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Editorial

Exploring some of the socio-economic realities of sustainable water management in irrigation: An overview

Water scarcity is one of the gravest risks facing society with 1.6 billion people currently living in regions experiencing severe water stress, a number which can potentially increase to 3.9 billion by 2050 (World Economic Forum, 2013; OECD, 2012). Current and future population growth will continue to increase demand for freshwater, while, on the supply side, freshwater resources will be impacted by climate change, and changing societal values will increase the demand to reduce the current level of extraction. Hence societies are struggling to find ways of managing water resources in a sustainable way; that is, finding ways of limiting consumptive water use to a rate at which it can continue in perpetuity, whilst minimizing negative externalities.

One of the sectors most impacted will be agriculture because its activities command the greatest share of global water use. Since the 1940s, agriculture, especially irrigation, has accounted for an increasing share of total water use and by 2000, irrigation was estimated to consume 70% of total global water use. This share varies by region ranging from 40% in countries that import food and have a developed economy, to over 95% in countries where agriculture is the primary economic activity. Irrigated land currently represents only 20% of the world's agricultural land but this has expanded considerably since the 1960s. Crop production is the largest water-consuming sector within agriculture. Rice, wheat, other cereals, roots and tubers, pulses, together with fruit and vegetables are the main irrigated crops for global food supply. Production of fibre and other industrial crops for biofuel production adds further pressure on water demand. These agricultural demands are predicted to nearly double in the next 50 years, driven by population growth and by increases in the consumption of vegetable oils and meat (UN Water, 2006). This increase in consumption is expected to be accommodated by increases in agricultural productivity, rather than by expansion of the land and water resources used for agriculture. In the past 50 years, agricultural production has grown between 250 and 300%, driven by increasing land under production, input intensification, mechanization and irrigation with associated multiple cropping (FAO, 2011). By these means, the increase in food production has managed to exceed population increase (FAO, 2007).

However, this increase in productivity has not been without negative impacts. Inappropriate and excessive agricultural water use can cause water scarcity and impact upon water quality. Farmers can incur additional costs through increased pumping due to lowering aquifer levels; borehole yield reductions; land subsidence and related impacts; aquifer compaction; and reduced water transmission. Water extraction for agriculture has environmental impacts on natural freshwater dependent ecosystems and contributes to salinity problems, sedimentation and pesticide pollution. These impacts can lead to decreasing agricultural productivity. Approximately 10% of the area under irrigation is affected by salinity, with higher percentages in arid and semi-arid zones. External water quality impacts can occur through increased use of fertilizers, resulting in eutrophication of water bodies and the development of algal blooms (UN Water, 2006). These impacts have increased environmental concern over the current level of extraction and have caused governments in many countries to stop issuing new licenses to extract water. In many other instances, steps have been taken to reduce the current level of consumptive extraction in order to meet environmental needs. Governments face a double challenge; dealing with an increase in demand accompanied by a general inability to increase supply. This raises serious policy challenges in developing ways to share existing resources that will be acceptable to competing stakeholders and to wider societal interests.

The issues discussed above illustrate the need for irrigation, and agriculture in general, to be 'sustainable' in the face of increasing water scarcity, greater food and water demand and increasing negative externalities. Sustaining irrigation is a complex concept. Sustainability is a goal that the world may strive towards but never reach as the goalposts keep changing. It could be argued that sustainability is a process rather than a fixed end-goal; an adaptive process in response to climate change, population growth, environmental knowledge and understanding, as well as to changing societal values towards water and the environment. Regardless of the open-ended nature of sustainability, there are a number of fundamental elements that shape/influence our ability to progress towards irrigation that is 'sustainable'.

This special issue is based on a conference that was held at the University of South Australia in Adelaide, Australia, in December 2012. The conference was designed to discuss and explore a range of influences associated with the socio-economics of irrigation. It is important to note that the study of economics is not solely related to financial impacts, it is also very much concerned with evaluating and measuring the larger social and environmental net benefits associated with any given action. It considers issues associated with institutional reform, property rights, environmental change, social demand, and conservation needs.

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The issue of property rights in water is of central concern. How do we design water rights in such a way that the interests of the holder of these rights are protected, while at the same time making sure the water is used responsibly and efficiently and that the changing interest of the society is also considered? While property rights have certain general characteristics, their design must reflect local contexts, which will differ significantly between developing and developed countries, as well as depending on the level of water scarcity and environmental stress.

The first three papers discuss issues related to property rights in water. The first paper by **Hanemann** discusses property rights from the perspective of a developed country. It traces the emergence of property rights in water in the United States and outlines how this history influences the issues faced by today's water managers. Hanemann discusses the synergies between collective actions, trust and property rights in the context of developing and running irrigation systems. He argues that the task of building an irrigation system is very different to that of running it. Financing and constructing the system do not require collective action and trust, but operating the system does. He argues that the complex system of property rights to water that emerged because of the way irrigation systems were created poses significant problems for the sustainability of irrigation.

The second paper, by **Meinzen-Dick**, provides a perspective on property rights from the developing world. She argues that the state is not the only source of coordination of property rights. This is especially the case in remote areas where the state has very little real capacity to implement, monitor or enforce property rights. In such settings, reliance on customary rights, together with institutions backed by shared norms and self-enforcement, water user groups and market mechanisms might all have a role to play in establishing and maintaining property rights. Meinzen-Dick stresses that there is no single optimal property right system. Rather, it is important to understand the range of options available and under what conditions each option might be successful so that property right systems can be tailored to meet the needs of the ever changing physical, social and institutional context in which they will be implemented.

The third paper, by **Young**, discusses property right structures in a changing world, primarily based on the Australian experience. He argues that implementing transformation reforms requires careful attention to detail to avoid third party impact and opposition from those with a vested interest in the current regime. He proposes a system with water sharing plans defining the consumptive pool and a re-specification of abstraction rates to be defined as a share of this pool and an unbundling of the rights traditionally incorporated into a single water right to provide water users with greater flexibility and risk management tools. He stresses that the implementation of such reform requires significant investments in the development of new administrative systems and in careful communication with stakeholders.

Once water rights are allocated to water users, formal and informal mechanisms need to be in place to facilitate a sharing of the available water that reflects changing priorities and that encourages more productive use of the consumptive pool. One option pursued in some parts of the world is to facilitate stakeholders' engagement in local decision-making processes to find mechanisms to resolve competing uses and interests in water. The paper by **Kauffman** discusses the experiences of Ecuadorian Water Trusts as vehicles to build local decision making, as well as being financial mechanisms for managing water resources in an integrated, sustainable manner, while balancing upstream and downstream interests. He finds that the Trusts have made a significant contribution by securing sustainable revenue streams, which facilitates a long-term approach to watershed conservation and thereby provides a level of political and financial security lacking in other payment for ecosystem services programmes.

A key demand management option pursued in some countries, such as the United States and Australia, is the use of economic instruments such as water markets and water pricing to encourage water to be transferred to different users. This facilitates water being put to the most productive uses. However, water markets are considered by many to have a range of negative and positive impacts. Given the growing importance of demand management mechanisms to solve water reallocation issues, there is a considerable focus in this special issue on water markets and water values. Four papers explore the use and impact of water markets and one addresses the issue of water pricing. The paper by **Palazzo and Brozovic** analyses groundwater trading impacts in Nebraska, the United States. They find that the ability of markets to reduce water users' cost of regulation, while maintaining in-stream flows, varies both within and between watersheds depending on local institutions and geophysical conditions. The paper stresses the importance of the initial distribution of permits.

The paper by **Grafton and Horne** provides an overview of water reform and water markets in the Murray–Darling Basin (MDB) of Australia and explains how the market has been used to secure water for environmental outcomes. Trading has increased significantly within the MDB over the last 20 years in response to the gradual removal of trading restrictions, improved flow of market information and the introduction of limits on total diversion. They offer 12 lessons from these experiences to assist decision-makers intending to introduce, or improve, water markets. The authors argue that markets are critical in mitigating the trade-offs between extractive water use and water for the environment. **Wheeler and co-authors** analyse the delayed impacts on irrigators from selling permanent water in the MDB and find very limited evidence of a delayed negative effect on the net farm income of the farmers who sell water entitlements, mainly because many sell unused or buffer water. Irrigators also use water trade proceeds to either improve the efficiency of their irrigation or to repay debt. However, given increasing water scarcity and predicted climate change, the paper suggests that all irrigators will have to make continued adjustment to their operations to remain viable.

Brooks and Harris explore the relationship between price and volume across two Australian water trading zones. They investigate how information is incorporated into market prices within each of the two zones and investigate whether traders within one zone have incorporated such information more quickly and therefore become a price leader, as is common in financial markets. Brooks and Harris find that the most active water market trading zone had become a price leader and suggest that this price lead–lag is caused by the different nature of production in the two areas, which creates different levels of liquidity.

Cooper and co-authors further our understanding about best practice pricing principles and the politics of water pricing in Australia. Australia's water policy reform process aims to introduce full cost recovery prices. Cooper et al. compare this objective with the recent policy effort to increase public investments in irrigation infrastructure, the cost of which is not to be incorporated into future water prices. They argue that this return to subsidizing irrigation runs counter to the spirit of the National Water Initiative which aimed at facilitating water markets, and promoting full cost recovery prices and the abandonment of subsidies. They conclude that a better understanding of the risk of political interference in water pricing in irrigation is needed.

A third approach to water sharing focuses on the planning processes to set parameters for sustainable water use at the regional or catchment scale and, based on the best available science, integrates social, cultural, environmental and economic interests. The success of such plans depends on the availability of reliable scientific