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Cap and trade policy for managing water competition from potential future carbon plantations

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ABSTRACT

Carbon sequestration from reforestation can play a large role in mitigating global climate change. However, resulting interception of rainfall runoff may impose high irrigation, water supply and/or environmental flow costs. This article presents an assessment of water trade policy to manage fresh water supply, carbon sequestration trade-offs for the Murray-Darling Basin. A linked Australian high spatial resolution land use and global integrated assessment framework evaluated plausible and internally-consistent global scenarios to 2050 involving significant carbon planting incentive. Substantial flow loss from increased interception was estimated absent policy to balance carbon water trade-offs. Absent policy to address the trade-off, irrigation opportunity costs was estimated to substantially exceed carbon sequestration economic value in futures with significant carbon sequestration incentive. The value of integrating interception from new carbon plantings into the existing water trade system was estimated at $3.3 billion and $2.0 billion (2050 annual value) for our strong and moderately strong global climate action outlooks with our reference case assumptions. The conclusion that trade provision in policy to cap interception impacts can produce significant benefits in scenarios with significant carbon sequestration incentive remained robust over a very broad set of sensitivities tested with benefit estimated at over $1 billion annually at 2050 even for very conservative assumptions.

1. Introduction

Significant potential exists for carbon emissions abatement through incentive to encourage reforestation of agricultural land (Bryan et al., 2014; Benitez and Obersteiner, 2006; Lubowski et al., 2006). However, significantly reduced water supply for human uses and the environment can result (Egginton et al., 2014; Bryan et al., 2015a). This is because forested land intercepts and evapotranspires more water than land covered with crops, shrubs, or pasture (Brown et al., 2007; Chu et al., 2010; Farley et al., 2005). Carbon-water trade-offs resulting from reforestation incentive are most challenging and most evaluated in semi-arid regions where greater proportional runoff reductions result compared with higher rainfall environments (Jackson et al., 2005). An example is the 872,000 ha of forest establishment estimated to reduce water availability by 8% in the southern Murray-Darling Basin in response to a $100/t carbon price (Schrobback et al., 2011). Similar trade-offs have been identified in the Fynbos ecoregion, South Africa (Chisholm, 2010), in individual sub-catchments within the Murray-Darling Basin (Bathgate et al., 2009; Nordblom et al., 2010; Nordblom et al., 2012), and in semi-arid parts of western China where major afforestation has taken place over the past decade (Gao et al., 2014). Carbon-water trade-offs from reforestation can also arise in higher rainfall areas such as New Zealand in locations where intercepted runoff would otherwise provide irrigation water supply (Dymond et al., 2012).

Despite recognition of the need for policy to manage carbon forest competition for water (Egginton et al., 2014; Calder, 2007; Young and Mccoll, 2009), actual policy to address the issue has been limited to date and implemented primarily through land use regulation. For example, in South Africa, new plantation forests require a permits which are only approved after investigation and agreement by relevant State agencies that stream flow impacts are acceptably small (Kruger et al., 2008). Zoning of where carbon forest incentive policy is allowable is another land use regulation approach. For example, the latest Australian carbon farming incentive policy defines zones where historic average rainfall exceeds 600 mm per annum as not eligible for carbon sequestration incentive payments because of the potential for significant run-off interception (Australian Government, 2015). A challenge with regulatory approaches like those implemented in South Africa

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is the time, effort and cost of the bespoke individual investigation and approval requirements. This can lead to very limited land use change, even where it may be possible without unacceptable negative consequences (Kruger et al., 2008). Zoning approaches like those implemented in the Australian carbon farming initiative overcome this transaction cost impediment. However, these are blunt instruments which coarsely target high interception impact land. In some cases reforestation of significant areas within the 600 mm per annum rainfall zone may have little consequential impact on runoff (Van Dijk et al., 2007).

Cap and trade policy could be a more efficient approach to address water trade-offs arising from carbon reforestation incentives. The approach has been effectively used to manage common pool resources including sulphur dioxide emissions (Schmalensee et al., 1998), carbon emissions (Paltsev et al., 2008; Grubb, 2012), and water diversions in several western US states (Lane-Miller et al., 2013), Spain (Kahil et al., 2015), Chile (Hearne and Easter, 1997), and in the Murray-Darling Basin (Kirby et al., 2014; Grafton and Horne, 2014). Applied to forest water interception, the approach would effectively cap the total effect on river flow of withdrawals for irrigation and interception from reforestation. New forests would need to compete for water via the purchase of water rights from regional irrigators who draw on the same water resources that would be impacted (NWC, 2011). The approach has the advantage that it could maintain a balance between benefits of climate mitigation from carbon sequestration and resulting water supply opportunity costs in a way that dynamically adjusts to evolving and uncertain land and water supply and demand drivers (Young and Mccoll, 2009).

In this study, we assessed potential for increasing carbon planting area to reduce runoff and river flows for the Murray-Darling Basin, Australia. We considered two global outlooks with growing carbon price and continuing Australian national policy incentive for carbon sequestration and three policy approaches to address carbon planting water interception. A no cap scenario considered a future without any attempt to limit flow losses from carbon planting water interception. Two cap scenarios evaluated policies to address reduced flow from additional interception. One cap policy scenario included the flexibility of a trading mechanism: this required landholders changing from current agricultural land uses to carbon plantings to purchase water rights from current irrigation water rights holders for the water intercepted. The other cap policy scenario included no water trading: flow balance was maintained by reducing irrigation water supply by the amount of growth in interception from new carbon plantings. We assessed the potential impacts of the three policy scenarios on land use, water use, carbon sequestration, and economic returns; mapped the spatial patterns of land use change; and undertook sensitivity analysis of the outcomes to variations in key parameter driving outcomes.

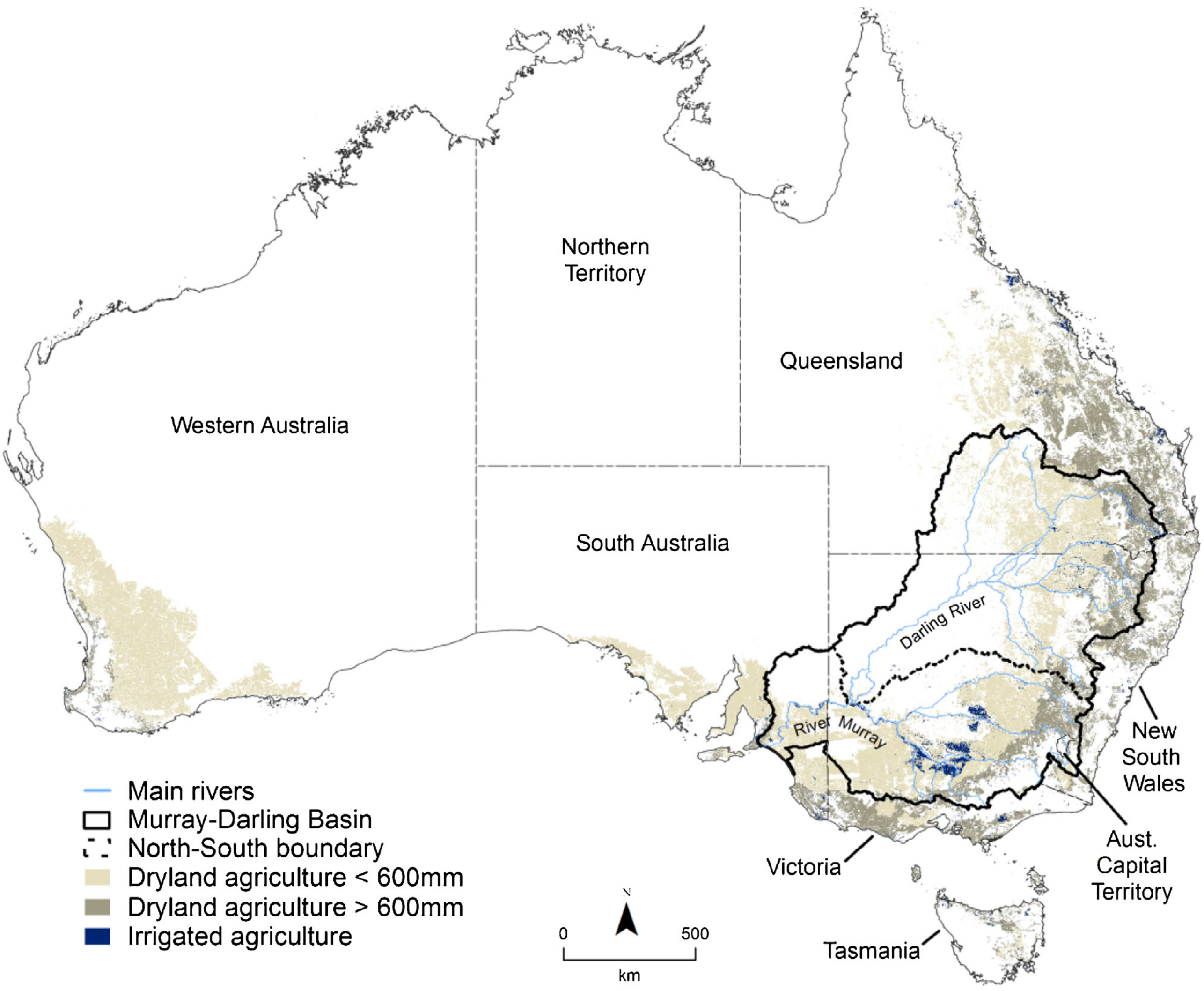

Fig. 1. Murray-Darling Basin study region.