Climate change and Australia’s plantations

REGIONAL REPORT 9: Tasmania
Radiata pine plantations
Introduction

Plantations have been managed for wood production in Australia for over 100 years, and silvicultural practices for establishment and growth are well-developed, particularly for the more established parts of the industry such as the softwood sector (Snowdon and James 2007). Australia’s climate is becoming more variable, and this represents a potential opportunity or threat to the viability of Australia’s plantations, and may mean changes in management or location of plantations may be required to capitalise on opportunities and reduce threats.

This report summarises the possible consequences of more variable climate for softwood plantations in Tasmanian pine plantations by 2030, in terms of stand productivity and wood properties, the likelihood of stand failure due to drought and implications of this for final stems per hectare, risks from fire and risks and impacts of pests. The bulk of Australia’s pine plantations are located in cool temperate south western and south eastern Australia (Figure 1).

The report also presents possible adaptation strategies to reduce negative impacts of climate change on plantation productivity. This work was done as part of a FWPA-funded project, and more details can be found in the project final report, ‘Adaptation strategies to manage risk in Australia’s temperate plantations’.

Figure 1 Current distribution of eucalypt plantations in Australia (National Forest Inventory 2012), and the focal region for this report (blue box).
**2030 Tasmania Regional Scorecard**

**2030 Volume change with no elevated CO_2 (Medium fertility, deep soils)**

### Key Points

#### Climate
- The climate is predicted to be warmer and little change in rainfall with average temperature increases of 0.74 degrees and a 3% decrease in rainfall.

#### Stand Volume and survival
- In the absence of an elevated CO_2 response, we can anticipate either no change for most areas or decreases up to -15% in some parts along the coast or the dry inland regions in the least favourable scenario. Areas that are potentially limited by cold temperatures may see increases in productivity as temperatures warm.
- There were no plantation failures in this region but without the modelling capacity to predict mortality in *Pinus radiata* it is not possible to determine the within stand level of mortality.
- The adjusted coefficient of variation (measure of variation independent of mean size) is relatively low across most of the estate, indicating there has been little shift in the inherent variability of the estate.
- It is likely small changes in silviculture will mitigate reduced productivity.

#### Fire risk
- For the majority of the estate, it is predicted there will be limited or only small increases the number of high forest fire danger (FDDI >25) days.
- Changes in fire weather and intensity are in summer, with a possible lengthening of the fire season into October to April.

#### Pest risk
- The range of key pests are unlikely to change much by 2030.
- Large increases in *Essigella* risk are predicted for the north and east coast of the region by 2050, with some small increases in risk along the north coast by 2030.
- Risk from other key pests is unlikely to change much.
Key points

- Where there is no response to elevated CO2 production, it is predicted that production will range from similar to current levels or with losses up to 15% under the least favourable conditions on shallow soil. The colder inland areas are likely to see increases in production as temperature limitations are reduced. Production is currently low in these areas due to cold and frost but may increase significantly as the climate warms, though frost will still be a significant risk.

- In regions where productivity is predicted to decrease, adaption through changes in silviculture may mitigate the potential losses or improve production beyond current growth predictions.

- Where there is a predicted response to elevated CO2, production is positive across both deep and shallow soils.

- The largest increases are generally seen where production is low and small absolute gains can result in a large percentage increase.
### Silvicultural Options to Address Changes in Production

All three reference sites are predicted to experience a drop in production. Results include output from 5 future climates.

**Silviculture**

- **Original** - plant 1300sph, 3 thinnings (age 11, 19, 26), clearfall age 35
- **Option 1** - plant 1600sph, 3 thinnings (age 11, 19, 26), clearfall age 35
- **Option 2** - plant 1300sph, 2 thinnings (age 15, 26), clearfall age 35

- **Site A**: Modelling suggests the biggest productivity gains were seen when the number of thinnings was reduced to 2 and delayed several years (~10%). There was a small increase (~5%) in productivity when sph were increased to 1600sph. Average diameters were broadly similar with less than 1 cm difference between the options (~42 cm).

- **Site B**: Modelling suggests increasing the stocking to 1600 ph at planting can increase productivity (~5%). When the number of thinnings was reduced to 2 and delayed several years, productivity gains were slightly larger (~7%) and average diameters were ~1 cm greater (50.3 cm) than the average for the original and option 1 silviculture.

- **Site C**: Modelling suggests increasing the stocking to 1600 ph at planting can increase productivity (~6%). The largest gains are predicted when the number of thinnings was reduced to 2 and delayed several years, (~9%) Average diameters were broadly similar with less than 1 cm difference between options (~46 cm).
Potential Board Output

**Site A**

- **SPH1300 (Original)**
- **SPH1600 (Option1)**
- **SPH1300 2 thin (Option2)**

<table>
<thead>
<tr>
<th></th>
<th>Density (kg m⁻³)</th>
<th>No. Boards (100 x 40mm)</th>
<th>% MGP15</th>
<th>% MGP12</th>
<th>% Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original</td>
<td>543 - 585</td>
<td>16</td>
<td>75</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Option1</td>
<td>538 - 582</td>
<td>16</td>
<td>75</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Option2</td>
<td>529 - 569</td>
<td>18</td>
<td>78</td>
<td>11</td>
<td>6</td>
</tr>
</tbody>
</table>

- Site A: Option 2, with the highest growth rates, had lower density overall.
- The Original and Option 1 treatments had similar numbers of predicted boards but the Original treatment has more reject boards
- Option 2 had a slightly higher percentage of MGP15 boards and the largest number of predicted boards.

**Site B**

- **SPH1300 (Original)**
- **SPH1600 (Option1)**
- **SPH1300 2 thin (Option2)**

<table>
<thead>
<tr>
<th></th>
<th>Density (kg m⁻³)</th>
<th>No. Boards (100 x 40mm)</th>
<th>% MGP15</th>
<th>% MGP12</th>
<th>% Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original</td>
<td>534 - 575</td>
<td>25</td>
<td>77</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Option1</td>
<td>533 - 570</td>
<td>25</td>
<td>80</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Option2</td>
<td>522 - 553</td>
<td>26</td>
<td>77</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

- Site B: Option 2, with the highest growth rates, had lower density overall.
- Board numbers and the percentage of MGP15 boards was broadly similar for treatments.

**Site C**

- **SPH1300 (Original)**
- **SPH1600 (Option1)**
- **SPH1300 2 thin (Option2)**

<table>
<thead>
<tr>
<th></th>
<th>Density (kg m⁻³)</th>
<th>No. Boards (100 x 40mm)</th>
<th>% MGP15</th>
<th>% MGP12</th>
<th>% Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original</td>
<td>533 - 578</td>
<td>20</td>
<td>85</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Option1</td>
<td>531 - 577</td>
<td>21</td>
<td>86</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Option2</td>
<td>515 - 557</td>
<td>21</td>
<td>86</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- Site 3: with the highest growth rates, had lower density overall.
- Board numbers and the percentage of MGP15 boards was broadly similar for treatments.
Fire

- Fire danger is characterised using the Forest Fire Danger Index (FFDI)
- For Tasmania FFDI is not predicted to change much during winter and but median FFDI may increase from October to April
- The number of days with FFDI>25 suggests a lengthening of the fire season at both ends.

Change in days with FFDI>25 for worst case (left) and best case (right) climate change

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Management Strategy</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire weather</td>
<td>Regional fire response plans</td>
<td>Climate change is expected to change the frequency and intensity of fires but not the nature of fire</td>
</tr>
<tr>
<td>Fuel loads</td>
<td>Clean up debris from under plantations</td>
<td>Maybe a strategy for high risk areas</td>
</tr>
<tr>
<td></td>
<td>Prune branches</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weed control</td>
<td></td>
</tr>
<tr>
<td>Fire spread</td>
<td>Landscape design to limit fire spread and aid suppression</td>
<td>Opportunities to avoid fire by relocating plantation estate were not identified</td>
</tr>
</tbody>
</table>
Pests: Production

Pest damage may amplify negative effects of climate change on stand productivity. Pest damage in the region includes defoliation, stem and root damage (Table 2). For 2 indicative sites (wetter and drier, and either low, medium or high fertility), we predict that, for stands experiencing defoliation:

- Maximum reduction in final volume will average 5% at these sites (~60 – 95 m³/ha), with greatest impact occurring when defoliation >60% and site fertility is low (Figure 11)
- There will be considerable between-site variability in responses
- Later age defoliation will have a greater impact than early age defoliation
- Multiple defoliations will have a substantially greater impact on volume than single events (Figure 12) particularly at lower fertility sites when impact may increase to 15% (160-220 m³/ha)

We do not have enough information to predict the impacts on productivity of other pest types.
Defoliating insects and stem borers are likely to be favoured by warmer mean temperatures but generally not by heatwaves.

Foliar diseases will be favoured by warmer mean temperatures but increasing droughts will likely reduce the abundance and distribution of these pests.

Stem borers are attracted to stressed trees and may amplify drought impacts.

Management strategies to control pest impacts are limited (Table 3), and include fertilising to promote crown recovery, thinning to manage drought stress or reduce humidity, managing slash to reduce overwintering sites, continued use of the Sirex biological control agent, and monitoring/controlling insect populations.

### Possible management strategies for reducing the impacts of pests on stand productivity

<table>
<thead>
<tr>
<th>Damage type</th>
<th>Management strategy</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defoliation</td>
<td>Fertilise to promote crown recovery</td>
<td>May increase drought mortality risk</td>
</tr>
<tr>
<td></td>
<td>Maintain biological control agent for Monterey pine aphid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduce spacing to lower humidity</td>
<td></td>
</tr>
<tr>
<td>Stem damage</td>
<td>Thin plantations to manage drought stress</td>
<td>Can help manage drought risk</td>
</tr>
<tr>
<td></td>
<td>Reduce slash to manage population build-up</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintain biological control agent for Sirex</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>Monitor populations and control when populations are high</td>
<td>Requires understanding of threshold population numbers for risk monitoring and modelling</td>
</tr>
</tbody>
</table>
Methods

CLIMATE: Historical climate data were obtained from the Bureau of Meteorology’s Data drill, consisting of interpolated grids splined using data from meteorological station records at a scale of 0.05 degrees, covering the years 1975 – 2005. We used the Climate Futures Framework (Whetton et al 2012) to select climate models that represented the worst case, most likely and best case climate futures for the main temperate plantation regions in Australia, resulting in 4 – 5 climate models being run per region, using an A2 emissions scenario. A regular grid of 0.1 degree was used across all regions, and climate data were generated centred around 2030 and 2050. We used the McVicar et al (2008) mean wind data set in the fire danger modelling.

PRODUCTIVITY AND DROUGHT: Productivity estimates were updated from previous analyses, using the process-based model CABALA. Six standard soil types were set up (low, medium and high fertility for each of shallow and deep soil depth) to provide broad representation of soils in each plantation region. The silvicultural regime was a 35 year rotation planted at 1300 stems/ha (sph), an at-planting fertiliser application and thinning at ages 11 (to 750 sph), 19 (to 450 sph) and 26 (to 250 sph). Twenty separate rotations were simulated by running the model with 20 different planting dates over a 30 year block of weather. For each region simulations included the factorial combination of 6 soils, 5 climate models, 3 timeframes and 20 planting dates. The number of surviving rotations out of 20 was calculated to estimate probability of plantation failure. The coefficient of variation provided a measure of inherent variability in the region. For all combinations, the model was run assuming either no acclimation or full acclimation of photosynthesis to higher atmospheric CO\textsubscript{2} concentration, reflecting the high uncertainty around how plantations will respond to higher CO\textsubscript{2}.

WOOD PROPERTIES: the wood properties model CAMBIUM was used to examine consequences of climate for basic density. The analyses were performed on a subset of sites in the region. The number of 100 x 40 mm boards in a range of structural grades was estimated. The sites used for wood properties modelling are the same as those used for silvicultural modelling.

FIRE: The Forest Fire Danger Meter model (McArthur 1967) was used to calculate daily forest fire danger index, which was used to characterise fire danger. Fire damage days were calculated as the number of days with plantation fire intensity above 4000 kw/m.

PESTS: Tables of key plantation pests were produced and potential responses to climate were summarised using literature review. The niche model CLIMEX was used to examine potential changes in the distribution of 3 pine pests. The process-based model CABALA was used at selected high and low productivity sites in each region to identify stand responses to defoliation, using the methods described above.

ADAPTATION: CABALA was used to examine how silviculture might be used to manage productivity. The silvicultural options were (1) original (plant at 1300 sph, 3 thinnings, clearfall at age 35); (2) Option 1 (plant at 1600 sph, 3 thinnings, clearfall at age 35); (3) Option 2 (plant at 1300 sph, 2 thinnings, clearfall at age 35). Stand volume and wood properties were estimated for a subset of indicative sites per region. For fire and pests risk management, adaptation strategies are suggested based on literature and expert advice.

Further information:
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References:
Other project outputs:


**Regional report 1**: South west Western Australia eucalypt plantations

**Regional report 2**: South west Western Australia radiata pine plantations

**Regional report 3**: Green Triangle eucalypt plantations

**Regional report 4**: Green Triangle radiata pine plantations

**Regional report 5**: Eastern Victoria/southern NSW eucalypt plantations

**Regional report 6**: Eastern Victoria/southern NSW radiata pine plantations

**Regional report 7**: Northern NSW radiata pine plantations

**Regional report 8**: Tasmania eucalypt plantations

**Regional report 9**: Tasmania radiata pine plantations

Spatial database: all data generated in the project is available via a spatial database (https://data.csiro.au/dap/)

Updated CABALA model, contact:

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Citation

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