Climate change and Australia's plantations

REGIONAL REPORT 9: Tasmania

Eucalypt plantations

Forest & Wood Products Australia
Knowledge for a sustainable Australia

CSIRO

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.

The bulk of Australia's eucalypt plantations are located in cool temperate south western and south eastern Australia (Figure 1). This report summarises the possible consequences of more variable climate for softwood plantations in Tasmanian eucalypt 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 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'.

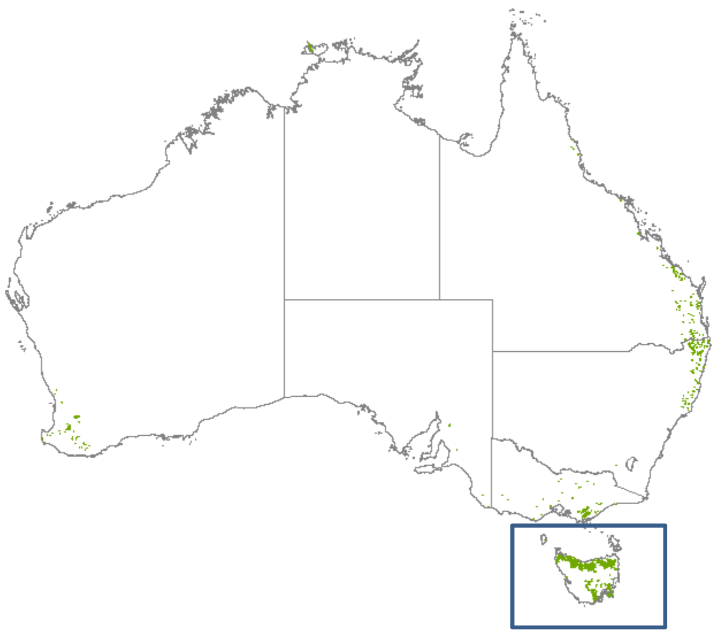
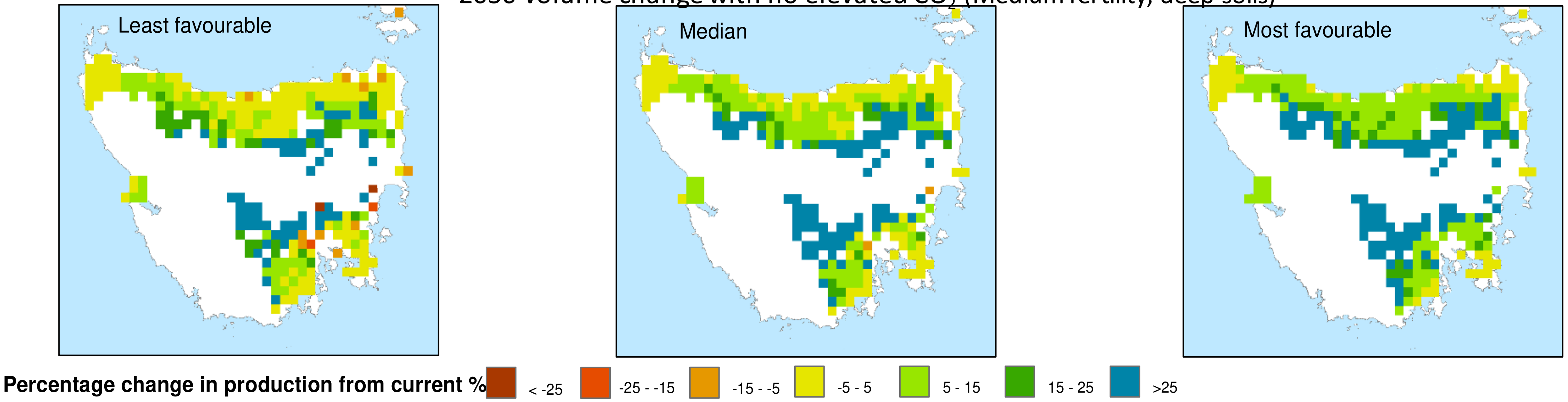


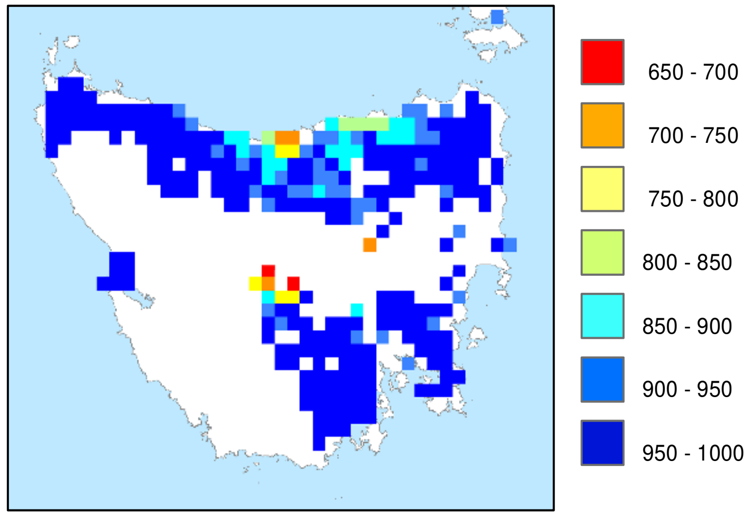
Figure 1 Current distribution of eucalypt plantations in Australia (National Forest Inventory 2012), and the focal region for this report (blue box).

2030 Tasmania Regional Scorecard

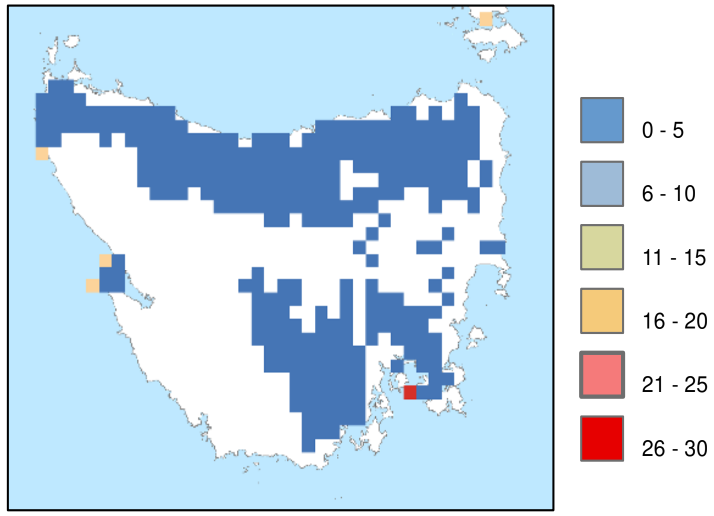
2030 Volume change with no elevated CO_2 (Medium fertility, deep soils)



Median Mortality (remaining SPH from 1000)



Increase in high FDDI days



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 a CO2 response, we can anticipate either no change for most areas or in decreases up to -15 % in some parts along the coast or the dry inland regions. Areas that are potentially limited by cold temperatures may see increases in productivity as temperatures warm.

• The number of rotation failures is predominately restricted to the inland areas where frost is likely to be the greatest cause of failure even under warmer conditions. Mortality is generally restricted to the central north and north east (some in the cold inland regions) but overall mortality is minimal.

•Adaptation option

Fire risk

•For the majority of the estate, it is predicted there will be limited or only small increases the number of days with a high forest fire danger index (FFDI>25).

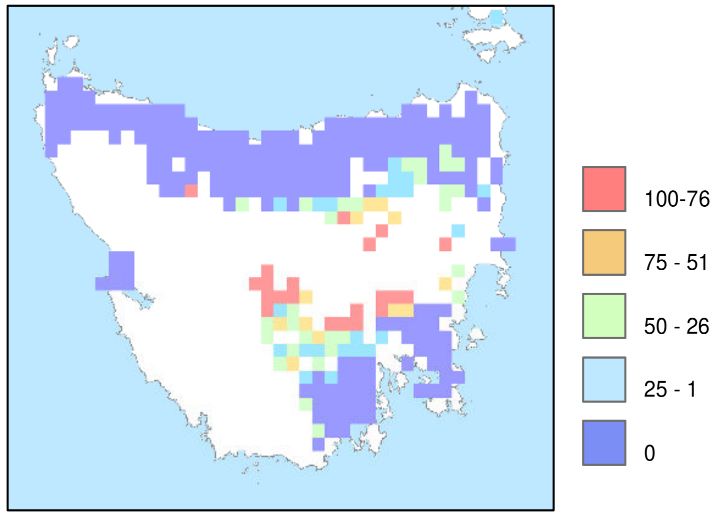
•Changes in fire weather and intensity are

Pest risk

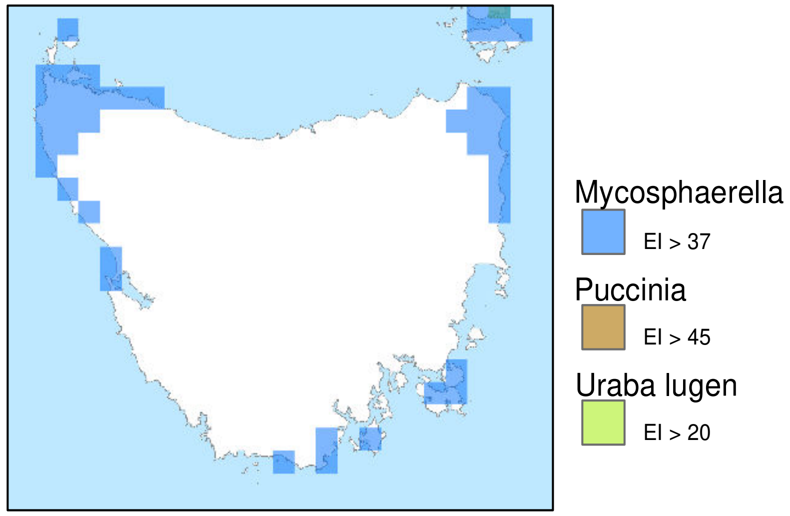
•Areas at high risk of pest damage are unlikely to change much by 2030

•Areas with optimal climate (EI) have climatic conditions conductive to high levels if defoliation (>60%) in most years

Number of rotations where there was plantation failure (out of 100)



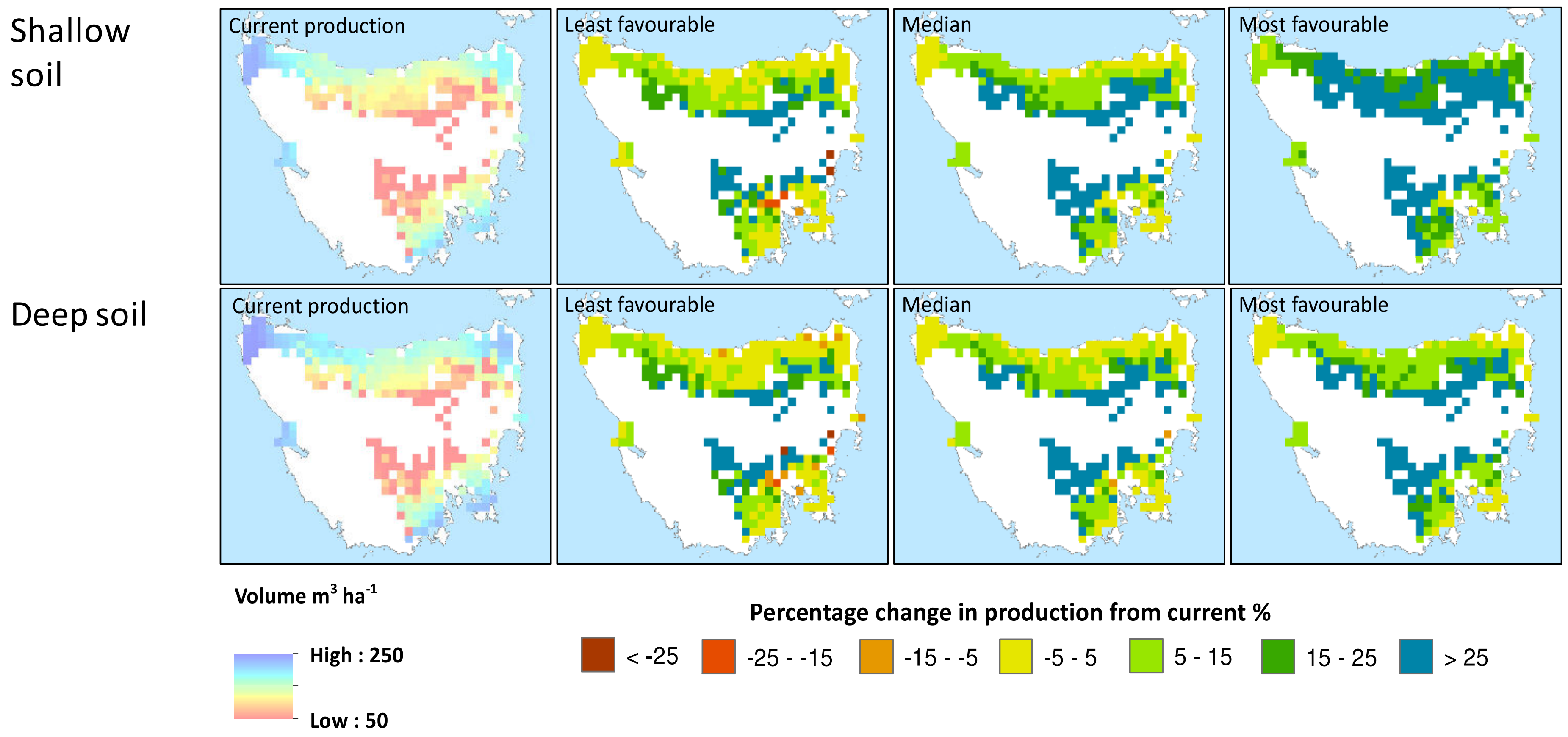
Optimum climatic suitability: defoliating pests



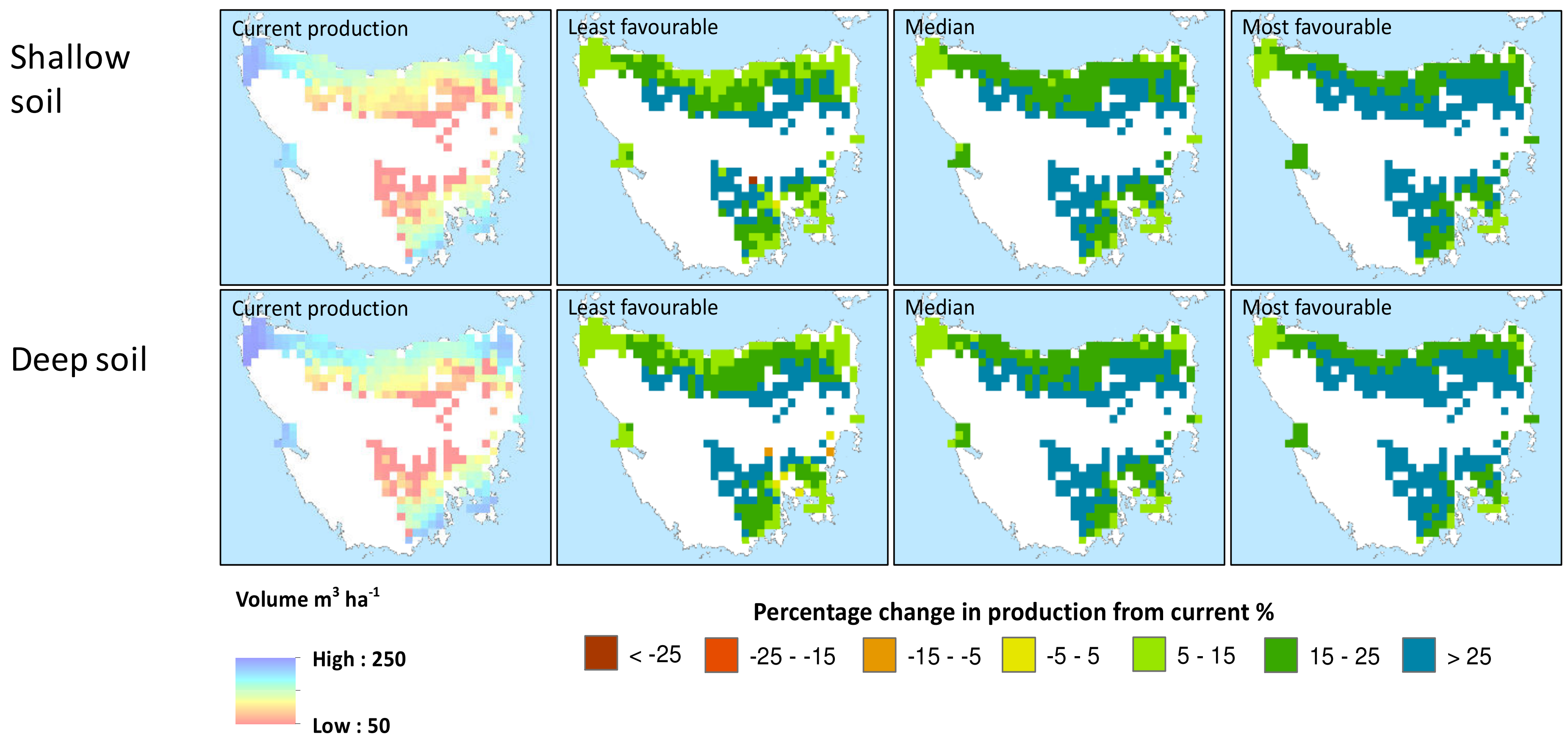
Overview

Production

2030 Volume change with no elevated CO_2



2030 Volume change with elevated CO_2



Key points

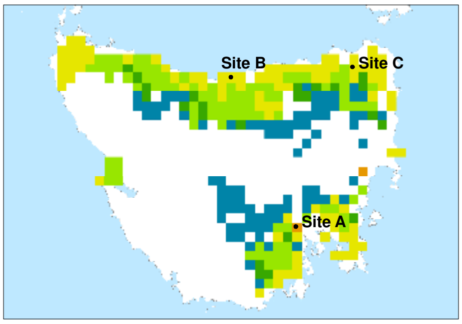
•Where there is no response to elevated CO2 production is predicted to range from similar to current levels or positive in the most scenarios, with some predicted losses in the cold dry region of the Derwent Valley. The colder inland areas are likely to see increases in production as the temperature 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 predicted response to elevated CO2, productions is positive across both deep and shallow soils.

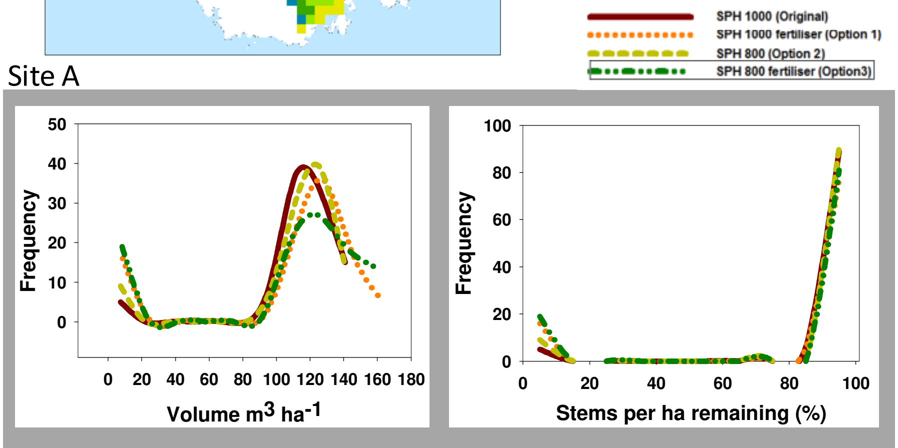
•The largest increases are generally seen where production is low and small absolute gains can have a large percentage increase.

Adaptation to changes in production and mortality



•Adaptation strategies examined were reduced spacing, and reduced spacing + fertiliser application
•Without these strategies all three reference sites are predicted to experience a drop in production by 2030

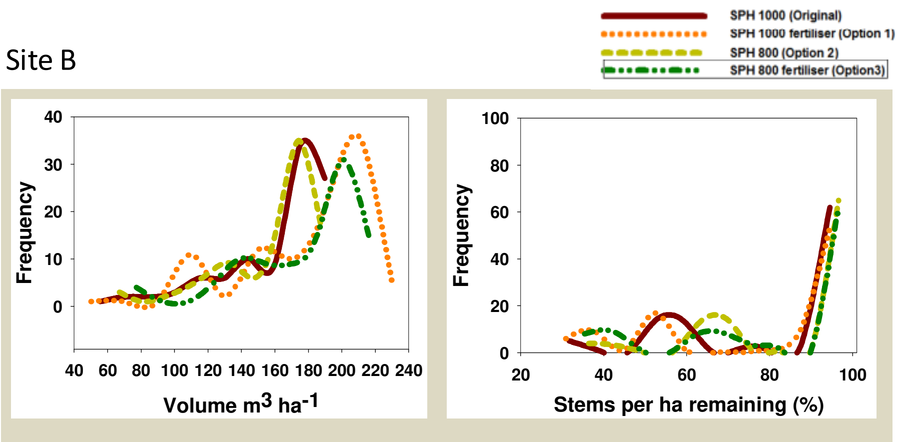
Site A



Effects in change in stocking and fertiliser application on production and mortality

Site A: Modelling suggests reducing the number of sph from 1000 to 800 resulted in little change in production. Applying fertiliser may increase production if the plantation survives but there is an increased risk of plantation failure (20 out of 100 rather than 10)

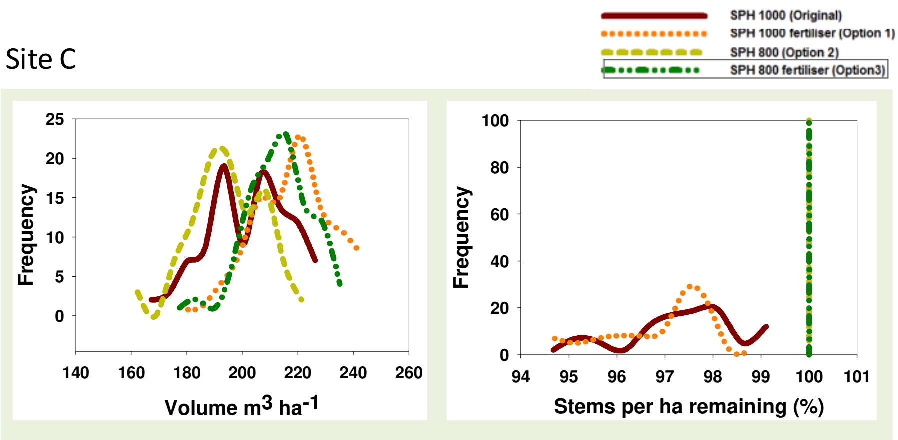
Site B



Effects in change in stocking and fertiliser application on production and mortality

Site B: Modelling suggests reducing the number of sph from 1000 to 800 resulted in a drop in production (10%) but this difference could be reduced to less than 2% if the stand was fertilised (increases of up to 12% if fertilised). There was only a small difference of 4% less mortality at 800sph compared with 1000sph.

Site C



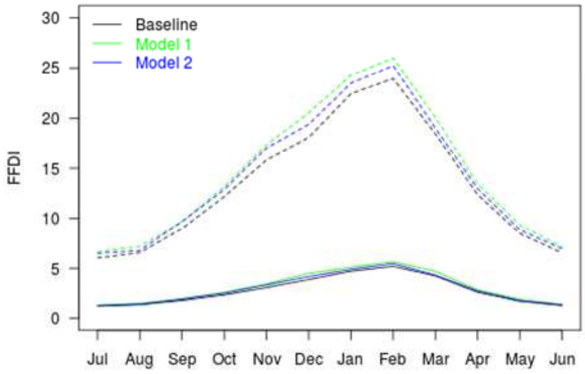
Effects in change in stocking and fertiliser application on production and mortality

Site C: Modelling suggests reducing the number of sph from 1000 to 800 resulted in a drop in production (3%) but mortality was reduced to negligible levels. Fertilising increased growth by 10% for the 800 sph treatment, and 8% for the 1000sph treatment.

Fire Danger

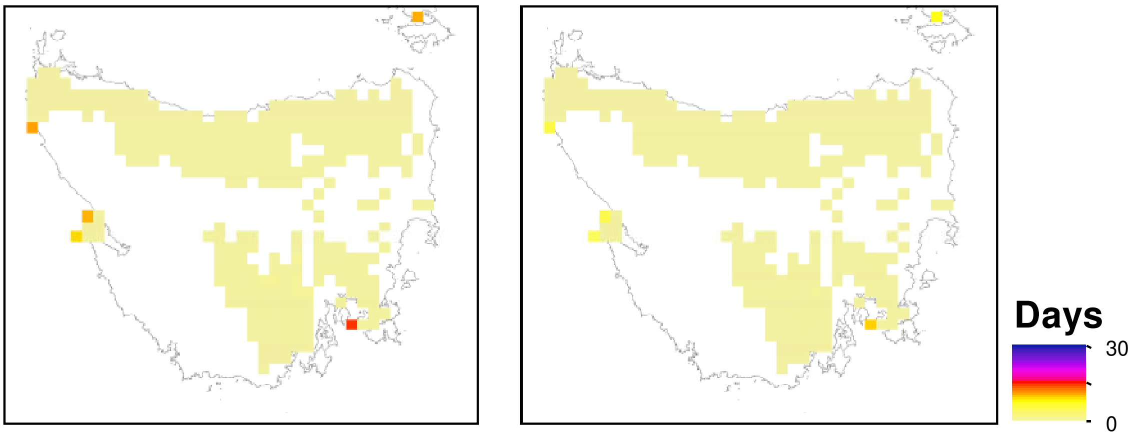
Fire

FIRE DANGER: Median and 99% FFDI for Tasmania



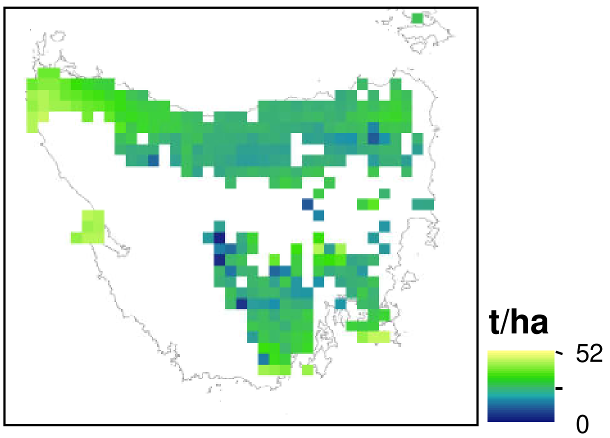
- Fire danger is characterised using the Forest Fire Danger Index (FFDI)
- Tasmania has the lowest fire danger of all regions and relative changes are predicted to be small
- Small increases in median FFDI from October to March are possible but values are so small that it difficult to make a robust assessment

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



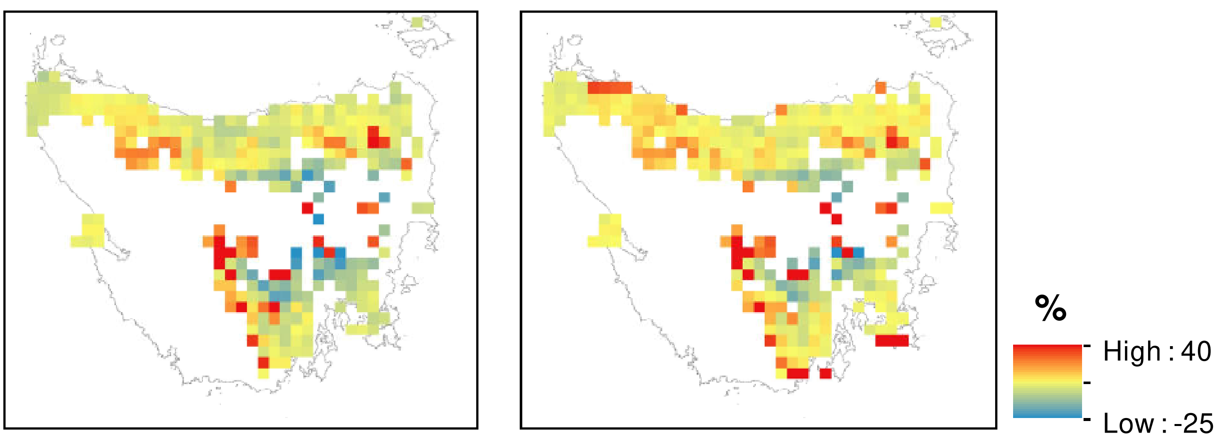
Fuel loads

Current litter fuel load

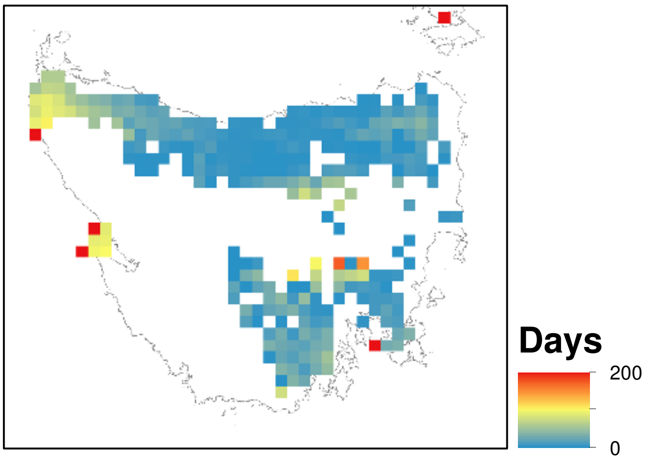


- Current fuel loads range from 3 – 47t ha^{-1}
- Litter amounts are projected to increase by around 7% overall by 2030
- The largest increases are predicted to be in the cold, high rainfall inland regions (15 to 25%) and the biggest reductions in the dry central zone (-10 to -20%) and the northern coastal regions in the worst case.

Change in litter fuel load for the worst case (left) and best case (right) climate change



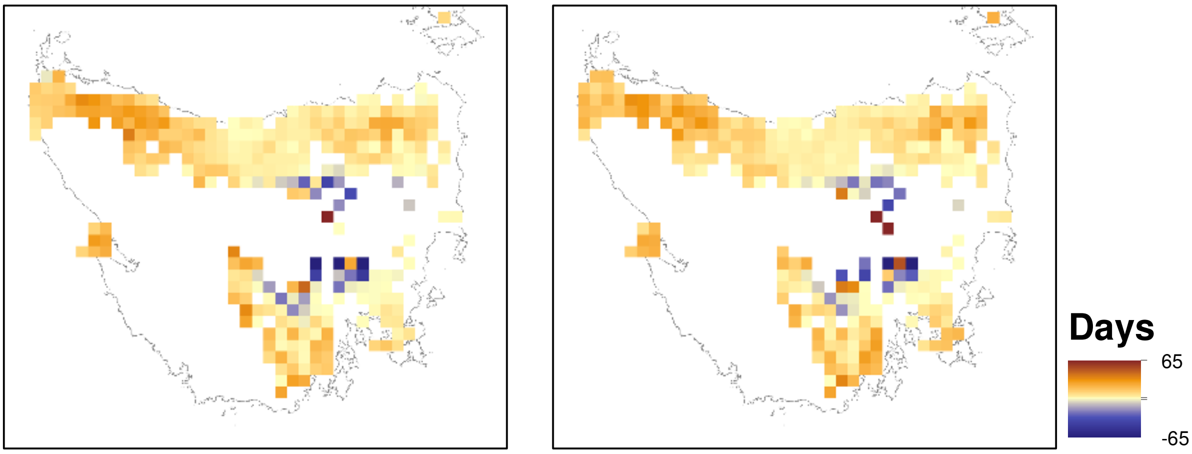
Current number of potential fire damage days



•Days with potential fire intensity >4000 kWm[-1] are likely to be difficult to suppress and cause significant damage

•Damage will occur at lower intensities but only smaller areas are expected to be affected

Change in damage days for worst case (left) and best case (right) climate change



•Average number of fire damage days under current climate are higher than fire danger days, because of the influence of litter amount on fire intensity.

•Inland areas of Tasmania and central northern regions have low numbers of fire damage days (0-10 days) while parts of the north west and south east areas have a higher risk (50-90 days) – FFDI is relatively uniform across Tasmania

•The number of fire damage days is projected to increase by 2030 across most regions, in particular the north west (15-30 days) north east coast (10-25 days) and the southern regions (5-25 days).

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

Pests: Production

Pests

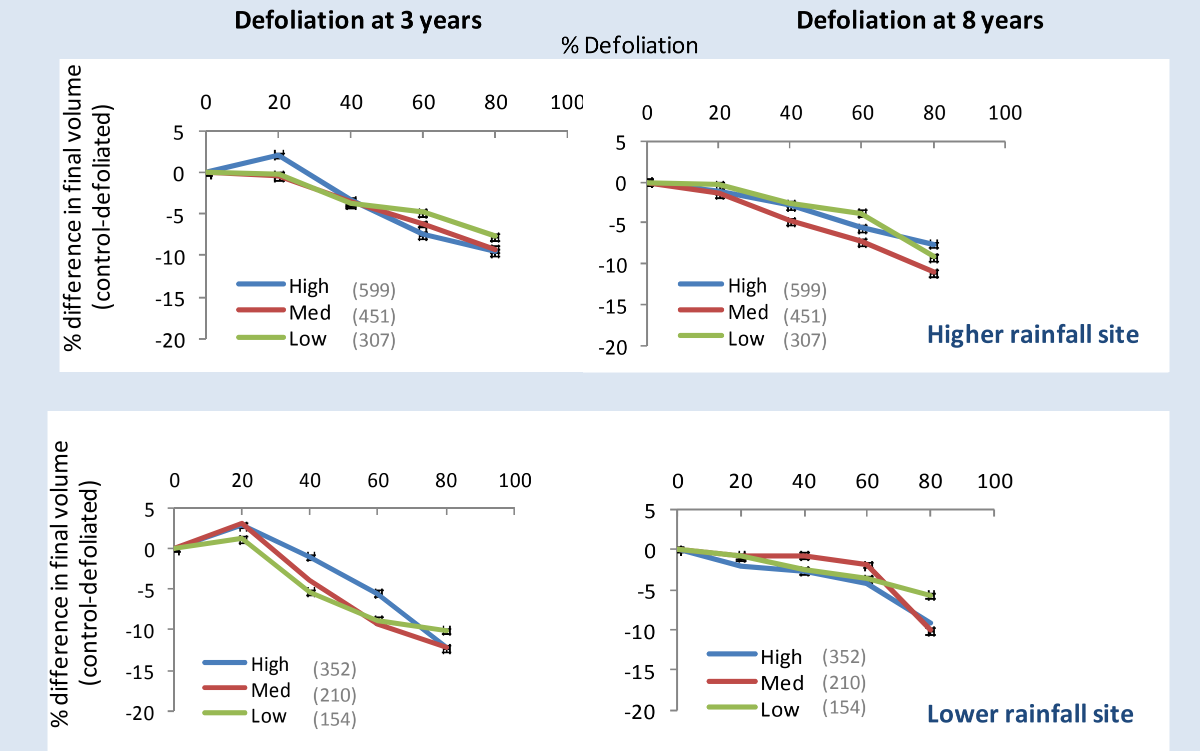


Figure 11. Effect of a single early (3 years)- or later (8 years)-age defoliation event on final stand volume,(age 15) for a wetter and drier site. The more negative the number, the larger the impact. High, med and low indicate site fertility levels. Numbers in brackets indicate predicted final stand volume in the absence of defoliation.

Pest damage may amplify negative effects of climate change on stand productivity. Defoliators are the main pest types in the region (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 be around 10% at these sites (~15-60 m3/ha), with greatest impact occurring with high defoliation . Fertility or rainfall may not have a large effect on defoliation responses (Figure 11)
- We anticipate considerable between-site variability in responses
- Both early and later age defoliation may have significant rotation-length impacts (
- Multiple defoliations will have a substantially greater impact on volume than single events, particularly at higher rainfall sites.

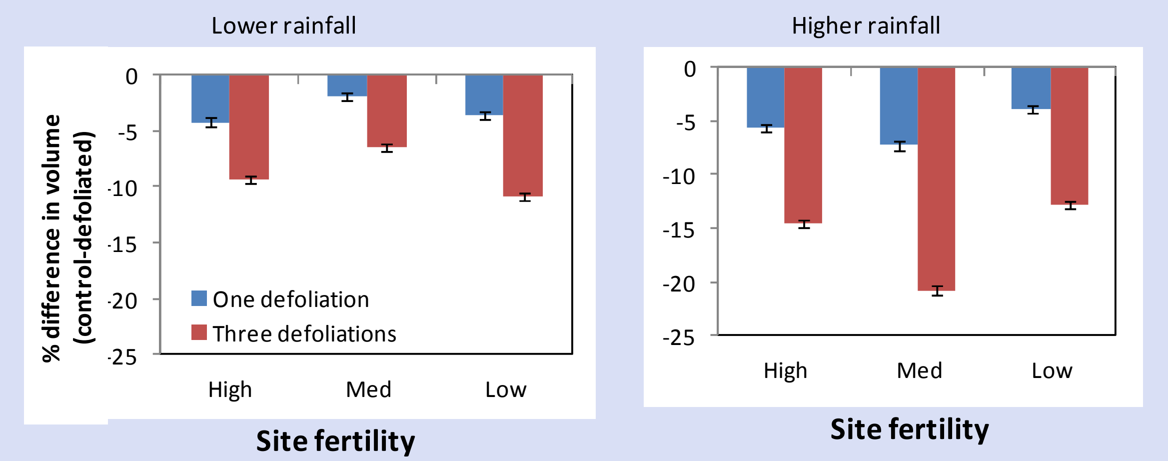


Figure 12. Rotation-length effects of single versus 3 60% defoliations starting at age 8, for a lower and higher rainfall site and three fertility levels

Table 2. Possible effects of climate change on abundance of current key pests in the region

Key pests	Damage type	Damage age	Warmer temps	heatwaves	Drought	Storms
Eucalypt weevil	Defoliation	All	↑generation ↓mortality	↑mortality		
Autumn gum moth	Defoliation	Seedlings and young trees	↑generation ↓mortality	↑autumn adult emergence		
Eucalypt beetles	Defoliation	All	↑generation ↓mortality	↑mortality Shorter diapause		
Gum leaf skeletoniser	Defoliation	All	↑generation ↓mortality			
Septoria leaf blight	Defoliation	All	↑spores and growth if also higher humidity		↓spores and growth	↑spores and growth if also higher humidity
Mycosphaerella leaf disease	Defoliation	Pre canopy closure	↑spores and growth if also higher humidity		↓spores and growth	↑spores and growth if also higher humidity
Eucalypt stem borer	Stem damage	Post canopy closure			↑abundance	↓abundance
Phytophthora cinnamomi	Root damage	<2 years of age	↑lifecycles per season		↓spores and growth	↑lifecycles per season

- **The main pests damaging eucalypt plantations in this region are defoliators**
- **Defoliating insects and stem borers are likely to be favoured by warmer mean temperatures but generally not by heatwaves**
- **Stem borers are attracted to stressed trees and may interact with drought stress**
- **Foliar diseases will be favoured by warmer mean temperatures but increasing droughts will likely reduce the abundance and distribution of these pests**
- **Root diseases will be favoured by warmer temperatures and more frequent storm events**
- **Management strategies to control defoliation impacts are limited (Table 3), and include fertilising to promote crown recovery, thinning and monitoring/controlling insect populations**

Table 3. Possible management strategies for reducing the impacts of pests on stand productivity

Damage type	Management strategy	Comments
Defoliation	Fertilise to promote crown recovery	May increase drought mortality risk
Stem damage	Thin plantations to manage drought stress	Can help manage drought risk
All	Monitor populations and control when populations are high	Requires understanding of threshold population numbers for risk monitoring and modelling

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. 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 10 year rotation planted at 1000 stems/ha, an initial fertiliser application of 50 kg/ah urea, and no further silviculture except an at-planting fertiliser application. 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, 4-5 climate models, 3 timeframes and 20 planting dates. The number of surviving rotations out of 20 was calculated to estimate probability of mortality occurring, and the mean stems/ha at the end of surviving rotations was calculated. For all combinations, the model was run assuming either no acclimation or full acclimation of photosynthesis to higher atmospheric CO_2 concentration, reflecting the high uncertainty around how plantations will respond to higher CO_2.

FIRE: Fuel loads were calculated as the litter load estimated using CABALA. Weeds or debris on-site were not included. 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 5 eucalypt 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 initial spacing or fertilising might be used to manage drought. Effects on final stand density, probability of stand mortality, 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

Whetton, P., Hennessy, K., Clarke, J., McInnes, K., Kent, D.S., 2012. Use of Representative Climate Futures in impact and adaptation assessment. Climatic Change 115, 433 - 442.

McVicar, T.R., Van Niel, T.G., Li, L.T., Roderick, M.L., Rayner, D.P., Ricciardulli, L., Donohue, R.J., 2008. Wind speed climatology and trends for Australia, 1975–2006: Capturing the stilling phenomenon and comparison with near-surface reanalysis output. Geophysical Research Letters 35.

Other project outputs

FINAL PROJECT REPORT

Pinkard E, Bruce J, Battaglia M, Matthews S, Drew D, Downes, G (2014). Adaptation strategies to manage risk in Australia's temperate plantations. Final report to FWPA prepared by CSIRO, and available at:

http://www.fwpa.com.au/rd-and-e/resources/418-adaptation-strategies-to-manage-risk-in-australia-s-plantations.html

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 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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