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Governing irrigation renewal in rural Australia

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Irrigation renewal schemes are taking place globally for water conservation and gains in agricultural productivity, as competition for water resources increases. The publically-funded renewal of irrigation infrastructure is a key platform of water reform in Australia's Murray-Darling Basin; it is considered by some to be a policy that contradicts market-based approaches. In this Australian study, we examine an irrigation renewal scheme in northern Victoria resulting from a large investment by the State and Federal Governments. The long historical development of infrastructure and institutions for irrigation in the region led to technological lock-in and exposure to international terms of trade and climate change. From interviews with water professionals involved in the region, three key themes were identified through an adapted grounded theory approach: (1) a lack of an appropriate platform for fostering community involvement in what was a large-scale investment of public money; (2) issues in the way that water losses and savings were calculated; and (3) contradictions in policies for water buyback and irrigation renewal that lead to some irrigators being disadvantaged. To better understand the situation, we also applied a theoretical lens based on social learning. We conclude that the framing of a water 'crisis' was used to the benefit of some irrigators in attracting large-scale investment of public funds for irrigation renewal. The proposed solution, a technologically-driven irrigation renewal scheme, was implemented at a pace that didn't match the planning horizons for many, leading many to exit from irrigated agriculture. Systemic insights for the design and implementation of irrigation renewal schemes internationally are highlighted.

Keywords: Irrigation efficiency; water governance; social learning; water policy, Goulburn-Murray Irrigation District

1. Introduction

Globally, renewal of irrigation infrastructure for water conservation is becoming more common as fresh water supplies dwindle due to increasing population, competition from other sectors, changing dietary preferences and climate change (Turrall, Svendsen, & Faures, 2010; Bogardi et al., 2012). Irrigation renewal is also implemented as a means

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for increasing agricultural yields, with the goal of producing more food with less water (Bjornlund, Nicol, & Klein, 2009). Schultz, Thatte, and Labhsetwar (2005) report that many Asian and Latin American countries will require an increase in food production on existing agricultural land to meet the demands of growing populations. They suggest such an increase is possible provided there is government support for irrigation renewal, improvements made to irrigation efficiency, water savings are achieved, and more reliable water delivery services are provided.

Designing programs for irrigation renewal that are equitable and acceptable to a range of stakeholders have proven challenging, with research indicating several factors that create resistance to renewal programs. These include concerns about high upfront costs (Seo, Segarra, Mitchell, & Leatham, 2008), an absence of consultative processes (van der Velde and Tirmizi, 2004), a lack of financial incentives for adoption (Bjornlund et al., 2009), and increased energy consumption to operate modernised systems (Rodríguez-Díaz, Pérez-Urrestarazu, Camacho-Poyato, & Montesinos, 2011; Rocamora, Vera, & Abadía, 2013). Attempts to address some of these concerns have been tried in different cases. For example, an irrigation renewal program in Spain saw the installation of channel control devices and a shift from open irrigation channels to closed pressurised pipes, with costs shared between irrigators and the government (Plusquellec, 2009). However, the criteria of success for such programs differ when viewed variously from hydraulic, economic, ecological and social viewpoints.

It is also argued that conventional approaches to irrigation renewal, where governments seek to influence irrigators' decisions to invest in modern irrigation technologies, are prone to low levels of adoption (Whittenbury and Davidson, 2009). Such approaches are characterised by technological innovations delivered by experts, such as engineers and scientists, excluding other options for non-technological improvements in water efficiency and overlooking the knowledge of irrigators. So, even when the technological and/or economic case for irrigation renewal is strong, programs can fail when they fail to account for the experience and knowledge of irrigators and the factors that influence their decisions (Whittenbury and Davidson, 2009).

The declining performance of irrigation networks is an issue in many south Asian countries, with irrigation renewal on the agenda in China and India; two of the world's largest agricultural producers (Shah, Giordano, & Wang, 2004). A comparative analysis of China and Australia concluded that while the biophysical characteristics of irrigated agriculture were similar, the governance structures for water resources management are quite different (Wei, Langford, Xia, Zhan, & Liu, 2009). However, Wei et al. (2009) suggest that a lot can be learned from the Australian experience, in particular the adoption of systemic approaches to improving irrigation efficiency. The case study presented in this paper directly addresses these systemic issues and should be applicable in most countries undergoing irrigation renewal.

In Australia, from 1997–2010 the south-eastern part of the country experienced the effects of a series of severe droughts (Wei, Langford, Willett, Barlow, & Lyle, 2011), which resulted in increasing water scarcity and a growing competition for water resources.

Water security was perceived as important for the sustainability and viability of regional areas (Schwarz and McRae-Williams, 2009). During this time, the Victorian State Government responded with an irrigation renewal program; the Northern Victoria Irrigation Renewal Project (NVIRP - later called *GMW Connections*). The renewal program aimed to improve water efficiency in a major irrigation district (Figure 1) through the modernisation of irrigation infrastructure. In brief, this involved lining major irrigation channels, upgrading water meters, installing automated flow control structures and retiring parts of the irrigation network. The program was funded in two stages amounting to over A\$2 billion, largely from public funds. The first stage was designed to save an expected 225 GL (gigalitres) of water, to be shared equally between environmental flows, agricultural production and urban water supply. The second stage was designed to save an expected 204 GL of which half would go to environmental flows (water allocated for the ecological functioning of rivers).

This Australian case study has been examined from several different research perspectives. Beilin, Sysak, and Hill (2012) explored farmer responses to the northern Victoria irrigation renewal against a background of increasing vulnerability to climate change and peak oil. From farmers' perspectives, concerns about the increase in energy use required to achieve water conservation were apparent. From a policy perspective, reliance on the technological innovation of farmers is perceived to be misguided and can result in maladaptive structural lock-in. Rochford (2012) inquired into the historical and contemporary drivers for irrigation development and renewal, highlighting the consequences of the 'rush for results', centralisation of policy, and critiquing the boundary judgements made in defining the 'backbone' on which the modernisation would occur. Wallis and Ison (2011a) explored the historical and institutional 'transitions' in the multi-level water managing

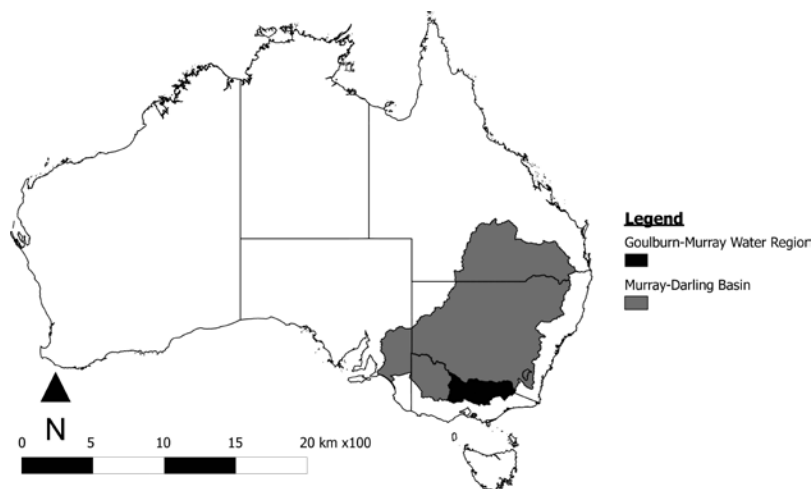


Figure 1. Location of the case study region, the Goulburn-Murray Irrigation District, within the Murray-Darling Basin, Australia.

system, highlighting this case of irrigation renewal as a prime example of a shift towards more centralised authority in state water policy. Crase, Pawsey, and O’Keefe (2013) concluded that policies for subsidising irrigation renewal are in direct conflict with water markets, and undermine the effectiveness of market-based policies for efficient water use. Wittwer and Dixon (2013) argued that public investment in this irrigation renewal case is likely to be less effective for fostering regional development than spending on education, health or other services. In this paper, we report the findings of empirical research with water management professionals involved in this Australian case, and draw out systemic insights from the governance of the irrigation renewal that can be used in future water reform projects nationally and internationally.

2. Research design and theoretical framework

Given the complexity of the northern Victorian irrigation renewal, and the highly political and dynamic context in which the program is situated, it is not possible to present an exhaustive account in one paper. This case study emerged as a line of inquiry from a broader study of historical and contemporary shifts in water governance and the role of social learning in transformative change (references de-identified). Methodologically we follow on from the earlier papers which outlined our mixed methods approach. Four strands of systemic inquiry were mentioned by (references de-identified); this paper reports the outcomes of the fourth and final inquiry.

This inquiry involved the use of a range of methods, including desktop analysis of published literature, news media and historical databases, summaries of board meeting minutes, corporate plans, annual reports, semi-structured interviews and participatory workshops. A series of semi-structured interviews were conducted with ten stakeholders in the Victorian water managing system (coded R1-R10; Table 1) in 2009, and four in-depth interviews were held with one of these respondents (R10) from 2009–13. The interviews generally lasted for sixty to ninety minutes and were audio-recorded; most were transcribed for subsequent thematic analysis. We draw on all data sources to construct this study of irrigation renewal. A modified grounded-theory approach was used in the first instance to generate emergent themes (Charmaz, 2008); only those themes that exemplify new insights and/or relevance beyond the study context are reported.

In addition to inductive and emergent themes we sought to draw additional systemic insights out of this inquiry situation using a theoretical lens of social learning (Figure 2). While understood in a variety of ways (Ison, Blackmore, & Iaquinto, 2013), we employ social learning as a theoretical framework that operates as a duality, comprising entity and process functioning together much like an orchestra which is both an entity and a means of creating a performance from multiple actors and instruments. The theoretical and empirical evidence for understanding social learning as a governance mechanism as well as a transformational process towards concerted action among stakeholders is introduced in Ison, Röling, and Watson (2007). The process dimensions can be understood as part of a social dynamic in which different knowledges and perspectives are valued.

Table 1
Interview respondents

Code	Description of respondent
R1	A former senior manager in the rural water industry, prior to privatisation.
R2	A former water reform advocate and senior figure in regional natural resources management and irrigation.
R3	A senior manager of a regional authority with a long history of involvement in regional water and salinity issues.
R4	A water engineer with a history of involvement in regional irrigation infrastructure.
R5	A senior manager involved in regional irrigation development with a history of involvement in salinity issues.
R6	A river manager working in a regional catchment management authority.
R7	A senior official working for a state department on regional issues with a long involvement of water managing a state and federal levels.
R8	A former elected representative at the state level involved in regional water reform and salinity.
R9	A scientist with a history of engagement with regional salinity issues.
R10	A water engineer and researcher involved in irrigation infrastructure and a history of involvement in catchment management.

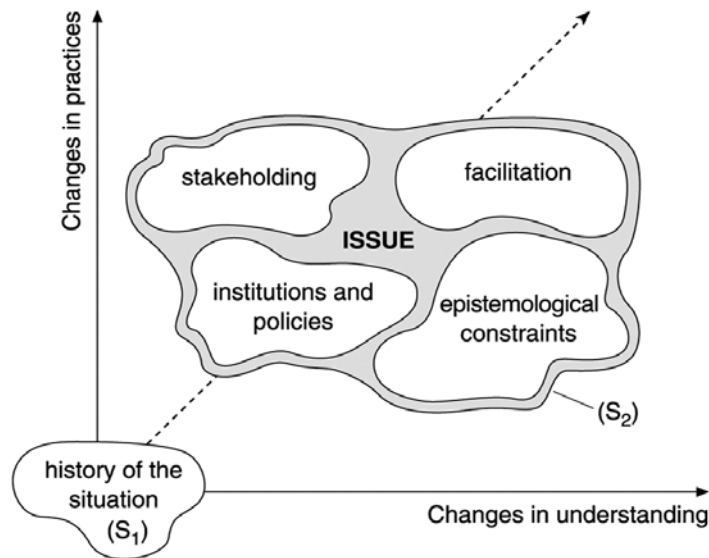


Figure 2. The SLIM heuristic showing a set of six variables that enhance or constrain the conduct and emergence of social learning as a result of the interaction of changes in understanding and changes in practice of those involved (Source: modified from Collins and Ison, 2009, reproduced with permission).

We used the Social Learning for the Integrated Management and Sustainable Use of Water at Catchment Scale (SLIM) heuristic, established through earlier empirical research (Steyaert and Jiggins, 2007) as an additional sense-making framework to examine the data generated by our inquiry. The SLIM social learning heuristic, as depicted in Figure 2 and

applied here, is comprised of six interacting variables: (1) the history of the situation, (2) epistemological constraints, (3) institutional arrangements, (4) how stakeholding is built, (5) whether adequate facilitation occurs, and (6) learning processes (represented by the dotted arrow).

The history of the situation refers to understanding the past and how it has shaped the current context, including through technological and institutional path-dependencies. Epistemological constraints refer to limits to the different ways of perceiving and knowing the situation, for instance the constraints induced by seeing irrigation renewal only as a technical, economic or political activity. Institutional arrangements are rules and norms which form the context and background to the situation. This 'variable' also concerns 'knowledge politics', i.e., whose knowledge counts. To build stakeholding is to shift situations of complexity and conflict in a more tractable direction through concerted action, creating new understandings and practices as a result (Ison et al., 2007). Facilitation can take many different forms, but is essentially understood as a person or object that influences and enables action. Learning processes, as understood by the arrow in Figure 2, emerge as a result of performing the previous five variables; learning is thus understood as a social process based on a social theory of learning (Blackmore, Ison, & Jiggins, 2007).

3. Consequences of Irrigation Modernisation

In 2007, parts of the irrigation network in northern Victoria were approaching 100 years of age (Powell, 1989) and were reportedly experiencing water losses in the order of 30 per cent (Rochford, 2012). Earlier irrigation renewal pilot schemes, such as the Central Goulburn Modernisation, were designed and implemented by the regional water authority Goulburn-Murray Water to demonstrate water recovery for the environment. These were publically funded by the Victorian State Government, as well as The Living Murray program and the Water for Rivers initiative. However, in the years following, the prolonged drought created a sense of crisis throughout northern Victoria as Australian farm gross domestic product (GDP) dropped by 18 percent in 2006/07 (Rayner, Tan, & Ward, 2010) and water shortages were experienced not only in northern Victorian irrigation communities but across the city of Melbourne (the State Capital). The State Government's response to ongoing drought was to implement a large-scale irrigation renewal scheme in northern Victoria, detailed in a water plan in the midst of a particularly dry period (DSE, 2007). According to the stated policy, irrigation renewal in northern Victoria was intended to alleviate some of the strain on water resources induced by drought through three strategies: (1) reducing the amount of water used for irrigation through improved hydraulic efficiencies; (2) achieving economic efficiencies by abandoning parts of the irrigation network; and (3) enabling greater operational efficiencies by automating parts of the irrigation network control system. An unstated aim of the renewal was to support the viability of an irrigated agriculture industry in the region where there were few alternative modes of production:

"If you look at the value of production, the vast majority comes from irrigation and if it's not going to come from irrigation and I don't know where it's going to come from unless it comes out of factories." (R5)

“We’re known as the food bowl of the state, and obviously our community, because we generate around twenty-five percent of Victoria’s rural export earnings, it wouldn’t be the case without water.” (R6)

The irrigation renewal program set out to change the physical features of the irrigation system through ‘modernisation’, rationalisation’ and ‘reconfiguration’ (DSE, 2009; Goulburn-Murray Water, 2013). ‘Rationalisation’ involved decommissioning smaller irrigation channels that carry less than 50 ML (megalitres) per day. ‘Modernisation’ involved lining irrigation channels with impermeable plastic sheeting, installing automated channel control structures, SCADA (supervisory control and data acquisition) operating systems and replacing older Dethridge wheel water meters with flow measurement and control gates. ‘Reconfiguration’ involved blocking channel outfalls and reducing the number of metered access points.

NVIRP, the agency created to deliver the irrigation renewal project, presented irrigators with different options depending on where they were located in the irrigation network. Those who were connected to the backbone, which are the main irrigation channels capable of carrying more than 50 ML of water per day, could cooperate (or not) with NVIRP to consolidate access points and grant access for new water meters to be installed. Those irrigators located off the backbone faced three main options. The first was to take charge of their own irrigation works and upgrade their connection to the backbone, which would entail great expense. Secondly, they could form a syndicate or consortium with neighbouring farmers to collectively take over the local network, share metering, and stay connected to the backbone. Thirdly, they could ‘choose’ to leave irrigation. Overall, the irrigation renewal was intended to halve the number of farmers with backbone access.

There are thus significant social costs entailed by the rationalisation of the irrigation system and the associated decommissioning of smaller irrigation channels. These are in addition to the substantial economic cost of the irrigation renewal, most of which was borne by taxpayers (Cruse et al., 2013). Social divisions emerge as farmers with backbone access become wealthier while those without access become poorer (R10). The speed with which these changes arise is also distressing, as communities have less time to adapt, which may result in “*people falling into the welfare net*” (R4). Farmers with irrigation channels that were not designed to carry more than 50 ML of water per day were not intended to have their irrigation infrastructure upgraded as part of the original expenditure commitment and instead would need to arrange for independent access to the defined backbone (R10). The resulting uncertainty reportedly created substantial distress among some of the farmers who own these properties because they are left with little choice but to retire from irrigation (R10). To further exacerbate the divide, farmers who were not on the backbone or who had not been provided with upgraded water meters were ineligible for the Federal Government and NVIRP-funded farm efficiency grant which aimed to reduce water losses associated with on-farm water use.

Three themes emerged from the interviews as key narratives that have implications for the feasibility of future irrigation renewal projects in Australia and internationally. They pertain to the economic, social and environmental well-being of northern Victoria, but all of them entailed significant social costs for the irrigation communities affected

by the renewal. The themes included: (1) a lack of community involvement; (2) the issue of calculating hydraulic efficiency versus economic efficiency; and (3) contradictions between the policies of water buyback for the environment and irrigation modernisation. These issues resulted from the halving of the irrigation network and the manner in which it was conducted. In each of the following three subsections, respondent views, supplemented by other data sources, of these themes are discussed and compared to other relevant water governance literature.

3.1. *Community involvement*

The stated intent of the government's 2007 irrigation renewal policy was that "*the Government will work closely in partnership with the community to finalise key elements of the project*" and that the new body created to deliver the project would "*work with local communities and all levels of government to manage and complete the project*" (DSE, 2007). The language used at this stage emphasised 'modernisation' of the irrigation network, with no mention that areas of the network would be 'rationalised'.

Community involvement as understood in the inquiry situation did not strictly entail engagement between government and the community, but was also among members of the irrigation community itself. Community meetings organised by NVIRP were often not facilitative (R10); rather, they were opportunities for NVIRP to inform the community of its plans, leaving room only for the voicing of grievances. More discussion around a vision of the irrigation network could have helped alleviate some of the uncertainty experienced by irrigators who were not on the backbone, as one interviewee explained:

"... if you had that discussion, which would've been pretty heated, and you had some vision of what the irrigation area's going to look like, it would've gone a long way." (R2)

In the irrigation communities of the GMID, there was a perception that NVIRP mainly worked one-to-one with irrigators as a tactic to "*divide and conquer*" (R10). On the one hand, there were sensitive issues and privacy laws dictated that discussions were classified as 'commercial-in-confidence'. On the other hand, invoking commercial-in-confidence can be detrimental to the community because it can foster a culture of secrecy, dissuading neighbours from talking to one another. When irrigators were forced to deal individually with NVIRP in tight timelines, collaboration and collective action became impossible. Additionally, neighbouring properties in the GMID typically share a channel system, which means the decisions made by one farmer directly affects other farmers in the region who share the same channel system. If one property is sold, it may devalue the adjacent properties. Other potential stakeholders, such as local environment groups and tourism operators, were also absent from the deliberations.

Farmers without backbone access felt particularly disenchanted because their options were to retire from irrigation, join with other farmers to form a syndicate to secure a connection to the backbone, or to operate independently and arrange their own supply via the backbone, all difficult options (R10). As a result, there were an increasing number of properties not serviced by the backbone which meant an increase in the number of

stranded assets. While ostensibly irrigators were presented with options, some reportedly believed they had no choice but to sell up and get out of irrigation. Had these farmers been provided with the time and encouragement to discuss their issues with neighbours, a more systemically desirable outcome might have been achieved.

Community involvement was also hindered by the overly generalised nature of the irrigation renewal. One report suggested that NVIRP encountered resistance because it failed to take into account that farmer support for the irrigation renewal was variable. Murdoch, Lourey, Kaine, and Johnson (2009) found that farmer support differed significantly depending on their location on the irrigation network, their business requirements, and the unique attributes of their farms. Insufficient recognition for this variability was an indication of what R10 referred to as the “*jelly mould approach*” where there is a lack of consideration of how local contexts and “*social nuances*” shapes implementation of engineering projects. The irrigation renewal in northern Victoria illuminates the risks of basing the design of engineering projects on the feedback from a small number of landholders, as it does not accurately reflect landholder diversity.

The lack of community involvement led to the misrepresentation of irrigators as one homogenous group. The following response could be interpreted as a deliberate tactic by larger area irrigators to intentionally distort the amount of revenue lost from water price rises, as a way to strengthen their own positions.

“The irrigators always appointed the most disadvantaged irrigator in the district to say ‘you can’t raise water prices, look what you are doing’. Well the people that benefit the most are the big area irrigators. They get a heap of money. They don’t contribute to the system and they surf off it in the name of helping this poor guy down the bottom.” (R1)

To put this response into context, the benefits gained by larger enterprises derives from the increased delivery reliability of the upgraded network, which is partly paid for through higher water prices. The “*big area irrigators*” (R1) have enjoyed individual success due to the lack of a diversity of farmer voices in the design of the NVIRP irrigation renewal. The absence of broader community involvement in the irrigation renewal and the associated unequal distribution of money, has reduced the potential for success of the irrigation renewal overall.

In summary, community involvement was a contentious issue that was poorly designed and rushed. As Ostrom (2011) argued “*when farmers have no voice in the design of systems that are supposed to help them, we can expect few successes over time*”.

3.2. *Calculating water losses and savings*

Several issues with the calculation of expected hydraulic efficiencies were raised by our interviewees. Many of these are already reported by others, for example in an inquiry by the Victorian Auditor-General (2010) the Victorian Ombudsman (2011), and also by Rochford (2012) and Crase et al. (2013). The economic case for irrigation renewal was also contentious, with the original project design not accompanied by a business case (Victorian Ombudsman, 2011). Here we summarise and critique some key aspects of the hydraulic rationale for the irrigation renewal.

There were several contested key assumptions of hydraulic efficiency in the case for investment. During drought years, channels were rarely full meaning low rates of seepage, but water savings resulting from lining irrigation channels were still calculated based on full channels in which seepage rates would be much higher (R10). The decommissioning of many of the smaller irrigation and outfall channels complicated the accurate measurement of water savings, since these can still carry water during wetter periods. Additionally, many of the water savings were realised through more accurate measurement rather than prevention of water loss (Victorian Ombudsman, 2011).

Preventing water from flowing through outfall channels (usually local creeks) by blocking up outfalls was calculated as a water saving, despite some farmers holding licenses to productively use outfall water. Outfall water is that which is ordered by an irrigator but cancelled after delivery has begun and allowed to spill into smaller 'outfall' channels. In modernised irrigation systems there is a view that outfalls are unnecessary. Prior to the drought, outfall channels were useful for preventing excess water reaching farms as they would enable spillage into nearby creeks, rivers and wetlands. During the floods of the GMID that occurred in 2010–11, the extent of flooding was exacerbated by the blockage of outfalls, as water that normally would have flowed into receiving bodies such as wetlands was delivered to farms in vast quantities (R10).

In summary, there are many uncertainties, in measuring water savings, setting boundaries, securing backbone access, assessing the costs and benefits of technology and the future consequences of reductions in cultivated land, making a clear assessment of potential hydraulic (and economic) efficiencies difficult. Essentially, water loss and subsequent savings can be measured in different ways, so any attempt at conservation will be shaped by the unit of analysis used to determine water loss (Samani and Skaggs, 2008).

3.3. *Water policies in conflict*

The final theme of the interviews to be discussed is the contradiction between the two policies of modernising irrigation infrastructure and government buyback of water (see Crase et al., 2013), in which farmers sell their water rights to Australian governments. Buyback was initiated in 2006 as a way for governments to acquire water for the environment, but it raises serious social issues since usually it is the most disadvantaged farmers who are selling their water. As one respondent explained, farmers are "*not selling water because they're profitable*" but simply for "*financial survival*" (R4). Irrigators who sell their water to the government for reallocation to environmental flows are known by NVIRP as 'willing sellers', yet such a framing is misleading given that:

"The people who are selling up are those that are in greatest strife, and it's not a willing seller nor it is a targeted method, it's just who you can get the water off cheapest. That leaves behind some inherent inefficiencies in the system, which is counter-productive in my view." (R5)

Thus it would be more accurate to make a distinction between 'willing' and 'forced' sellers within the irrigation community of the GMID (see Alston and Whittenbury, 2011).

Some farms are reportedly unprofitable given their locations within the water catchment combined with the costs of irrigated agriculture (R4). The irrigation renewal has exacerbated this situation, as unprofitable farms become even less valuable since these are also the least likely to have access to the backbone. As mentioned earlier, Wittwer and Dixon (2013) calculated that the money spent on irrigation renewal throughout the MDB would be better spent on services, as this would create three to four times more jobs.

Irrigators are reportedly unsure of what the future land use of areas removed from irrigation will be, what new industries may potentially replace irrigated agriculture, and the role of government, both state and federal, in this new situation (R4). It is not only the pace of change that is distressing for irrigators, but also its scale. As one respondent claimed:

“The face and nature of irrigated agriculture (across the MDB), it’s going to change substantially with climate change, with buy back of water for the environment” (R4).

Australian government authorities operating at state and federal levels appear to lack an appreciation of the local contexts motivating farmers to sell their water, or acknowledge that policies which work in isolation may not work in combination. Since the most disadvantaged farmers are usually the ones who sell their water, and the farmers who are unable to benefit from irrigation renewal are further impoverished by their lack of backbone access, the two policies have combined to create noticeable social distress in irrigation communities in the GMID and in the MDB more broadly. There is also evidence that before the advent of government irrigation renewal programs, the irrigators were upgrading their own infrastructure and keeping the savings:

“Irrigators have invested a lot in improving their efficiency over the years but the water hasn’t gone back to the environment, it’s gone to the irrigator and that was part of their cost share.” (R5)

A stated aim of the irrigation renewal was to save water, and yet water savings, in the absence of other signals and motivations, are rarely a motivation for farmers to make changes to their farms (R10). Motivations for changes are more likely to be for the sake of productivity gains, enterprise expansion or succession planning. Resistance to irrigation renewal can be interpreted as irrigators defending their stake. NVIRP attempted to manage the water resources in the GMID by upgrading the irrigation infrastructure, but overlooked the local context and human relationships existing within the irrigation communities of the GMID.

4. Social learning analysis

In order to inform the design and implementation of irrigation renewal schemes in other international settings, we consider the systemic consequences of governing irrigation renewal in the northern Victoria situation. Here the SLIM social learning heuristic provides a useful framework for interpreting how collective action was enhanced, or in this case limited, through the set of six elements described earlier.

4.1. *What the SLIM social learning heuristic reveals*

The history of the situation set technological and institutional path dependencies, in that the physical infrastructure of the irrigation network and its governing agencies were developed as public schemes almost one hundred years prior to the renewal scheme and were arguably not fit-for-purpose in recent times (Wallis et al., 2013). One narrative of change highlights the long-running drought, climate change, peak oil, and international terms of trade and regional change as factors that have prompted a slow decline in the viability of irrigated food producing systems in Victoria. The proponents of the northern Victoria irrigation renewal (the *Foodbowl Modernisation Group*) used these and other arguments to convince the government to invest public money in infrastructure to extend the apparent viability of the system, but arguably made some irrigators better off and some worse off.

Ineffective stakeholding was evidenced by the lack of community input into the irrigation renewal process, leading to community resistance. NVIRP dealt with farmers on a one-to-one basis, thus a culture of secrecy was created in which neighbours were dissuaded from talking to each other and developing joint responses. Many irrigators might have been able to keep their water entitlements had they worked collectively as part of an irrigator consortium or syndicate, as irrigators on contiguous properties could have collectively organised access to the backbone rather than leave irrigation. Alternatively collaborative action may have enabled creative innovations of a social and institutional nature to emerge.

Further antagonism toward NVIRP was a result of inequities created by the renewal program as irrigators who were not on the backbone were immediately affected by the boundary set for rationalisation of the irrigation network, and then further disadvantaged by their ineligibility for government funding to improve on-farm water efficiency. Other regional voices were absent from discussions. It was not possible to identify any individual or group carrying out a facilitative role, while the interpretation of the irrigation renewal process as a strictly technical issue appears to have limited learning and thus systemic transformational processes. Our inquiry reveals the power of deeply held technical rationalities of the sort that Rittel and Webber (1973) identified as conserving 'wickedness' in public policy situations.

The conflation of economic efficiency with hydraulic efficiency is an example of epistemological constraints in which terminology used by government confused stakeholders and, in some cases, led to questionable engineering designs (e.g. closing outfall channels). The use of terms such as 'efficiency', 'modernisation', 'rationalisation', 'reconfiguration', 'renewal' and 'harmonisation' in the context of hydraulic efficiency are confusing because of their economic connotations, making it difficult to understand just what type of efficiency NVIRP were referring to. The concept of the 'willing' seller provides another example, since farmers who sold their water rights to governments were usually unwilling (or 'forced') but had no other option. Further epistemological constraints arose with the assumption that irrigation technology was the answer to the water 'crisis'.

The irrigation renewal was implemented based on the traditional linear ‘transfer of technology’ model in which the views of experts, such as engineers, were privileged. This sentiment is reflected by the Victorian auditor-general, who stated “*the decision-making process from the concept stage to development of a service requirement lacked transparency and rigour*” (Victorian Auditor-General, 2010). Alternatively framing the situation, for example as regional development, could have seen a broader range of stakeholders and perspectives in conversation about the future of the region and the possibilities created from the substantial investment of public funds.

The institutions developed to deliver the renewal scheme were added into an already complex mix of regional, state and federal arrangements (Wallis and Ison, 2011b). Changes to various institutional arrangements have influenced the irrigation renewal process, most notably at the Federal and State levels including the Murray Darling Basin Cap (a basin-wide limit to diversions), unbundling (separation of water from land) and transferable entitlements (water trading). Anderies, Ryan, and Walker (2006) highlighted the implications of, at the time, the institutional arrangements relating to catchment social-ecological system resilience in northern Victoria (specifically the Goulburn-Broken Catchment). They conclude that a drive to agricultural efficiency might achieve higher outputs from irrigated dairy, but would make the system more vulnerable to wetter periods (in relation to salinization, but also as subsequently seen in the 2010–11 floods). Some institutional arrangements have delivered benefits; irrigators recognise the value that transferable entitlements yielded over the past thirteen difficult years, as did our respondents, captured in this quote by R3, “*I’d say in my time the separation of land and water and establishing a water market has been the finest bit of public policy*”. Future institutional arrangements for climate change adaptation need to relate to institutions in the water sector (Dinar and Jammalamadaka, 2013) to ensure systemically desirable transformation in the whole region.

4.2. *Issues the SLIM social learning heuristic may conceal*

The SLIM social learning heuristic does not explicitly mention power relations, although we understand power as running through all of the variables: history, institutions, facilitation, epistemology, stakeholding and learning processes. In earlier work (reference deidentified) we have drawn on John Heron’s modes of facilitation, which include (1) the hierarchical mode or ‘power over’; (2) the co-operative mode or ‘power with’; and (3) the autonomous mode or ‘delegated power to’ (Heron, 1999). Another framework by Hardy (1996) draws attention to three ‘types’ of power: the power of resources, process and of meaning. With these understandings, the design and governance of the irrigation renewal in northern Victoria displayed a strong hierarchical mode of facilitation and exerted the power of resources and process to achieve their goals. Importantly it is not enough to categorize power but to seek modes of praxis (theory informed practical actions) that address all of the SLIM ‘variables’ systemically and contextually so as to generate effective performances that are equitable and ethical (Ison and Wallis, 2011).

For example, the Victorian Ombudsman's (2011) report found that an irrigator lobby group *Foodbowl Unlimited* provided the then Treasurer with a proposal to upgrade irrigation infrastructure. This was an interesting case of political dynamics, as these negotiations apparently bypassed the minister and department responsible for water policy, as well as reducing the open participation of a range of water users. The planning phase that followed was unclear and reportedly poorly documented, with the end result that the northern Victorian irrigation renewal was announced as policy before a business case was produced. This was hardly ethical or equitable.

In summary, we claim that the SLIM social learning heuristic is both a useful interpretive framework that could equally be used for policy design in future to address the sorts of issues we identify in this case of irrigation renewal. In this case, combining systemic with systematic approaches to planning is critical for both transparent investment of public funds, but also for desirable regional transformation. In designing irrigation renewal programs for systemically desirable outcomes (i.e. that benefit a region, not just the hydraulics), the elements of the SLIM heuristic need attention, interpretation and enactment in contextual, ethically defensible, ways.

5. Conclusion

In conclusion, we examined the irrigation renewal in northern Victoria through an adapted grounded theory approach as well as through the lens of a social learning theoretical framework. A key background dilemma of the situation was that the authority in charge of irrigation renewal aimed for a rapid delivery of outcomes, working with irrigators on an individual basis to roll-out infrastructural upgrades to the water delivery 'backbone'. Irrigators had no choice about participating; this mode of practice was imposed on them. Farmers were pressured to make immediate decisions about their properties in unrealistic time frames, on matters of significance to generational planning and farm succession. We claim that governance of irrigation renewal programs globally needs to acknowledge the seriousness of such decisions and act in a facilitative role by creating opportunities for farmers to talk with one another – in essence to have the opportunity to become co-inquirers or co-designers (Jones, 2014). The importance of facilitation and stakeholder platforms for working through perceived water conflict is highlighted in the international literature, such as in Warner (2007), but has been seriously lacking from program design in northern Victoria. We would contend that having the support of only some farmers, notably those who stood to gain the most from the irrigation renewal, does not create sufficient stakeholding to achieve equitable outcomes and leaves the investment and innovation exposed to systemic failure at a later date.

Navigating a successful path for the future of irrigation was a difficult prospect to consider in NVIRP situation and the resulting program of investment was politically-motivated, technology-centric and fast-paced. In the renewal, local knowledge was largely ignored, and instead the insights provided by experts were privileged. In this context, and from our interviews, we found that concerted learning opportunities were limited due to

inadequate facilitation, a misrepresentation of stakeholders and confusing and complicated institutional arrangements. Of particular significance were the frame divergences between 'willing' and 'forced' sellers of water and the primary framing of the investment as a technical engineering issue. The irrigation renewal could also have been interpreted as a means to secure water resources for the state of Victoria or as an attempt to maintain current levels of economic output from agricultural production and export.

In similar situations internationally, the aim of future water reform projects should be to have in place a well-designed and inclusive planning process, which in its enactment attends to the various 'elements' of social learning (Figure 2). This would give farmers in neighbouring properties a chance to resolve their own irrigation issues, and could reduce the number of stranded assets (farms surrounded by abandoned properties lacking irrigation infrastructural upgrades) since it would give farmers the chance to organise backbone access with their neighbours. More importantly, such a process would incorporate farmer consultation and input and devise ethical means to identify who were genuine, willing sellers, thus giving communities a sense of pride. This would minimise the breakdown of social capital and ensure thriving communities based on the joint development of institutional arrangements that are considered a form of social capital (Brondizio, Ostrom, & Young, 2009). To incorporate community perspectives, irrigation renewal needs to be reframed from an engineering issue to one that acknowledges community perspectives, which would then require more community involvement to address what the future of the region should be and how it should be managed (Wei, Ison, Colvin, & Collins, 2012). Opportunities for enhanced mutual learning between those at the local level, such as the irrigators and local organisations such as catchment management authorities and local government, and organisations at the state level were missed. In future we advocate the need for systemic approaches to water governance, including irrigation renewal, that start with a broader, multi-perspective framing of the situation to be 'improved'.

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