Forestry

The forestry sector has a different vulnerability profile to many other primary sectors given its slower biological response rate and long harvest cycle. Forestry, like most other agribusiness, will have to overcome potentially significant climate-induced impacts on its operations over the next 100 years in order to continue to maximise profitability and growth, and to minimise environmental impacts.

Climate change exposes forestry to some extreme risk and established forests have fewer options for adapting to a change climate, due to current levels of investment.

Adaptation options for future forests are mostly transformational, with typical options promoting better, more resistant tree species matched to site-specific risks and environment.

With higher concentrations of $C^{O}2$, radiata pine productivity is expected to increase by an average of 19% by 2040 and 37% by 2090.

Wind, Fire and Invaders

Direct climate impacts are largely positive for tree growth. However, storms, wind and fire can seriously affect mortality and timber production, as can result in direct and indirect climate-induced changes to the wider forest ecosystem.

Wind is a significant physical risk to forests. The degree of risk relates to a stand's vulnerability to toppling or breakage. Moderate increases in wind speed will not unduly affect many stands with a high critical wind speed, but vulnerable stands will be susceptible to small changes in the wind climate.

Fire risk arises from the combination of weather, ignition sources and fuel. Climate change can alter the frequency, intensity and activity of fires, extending both the fire season and area burnt. Increasing temperatures, higher wind speeds, and lower rainfall and/or humidity will see fire risk increase.

Browsing insects and pathogens have potential to reduce productivity and degrade trees. Changes in temperature and rainfall can prompt sudden expansions in pest populations and their habitable range. Climate can influence the growth and development of natural predators of pests, with consequent flow-on impact.

Weeds are expected to respond to increases in temperature and CO_2, subject to constraints from rainfall and nutrient availability. Overall, this will probably result in warm-adapted weeds colonising new locations and current 'sleeper' species could become more of a problem. Wider weed distribution, and more aggressive growth, will increase competition with trees for nutrient and water resources, and probably lower stand productivity.

Table 1: Potential climate impacts on selected forest operations and generic risks.
Ticked items (✓) are the main climate drivers of risk and impacts.

Forest operations	Increasing temperature	Increasing rainfall	Decreasing rainfall	Increasing wind	Increasing wind and rainfall	Increasing CO2 concentrations
Site selection	✓	✓	✓	✓	✓	
Species selection		✓	✓	✓	✓	
Establishment	✓	✓	✓		✓	
Silvicultural and forest management				✓	✓	
Fire management	✓	✓	✓	✓		
Pest and Disease Management	✓	✓	✓	✓		
Weed Management	✓	✓	✓			✓
Forest operations (infrastructure and harvesting)		✓			✓	
Estate planning						✓
Generic Risks						
Productivity risks						
Ecosystem services		✓		✓	✓	

Sources of adaptation options are Pinkard et al. (2010) and Seppala et al. (2009)

Further Information

The full technical report, *Forestry. Long-term adaptation of productive forests in a changing climatic environment* can be downloaded from http://www.climatecloud.co.nz/CloudLibrary/2012-33-CC-Impacts-Adaptation_SLMACC-Chapter7.pdf

The following articles provide further information for forest managers:

- *Future proofing plantation forests from pests*. MAF Technical Paper No: 2011/42. http://www.climatecloud.co.nz/CloudLibrary/2011-42-Future-proof-plantation-forests-from-pests.pdf
- *Future Forest Systems*. MPI Technical Paper No: 2012/40 http://www.climatecloud.co.nz/CloudLibrary/2012-40-Future-Forest%20Systems.pdf