Ecosystem water use efficiency in an arid shrubland in Chile under natural and afforested conditions

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Quantification of ecosystem water-use efficiency (WUEe) in natural and managed ecosystems is important to address uncertainties related to the effects of global warming and land use change. This is especially important in arid ecosystems, where the impacts of these processes are expected to be high. We continuously measured net ecosystem production (NEP) and evapotranspiration (ET) in an arid shrubland in the Coquimbo Region of Chile, during 30 months (May 2008-October 2010), using a Bowen Ratio Energy Balance tower. A second tower operated for two months in 2009 on an adjacent shrubland site that was planted in 2005 with *Acacia saligna* (a fast-growing non-native legume tree species). Prior to planting, the soil was ripped and mounds of soil were formed to increase soil depth and improve water retention. WUEe was defined as NEP/ET (mmol CO_2 mol^{-1} H_2O), considering only daytime data.

The results showed that although annual precipitation was very low (average 148 mm), the natural site was a net sink of carbon most of the year, reaching maximum positive NEP (towards the ecosystem) of 1600 mmol CO_2 m^{-2} d^{-1} (70 g CO_2 m^{-2} d^{-1}). ET reached a maximum of 210 mol H_2O m^{-2} d^{-1} (3.8 mm d^{-1}). There was a lag between the times when the maximum CO_2 and H_2O fluxes were observed. Precipitation events

occurred only during the winter, creating greater water availability in the soil, which could not be used so efficiently by vegetation because some species were leafless, while other species were less active due to lower temperature. This resulted in maximum ET values in early September (end of winter), whereas NEP reached its maximum near the end of December (early-summer). WUEe series followed that of NEP, which was similar to patterns observed in other studies, where high WUEe concided with periods of high water stress. WUEe in the natural site reached a maximum of 17 mmol CO_2 mol^{-1} H_2O, which is high compared to values observed in other studies. During the comparison period, WUEe reached a maximum of 15 mmol CO_2 mol^{-1} H_2O on the natural shrubland site, which was much higher than the 5 mmol CO_2 mol^{-1} H_2O observed on the afforested site. This was explained by increased NEP and slightly lower ET levels in the natural condition site. The decreased NEP in the afforested site was likely due to the lower shrub cover caused during the soil preparation process prior to planting *A. saligna*.