaum, pers. comm. 25 Nov. 2007

Regional economic studies of varied sophistication have been completed for many parts of the world, including for Australia.<sup>49</sup> Global industry studies are less common. Those that exist generally show an overall increase in global timber production<sup>50</sup> (Figure 3) and an increase in both consumer surplus (lower prices) and producer surplus (increased profits) in most parts of the world (Figure 4). Of note is the projection of a consistent decline in production from Oceania forests using the Hamburg T106 model<sup>51</sup> and associated assumptions. Using the University of Illinois at Urbana-Champaign climate model, the results are quite different.

The observation here is that the choice of model and assumptions has a very large impact on the outcomes. They both can't be 'right'. Equally, they can be both 'wrong'.

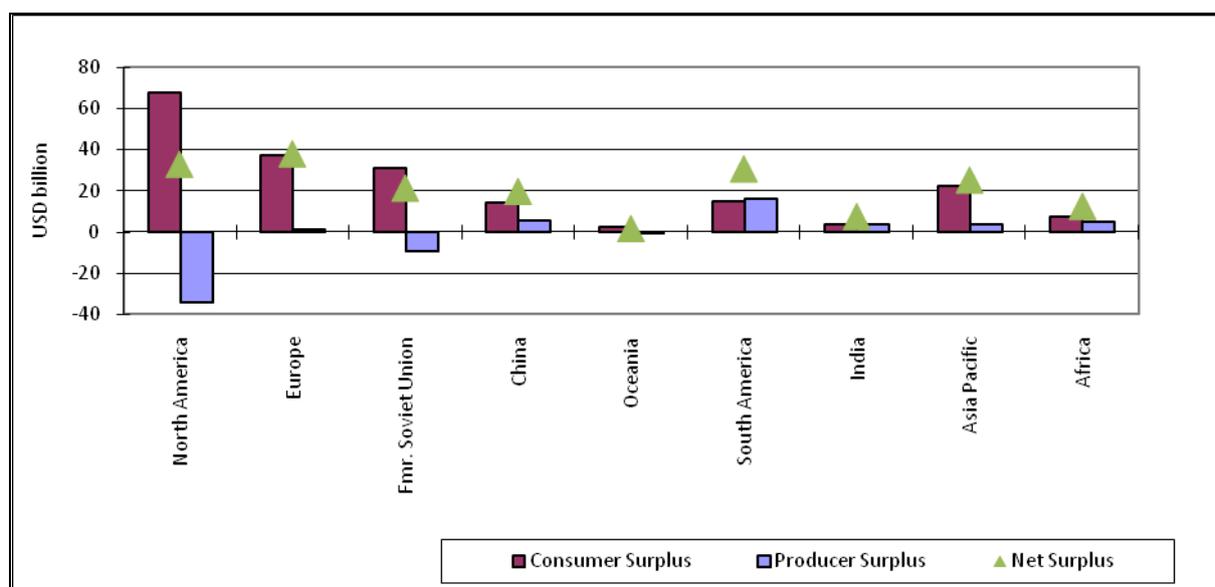


**Figure 3: Regional timber production trends to 2145 using two climate models**

<sup>49</sup> Kirschbaum (2004)

<sup>50</sup> Eastaugh 2008, based on data from Sohngen et al 2001

<sup>51</sup> This is because the BIOME3 model using the Hamburg scenario a) assumes large losses in so-called 'high latitude' forests (due to dieback and related effects), b) no migration of forests to agricultural lands, and c) higher interest rates reduce plantation development.



**Figure 4: Welfare effects of increased forest productivity**

A rise in comparative profitability of the sub tropics (over higher-latitude producers) is perhaps already occurring, as production shifts to lower-cost regions. Climate change economic modelling seems to accelerate this trend. Markets can be expected to adapt to changing conditions, and thus ameliorate some of the effects of climate change on the forest industries.

## 4.5 Predicted social impacts

The increase in welfare for forest producers is not expected to be globally consistent, and some areas will suffer. These societies may be expected to come under pressure from job losses and reduced community viability. Forestry communities will be particularly vulnerable to the effects of climate change both from the direct effects on their resource base and because of their social context.

Secondary effects such as a reduction in land price or uncertain land tenure may add to the pressure on communities.

How well communities adapt to these challenges will depend on their adaptive capacity. Factors which make communities more resilient include:

- Wealth
- Mobility
- Education
- Social networks
- Trust
- Solid institutions
- Risk perceptions
- Natural resource endowments

These factors are closely connected to the social indicators studied by many researchers in the context of exploring community sustainability.<sup>52</sup>

<sup>52</sup> Parkins and White (2007) (for example)

## 4.6 Concluding comments

We can see that the impacts of climate change on forests are likely to be ecological, economic and social. These impacts may be observed or they may be predicted. This section raises many questions of relevance to this project:

- How have governments tackled the question of climate change and forests?
- What mitigation and adaptation responses have been adopted?
- How have these been translated into policy and frameworks (for action)?
- How successful have they been (i.e. strengths and weaknesses)?
- What could be identified as best practice?

These will be tracked in the following sections, where we first look at the European experience. We then review this for North America and conclude by reporting on the Australian scene.

## 5 European mitigation and adaption responses

As we can see from the preceding section, the impacts of climate change on forests are likely to be ecological, environmental and social. How has this been looked at internationally and what mitigation and adaptation strategies have been employed?

Internationally, we are seeing more formal moves to maintain flexibility in forest environments, to best cope with unpredictable challenges such as climate change. In some countries we are seeing policies flowing through to management plans focusing on (for example) mixed species and mixed age forests<sup>53</sup>, primarily to spread the risk of unknown climate change effects. Conversely, in some regions subsidised support for bioenergy is increasing the commercial pressure on forest environments. Some country specific examples are:

- Increased use of pelletised wood waste for fuel in Germany. Although pellet producers (typically large sawmills) use dome waste for their own energy needs, the demand for this product has outstripped supply so that mills continue to purchase their energy from the national grid.
- Prices for fuelwood in Scandinavia have risen to become competitive with pulpwood prices, adding to the difficulties faced by Finnish pulp producers in sourcing raw material.
- The Finnish government provides subsidies designed to make wood-fired boilers (for heating and electricity generation) competitive with oil. This has led to an increase in ‘whole tree utilization’, where stumps are dug from the ground and small branches are baled for fuel.

European forests differ from those in North America, for example, as there is very little original forest remaining. With the exception of northern Scandinavia and the Belovezhskaya forest<sup>54</sup> in Belarus and Poland, virtually all of Europe’s forests are grown on previously cleared land. Public attitudes to forestry are generally positive, and people recognise that forests are largely the result of human intervention, past and present. This gives forest managers a greater degree of freedom of intervention than may be the case in places where a ‘wilderness’ paradigm is still in the public mind i.e. Australia. Europeans are on the whole aware of climate change issues, and recognise the need for adaptation.



<sup>53</sup> The distinction between mixed species and mixed age forests is not always clear. Most European agencies seem to prefer natural regeneration, but they are willing to introduce new species or selectively thin to promote desired species. Even where the focus of a particular forest is firmly on production, biodiversity and recreational goals are still taken into account. Most people spoken to consider these to be ‘native’ forests. However, it depends on your definitions.

<sup>54</sup> This ancient woodland straddles the border between Belarus and Poland and is the only remaining part of the immense forest which once spread across the European Plain (Wikipedia).

## Figure 5: Part of the Belovezhskaya Forest

In most European countries, forest agencies and managers are given a high degree of latitude in how they manage their responsibilities. National laws are often couched rather vaguely, and managers are left to best decide appropriate courses of action. For example:

- The Austrian Forest Law states that actions leading to increased pest numbers are prohibited, but no specific actions are listed.<sup>55</sup>
- French national policy supports an increase in mixed age/mixed species forests, but the precise mix and mechanisms for this are left for district foresters to decide.

For historic reasons, most of Europe has a high proportion of private forest owners, with holdings of between one and 200 hectares. Legislation generally dictates that forestland must be retained as forest or regenerated after harvesting. However, by Australian standards, regulatory restrictions on forest owners are slight.

### 5.1 Expected challenges

Climates in Europe are expected to become warmer, and precipitation patterns are expected to change to generally drier summers, particularly in Mediterranean and Atlantic areas. Although forest productivity is expected to rise, increased and novel disturbances are expected to impact biodiversity and some commercial timber species. For example:

- The intensity and frequency of fires in Mediterranean regions will increase, and perhaps fires will be introduced into regions where they have previously been rare or unknown. This has been picked up in national reports from Spain, Greece, Italy, Switzerland and Norway.
- Insect and pathogen problems are already seriously affecting some species, in particular bark beetle (*Ips typegraphus*) in spruce (*Picea abies*).

### 5.2 Options and examples

Various strategies and policies have been proposed in Europe to manage the challenges of climate change. To neatly apply 'mitigation' or 'adaptation' labels is both difficult and misleading. However, we have placed these under headings which most apply to the response, even though some are mitigation (i.e. reduce emissions or sequester carbon) and adaptation (coping with change) responses. These include:

#### 5.2.1 Primarily adaptation responses

- France, Germany, Spain, Belgium, Belarus, Bulgaria, Austria, Slovenia, Czech Republic, Finland, Poland - Changing the species compositions of forests, in particular the promotion of diverse, mixed age and mixed species forests or a change from coniferous to deciduous species.
- Netherlands, Spain, Belgium, Poland, Sweden, Switzerland - Extending natural reserves, particularly in altitude or in linkages (nature corridors).
- Finland, Germany, Switzerland, Bulgaria, - Stronger focuses on forest health, including more intensive pest monitoring, forest stand thinning, altered rotation lengths, fertilising and other silvicultural treatments.
- Sweden, France, Bulgaria, Ukraine - Genetic adaptation.
- Greece, Spain, France, Italy - Improve fire detection and suppression.
- France, Finland, Czech Republic, Austria - Stricter quarantine and sanitary management.
- Finland, Sweden - Development of new harvesting techniques.

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<sup>55</sup> Kellomaki and Leinonen (2005)

## 5.2.2 Primarily mitigation response

- Latvia, Italy, Belarus, Slovenia, Lithuania, Denmark, Ireland, United Kingdom – Promotion of reforestation of agricultural land.
- France, Sweden – Promotion of wood products as building materials.
- Finland – Promotion of forest biomass as fuel.
- Some country specific examples follow.

## 5.3 Country specific examples

### 5.3.1 Finland

Finland is particularly well advanced in the development of adaptation policy. The *Finnish 4th National Communication to the United Nations Framework Convention on Climate Change (UNFCCC)* lists the following policy prescriptions:<sup>56</sup>

- Inclusion of climate change aspects in their National Forest Program
- Revision of forest management recommendations to correspond to climate change
- Protection of gene pools of forest trees
- Development of forest management adapting to and mitigating climate change
- Development of a system for anticipating and monitoring change
- Development of new harvesting technologies
- Control of pests and diseases
- Maintenance of forest roads
- Rapid repair of wind damage in order to prevent consequential damage
- Selection of origin of artificial regeneration material
- Assessment of the needs for change in forest legislation in changing climatic conditions
- Potential bans on wood imports from areas most badly contaminated by pests
- Preparation of forest plans on the basis of new management recommendations

## 5.4 Species composition

The most important effect of climate change noticed in Europe to date is the increased incidence of spruce bark beetle. Many spruce forests were also severely affected by the December 1999 storms.

- One response to this is to replace spruce with North American Douglas fir (*Pseudotsuga menziesii*) - this is an increasingly attractive option for private forest owners in France and Germany.
- Public opinion about the use of introduced species is divided, but some State agencies are selectively introducing and encouraging Douglas fir in mixed species forests.
- Many forest agencies (notably the French Office National des Forêts and Saarforst and Landesforsten in the German Saarland and Rheinland-Pfalz regions) in Europe concentrate on the growth of high value broadleaf species. Oak (*Quercus spp.*) is most common, but walnut (*Juglans spp.*) and wild cherry (*Prunus avium*) are gaining in popularity. Oaks are widely expected to be robust in the face of climate change, but in some regions *Q. robur* is being scaled back in favour of *Q. petraeus* to better suit warmer climates.

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<sup>56</sup> Roberts (2008)

- Shorter rotations of species such as beech (*Fagus sylvatica*) are undertaken in some areas (i.e. Rhineland Pfalz in Germany, Mont Aigoual in France) partly to speed up the autonomous adaptation of the forest stand to new climate conditions.
- Broadleaf species are widely considered to be more resilient to changing climates than conifers, and the introduction of small broadleaf plots into conifer stands is being trialed in eastern Spain.
- Warmer climates are expected to suit the expansion of cork oak (*Q. subor*) for cork production in parts of Portugal and Spain.
- Following wildfires in 1998 some areas of privately owned conifer forest in Catalonia (Spain) have been planted with holm oak (*Q. ilex*) for truffle production. While the decision to change the land-use would have been made on economic grounds, the opportunity was made possible by a large fire which swept through the conifers. If climate change gives rise to more stand-replacing fires, then we could expect more opportunities for changing forest structures to provide greater economic (or other) benefits – highest and best use? In this particular case, new climate conditions are expected to better suit truffle production in this area.
- The *French 4th National Communication to the UNFCCC* specifically mentions a goal of promoting mixed age, mixed species forests, to increase the flexibility and resilience of forests to changing climates. In practice, this is being carried out in many parts of western and central Europe, using a range of silvicultural techniques. This is generally presented under the heading of ‘close to nature’ forestry.

## 5.5 Natural reserve management

Park management in Europe commonly emphasizes human and non-human landscape dimensions. It is common for parks to include privately owned lands, with owners subsidized heavily for following park management guidelines.

- Parks (and other state lands) in Spain and France are often divided into four zones, for areas concentrating on production, recreation, conservation and biodiversity goals. Our understanding here was that ‘conservation’ is focussed on the preservation of a particular species, while ‘biodiversity’ is more generally aimed at providing a diversity of habitat. Some timber harvesting may be still carried out in these zones, but it is not the primary management goal.

Areas with significant altitudinal differences are recognised for their importance in biodiversity conservation, as species are expected to be forced uphill by climate change.

- Monseny Natural Park (Monseny) in Catalonian Spain is a 30 000 hectare park, containing agricultural landscapes and nature habitats from Mediterranean lowlands up to sub-alpine areas at over 1700 metres.
- Monseny contains Europe’s most southerly stands of silver fir (*Abies alba*), which are currently being invaded by beech due largely to warmer climates. Holm oak is gradually replacing beech at lower altitudes.
- Sorteny Natural Park in Andorra also has significant altitudinal differences, and concerns exist for the wellbeing of high-altitude species. A garden of these species has been constructed at a mid-altitude level, and will serve as a monitoring and research plot to see how particular species may respond to warmer climates.

Management of particular species in particular places will be problematic, as climate changes and habitats become less suitable.

- The Foret des Oriental in eastern France has a program to encourage small ponds for frogs and salamanders, and ash/alder trees in damp areas. This is in direct opposition to what would naturally occur under a warming climate. This is recognised, and the program is described as an ‘experiment’.

The importance of nature corridors or linkages is widely recognised.

- The Dutch Ministry of Agriculture, Nature and Food Quality aims to purchase land (including what would have been industrial developments) to link several natural areas in the Netherlands, and extend this to link with parks in Germany and Belgium.
- Finnish authorities in Karelia are also interested in linking their park areas with less developed parts of Russia, to allow the influx of plants and animals.
- The creation of north-south nature corridors was a common theme in many European National Communications to the UNFCCC.<sup>57</sup>

## 5.6 Forest health

Forest health is important in determining a stand's resilience to adverse climate or pest attacks. Silvicultural practices such as thinning, fertilisation or irrigation have been presented as climate change adaptation measures, although it seems likely that these would occur regardless, driven by commercial goals.

- The storm Lothar in 1999 prompted the use of irregular stands rather than even-aged plantation, as being better protection against wind damage. Lower stand densities will give stronger trees, which may be more resistant to pests and diseases.
- Thinning earlier (pre-commercial thinning) may also limit the stress on trees due to water or nutrient deficiencies. Such silviculture has been practiced in Bluegum (*Eucalyptus globulus*) plantations in the Green Triangle region of southern Australia, where stockings in drought affected plantations were significantly reduced to allow the remaining trees to survive.<sup>58</sup>
- The use of fertilisers is encouraged in Finland, but generally avoided in Germany for environmental reasons. This highlights some of the fundamental differences in forest management philosophies. There is good agreement that healthy forests will be more resilient to climate change, but what exactly does 'healthy' mean? The Finns would argue that fertilisation is necessary to promote healthier trees; the Germans, on the other hand, would argue the opposite. Fertilisation could, in some cases, be a key management tactic to strengthen the disease resistance and general resilience of particular species. But this would seemingly oppose 'close to nature' forest management, and the publicity issues would need to be carefully managed.

## 5.7 Genetic adaptation

Genetic diversity (in both natural forests and in plantations) is also a means of increasing resilience to pest attacks or inclement climate. This can be encouraged by using natural regeneration rather than replanting after harvest. Where seed or seedlings must be used, seed sourced from a number of different sources (possibly weighted towards provenances from warmer or drier areas) will increase the genetic diversity.<sup>59</sup> Coppice regeneration is inadvisable.

- Work is being done in several places to develop more attractive commercial hardwood species.
- The Institut de Recerca i Tecnologia Agroalimentàries in Spain is developing hybrid walnuts for timber production in Mediterranean climates, and preserves various provenances from across Eurasia as a hedge against future needs.
- Selective breeding for tolerance to climatic variability is encouraged in several countries, and the forest research institute of Sweden (Skogforsk) has been developing climate driven adapted timber cultivars since the early 1990s.

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<sup>57</sup> Reviewed by Roberts (2008)

<sup>58</sup> Timbercorp advises in 2007, they non-commercially thinned large areas in Victoria and South Australia in direct response to the drought.

<sup>59</sup> It is common practice for Bluegum growers in Australia to use around 20 clones/provenances, adding new clones/provenances each year and removing a similar number of older ones, simply to maintain genetic diversity to improve environmental tolerance.

## 5.8 Fire suppression

Prescribed burning in Europe is rather small-scale by Australian standards.

- It is increasingly used in fire-prone areas of Spain as a means of providing fuel-reduced areas for more effective fire control. Catalonian Spain has an extremely intensive fire suppression response, with a high reliance on aerial attack. The policy is that all wildfires are to be immediately contained.
- In contrast, little effort is put into fire research, planning or policy in countries that presently see few serious fires (such as Switzerland or Germany), even though fire frequency is predicted to rise.

## 5.9 Quarantine and forest hygiene

Forest hygiene is important in reducing the severity of insect attacks and other pathogens.

- In Austria, windthrown spruce trees must be harvested or debarked to prevent the build-up of bark beetles, even in protected forest areas. The need for stricter quarantine measures to prevent the import of exotic pests and diseases has been mentioned in several reports.
- France, Finland and the Czech Republic have announced intentions to more tightly regulate the import of timber products, ostensibly for quarantine reasons.

## 5.10 Harvesting techniques

In boreal countries, shorter winters are expected to reduce the amount of time available for harvesting timber. Softer soils and roads will be a problem, as soils will not be frozen for as long as at present.

- New machinery and engineering solutions are being developed, particularly in Finland and Sweden.

## 5.11 Summary

It is not possible in this report to identify all climate change mitigation and adaptation response measures in all European countries and all forests – this is occupying many people in many places and would require a small book to cover adequately. As we have reported, hard evidence of climate driven forest policy changes that have made their way into management planning is almost non-existent. A summary of mitigation and adaptation responses are contained in Table 1, ignoring the status of their implementation or ‘non-implementation’.

**Table 1: Summary of European mitigation and adaptation measures**

<b>Response</b>	<b>Mitigation/Adaptation</b>	<b>Countries reporting measures</b>
Changing species compositions	Adaptation	France, Germany, Spain, Belgium, Belarus, Bulgaria, Austria, Slovenia, Czech Republic, Finland, Poland
Increased use of forest products for biofuel	Mitigation	Germany, Finland,
Increased focus on forest health	Adaptation	Austria, Finland, Germany, Switzerland, Bulgaria
Increased fire-preparedness	Adaptation	Spain, Greece, Italy, Norway, Switzerland, France
Extended natural reserves	Adaptation	Netherlands, Spain, Belgium, Poland, Sweden, Switzerland
Genetic adaptation	Adaptation	Sweden, France, Bulgaria, Ukraine
Quarantine and sanitation	Adaptation	Austria, France, Czech Republic, Finland
New harvesting techniques/machinery	Adaptation	Sweden, Finland
Promotion of wood products for building materials	Mitigation	Sweden, France
Reforestation of agricultural land	Mitigation	UK, Ireland, Italy, Latvia, Belarus, Slovenia, Lithuania, Denmark
Shortened rotation times	Adaptation	Germany, France

## 6 North American mitigation and adaptation responses

North American forests are arguably among the world's most already affected by climate change. Insect plagues have devastated vast areas of the US Pacific northwest, British Columbia and Alaska, while fires in California and more northern states continue to increase in scale and frequency. It is perhaps surprising then that many North American jurisdictions are rather poorly developed in promoting policies regarding the adaptations of their forests to climate change. The Pew Center on Global Climate Change released a review of US state adaptation planning (not specific to forestry), and found that only Alaska, Washington, Oregon, California, Florida and Maryland have formal climate adaptation plans.<sup>60</sup> In Canada however, several provinces have introduced programs for dealing with expected increases in major fire and insect disturbances.

Research on climate change in general is well supported in North America, and several excellent reports pertinent to forestry have been produced.<sup>61</sup> Nevertheless, it is rare to find examples of the recommendations from these reports being put into practice. A lack of public support for management intervention in forests and rigid legal and regulatory systems may be partly to blame.

Public attitudes to climate change in the United States are often quite sceptical or blasé, including within forest management agencies. Oregon state's recent forests and climate change synthesis report<sup>62</sup> includes a chapter written by their state climatologist which argues against the prevailing views of global warming.

### 6.1.1 Adaptation recommendations

Recommendations for adaptation planning and action generally mirror those described for Europe, with possibly added emphasis on fire management. Other ideas not previously discussed include adjustments to conservation management philosophies:

- Social concerns
- Scenario modelling

## 6.2 Adjustments to conservation management philosophies

British Columbia's Ministry of Forests and Range notes that 'hand's off' wilderness management philosophies may no longer be appropriate.<sup>63</sup> Appropriate habitats for protected species are expected to move northward and upward, and so unmanaged fixed-boundary protected areas may not be sufficient protection. Planting of alternate species in protected areas is a possibility, as is the growing of food for mistimed migratory species such as waterbirds. Habitat restoration programs will also need to be reviewed, as the current guidelines generally aim to restore historical (pre-European) ecosystems, which will no longer be possible. Assisted species dispersal, wildlife corridors and the increasing of redundancy and widening of buffer zones are often suggested. Forest agencies in Oregon recognise the need for intensive management in important areas, but describe it as "paddling upstream" against nature. "Maintaining prior species may require significant extra and repeated efforts to supply needed nutrients and water, remove competing understory, fertilize young plantations, develop a cover species, thin, and prune."<sup>64</sup>

The *US Climate Change Science Program*<sup>65</sup> suggests using the post-fire regeneration phase as an opportunity to re-set species succession more in tune with expected climate changes, and the establishment of 'neo-native' afforestation schemes in areas where species are not endemic, but are expected to become climatically suitable. Tree nurseries may need to be expanded to cope with large-

<sup>60</sup> PCGCC (2008)

<sup>61</sup> In particular Lemmen and Warren (2004); MFR (2006); CCSP (2008).

<sup>62</sup> OFRI (2006)

<sup>63</sup> MFR (2006)

<sup>64</sup> OFRI (2006), p. 52

<sup>65</sup> CCSP (2008)

scale afforestation or recovery programs. Potential species refugia areas need to be identified and guidelines for possible species translocation should be developed.

Waterway management is particularly important in the Pacific northwest, largely due to the prevalence of salmon in this area. Many reports stress the need to maintain or re-establish streamside vegetation, to prevent excessive water temperatures. Road system environmental flexibility is currently a big issue, and Washington State Department of Natural Resources is in the process of installing many fish-passage road culverts in line with their Aquatic Organism Passage policies. The Cascade region of Washington DNR already designs road culverts to handle 1 in 100 year storm events, to prevent culvert failure and the subsequent risk of sediment delivery to streams.

### **6.3 Social concerns**

The Alaskan Department of Environmental Conservation has described smoke from wildfires in 2004 as being hazardous to the health of residents of several towns, and has since taken steps to mitigate this. Increased fire support personnel have been hired, portable equipment is now available for routine air pollution (smoke) monitoring in the fire season and smoke pollution forecasting is available to the public.<sup>66</sup>

### **6.4 Scenario modelling**

It has been suggested that the mathematics of risk management may dictate that little ‘on the ground’ work should be done for a few decades, until the impacts of climate change warrant intervention.<sup>67</sup> The need to prepare for these impacts is however clear, and scenario modelling can assist in developing appropriate plans and guidelines. Comprehensive monitoring, assessments and sensitivity analyses are needed to identify threats and opportunities, and contingency plans made for a range of possible disturbance events.

### **6.5 Species composition**

Changing the species composition of forests in various parts of North America has been suggested in several reports. The use of mixed age, mixed species forests is also promoted as a means of combating potential insect and disease problems, and increasing biodiversity. The United States Forest Service suggests underplanting thinned stands with better adapted species or genotypes.<sup>68</sup>

In the southeast United States, climate change is expected to shift the focus of timber harvesting northward, as conditions in the south become drier. The use of drought hardy strains is promoted, as is the desirability of shorter rotation times to more quickly replace trees with better adapted species and genotypes.

### **6.6 Forest health**

Forest thinning is commonly promoted as a means of increasing forest vigour and resistance to pests and diseases. This however may be at odds with greenhouse gas mitigation goals, which aim to maximise in-forest carbon storage through reducing disturbance.

To reduce the risk from mountain pine beetle heavy thinning is recommended and harvesting when insects are present. In some cases the removal of at-risk stands or species may be warranted. Washington state is developing forest health legislation to reduce beetle spread.

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<sup>66</sup> Hartig (2008)

<sup>67</sup> Spittlehouse (2005)

<sup>68</sup> Anderson (2008)

## 6.7 Fire suppression

Thinning is also promoted as a means of reducing fire spread, and prescribed burning is also commonly suggested. Thinning is seen as preferable in some cases, to minimise greenhouse gas emissions.

## 6.8 Barriers to adaptation

Barriers to adaptation in United States forests were identified by the *US Climate Change Science Program* as:

- Public opposition
- Insufficient funding
- Limited staff capacity
- Large scope of current on-ground needs
- Disjointed ownership patterns
- Existing environmental legislation<sup>69</sup>

Similarly, in British Columbia a recent technical report noted that:

- Present policies often lack flexibility, as they are designed for consistent climates.
- There are currently no requirements for adaptation strategies in forest management plans, no guidelines nor experienced personnel available and a lack of funding for long-term planning.<sup>70</sup>

Many of these problems could be reduced though injecting more resources, but the issue of public opposition will be troublesome. The ‘wilderness movement’ in North America is strong, and there is considerable public resistance to management intervention in forests in many areas. This is exacerbated in some areas by changing community demographics, as landowners adjacent to forests find some management actions (such as prescribed burning) unacceptable. This is recognised by policy formulators, but little action seems to be being taken to inform public opinion.

Forest adaptation measures are in some cases seeming at odds with agencies’ goals of reducing greenhouse gas emissions. Conflict is presently brewing over the intensity of management of commercial forests in California, based on conflicting studies of carbon sequestration. Modelling in this field is inconclusive, as different models or model assumptions often produce vastly different results.

## 6.9 Summary

As we stressed in the European section, it is not possible in this report to identify all climate change mitigation and adaptation response measures in all North American forests. A summary of North American mitigation and adaptation responses are contained in Table 2, again ignoring the status of their implementation or ‘non-implementation’.

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<sup>69</sup> CCSP (2008)

<sup>70</sup> Spittlehouse (2008)

**Table 2: Summary of North American mitigation and adaptation measures**

<b>Response</b>	<b>Mitigation/Adaptation</b>	<b>Countries reporting measures</b>
Changing species compositions	Adaptation	Canada (BC), USA
Designing infrastructure for extreme events	Adaptation	USA (WA)
Smoke pollution monitoring	Adaptation (social)	USA (AK)
Shorter rotation times	Adaptation	USA (AL)
Heavy thinning for Mountain Pine beetle	Adaptation	Canada (BC), USA (WA)

## 7 Australian mitigation and adaption responses

Mitigation and adaptation as they relate to climate change are becoming common themes throughout the forestry environment in Australia (and elsewhere). The most tangible mitigation response is the planting of trees specifically to sequester carbon. Other responses are less tangible. The opportunity for adaptive management of forests is largely related to the growth rates of the forests – low in slow growing forests and greater in faster growing forests.<sup>71</sup>

As a nation, Australia has a strong capacity to plan for and respond to the impacts of climate change—that is, its adaptation potential is high. Australia has a well-developed and flexible economy with high per capita income, advanced scientific and technological knowledge, low population densities, strong emergency management capabilities, and abundant natural resources.<sup>72</sup>

The level of interest in forestry and climate change is increasing rapidly. For example, the 2009 Institute of Foresters of Australia conference theme is 'Forestry: A Climate of Change'. With climate change rapidly becoming one of mankind's greatest long-term challenges, forestry and forest products are uniquely positioned to play a lead role in providing a solution.<sup>73</sup> The conference will focus on the challenges and opportunities facing industry and will feature several sub-themes, all of which are climate change related:

- Impacts and adaptation challenges for forestry
- Mitigation opportunities for forestry and forest-based industries
- The changing role of forests
- Reshaping the forestry agenda
- Promoting innovation in forest management and processing

### 7.1 National response

#### 7.1.1 Mitigation - Australian Carbon Pollution Reduction Scheme

The largest developing mitigation program follows the Australian Federal Government's recognition of the importance of climate change by ratifying Kyoto in December 2007. More recently (June 2008), the Office for Climate Change announced plans for *The Australian Carbon Pollution Reduction Scheme*. Within this Scheme, there will be so-called Covered Sectors, such as transport and stationary energy, which will formally report their emissions and be responsible for emission reductions or offsets relative to a yet-to-be-set cap on emissions for each sector (or maybe all sectors). The cap and associated mechanisms have not been announced, but could be a 20 per cent reduction by 2020, based on 2000 emissions, or not exceeding 2000 emissions by 2020. Given our emissions in 2000 were around 500 million tonnes CO<sub>2</sub>-e and some projections for business as usual are 900 million tonnes CO<sub>2</sub>-e by 2020, then our emission reduction and/or offset targets will eventually be measured in hundreds of millions of tonnes<sup>74</sup>.

An important question arises: How can these large quantities be offset and what role can forestry play?

There will also be Uncovered Sectors, which do not have to report emissions (yet) but will be able to offer offsets, such as carbon sequestration using forests or carbon sequestration using the soil or some form of land use change (i.e. the agricultural sector), for example. While the rules have yet to be formulated, emissions reductions within a Covered Sector, by technical improvement or efficiency gains for example, will be viewed as reduced need for permits rather than as offsets for emissions.

<sup>71</sup> Eastaugh, C. (2008) p24

<sup>72</sup> Garnaut (2008)

<sup>73</sup> IFA Conference publicity material

<sup>74</sup> It is not the purpose of this report to define this, nor to be precise here – this is simply illustrative.

- Where the cost of emission reductions by whatever means is less than either the cost of permits, the penalty for emitting above the cap or the cost of offsets, the emitters will, in theory, be encouraged (economically) to reduce emissions within their own facility or ‘within-the-fence’ as it is referred to.
- Where the cost of emissions reductions is more expensive than offsets, then, again in theory, emitters will pay for offsets in uncovered sectors or, if allowed, purchase Certified Emission Reduction (CER) units from Kyoto’s Clean Development Mechanism (CDM)<sup>75</sup> or Emission Reduction Units (ERUs) from Kyoto’s Joint Implementation (JI)<sup>76</sup> programs.<sup>77</sup>

The reality is that there will be too few opportunities to offset large quantities of emissions in non-covered sectors as land availability will be limited for carbon sequestration plantations and windfarms. There are also limits on our ability to produce or purchase wind turbines.<sup>78</sup>

MBAC understands that large emitters are presently examining their options. An emitter, for example, may have to account for 10 million tonnes CO<sub>2</sub>-e each year. Assuming this was entirely offset by wind-renewable energy at 4 000 tonnes per turbine, this will require 2 500 turbines. If forests were chosen, assuming 30 tonnes CO<sub>2</sub>-e per hectare per year, this would require 333 000 hectares of new plantations. There will be many emitters or potential emitters (i.e. yet to be announced coal mines) that will have million tonne plus emission accounting problems. Clearly, forestry can only be a small part of the ‘solution’ and other measures will be required to reduce or offset our emissions (i.e. reduced demand, greater efficiency, geo-sequestration, nuclear power etc).

### 7.1.2 Mitigation - global initiative on forests and climate

Reductions in deforestation, encouraging reforestation, promotion of sustainable forest management.

## 7.2 Tasmania

David Bartlett, the then Tasmanian Premier<sup>79</sup> has stated that “changes might be forced on the state’s contentious forest industry by climate change and the introduction of carbon trading.”<sup>80</sup> Forestry Tasmania is proactive on the forest-carbon front, with public meetings, independent reports<sup>81</sup> and carbon brochures (“This little guy eats carbon for breakfast”). They are also adopting policy positions which will be reflected in management planning, although this has yet to occur.

### 7.2.1 Tasmania’s Climate Change Strategy 2007

Not surprisingly Tasmania is tending towards more knowledge and research which we can see developing in FT’s SFM Plan.

### 7.2.2 Forestry Tasmania’s Sustainable Forest Management 2007 report

One of Forestry Tasmania’s mitigation responses is to better account for carbon from existing plantations, productive native forests and conserved native forests. Forestry Tasmania is also initiating research programs to get a better understanding of some of forest carbon dynamics, such as impact on

<sup>75</sup> Annex I countries investing in or purchasing CERs from so called Annex II or developing countries that have ratified Kyoto.

<sup>76</sup> From Annex I countries investing in or purchasing ERUs from other Annex I countries.

<sup>77</sup> There is no certainty purchasing CERs or ERUs will be allowed. There may be some limit to the proportion of these that can be purchased relative to offsets or emission reductions achieved from within Australia. Ironically, the whole purpose of Kyoto is a) to recognise that country borders are irrelevant in dealing with emissions and b) the market mechanisms should allow reductions or offsets to occur in lowest cost situations (i.e. invariably in Annex II countries where dollar for dollar greater reductions can be achieved)

<sup>78</sup> This assumes the renewable energy sector can be used to provide offsets for the covered sector (i.e. fungible) – this is by no means certain, as these are very different markets (non-fungible). The renewable energy sector is aiming at 20per cent renewable energy use by 2020 or 9 500 GWh (9 500 000 MWh) of renewable energy by 2010. The key is the renewable energy units are G/MWhr rather than tonnes of CO<sub>2</sub>-e. The *Carbon Pollution Reduction Scheme* units will be tonnes of CO<sub>2</sub>-e. While there are some rule-of-thumb conversions from MWhr of wind turbine energy (roughly 4 000 t CO<sub>2</sub>-e saved per wind turbine), there is no precise conversion of MWhr to a tonne of CO<sub>2</sub>-e, as this would depend on which type of energy it replaced – a brown coal fired MWh or a black coal fired MWhr. In addition, the efficiency of wind turbines, for example, is constantly improving and any conversion ratio is therefore also changing. On the positive side, Kyoto’s CDM allows for investment in or purchase of renewable energy derived CERs, where one CER equals one tonne CO<sub>2</sub>-e. MBAC is of the view that the renewable sector will be available for offsets, otherwise a) forest and agricultural offsets will be quickly ‘consumed’ and Australian emitters will be forced to secure offsets offshore (i.e. investment leaving Australia).

<sup>79</sup> David Bartlett took over from Paul Lennon on May 26<sup>th</sup>, 2008.

<sup>80</sup> The Weekend Australian. May 31-June 1, 2008. “Bartlett in fresh start on forests”

<sup>81</sup> MBAC (2007a)

soils. While Forestry Tasmania has not planted forests specifically for carbon sequestration purposes, they are investigating the possibilities for new programs e.g. planting of new forests on degraded agricultural land, where carbon would be an explicit component.<sup>82</sup>

Regarding adaptive response, such as deliberate broadening of diversity, change in species, change in genetics, changes to forest health, change to fire suppression activities/forces, change to quarantine approach, the present focus is in seeking to establish a bioenergy market to utilise harvest waste, both to increase revenue/reduce cost, and to mitigate the issues we currently have in regard to regeneration burning.

Forestry Tasmania is preparing a new 10 year management plan, which features climate change and carbon as a specific issue, with strategies related to maintaining and better understanding carbon storage dynamics, seeking bioenergy markets and monitoring trends that may require active adaptation response in forest management (which are otherwise not yet apparent). They will make this available from their website in the near future

**FT Carbon Management Policy**

- **reforest** after harvest
- maintain forest age/growth stages: **harvest=growth**
- maximise **wood recovery** from harvest areas
- promote use of **bioenergy** from forest waste
- **protect** forest against wildfire, pest and disease
- encourage long-life cycle **solid wood products and recycling**
- **research** into forests carbon accounting, carbon life-cycle analysis
- regular **reporting** on state forest carbon stocks



**Figure 6: Forestry Tasmania's Carbon Policy**

### 7.2.3 Fire

Risk assessment undertaken by Forestry Tasmania<sup>83</sup> showed the threat of a mega fire occurring in Tasmania had increased. In 2006-2007, more than 300 Forestry Tasmania staff were deployed to fight wildfires that burnt about 74 000 hectares. Of this, one third was in state forest and the remaining two thirds in private lands.

<sup>82</sup> Personal communications Hans Drielsma, Executive General Manager, Forestry Tasmania

<sup>83</sup> <http://www.forestrytas.com.au/news/2007/12/climate-driven-change-heightens-need-for-fire-management>

Forestry Tasmania, the Tasmanian Fire Service and Parks and Wildlife are cooperating on an ongoing Fuel Reduction burning program funded by the Tasmanian Government.

Forestry Tasmania advises that “if climate change predictions were correct, the risk of fire in future would increase and fire management would need to adjust to the growing threat.”

## 7.3 New South Wales

New South Wales is covered by a number of plans:

- The NSW Greenhouse Plan
- The State Plan
- A New Direction for NSW
- The National Biodiversity and Climate Change Action Plan

Because there are so many unknowns, the initial emphasis has been on research to quantify likely impacts.<sup>84</sup> Research is being undertaken by the Department of Primary Industries (DPI) and Forests NSW. An important part of this has been the Office for Rural Greenhouse Gas Studies within the Primary Industries Innovation Centre - a collaborative joint venture with the University of New England.

### 7.3.1 Research and modelling

The impacts of climate change on tree growth and carbon dynamics is being studied through a research project entitled the Hawkesbury Forest Experiment. DPI is collaborating with national and international experts to conduct research into the direct effects of increased atmospheric carbon dioxide on tree growth and below-ground respiration. This research will produce valuable information for future forest management policy.

Forests NSW inventory modelling does not currently have the capability to incorporate the large number of variables required to simulate climate change, although CSIRO data has been referred to.

### 7.3.2 Mitigation responses

During 2007-2008 approximately 690 000 *NSW Greenhouse Gas Abatement Certificates* (NGAC's)<sup>85</sup> were registered with the Independent Panel and Regulatory Tribunal (IPART). This included approximately 100 000 NGAC's which were created as a result of a review of the eligibility criteria for plantations planted since 1990. Forests NSW, in consultation with the regulator, IPART now includes all areas of plantation established since 1990 on land that was already cleared in 1990. The inclusion of these additional plantations will result in the creation of additional NGAC's annually throughout the life of the plantations.

In addition to post 1990 plantation carbon accounting, Forests NSW is currently improving the methodology used to account for carbon in native forests. This information will initially be used as a guide for management and policy decision making.

The NSW government has a range of policy responses available to address climate change through the provision of direct or indirect incentives for the implementation of available mitigation measures – from subsidies, penalties and taxes to market-based mechanisms and funding for research and education programs. The *NSW Greenhouse Plan* encapsulates the current suite of policy responses, in particular, emissions trading, which provides incentives for mitigation measures, and opportunities for research, extension and education.<sup>86</sup>

<sup>84</sup> Fairweather, H. and Cowie, A. (2007). Ministerial introduction

<sup>85</sup> 1 NGAC equals one tonne of CO<sub>2</sub>-e sequestered

<sup>86</sup> Fairweather, H. and Cowie, A. (2007). Pv.

The *NSW Greenhouse Gas Abatement Scheme* (GGAS) was the first mandatory emissions trading scheme in the world. The national *Carbon Pollution Reduction Scheme* includes incentives for sequestration through reforestation and carbon capture and storage. Sequestration through soil carbon management in agricultural systems, and management of existing forests, are flagged for future inclusion.

Research into mitigation options in agriculture and forestry have been through:

- Full life cycle analysis of current and alternative farming and forest systems, including direct and indirect emissions and removals.
- Development of technologies for the production of bioenergy and other products from biomass, through an examination of a range of feedstocks (including woody plants) and alternative energy conversion technologies, assessment of the socioeconomic impacts of a bioenergy industry on other NSW primary industries, assessment of potential to produce high value chemicals from biomass.
- Development of the supporting science to facilitate mitigation through emissions trading, through, development of improved models of soil carbon dynamics, sequestration of dryland forest species and mixed-species revegetation.
- Research into the role of forest products in climate change mitigation.
- Development of greenhouse accounting methods for use in inventory calculation and emissions trading that recognise the role of wood products in climate change mitigation, providing an incentive for management practices that reduce emissions or enhance sequestration in agricultural and forestry systems that are cheap to use, thereby facilitating inclusion of small-scale revegetation projects.
- Developing agricultural and forestry systems to help mitigate climate change. DPI has considered three key criteria:
  - life cycle greenhouse gas and energy balance, to ensure systems deliver benefits in these areas
  - sustainability of production systems, including impacts on all environmental attributes
  - adaptation capacity of new systems.

### **7.3.3 Adaptation responses**

In 2007-2008 Forests NSW Climate Action Grant project ‘Developing Elite Trees for Economically Viable Plantations in Low Rainfall Environments of Australia’, progressed well with many trials now assessed for growth and density traits. Further adaptation responses undertaken by DPI from the discussion paper ‘Climate change research priorities for primary industries’ are:

- Development of sustainable production systems with enhanced carbon sequestration and lower life cycle emissions, that have the capacity to adapt to climate change.
- Development of resilient agricultural and forestry production systems with increased capacity to cope with climate variability, trends in climate variables, and indirect impacts (e.g. fire, pests) anticipated under climate change, for example:
  - research into the interactive effects of increased atmospheric carbon dioxide in a water- and nutrient-limited environment, on growth of major crop, pasture and forest species
  - research into the impacts of climate change on product quality, pests and diseases
  - development of strategies for minimising water losses, both on-farm and on a regional scale

- improving water use efficiency for irrigated agriculture, while minimising increased energy requirements.
- Evaluation of the impacts of alternative management strategies.
- Robust monitoring systems to understand the impacts of climate change.
- Research into the impact of climate change on ecological health.

The University of Western Sydney is conducting an experiment<sup>87</sup> regulating the carbon dioxide to 600 ppm to Blue gum trees. The trees are taking up more carbon, although “the largest factor determining the uptake of carbon dioxide is still the availability of water”.

#### **7.3.4 Mitigation/adaptation responses and management planning**

Ecologically Sustainable Forest Management (ESFM) plans have been developed in the context of known information and the regulatory environment to provide blueprints for the ecologically sustainable management of NSW State forests. No explicit mitigation/adaptation responses are stated in the current plans.

As a NSW Government agency, Forests NSW is committed to a significant effort to minimise the impacts of climate change under the *NSW Greenhouse Plan*, *The State Plan*, *A New Direction for NSW* and the *National Biodiversity and Climate Change Action Plan*.

The NSW Biodiversity and Climate Change Adaptation Framework was compiled with significant input from DPI. This document is the starting point for raising awareness, undertaking vital research and monitoring projects, and implementing strategies to maintain biodiversity and protect threatened plants and animals.

Examples of where mitigation/adaptation responses have been documented include:

- DPI climate change action plan (internal)
- NSW Biodiversity management plans and the discussion paper ‘Climate change research priorities for primary industries’.

Areas of focus include carbon emissions trading, reforestation, role of forest products, bio-energy, and mitigation of non-CO<sub>2</sub> greenhouse gas emissions.

#### **7.3.5 Related plans for the future**

Further details and plans for the future can be found in the discussion paper ‘Climate change research priorities for primary industries’, which outlines the causes and effects of climate change, the impacts on primary industries, actions currently being undertaken by NSW DPI and identifies future research priorities.

#### **7.3.6 Frameworks**

The main NSW Framework document is the NSW Biodiversity and Climate Change Adaptation Framework.<sup>88</sup> The Framework is the starting point for raising awareness, undertaking research, monitoring projects and implementing strategies. The Framework identifies six key action areas:

- Share knowledge about biodiversity and climate change, and raise awareness of adaptation actions.
- Research and monitor impacts of, and adaptation to, climate change.
- Incorporate adaptation strategies that deal with the impacts of climate change on biodiversity into policy and operations.

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<sup>87</sup> Tissue, D (2008)

<sup>88</sup> NSW Inter-agency Biodiversity and Climate Change Impacts and Adaptation Working Group (2007)

- Provide adaptation planning methods and tools to deal with climate change impacts on biodiversity.
- Minimise the impacts of climate change on key ecosystems and species.
- Minimise the increased threat of invasive species on native species that comes with climate change.

Within each of these key action areas, specific actions and commitments are outlined.

## 7.4 Victoria

Victoria's forestry and forest products industry generates output of about six billion annually and employs 25 000 people.<sup>89</sup> Victoria's native forests are administered by the Department of Sustainability and Environment (DSE) with commercial operations managed by VicForests. The key drivers for change (in Victoria) are expected to be population growth, climate change, changing global trade, the emergence of a carbon market, greater community commitment to and involvement in land management and technical improvements that increase land productivity and reduce impacts.<sup>90</sup>

It is no surprise that the Victorian Government has been proactive on discussing and debating the relationships between forest and climate change and between climate change and forests. There are numerous policies, programs and developments in this sector.

### 7.4.1 Our Forests Our Future

There has been a continual decline in the quantity of sawlogs available from Victoria's public native forests. The Victorian hardwood sawntimber industry is now facing a further 25 per cent reduction in sawlog supply from public forests on top of the 31 per cent reduction under the *Our Forests Our Future* (OFOF) program.

- Sawlog supply (D+) from public native forest declined from licence commitments of over 861 000 m<sup>3</sup> per annum in 2000-2001 to 595 000 m<sup>3</sup> per annum under OFOF<sup>91</sup>.
- Allowing for the phasing out of harvesting in the Otways and Midlands and new projections, sawlog supply from public native forest is expected to decline by another 146 000 m<sup>3</sup> per annum to 449 000 m<sup>3</sup> per annum (derived from VicForest's projections).
- Victoria has experienced two major fire seasons (2007 and 2008). As a result, some resource estimates (sustainable sawlog yield) have been as low as 380 000 m<sup>3</sup> of sawlogs a year.
- The harvesting of timber from catchment forests is presently being reviewed<sup>92</sup> with a view to halting harvesting operations to conserve water. Should this occur, there will be a further reduction in sustainable yields, unless this can be offset by plantations – one of the sub-projects in this program.

### 7.4.2 Our Environment Our Future

The *Our Environment Our Future* initiative is DSE's primary and most current platform on the environment. As part of this platform, DSE released a Green Paper titled "Land and biodiversity at a time of climate change"<sup>93</sup>. The purpose – to generate feedback and discussions to inform the development of the White Paper<sup>94</sup>, planned for release in the first half of 2009. This will establish policy and program directions in this field.

<sup>89</sup> Philip Dalidakis – Victorian Association of Forest Industries (VAFI) Executive Director in Timber and Forestry e-News issue 39 26/07/08

<sup>90</sup> DSE (2008). Land and biodiversity at a time of climate change.

<sup>91</sup> DNRE (2002)

<sup>92</sup> The Victorian Government's White Paper "Securing Our Water Future Together" (DSE 2004) outlines a commitment to investigate the impact of timber harvesting on water yield within catchments that supply water to Melbourne

<sup>93</sup> DSE (2008). Land and biodiversity at a time of climate change.

<sup>94</sup> The White Paper process is one element of the Victorian Government's response to the challenges posed by climate change. The Climate Change Framework for Victoria will reflect the Victorian government's broader response to climate change.

According to the Green Paper, “Victoria’s future is expected to be hotter and drier with more variable weather patterns. Uncertainty over the likely impacts of climate change and where they will occur means we are facing a great threat to our livelihood. We need to focus on preparedness for different climate futures, as well as actions to build the resilience of Victoria’s ecosystems.”<sup>95</sup> However, DSE flags the difficulty saying “a key challenge in developing policy responses to land and biodiversity management is the inherent complexity of natural systems and the impacts of management responses.”

Some of the key mitigation and adaptation responses from the Green Paper are.

- Mitigation focus
- Biosequestration plantations for carbon offsets and permanent carbon capture (i.e. geosequestration) have the potential to bring about significant changes although significant work is required on some measurement issues and the economic models that would support investment strategies.
- Work undertaken by Melbourne University<sup>96</sup> is focused on non-CO<sub>2</sub> gases and the implications of land use change. The researchers also supervised a Masters student<sup>97</sup>, who developed new estimates for carbon stock in native forests in Victoria.
- Recent policy changes have occurred in Victoria to increase the level of prescribed burning to mitigate<sup>98</sup> the future impacts of large scale fires as a response to climate change. The view is that the frequency and intensity of wildfires will increase under future climate change and that different burning approaches are required to deal with this.<sup>99</sup>
- Adaptation focus
- New market mechanisms encourage and support business to seek creative solutions to sustainability issues and new business models can build them into everyday practices. Government can play a role in ensuring markets effectively include all production costs, particularly currently discounted environmental costs.
- One of Government’s roles is to identify appropriate mechanisms to deal with areas of market failure and to facilitate their successful implementation. Depending on the situation, the appropriate mechanisms can include education programs, regulation, incentives and public investment.
- The role of Government differs between private and public land<sup>100</sup>. Wherever possible, it should aim to maximise the potential for win-win outcomes. At times, Government is required to make decisions about trade-offs between values.
- Better corporate partnerships with diverse user groups and increasing the emphasis on education and training.
- Supporting growth without increasing resource consumption beyond the capacity of the environment will be increasingly important.
- Adapting to a changing climate will require a fundamental shift in the way the Victorian government designs and implements environmental policies.
- The capacity for Victorian ecosystems to adapt to a changing climate has been reduced because landscapes are highly fragmented.
- Climate change will provide opportunities, such as capitalising on the emerging global carbon market, particularly the market for carbon offsets, particularly where new technologies produce

<sup>95</sup> Victorian Minister for Environment and Climate Change in DSE (2008). Land and biodiversity at a time of climate change. foreword.

<sup>96</sup> Personal communications Professor Rod Keenan, Melbourne University – specifically work by Stefan Arndt and Steve Livesley.

<sup>97</sup> John Kaye based at DSE.

<sup>98</sup> This could be viewed as mitigation (i.e. reducing emissions associated with wildfire) or adaptation (change in prescribed burning in response to change). We have placed this in ‘mitigation’.

<sup>99</sup> Contact Liam Fogarty at DSE for a copy of the new policies.

<sup>100</sup> Victoria is approximately 1/3<sup>rd</sup> public land and 2/3<sup>rd</sup> private land. DSE (2008). Land and biodiversity at a time of climate change. p25

multiple benefits, such as those that increase land productivity and reduce environmental impact while improving biodiversity.

- At the time of producing this report, I am not aware of any changes to forest management practices to adapt to climate change.<sup>101</sup>
- The Victorian Fire division is working on better managing fire in Victorian forests and parks as a result of climate change.<sup>102</sup>
- Any change to fire management (i.e. controlled burning etc) will have ecological implications.

### 7.4.3 Utilising forest waste

Victoria is actively investigating the utilisation of harvesting waste from native forests for biofuel.<sup>103</sup> Trials have been undertaken to supply biofuel for power generation. While estimates were not provided, there is likely to be some millions of tonnes of residue produced each year by harvesting operations. Utilising this material only becomes a consideration when the cost of conventional fuels becomes more expensive than renewable energy alternatives such as biofuel. The Victorian government's interest in this sector is a direct response to the importance of renewable energy in any climate change 'solution'. Any activity here will undoubtedly involve considerable public consultation, scientific assessments (underway) and management planning prior to implementation.

## 7.5 Privately owned forests (plantations)

Privately owned plantations represent 60per cent of Australia's plantation estate – 86per cent of our hardwood plantation estate and 37per cent of the softwood plantation estate.<sup>104</sup> There are many examples of adaptive responses to the environment:

- Thinning earlier (pre-commercial thinning) or thinning in short rotation crops may also limit the stress on trees due to water or nutrient deficiencies. Such silviculture has been practiced in Bluegum (*Eucalyptus globulus*) plantations in the Green Triangle region of southern Australia, where stockings in drought affected short rotation plantations were significantly reduced to allow the remaining trees to survive.<sup>105</sup>
- Diversification. Some MIS companies are increasingly diversifying their operations to northern Australia in an endeavour to locate lands with more reliable precipitation or access to water. Of course, this is not without difficulties, as such a shift comes with significantly enhanced pest and weed issues. Again, the reasons for this shift are not simply 'climate change'. Rather, they are an accumulation of factors, including lack of suitable land and affordable land and continuing drought impacts in southern Australia, and market opportunities to explore new species, such as Red mahogany (*E. pelita*), Sandalwood (*Santalum album*) and Teak (*Tectona grandis*).<sup>106</sup>
- An increasing focus for these forests is biofuel. Energy fuels from forestry biomass are becoming a more effective alternative energy source. Specifically, the interest is in the cellulosic material including logging residues, thinnings, tops, limbs, roots, stumps, woody debris, brush and other forest material. The advantage for the forest owner is reduced fire hazard and income from sale of residues. The downside is some loss of nutrients. However, in the face of changing fire risk (i.e. due to climate change), this is now gaining attention with trials underway in Western Australia and elsewhere.
- Summary

A summary of Australian mitigation and adaptation responses presented in this report are contained in Table 3, again ignoring the status of their implementation or 'non-implementation'.

<sup>101</sup> Personal communications Professor Rod Keenan, Melbourne University.

<sup>102</sup> Personal communications Rod Anderson (DSE).

<sup>103</sup> Personal communications Ross Potter (VicForests).

<sup>104</sup> Garvran, M. and Parsons, M. (2008)

<sup>105</sup> Timbercorp advises in 2007, they non-commercially thinned large areas in Victoria and South Australia in direct response to the drought

<sup>106</sup> ITC (2007)

**Table 3: Summary of Australian mitigation and adaptation measures (mentioned in this report)**

<b>State reporting measures</b>	<b>Response</b>	<b>Mitigation/Adaptation/Framework</b>
New South Wales	Four clear plans (see 7.3)	Framework
	Hawkesbury Forest Experiment - Research on climate change, tree growth and carbon dynamics	Information
	GGAS offsets of c. 700 000 t CO <sub>2</sub> -e	Mitigation
	Improved methodology to account for carbon sequestration in plantations	Mitigation
	<i>NSW Greenhouse Plan</i> - Incentives for implementation of mitigation measures	Mitigation
	Full cycle analysis of alternative forestry systems	Mitigation (adaptation)
	Research into bioenergy production from woody plants	Mitigation
	Improved carbon sequestration and soil carbon models	Mitigation
	Role of forest products (i.e. life cycle analysis) in climate change	Mitigation
	Developing Elite Trees for Economically Viable Plantations in Low Rainfall Environments of Australia'	Adaptation
	Development of sustainable production systems	Adaptation
	Various research projects – increased atmospheric carbon dioxide on forest species; impacts of climate change on product quality, pests and diseases; minimising water loss;	Adaptation
	Framework plans (many)	Framework
Victoria	Dealing with the impact of past fires and likely increasing fire danger is central to Victoria's mitigation and adaptation programs	Mitigation and adaptation
	Carbon sequestration using plantations	Mitigation
	New estimates of baseline carbon stocks	Mitigation
	Mechanisms to deal with market failure (education, regulation, incentives and public investment)	Adaptation
	Public consultation	Adaptation
	Implementation of environmental policies	Adaptation
	No direct changes to forest management planning	Adaptation
	Utilisation of waste for biofuel (i.e. fuel substitution) and reducing fire risk in the forests	Mitigation
Private plantations	Carbon sequestration	Mitigation
	Utilisation of waste (residues)	Mitigation
	Silvicultural change	Mitigation
	Geographical (spatial) diversification	Adaptation

## 8 Policy and framework assessment

The Garnaut Review examines the impacts of climate change on the Australian economy, and recommends medium- to long-term policies and policy frameworks to improve the prospects of sustainable prosperity.

Frameworks are useful for assessing the likely impact of policy. In the field of climate change and forests, this invariably involves helping to define and quantify the impact of doing nothing (i.e. business as usual) through to ambitious-mitigation and adaptation policies and programs, for example.

### 8.1 Strengths and weaknesses

The Expert Panel on the Adaptations to Climate Change is currently developing a theoretical framework for the development of adaptation policies. The Panel has been organised by the International Union of Forest Research Organisations (IUFRO), and is expected to report to the UNFCCC in 2009. Preliminary discussions centre on four main points:

- Scientific uncertainty.
- The multi-sectoral nature of forest and climate policy.
- Participatory governance.
- The science/policy interface.

As we have seen in Section 5 and 5.2, climate models and forest growth models all contain a high degree of uncertainty in their outputs. Policies formulated on the basis of these models must retain a high degree of flexibility, allowing for the possibility that model scenarios may be inaccurate.

Forest policy in general interacts heavily with other sectors of the economy and of society - climate change policy likewise. It is important to recognise the difficulties of developing multi-sectoral policies, and identify any unintended consequences of forest adaptation or mitigation programs (conflict, environmental stress, small community survival etc).

Forest policy in most countries is moving towards models of participatory governance, including a wide range of stakeholders in the decision making process. This is certainly so in Australia as evidenced throughout this report. A policy process that facilitates public debate on the risks and benefits of adaptation policies is seen as vital by policy researchers.

Highly technical scientific debates do not lend themselves to sound policy formulation, particularly in publicly contentious fields. The science/policy interface is poor, and efforts to communicate scientific knowledge to policy makers could be improved.

### 8.2 Contrasts between Australian and international policy management

What contrasts can we highlight from the preceding work in terms of international policy frameworks and management philosophies? How are these of relevance to Australian conditions (both climatic and social)?

Firstly, there is a clear difference in public attitudes to forest management agencies between Europe and North America, due to historic and social differences. The main points are:

- Europeans are generally comfortable with manipulated forests, as long as the aesthetic and recreational values are maintained.
- In North America however there is a widespread public mood that forest agencies are overly oriented towards timber production, and that greater areas need to be 'preserved' in an essentially unmanaged condition.

We conclude that European forest agencies have more latitude in their responses to climate change relative to their North American counterparts, although this is not limitless and the issues are complex. Some examples:

- Public opposition to blue gum plantation developments in parts of Spain have led to arson attacks, as local villagers resist the change in landscape usage.<sup>107</sup>
- Similar issues can also be found in Eucalypt plantation regions in Chile and South Africa, for example. Although this level of civic disobedience is unlikely in Australia, resistance to large-scale landscape change is increasing in some regions, particularly at a local level.
- The European concept of ‘natural parks’ containing a strong agricultural element is a recognition that people prefer landscapes to remain unchanged, and European governments are willing to subsidise agricultural producers to keep landscapes in a historic condition.
- There are some similarities here with the concept of ‘green belts’ surrounding major Australian urban centres, but in general the Europeans use subsidies to influence landholders, rather than regulation.
- Small-scale private forest ownership is far more prevalent in Europe than in North America. France, for example, has 71 per cent of its 15.5 million hectares of forest in private hands, normally in allotments of between one and 200 hectares. Although this sometimes poses challenges for national forest policy, it does give the country a great deal of management diversity in its forests, compared to more monolithic ownership structures. This is because small-scale owners generally do not depend on an income from their forests, and may have a wide range of management goals.
- Outside of Scandinavia, corporate ownership of forests is uncommon, whereas in North America large forest companies and Timber Investment Management Organisations (TIMOS), for example, typically have estates in the hundreds of thousands of hectares, operated almost exclusively for profit.
- Forest management units in Europe are quite small, with forests in the Rhineland Pfalz region of Germany, for example, having one forester responsible for around 1 000 hectares<sup>108</sup>. This allows quite intensive management, and regional foresters have an intimate knowledge about their regions. Conversely, a consultancy to the United States Forest Service<sup>109</sup> has identified ‘decentralisation’ as a problem in forest management rather than an advantage.<sup>110</sup>
- Most of Europe is more intensively settled than North America, and they do not have the vast areas of forest common to Canada. The sheer size of Canadian forests makes intensive management impractical (and unnecessary), and much of the northern region will need to adapt to climate change autonomously, without interference.
- Leaving the forests ‘to fend for themselves’ would be unacceptable in Europe.
- In the United States there is recognition that unmanaged forests are likely to become more fire-prone, and there are moves towards increased fuel reduction burning and mechanical thinning, particularly in urban/wildland interface areas. Some green groups have criticised this approach as being simply a front for increased timber removal. Early thinnings are generally not economically viable, but there have been suggestions that this cost could be offset against fire control budgets, and that the development of a woodfuel power generation industry may make this an economically viable option. Woodfuel bioenergy is attractive particularly in Scandinavia, as one of the primary needs is for community heating (a more efficient use of woodfuels than electricity generation).
- Europe has thus far resisted moves to include forestry in carbon trading schemes. A recent report<sup>111</sup> noted that management for maximising carbon storage is not compatible with

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<sup>107</sup> Seijo (2005).

<sup>108</sup> Personal communication Georg Wilhelm (Landesforsten Rheinland Pfalz, Germany). Recent restructuring will gradually increase this to around 1 800 ha

<sup>109</sup> Reference required

<sup>110</sup> Dialogos International (2007)

<sup>111</sup> Kellomaki and Leinonen (2005)

management for maximum timber production, and that in some cases a carbon price of €100 per tonne may be necessary to offset lost production. Conflicting carbon storage models are at the heart of a current controversy in California, with a timber company citing a model showing that intensive management increases sequestration while environmental groups cite models showing the opposite.

How are these of relevance to Australian conditions (both climatic and social)?

Apart from the boreal regions, climatic conditions in much of Europe and North America are not so dissimilar to parts of Australia, and the challenges that climate change poses are the same. The main concern of forest managers in the Mediterranean to temperate zones of southern Europe, and the warmer areas of the Pacific Northwest is the increasing danger of fire, as it is in many parts of Australia. The rising levels of insect damage in cooler temperate regions may have parallels with the recurrent waves of psyllids that pass through the Australian Alps. Social concerns are also similar, with added pressures on forests from urban encroachment and other societal demands. The differences in adaptation responses that will occur will not arise from the differences in climate or landscapes, but from different attitudes and management philosophies.

European forest managers have two marked advantages. Firstly, they have a more 'personal' contact with their forests. Managers are typically responsible for relatively small areas, individual foresters stay in one region for most of their careers, and local regions have a great deal of management autonomy. In many ways, this system is reminiscent of how Australian forest agencies were managed fifty years ago, before economic pressures forced 'rationalisation' and centralisation. Although European forest agencies also face economic pressures, their concentration on long rotation, high-value timbers makes labour-intensive management more justifiable. There have been suggestions<sup>112</sup> that *E. regnans* in Tasmania could be profitably managed on a 250 year rotation.

Societal attitudes in Australia have more in common with those in the US rather than those in Europe. The wilderness paradigm is strong in Australia, and seems to have become accepted wisdom in many quarters. Victoria's recent Green Paper from the DSE is notable for its strong preservationist tone, to the point that forest products do not even rate a mention as a positive output of the natural environment. This attitude may be highly counterproductive in adapting to climate change.<sup>113</sup> In the US it is not uncommon for standard forest management actions (such as prescribed burning or stand thinning) to be challenged in court. Agencies that over-stress the 'natural' nature of unmanaged regions will find themselves hamstrung when management is necessary to retain their core ecological values. European agencies place great importance in explaining the interconnectedness of natural processes and human history, and Europeans in general recognise that the two forces evolve in tandem. The Australian Forest History Society could be a useful resource for forest agencies wishing to promote this element of environmental management.

Urban/wildland interface issues are common to all jurisdictions. Private land owners in the US and Europe generally enjoy stronger property rights than those in Australia, and so government influence is more commonly in the form of subsidies rather than regulation. Although expensive, this does have the advantage of retaining local community support for government priorities. The European concept of 'natural parks' may prove an ideal way of limiting urban sprawl without overly disadvantaging local residents.

Private ownership of forests is more prevalent in both Europe and North America than it is in Australia. The Queensland government is strongly supportive of private forestry, and similar schemes (financial incentives, equity loans etc) may be viable in other Australian states. One of the main advantages of small-scale private forestry in regard to climate change is the diversity of management approaches that may be taken by private owners, so the temptation of Australian authorities to over-regulate management activities would need to be guarded against.

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<sup>112</sup> Personal communication from Neil (Curly) Humphries

<sup>113</sup> Eastaugh, C. (2008b)

Large European private forest owners (mainly in Scandinavia) are rapidly diversifying their holdings, often to South America (i.e. Norske Skog, Stora Enso etc), while in some cases scaling back their home-country operations. Like any large business, forestry companies will go to where the profits are. Climate change may put added pressure on the profitability of large forest enterprises in Australia.

Moves to include forestry in a global carbon trading scheme may be resisted by European governments, simply because in most cases they have little scope for (or societal desire for) significant forest expansion into agricultural lands.

## 9 Conclusion

### 9.1 Knowledge gaps

- Accurate modelling of carbon storage in forests under different management regimes will need models designed specifically for regional conditions. While these are being developed, they are not available for Australia as a whole.
- Useful regional climate modelling for Australia will be impossible without a better understanding of El Nino phenomena.
- Climate change and forests know no borders. There is a pronounced State for State approach to framework and policy development. There is no Australian national framework.
- The focus has been the impacts of climate change on forests. There is little knowledge on the impacts of forest changes on climate change (so-called feedback impacts) and models do not account for these adaptive change. An excellent example of this is the impact of the North American Mountain pine beetle on net emissions in Canada. In the worst period of the infestation, the losses were equivalent to 75per cent of the average annual direct forest fire emissions from all of Canada during 1959–1999. However, this had not been factored into any climate change modelling.<sup>114</sup>
- The linkage between climate change and employment is not yet done. We expect adaptation, if properly planned, to avoid job losses and create jobs in the forest sector.<sup>115</sup>

### 9.2 Research

- Regional climate change models.
- Impact of forest change on climate change (feedback).
- Feedback (forest change to climate change) integration in regional/national climate change models.
- Intensively managed, long rotation, high value timber production
- Community governance for European-style ‘natural parks’ in urban/wildland interface areas
- Behaviour of cyclic insect infestations in Australia (i.e. psyllids)
- Scenario modelling of environmental recovery following extreme disturbance events
- Risk management aspects of forest agency centralisation, with respect to climate change adaptation flexibility.

### 9.3 Trials

From this analysis, can we recommend any research targets and/or trial projects that may be useful in forests and their role in climate change mitigation or adaptation? Yes:

- A possible role for government in Australia is the participation in the breeding of new tree varieties that are tolerant of a wider range of climatic conditions and the dissemination of the results.
- Eucalypt production for high-value veneer products. Trial areas managed on a 200-250 year rotation. This would most likely need to be done in partnership with academic organisations or professional societies, and be funded through some form of trust.

<sup>114</sup> Kurtz, W., et al (2008).

<sup>115</sup> Annabella Rosemberg. Climate Change and Forests. ForestWorks Conference. Sydney. August 2008

- ‘Canary in a mineshaft’ plots established on the edge or outside the natural range of the species (more northerly, drier, or lower altitude). These plots may give some advance warning of climate driven pressures, and provide data on how these species may fare under a new climate.
- ‘Pioneer’ plots established at the opposite of the natural species’ range than the ‘canary’ plots (more southerly, wetter, or higher altitude). These will give an indication of what species may be advantaged by new climate conditions.

## 9.4 Recommendations

- The outputs from models need to be treated with caution. Where possible, different models should be used for predictions and the variability of the ‘answers’ understood before conclusions are drawn. Where single models are used, there should be analysis of the sensitivity of outcomes to the variables.
- Despite the growing public awareness and profile of climate change in political debate there has been little scientific analysis of the impacts of climate change on Australian native forests and little evidence that forest managers are considering the potential impacts of climate change in management planning.<sup>116</sup> This needs to be addressed.
- The social effects of climate change are highly uncertain, and projects to strengthen community resilience and reduce vulnerability are recommended.<sup>117</sup>
- A national forest framework for research, policy formulation and implementation be established with all of the states contributing.
- There is a strong need for research and development support for forests and climate change. The present level of investment is pitiful in relation to the opportunities that exist and the importance to the globe.<sup>118</sup>

## 9.5 Best practice

At present, adaptation responses are focusing on short to medium term timeframes, aimed at strengthening the resilience of forests and maximising diversity. Increased focus on fire suppression and pest resistance is common.

In light of the uncertainties of future climate, maintaining flexibility in the forest is integral. Considering that no one person or organisation can be expected to have ‘the answer’, maintaining management diversity (as well as ecological diversity) will help to spread risk, and give a greater chance of finding successful solutions.

A key theme has been looking at ways to enhance the resilience of forests to adapt to climate change. Carbon modelling is becoming common as forest managers begin to better understand their baseline carbon state. This has occurred in Victoria and Tasmania and is underway in Queensland. These models are strategic in nature with a purpose to direct debate and policy development.<sup>119</sup> There is now considerable debate in this field.

Globally and as a nation we probably need to get this right because, as they say, later will be too late. Climate change poses threats, but also the opportunity for us to regain our place in the public imagination as supporters of nature, rather than opponents.<sup>120</sup>

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<sup>116</sup> Nitschke, C. et al (2007)

<sup>117</sup> Eastaugh, C. (2008)

<sup>118</sup> Dr John Raison. CSIRO. Climate Change and Forests. ForestWorks Conference. Sydney. August 2008.

<sup>119</sup> Michael Wood. Forestry Tasmania’s Business Development Manager. Personal communications.

<sup>120</sup> “Green Philosophies in the face of climate change”

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## Appendix 1 – Objectives and scope

### Project Objectives

Consider current best practice in incorporating mitigation and adaptation responses to the effects of climate change in forest management planning. This is to cover national and international situations to help identify the effectiveness, risks and ramifications of different policies and management frameworks.

### Project Scope

The scope is national and international with a focus on native forests but plantation forests should also be included. This report details:

- The extent to which mitigation and adaptation to climate change is being incorporated into strategic and operational forest management planning in Australia and internationally.
- The approaches used to incorporate mitigation and adaptation responses into forest management planning.
- The strengths and weaknesses of the different approaches.
- Considered best practice in the Australian context.

While this is seemingly straightforward, the reality is this is quite difficult. Why? Because there is no consistency in how aspects of climate change and forestry are addressed and reported. Equally, imprecision, confusion and misinformation abounds. Lack of understanding or agreement of some of the simpler concepts - management of forests and their carbon storage potentials is an excellent example – also abounds. Vested interest groups take opposing positions on the same topic citing the same ‘scientific evidence’.

## Appendix 2 – Key definitions

### Key definitions

Australia's level of exposure and sensitivity to the impacts of climate change are high. The extent to which these impacts are realised will depend on the success and timing of global greenhouse gas mitigation and on national adaptation efforts.<sup>121</sup>

What is the difference between 'mitigation' and 'adaptation'?

- A good example of mitigation would be activities which reduce greenhouse gas emissions, such as geo-sequestration or bio-sequestration i.e. to reduce adverse effects such as increasing temperatures and sea levels.
- A good example of adaptation related to the above examples would be coping (adapting) to higher temperatures by changing the design of houses or making artificial snow in some snowfields or learning to cope with (adapt to) sea level rise, by movement of population, building walls or changing the design of houses.

It would be informative to look at this in more detail and present some simple forestry mitigation and adaptation examples before looking at the impact of climate change on forests.

### Mitigation

Mitigation of global warming involves taking actions to reduce greenhouse gas emissions, enhance sinks aimed at reducing the extent of global warming<sup>122</sup> or the stabilisation of greenhouse gases in the atmosphere. In forestry terms, this encompasses (for example):

- Afforestation - growing forests where forests were not previously growing.
- Reforestation - growing a forest where there was previously a forest.
- Avoiding deforestation (a major source of emissions in, for example, Indonesia and Brazil) and referred to as reduced emissions from deforestation and degradation (REDD).<sup>123</sup>
- Managing forests where one of the goals is to maintain or enhance sequestered carbon is beginning to occur in some of Australia's native forests.
- Better accounting for carbon sequestration in wood products (definite developments here in Victoria and Tasmania).
- Utilising residues for biofuel (developments in the Managed Investment Scheme (MIS) plantation sector and in native forests in Victoria and elsewhere).<sup>124</sup>

Of course, there are time and scale dimensions associated with mitigation. Garnaut discusses no-mitigation (business as usual with CO<sub>2</sub>-e concentrations exceeding 900 ppm); strong-mitigation (stabilising atmospheric concentrations of CO<sub>2</sub>-e at 550 ppm<sup>125</sup>); and ambitious-mitigation (450 ppm) and provides timelines for these mitigation targets. Garnaut also states that in the absence of strong mitigation, strong growth (in greenhouse gas emissions) is expected to continue for the next two decades.

<sup>121</sup> Garnaut (2008) p164

<sup>122</sup> [http://en.wikipedia.org/wiki/Mitigation\\_of\\_global\\_warming](http://en.wikipedia.org/wiki/Mitigation_of_global_warming)

<sup>123</sup> REDD currently excluded from the Kyoto Protocol, but if included, would allow developed (Annex I) countries to compensate developing (Annex II) countries for saving their forests and woodlands.

<sup>124</sup> There is substantial interest in biofuels from forest residues worldwide. MBAC has been involved in a number of confidential offshore studies with major energy companies looking for 2-4 million tonnes of residues per year. This interest extends to all forests in all countries, favouring FSC certified forests (most plantations and some native forests). Some Australian MIS companies have signed off-take agreements for residues from hardwood plantations.

<sup>125</sup> Garnaut (2008). Based on a 'best estimate' climate sensitivity of 3°C, stabilisation at 550 ppm CO<sub>2</sub>-e is likely to lead to an equilibrium global mean temperature increase of 3°C above pre-industrial levels.

This introduces important features of ‘mitigation’ in this context:

- It is commonly discussed in global, national or state terms, such as a global 20per cent reduction in greenhouse gas emissions or a 20per cent increase in use of renewable energy (to offset use of high-carbon energy sources).
- The impacts of mitigation are not immediate i.e. they will be observed sometime in the future i.e. some form of climate change is considered ‘locked-in’ because of our present level of greenhouse gas emissions.<sup>126</sup>

## Adaptation

Adaptation involves taking action to minimize the effects of global warming. Action can be adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects.<sup>127</sup> The critical point is that adaptation can be ‘man-induced’ (i.e. land use change) or natural (i.e. evolution). Some examples are:

- Developing new technologies and sciences that allow us to cope with change.
- Increasing public awareness through consultation, education and training.
- Regulation or incentives, forcing change.
- Direct public investment to reduce impacts (i.e. sea walls).
- Rapid evolutionary change i.e. natural adaptation.

In forestry terms, adaptation covers a very wide range of activities, including:

- Simply providing information on climate change impacts on forests and forests impact on climate change (i.e. knowledge) which becomes the starting point for adaptation.<sup>128</sup>
- Change in forestry practices - a good example here is changing from planting forests in regions where precipitation is declining or becoming more irregular to those regions where precipitation is stable, increasing or likely to be more reliable – i.e. land use change.
- The use of fast-growing plantations to replace ‘lost’ production from other forests.<sup>129</sup>
- Developing market mechanisms that encourage use of forests for multiple purposes including biodiversity, environmental improvement, production and storage of carbon – i.e. emissions trading scheme, carbon market or environmental credits markets.
- Facilitating landuse change that allows for greater aggregation of forests to improve their ability to withstand change i.e. regulation combined with public consultation.
- Encouraging economic development in developing countries that then take people out of dependency on agricultural production.
- Species actually adapting naturally to change (i.e. accelerated evolution).

The impacts of adaptation:

- Are commonly discussed in national, state, regional or individual terms.<sup>130</sup>
- Can be immediate – i.e. changing planting of forests to the tropical north of Australia from the drier southern parts or building sea walls to eliminate rising sea levels.

<sup>126</sup> Garnaut (2008) p162 reports that up to 2030 climate change impacts can be broadly considered as locked in because of our present level of greenhouse gas emissions. The magnitude of these impacts can only be tempered by our level of adaptation effort.

<sup>127</sup> Garnaut (2008) p522

<sup>128</sup> Adapted from Garnaut (2008) p317

<sup>129</sup> Eastaugh, C. (2008) p25

<sup>130</sup> This is not to say that international adaptation responses are not possible – they are.

- Are designed to moderate harm or exploit beneficial opportunities. Both mitigation and adaptation are and will be challenging<sup>131</sup>.

## Sustainable Forest Management

A central theme in climate change and forestry is sustainable forest management - the primary objective for most forest management agencies. Sustainable forest management is also a key activity in addressing climate change.<sup>132</sup> This is because the opposite – non-sustainable forest management - can only add to greenhouse gas emissions.

Sustainable forestry and climate change timescales are not dissimilar, and substantial change is expected within the rotation length of many forest species. Not surprisingly, the impacts of climate change on forests and the feed-back impacts of forests on climate change are increasingly receiving local, regional, national and international attention. At present there is no formal method of assessing ecosystem vulnerability to climate change, even though numerous studies have been undertaken and considerable debate has occurred (community, government, etc).

Professor Ross Garnaut<sup>133</sup> best sums up the situation by stating that “there remains a great deal of scientific uncertainty and subjectivity which has led to confusion, misinformation and a lack of coordinated responses. However, this uncertainty is not a reason for inaction on climate change nor policy debate associated with climate change.”

How far such debates and resulting actions have resulted in mitigation and adaptation to climate change being incorporated into strategic and operational forest management planning is the subject of this report. An appropriate starting point is to introduce the relationship between climate change and forests – specifically, actual, perceived or anticipated change.

The following section introduces these impacts.

## Framework

A framework is a basic conceptual structure used to solve or address complex issues. A conceptual framework is used in research to outline possible courses of action or to present a preferred approach to an idea or thought.<sup>134</sup>

Frameworks are useful for assessing the likely impact of policy. In the field of climate change and forests, this invariably involves helping to define and quantify the impact of doing nothing (i.e. business as usual) through to ambitious-mitigation and adaptation policies and programs, for example.

## Vulnerability

Vulnerability is described by the IPCC (2001, p. 6) as “the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.”

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<sup>131</sup> If Australia wished to reduce all their greenhouse gas emissions by 20 per cent by 2020 based on (say) current emissions using forests, we will need to reduce from around 580 million tonnes CO<sub>2</sub>-e to around 465 million tonnes – a difference of about 115 million tonnes. Biosequestration alone cannot account for this quantity of CO<sub>2</sub>-e by 2020, as this would require approximately 3.8 million ha of new plantations. Of course, this is planned to be achieved by a combination of energy efficiency, energy replacement (renewable for fossil fuel) and offsets (i.e. into forestry).

<sup>132</sup> Hansard, A. (2007)

<sup>133</sup> Garnaut (2008). One of the three themes put forward by Professor Garnaut in his Draft Climate Change Review Report.

<sup>134</sup> Wikipedia

## Layout of this report

Wherever possible information will be provided under suitable headings followed by:

- Key points provided in dot points
- Country specific information as dot points.<sup>i</sup>

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<sup>i</sup> More detailed technical information is provided in footnotes