Quantifying Water Savings with Windbreaks

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Windbreaks, or shelterbelts, are common features of flat agricultural landscapes subject to high winds. The reduction in wind speed is a function of their porosity, location, height, and distance from the windbreak. Windbreaks not only reduce potential wind erosion; they also reduce crop evapotranspiration (ET) and provide shelter for livestock and crops. In the Canterbury plains of New Zealand there are over 300,000 km of windbreaks which were first implemented as a soil conservation strategy to reduce wind erosion of prime agricultural land (Price, 1993). Agriculture in the region has since changed to irrigated pasture cultivation for dairy production and windbreaks are being cut down or reduced to heights of 2 m to allow for large-scale center-pivot irrigation schemes. Although soil erosion is no longer a major concern due to permanent pasture cover, irrigation water is supplied from limited ground and surface water resources and thus the effects of wind on irrigation losses due to spray evaporation and increased ET are of significant concern. The impact of reducing windbreaks needs to be understood in terms of water resources use.

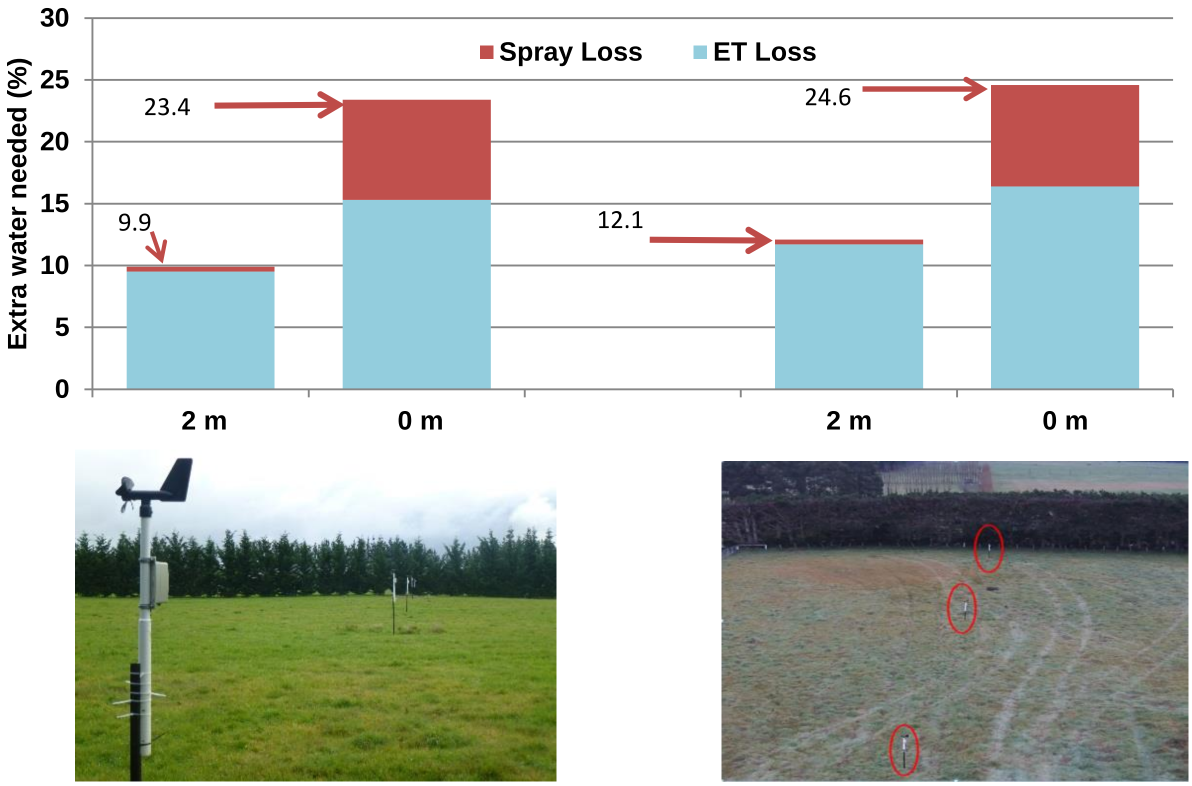

Figure 1. Estimation of extra yearly irrigation water needs due to windbreak height reduction at two example sites with original windbreak heights of 6 and 8 m of different porosities.

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Experimental and theoretical work was conducted to quantify the reduction in wind speeds by windbreaks and in spray evaporation losses. A temporal and spatial model was also developed to quantify the impact of single and multiple windbreaks on irrigation water losses. Wind speed measurements, spray loss experiments, and estimations of ET at two locations in the Canterbury plains resulted in estimations of irrigation water needs with existing windbreaks, without any windbreaks, and with use of only 2 m high windbreaks (Figure 1). Irrigation needs increased by up to 25% without windbreaks. Wind speed, air temperature and relative humidity all had considerable impact on spray evaporation losses; estimated losses ranged from less than 1% to 67% for 5 and 0.2 mm droplet sizes, respectively. Initial spatial modelling results showed that for the hot windy dry conditions in Canterbury, ET can increase significantly when windbreaks are reduced to 2 m in height (Figure 2). ET can be reduced by up to 30% in the windbreak leeward zone relative to ET in areas not protected by windbreaks. Potential reduction in ground and surface water resources use for irrigation can be significant if windbreaks are maintained by using irrigation systems that can be adapted to work within windbreaks.

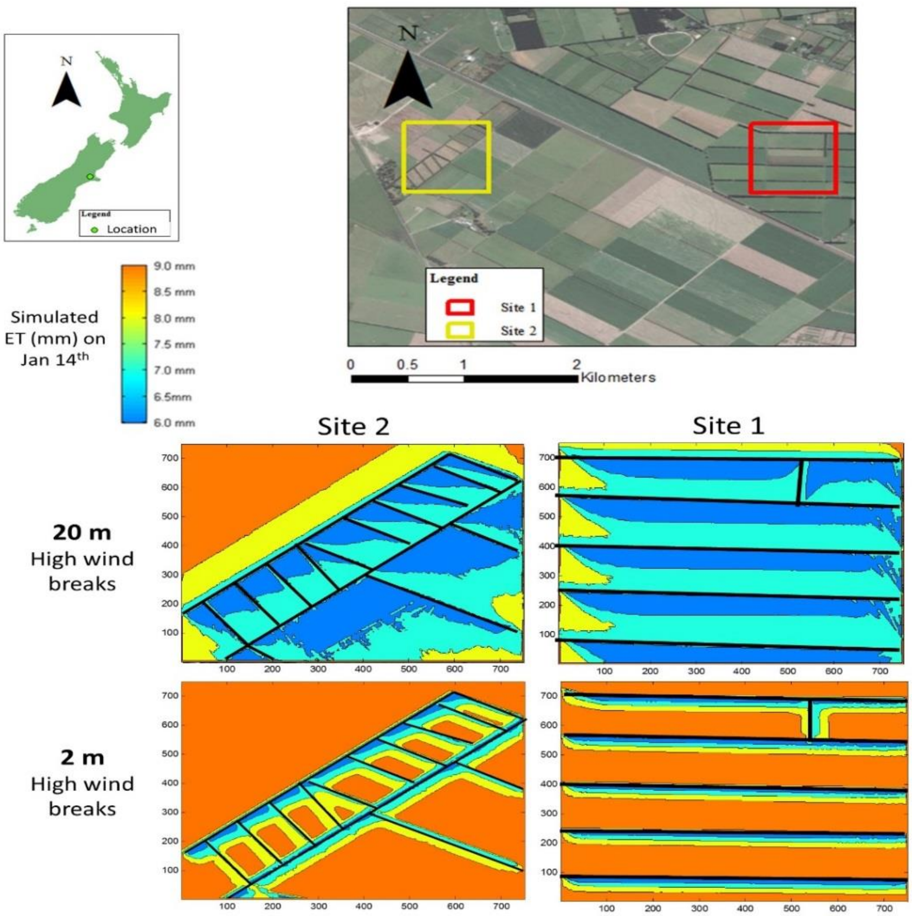

Figure 2. Model simulations showing impact of windbreak height on ET for a particularly hot day in the Canterbury plains (Modified from: Grierson, M.J. and P.T. Rodgers, final year project, Natural Resources Engineering, University of Canterbury).

References

Price, L.W. 1993. Hedges and shelterbelts on the Canterbury Plains, New Zealand: Transformation of an antipodean landscape. Annals Assoc. Amer. Geog. 83(1): 119-140.