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Water markets and soil salinity nexus: Can minimum irrigation intensities address the issue?

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ABSTRACT

Agricultural water markets can facilitate adjustments to water scarcity and competition and enhance economic efficiency, but markets cannot automatically balance efficiency, equity and environmental sustainability goals. The consequences of water trading on soil salinity in irrigation areas are not yet fully understood, but recognized as an issue that needs to be analysed. This paper explores the nexus between water trading and groundwater-induced soil salinity in a selected irrigated area in the Murray-Darling Basin. Results show that minimum irrigation intensities must be met to flush salts out of the root zone especially in shallow water table/high salinity impact areas. Such minimum irrigation intensities are helpful but not necessarily in deep water table/low salinity impact areas. Should water markets lead to permanent water transfers out of mature irrigation areas, minimum irrigation intensity needs might not be met in high salinity impact areas, causing substantial negative impacts on resource quality and agricultural productivity. Water trading that adds to salinity cannot be economically viable in the long run. The tradeoffs between water trading and environmental and equity goals need to be determined. This work contributes to the wider debate on Australian water policy aimed at achieving water security through water trading in the Murray-Darling Basin.

1. Backdrop

> “the discovery [of salinity] was certainly a blow for which I was not prepared” (Sturt, 1833: 1, 83).

> “[The] water trading as a foundation in maximising the profitable and sustainable use of water, while protecting the environment and catering for social needs” (MDBC, 2006).

These epigraphs and their authoritative authorships – first by the European explorer, Charles Sturt, who first found the waters of the Murray-Darling River to have a high salt content; and the second the vision statement by the Murray-Darling Basin Ministerial Council, the interstate Australian government mechanism for managing the basin on a sustainable basis – canvass the origins of the salinity issue and current thinking to its management in Australia.

Irrigation development in Australia dates back to late 1880s. The Mildura Irrigation Colony was the first scheme established on the Victorian side of the Murray River in 1887 (Proust, 2003). The first drainage and salinity problems appeared in 1891 as the soils were ‘second class’ or strongly alkaline. Pseudo irrigation schemes were initiated in the 1890s in New South Wales. The Murrumbidgee Irrigation Scheme was the first intensive irrigation project in Australia. The

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scheme officially opened in June 1912 when water was first made available in the Yanco irrigation area (Blackmore, 1995). Inexperienced farmers tended to over-irrigate crops. Rising watertables and waterlogging became evident by 1914, prompting the first government inquiry into the scheme. The issue covered a wide area by the 1920s, and the first signs of surface salinity appeared in 1931 (Proust, 2003).

Salinity and waterlogging reduce crop yields and degrade the productivity of agricultural land in many irrigated settings (Conyers et al., 2008; Khan and Hanjra, 2008; Khan et al., 2008a; Wichelns, 1999, 2005; Wichelns et al., 2002). Today irrigated agriculture covers about 2.332 million hectares (Mha) and contributes just over a quarter of the value of agricultural production in Australia or about $9.6 billion per annum (Khan et al., 2006). The Murray-Darling region accounts for about 70% of irrigated agriculture in Australia. Irrigation practices contribute a significant portion to the estimated $46 million per annum cost of salinity in the Murray River (Duke and Gangadharan, 2005). Salinity in dryland cropping areas costs the Australian farming economy about $1330 million per year (Rengasamy, 2002). Worsening salinity extent and severity are estimated to have a net present value impact of $712 million to $946 million during 2000–2020 (Hajkowicz and Young, 2005) (all monetary values reported in this paper are in Australian dollars, A$1 = US$0.94 in April 2008). Salinity has numerous economic impacts on agriculture and other industries, but the focus here is limited to decreased crop and pasture yields and the cost of perennial revegetation for salinity control. These estimates reveal the attractiveness of returns to salinity managing investments. The direct costs and environmental impacts of salinity can be substantial (Wichelns and Oster, 2006), while the non-market benefits of salinity management, such as maintaining biodiversity, are often ignored.

Early irrigation developments were supported by public investments in infrastructure, to help boost agricultural exports and settlement in rural Australia. The model promoted low return irrigated agriculture, with low irrigation efficiency. The initial allocation of water was tied to the land, effectively preventing water reallocation to higher valued uses. Farmers therefore faced a perverse incentive to over-irrigate, as higher yield often came with greater use of water. Consequently water diversions from the river system rose dramatically until the middle 1990s. A 1995 water audit showed that continued growth in diversions in the basin would exacerbate river health issues, diminish the security of water supply for existing irrigators, and reduce the reliability of water supply during droughts. Hence a volumetric limit was imposed on water diversions from the entire river system for any consumptive use (MDBC, 2006). The river diversions across all the Murray-Darling Basin were 'capped' at the 1994 level of development. The water diversions corresponding to the 1994 level are about 11,500,000 ML, excluding urban water supplies of about 650,000 ML to Adelaide city (Khan, 2008; Khan et al., 2008b). The cap on water diversions pertains to the entire Murray-Darling Basin, and thus the cap effectively limits any increase in water diversions. The cap does not limit new developments where water requirements can be met by more efficient use of existing allocations or by water trading within existing irrigation areas (Crase et al., 2004). At a broader scale, pilot studies are underway for interstate water trading (Fig. 1) involving New South Wales, South Australia and Victoria.

The objective of the cap was to achieve a balance between the economic and social benefits of water resources development and the provision of water for ecological needs. This development was accompanied by the unbundling of water rights from land titles and the establishment of a water market (Topp and McClintock, 1998). The cap on diversions, unbundling of water rights, and the prolonged drought and scramble for water further intensified the need for effective water markets. In 1992 the Council of Australian Governments (COAG, 2003) envisioned the need to promote efficient and sustainable use of water resources in Australia. Water markets were introduced in many states as a tool for reallocating water to its most efficient use (Bjornlund, 2003; Bjornlund and Rossini, 2007; Brennan and Scoccimarro, 1999; Crase et al., 2004; Topp and McClintock, 1998).

Water markets can boost productivity by reallocating water from low to high valued uses and by enhancing the availability and reliability of water supplies. The economic gains from water trading within an individual water district may be relatively modest, while inter-district water trading can generate substantial economic gains (Bjornlund, 2004; Brooks and Harris, 2008; Peterson et al., 2005). Water trading policy must acknowledge third party effects of trading that result from changes in return flows. Those impacts can include declining economic activity in the districts of origin, impacts on equity and welfare of the local population, lower returns to irrigation infrastructure and other fixed investments, and impacts on salinity and overall health of the river system (Easter et al., 1999; Etchells et al., 2006).

Water markets can lead to substantial environmental externalities due to hydrological and environmental constraints and thus have the potential to alter flow regimes and impact surface and groundwater salinity levels and riverine environments, particularly where permanent and large transfers of water upstream are involved. For instance, a 30-fold increases in the magnitude of salinity is likely as water trade moves water from a low impact zone – where groundwater moves slowly towards the river, to a high impact zone – where salt additions to the river system per unit of water use are greatest (Duke and Gangadharan, 2005). Interstate water trading should not result in reductions in environmental flows, degradation of the natural environment, or increased levels of salinity. Rather, water markets should ensure that each transfer is at least salinity neutral, having no salinity impact.

2. Issues under study

The transfer of water to different locations or to new irrigation development can affect salinity levels in the river system in three ways. First, transfer of water entitlements changes the volume of water in the river system at different reaches. This would affect the river's dilution capacity and change the salinity concentration in the water. Second, expanded or new irrigation developments can increase or decrease the amount of saline drainage water that enters the river system. Third,