EGU2020-6192, updated on 17 Oct 2021
https://doi.org/10.5194/egusphere-egu2020-6192
EGU General Assembly 2020

Demonstrating sustainable land management and delivering multiple environmental, economic and social benefits in Australian pastoral systems.

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Globally, grazing systems have been consistently implicated in land degradation as reflected by changes in woody cover, soil degradation and losses of biodiversity. Pastoral systems can be a major contributor to global greenhouse gas (GHG) emission or a low-cost carbon sink for climate mitigation. In Australia, the $AUD 2.55 billion Emissions Reduction Fund (ERF) is the centre piece of climate policy and has resulted in >3.8 million ha of land use change. Traditional pastoral systems are now including management which increases carbon pools in vegetation (regeneration of native vegetation in rangelands) and soils (regenerative pasture management to increase the amount of soil biomass and limit soil disturbance). The scale of this land-use change is providing an unpredicted opportunity to deliver multiple ecosystem services, or core benefits (production of food and fibre, carbon sequestration and reduced loss of soil carbon). While there is increasing anecdotal evidence that regenerative agricultural practices results in increased farm profitability and greater wellbeing, there are key uncertainties around their potential to deliver multifunctional landscapes and contested views on the magnitude of these changes and opportunities. A major uncertainty revolves around climate impacts on carbon sequestration.

We provide two case studies which explicitly incorporate carbon sequestration and regenerative management practices and have the potential to deliver multiple environmental, economic and social benefits; (i) using a rangeland carbon farming example, we show how income from carbon sequestration in vegetation, re-directed to managing of grazing intensity, is leading to greater ecological and social resilience. Additional value of these carbon farming areas through ecological thinning and the use of woody residue for biochar production represents further mitigation potential as well as increased benefits in habitat for biodiversity (ii) using a temperate grazing system, implementing regenerative agricultural practices which reduce the amount of soil organic matter decline through minimal disturbance and pasture management may increase soil organic carbon. For each case study, Land Use Trade-Offs (LUTO) model, a high-resolution integrated environmental-economic model, is used to illustrate spatiotemporal dynamics of land-use options, quantify the magnitude of trade-offs adjusted for future climate impacts and assess farm-scale land use prioritisation and optimisation for multiple benefits. We identify land management

practices that increase carbon sequestration (vegetation and soils) and realise opportunities for additional farm income are integrated with sustainable land management.