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Irrigator relations with water in the Sunraysia region, northwestern Victoria

[Running head] Irrigator relations with water in Sunraysia

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Abstract

Irrigated agriculture faces significant challenges under climate change, and may not be feasible in parts of the Murray-Darling Basin beyond 2050. Recent research into the cultural politics of water has paid limited attention to the water cultures and relations of irrigators in

Minority World countries. We analyse the water relations of grape farm irrigators in the Sunraysia region of Victoria, using interviews and farm tours undertaken between 2014 and 2016. Findings are summarised under five themes: (1) the sociality of irrigation water, (2) temporal and spatial relations, (3) the risk of rain, (4) the micro-scale of water knowledge, and (5) environment as actor. These themes shed light on the diverse relations that constitute both environmental and irrigation water. Irrigators are embedded in these relations at multiple scales, local and distant, mediated by technology and infrastructure. The scale of our focus makes visible water and other environmental knowledge that often goes unnoticed in broader debates over irrigation. The concept of "the environment", understood as an embodied actor in policy discourse and by irrigators, is an emergent trend that warrants ongoing research attention.

Keywords *horticulture, grapes, qualitative research, environmental knowledge, Australia, relational approaches to water*

Introduction

Irrigated horticulture is in a state of flux in many parts of the world due to the increased variability and diminished water supply associated with climate change (Alonso & O'Neill, 2011; Belliveau *et al.*, 2006; Weber & Hauer, 2003). In different contexts irrigation is understood as both a potential adaptive strategy (Pittman *et al.*, 2011) and a source of vulnerability that will require adaptation (Wheeler *et al.*, 2013). Australia's Murray-Darling Basin (MDB) provides a prime example of these challenges. Irrigation uses up to 70 per cent

of available freshwater in Australia, and the MDB accounts for about 85 per cent of all irrigation in Australia (Schofield, 2011), providing 39 per cent by value of Australian agricultural produce (Kiem, 2013). Beyond 2050, without significant climate change mitigation, irrigation will not be feasible in many parts of the MDB (Quiggin *et al.*, 2010), leading to significant food security challenges for Australia (PMSEIC, 2010). Irrigated horticulture in the MDB is arguably, or needs to be, in the early stages of transition from productivist modern agriculture to something else, with a much less certain future (Lawrence *et al.*, 2013; Quiggin *et al.*, 2008).

In such a context, there has been extensive debate about the macro-scale problem of irrigation water availability and use, leading to policy transition at the Commonwealth level (Connell & Grafton, 2011). What remains unexamined in the literature is the water experience of irrigators themselves, and the ways in which they live with irrigation water in a period of transition. This paper analyses the water relations of grape vine irrigators on family farms in the Mildura-Robinvale area of the MDB (Figures 1 and 2).

<Take in Figures 1 and 2>

We use a relational framing to examine irrigator experience of water because it is the best way to make sense of the entanglements of meaning, experience and infrastructure with human and nonhuman lives. Relational approaches 'foreground water as an integral part of social and political relationships, arguing that, rather than being imposed, water's meanings are emergent from these relationships' (Krause & Strang, 2016, p.634). They also focus on water's materiality, 'the role that its biophysical and ecological characteristics play in shaping

human perceptions, discursive constructions and responses to water' (Bakker, 2012, p.617, see also Whatmore 2006).

As Mollinga (2014) makes very clear, irrigation systems have long been recognised and conceptualised as hybrids of the human and physical, the social and technical—for example in the key work by Swyngedouw (2009, p.56), who insists 'on the inseparability of the social and the physical in the production of particular hydro-social configurations'. Nevertheless, the literature has paid limited attention to the contemporary water cultures and relations of irrigators in Minority World[1] contexts. Orlove and Caton (2010) review a number of detailed analyses of irrigation societies, including the connections between water, religion, governance regimes, and wider landscapes; these were all in the context of Majority World countries or historical examples. The collective nature of irrigation management means that questions of community identity are closely linked with irrigation (Boelens & Gelles, 2005; Hoogesteger, 2013; Ostrom, 2011; Ruiz-Ballesteros & Gálvez-García, 2014). The relative focus in Minority World studies on large scale infrastructure and governance systems may reflect the universalising, unifying, and scientific understanding of water under modernity, in which 'local, place-based practices and perceptions of qualities of different waters were deemed "backward", or "uncivilized"' (Bakker, 2012, pp.617–8).

In this paper, we pay attention to the place-based practices and localised experiences of Australian irrigators. In adopting a scale of analysis more often used in studies of irrigation in the Majority World, we aim to open up thinking about water at a time when more innovative ideas are needed (Jackson & Palmer, 2014; Krause & Strang, 2016). The following section

situates the study in the broader context of relational approaches to water, noting the key contributions that Australian scholarship has made in this field.

Relational perspectives on water

In the recent growth in research on human-water relations, concepts such as waterscapes (Budds & Hinojosa, 2012; Swyngedouw, 1999), hydrosocial cycles (Linton & Budds, 2014), and assemblages (Gibbs, 2013) have all been used to provide relational perspectives on water that are infused with cultural politics and power dynamics (Boelens, 2014; Krause & Strang, 2016). In conceptualising the 'hydrosocial' cycle, Linton and Budds (2014, p.172) aim to transcend the dualistic categories of 'water' and 'society', and draw on Swyngedouw's contributions, arguing that

> components of the process – water and social power – are related *internally* rather than *externally*, and should thus be considered as *hybrids* rather than pre-given entities that fall within the realm of either nature or society.

For Linton and Budds (2014, p.173), understanding things as related internally means that their constituent properties:

> emerge as a function of their relations with other things and phenomena. It implies a shift from thinking of relations *between* things – such as the impacts of humans on water quality – to the relations *constituting* things – such as the cultural, economic and political processes that constitute the particular character of desalinated water, treated drinking water or holy water.

It is this understanding of relationality as constitutive rather than interactive that we apply in this paper. Following Whatmore (2006) among others, relational perspectives pay close attention to the particular materiality (Strang, 2014) of water. 'Water's unruliness' (Linton & Budds, 2014, p.176) flows through into social rhythms in various ways. Documenting the spatial and temporal flows, frictions, and stabilisations of irrigators' water relations becomes an important task to which this paper contributes.

Australian research has made important contributions to this literature, highlighting the differences between indigenous and settler Australian water relations (Gibbs, 2006; Jackson, 2006; Rose, 2004; Toussaint *et al.*, 2005; Weir, 2009; Woodward & McTaggart, 2016). Broadly, indigenous understandings of water are relational, based on 'an ontology of interconnection, reciprocity, and responsibility, in which landscape is living and life giving, inseparable from human existence' (Gibbs, 2010, p.365; see also Bawaka *et al.*, 2013). Dominant settler values are Eurocentric and grounded in an ontology that separates humans and the environment, such that the latter can be "managed". Indigenous perspectives thus may differ from and challenge a bio-centric science-based view of what "the environment" needs (Finn and Jackson, 2011). For example, indigenous people may consider a different suite of species important; common species are likely to be more important to indigenous subsistence, whereas rarity is important to biodiversity conservation. There are questions about how indigenous people-place relations might be maintained under different irrigation flow regimes. These relations present a consistent challenge to the quantitative and competitive methods of resource distribution in market-based water allocation programs, and to scientists and environmental water managers who tend to divorce aquatic ecological components from

social relationships, cultural practices, belief systems, and social context (Jackson, 2017).

On the settler side, Gibbs's (2006) work reminds us not to treat western values in water management as implicit or as the presumed norm against which others are compared. Gibbs' relational approach has pointed to the cultural specificity of non-indigenous water values, and advanced the argument that they are themselves variable in place and time; 'meanings and values associated with water are diverse, changing and complex' (Gibbs, 2006, p.77). She has shown how pastoralists in the Lake Eyre Basin value the variability in different types of water (river, dam, bore, fresh, brackish), for different uses (drinking, swimming, washing, watering stock, cooling down). Strang (2014) has used the fluidity of water as a narrative device to travel down Queensland's Brisbane River, noting the diverse embodiments and understandings of water on the journey. One such understanding is captured in irrigator descriptions of reservoirs as 'liquid gold', an encapsulation of the 'view that this is an economic reserve in which water and its potentiality are captured and held' (Strang, 2014, p.145). In both material and conceptual senses, water is thus "turned into" foods including beef, vegetables, fruit, and wine (Strang, 2006). In unsettling the presumed binary of a relational indigenous approach to water and a non-indigenous approach framed around separation, the works by Gibbs and Strang echo the phrase advanced by Latour (1993) that we have never been modern. That is, modernist framings of water have cultures of their own that should not be presumed but are worth documenting empirically. Further, supposedly separationist framings of water are themselves constituted by complex webs of relations among humans, water, infrastructure, and other things.

No empirical study comparable to Gibbs's work with pastoralists has been undertaken for other groups of Australian rural water users, including irrigators, the focus of this paper. Our intention here is not to equate indigenous and irrigator cultures of water, nor to automatically valorise local knowledge (Ellemor, 2003). But we do contend that better understanding of diverse people's close relationships with water, and the hydro-social configurations these processes produce, 'can nurture new understandings of variable water availability and offer opportunities for adaptation and change' (Kiem & Austin, 2013, p.1310).

The changing policy context for irrigated agriculture in the Murray-Darling Basin

Understanding irrigator relations to water requires understanding the broader context in which farmers have operated over the last several decades. Lawrence *et al.* (2013, p.31) highlight 'the role of global neoliberalism in fostering productivist responses to the climate-change challenge, and to other challenges, faced by agriculture'. They outline the pressures on Australian farmers to compete in export markets, conform to the demands of supermarkets, and manage risk at the individual farm level while dealing with the 'progressive withdrawal of state support for farming' (Lawrence *et al.*, 2013, p.31). The challenges arising from long-term over-allocations of irrigation water throughout the Murray-Darling Basin came to a head during the so-called Millennium Drought in the first decade of this century (Alston *et al.* 2016; Connell *et al.*, 2005; Connell, 2007; Connell & Grafton, 2011; Lawrence *et al.*, 2013). The increased corporatisation of agricultural industries, family succession issues, and demographic changes in the wider community have added to the multiple drivers of change (Argent 2002, 2015; Askew *et al.* 2014; Holmes 2006; Pittman *et al.* 2011; Smith & Pritchard

2014). Pressure for a new paradigm by which to understand water management was seen by Connell *et al.* (2005, p.86) as a combination of two broad trends through the 1980s and 1990s: 'rising concern for environmental sustainability, and the increasing dominance of neo-liberalism with its emphasis on economic efficiency'. Thus, when the policy responses came, first in the 1994 Council of Australian Governments (COAG) package and later the 2004 National Water Initiative (NWI), they were in the form of market-oriented solutions that separated land title from water rights, and made water a tradeable commodity (Smith and Pritchard, 2014).

As the Millennium Drought intensified so, too, did pressure for the Commonwealth Government to take further action. The *Water Act 2007* established the Murray-Darling Basin Authority (MDBA) as the independent water resource planning authority for the Basin, leading to the release of a Guide to the proposed Basin Plan in 2010 and, following considerable controversy and a Parliamentary Inquiry, the Basin Plan in 2012 (Alston *et al.*, 2016). Of most controversy among irrigation communities in 2010 was 'the plan to buy back water from licence holders and return this to the environment' (Alston *et al.*, 2016, p.54; see also Lawrence *et al.*, 2013). The 2012 Basin Plan focused not only on buybacks but also 'major investment in infrastructure efficiencies on and off farms' (Alston *et al.*, 2016, p.54). Infrastructure improvements included movement away from open channels to drip irrigation and micro-sprinklers.

Proceeding from scientific and public concern over the long term water health of the MDB, the Commonwealth Government "buy-backs" of water from farmers for "environmental flows" (Lawrence *et al.*, 2013), are seen to represent a long-term de-

privileging of agriculture in the allocation of Australia's water (Alston *et al.*, 2016; Smith & Pritchard, 2014). Environmental flows are defined as 'the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and wellbeing that depend on those ecosystems' (Finn & Jackson, 2011, p.1237). Water for environmental flows is "held" by the Commonwealth Environmental Water Holder, a position created by the *Water Act 2007*. When the purchasing program is complete, the Commonwealth Environmental Water Holder will hold more than one quarter of the MDB's extractive water rights and, in some regions, the figure could be 50 per cent (Jackson, 2015). Examples of environmental flows in the context of our study area include the diversion of flows through the Hattah Lakes system, an ephemeral wetland chain encompassed within the Hattah Kulkyne National Park between Robinvale and Mildura (Figure 2), providing important habitat for animals, birds and plants.

By allowing pricing water, governments' water policies explicitly encourage farmers to move towards high-value agricultural commodities (for instance, almonds and table grapes for export), in order to incentivise efficient use and maximise return from scarce water resources. Note here that the "value" of agricultural commodities is understood in economic rather than broader terms such as local or national food security (Kiem, 2013). Bjornlund *et al.* (2011) have identified persistent concerns among irrigators about water trading. While buy-backs have enabled many to retire debt and restructure their farms, there has also been an increased burden for remaining irrigators as entitlements are traded away from farmland and some farmers choose, or are financially forced, to exit. Other burdens include the increased need for weed control as more blocks are left un-irrigated and empty. More broadly, there has been

concern that, due to water buy-backs, declining numbers of active farms would exacerbate other trends such as declining population and diminished service provision in regional communities (see also Lawrence *et al.*, 2013). Hussey's (2014, p.322) analysis of contemporary water policy in Australia demonstrates 'that the water market is doing precisely what it is designed to do: allocating a scarce resource in the most economically efficient way possible'. However, the market has created a number of inequities, including those between larger non-family farm operations and smaller family farmers, between 'water-rich' and 'water-poor' irrigators, and via the 'stranded asset' problem, whereby a smaller number of operators must pay for irrigation infrastructure as less efficient producers exit the system (Hussey, 2014, pp.310–11).

Study area

Our study area in the Sunraysia region has focused around the rural city[2] of Mildura and a smaller nearby town, Robinvale, both of which are located in north-western Victoria on the banks of the Murray River (Figure 2). This key horticultural region produces almost all of Australia's dried vine fruits (98%) and table grapes (75%), as well as significant volumes of citrus, pistachios, almonds, and olive oil (Department of Environment Land Water and Planning 2016; Mildura Development Corporation (MDC) 2014). Most of these crops are now watered with drip irrigation and micro-sprinklers as a result of improvements to infrastructure over the last two decades.

Drought, climate change projections, and changes in water policy have exacerbated the existing uncertainty around family succession for irrigators throughout the MDB (Wheeler *et*

al., 2012). To take the specific example of our study area, when the recent experience of drought and required irrigation infrastructure changes at the farm-level intersected with a certain point in farmers' life cycles, a number of older farmers chose to retire both themselves and their blocks from irrigation. The result was a landscape mosaic of dried-up blocks within the Sunraysia region's irrigation areas (Cummins & Thompson, 2013, figures 2 and 6).

Notwithstanding improved irrigation efficiency on those blocks that are still in production, without climate change mitigation many of these crops are likely to be ill-suited to their present locations over the longer term (MSSI, 2015). Of particular relevance to the Sunraysia Region is that 70 per cent of Australia's wine-grape growing regions with a Mediterranean climate are predicted to be less suitable for growing grapes by 2050 (MSSI, 2015). It is highly probable that crop varieties will need to change over the coming decades, and that the region's perennial plants, such as grape vines and almond trees, will at some point be forced to give way to annual crops that can be left unplanted and unwatered during drought years (Connor *et al.*, 2009, 2012; Kiem & Austin, 2013).

Methods

Our broader research project seeks to understand the influence of cultural and ethnic diversity in environmental knowledge and practice. This paper draws on 22 semi-structured interviews undertaken between 2014 and 2016 as one component of the project. It also includes reference to observations from a number of farm tours with grape farmers (variously for table grapes, wine, and dried fruit), industry representatives, and other irrigation stakeholders, and a

field day with dried fruit farmers in the Merbein area adjacent to Mildura. All such work was given the appropriate ethics clearances.

Most of the farmers discussed in this paper are of Anglo-Australian heritage, but several had parents who were part of Australia's post-World War II southern European migration intake, especially from Italy and Greece. Many of the latter came from farming backgrounds (Klocker et al. 2018). All of the farmers interviewed were aged in their fifties and sixties, and none had children who were intending to take over the farm. Most participants were male, but in several cases male and female partners were interviewed together.

Interviews included core questions that specifically addressed water (for example by asking participants about their relationships or engagements with the Murray River). The topic of water also emerged during discussions of environment and climate change, and elsewhere in interviews as people talked about aspects of daily life and livelihoods, and pondered the future. Interviews were transcribed in full and analysed for themes structured by the questions, and for themes that emerged in the course of conversation. The following sub-sections are structured around the dominant themes, and exemplar quotes are used to illustrate wider trends. In accordance with the ethics protocol, participants were given the option of being referred to by either their real name or a pseudonym in research publications. Their preferences have been adhered to in this paper.

Results

The sociality of irrigation water

A broad theme evident across interviews is the centrality of irrigation water to the social fabric of the family farm and to the wider regional society of which it is a part. As John B expressed it, 'water is a backbone of Mildura, irrigation water'. Varying levels of distress, anger, and frustration were expressed in the context of the multiple pressures described above; our interviews capture something of irrigator experiences at a key period of transition. We are referring to several intersecting transitions here. Many growers approaching their personal transition to retirement are not in a financial position to undertake the shift to more water-efficient irrigation infrastructure, which requires significant investment. Some have chosen to get out of agriculture completely, leading in turn to land-use transitions in regional landscapes. Dried fruit industry representative John A described the 'Swiss cheese landscape' that has evolved as some blocks are 'dried up'. He noted also that the only farmers who were still furrow[3] irrigating are those in their sixties, approaching retirement, at a point when investment in new infrastructure is not viable.

Anger at the separation of land and water titles is exemplified by Danny, a retiring irrigator who had been very active in the Sunraysia Irrigators Council. Danny had lived with his family on the property since his parents bought it 50 years ago. For him, the separation of land and water titles rang 'the death knell' of family farming throughout the region:

> The…death knell to all of that was the separation of land and water and making water a commodity. That was the death knell of the Basin, and it was the death knell of that, that type of farming. Without question … The moment they made water a tradeable commodity, it was open slather to the richest, so the ultimate

> end of that will be that a mere handful of people are going to own this nation's water.

The Sunraysia Irrigators Council[4] has positioned itself in contrast to corporate horticulture, notably the almond plantations funded by managed investment schemes. In their submission to the Australian Senate Inquiry into Agribusiness Managed Investment Schemes, local irrigators positioned almond investors as industrial foresters rather than farmers: [they have] 'not been able to show any resilience through a severe drought and economic downturn, unlike the majority of farmers in Australia' (Sunraysia Irrigators Council, nd). Observations about the social resilience of the family farm are also expressed by Maria:

> You know on the farm you have a lot of ups and downs; you have your good years and your bad years; and there was a bad run with the drought with the water and then they made you buy, pay for water … and there's been a lot of downs as well but everyone has stuck it out because you have got the family there … no one's left and taken off, everyone's fought the ups and downs and stayed on.

These irrigators are not necessarily arguing that the social relations of the family farm contribute to more sustainable relations with water resources. Rather, they are invoking the importance of irrigation, in the context of the family farm, as the underpinning of a sustainable rural community.

For many, the separation of land and water titles had ruptured the particular configuration of land and water on which this sociality depends, as Dom articulated:

> In irrigated horticulture … you're only a farmer when you've got land and water married together. That's it. There's no other way. It's pointless. Land is worth

> nothing without water security, right. So they should never have been separated. It's fine for a dryland farmer, because they rely on the rain, and you take your chances.

Dom can be understood here as seeking to naturalise a farm/land/water relationship dependent on access to irrigation infrastructure, while also clearly being aware that it is a relationship quite different from that experienced by the dryland farmer who relies on the rain. Dom is also conscious that this particular mode of farming is unlikely to be passed on to his children and their children, in the way that family farming of previous generations would have been. Dom's children will inherit his debt. Guiseppa and Guiseppi have 'a son to cover the land. And for him to survive he have to do other job, not only live on the land that the way we used to do it. He'd have to go and do contractor work with a tractor …'. A number of our research participants bemoaned the loss of the family farm possibility for their children, but none would have advised those children to take up farming under such conditions. As Dom said, 'I would love to be able to say that there are young people, but if you do a statistic thing here, the average age of growers is 65 to 70'. In Linton's and Budds' (2014) terms then, irrigation on family farms is here understood as internal to, and constitutive of, the social relations of the region.

Temporal and spatial relations to water

If land and water are 'married together' to underpin irrigated horticulture, as Dom puts it above, it is a complex marriage. The Sunraysia's embeddedness in the whole Murray-Darling system makes it dependent on water flows and transfers from thousands of kilometres away, delivered in one sense by the river itself, but also via pipes, pumps, weirs, and web-based

financial transfer instruments. This assemblage mediates human-water relations in various ways across both time and space.

There are a number of different temporalities, but in some way they all involve a synchronisation, or at least intersection, between the temporalities of plants, people, and water (Brice, 2014). The first of these is the annual cycle. Brothers Malcolm and Steve noted that the recent infrastructure changes and modernisation of pumping systems had created new opportunities because it is now possible to irrigate year round, and Malcolm said:

> Yeah so with the open channels they always, over winter time there was always a maintenance period of four weeks, six weeks. And so with water [now] being available, well it won't be available to everyone, but to the majority of growers all year round, that might open up opportunities for different crops rather than the traditional crops that we have been growing.

Long-lived tree and vine crops such as citrus and grapes have longer-term needs for water through two different kinds of temporalities. First, they need to be maintained during drought years to keep the plants alive. (Indeed it was during the recent drought that many citrus and grape plantings were 'turned off' because they couldn't be kept alive.) Second, at times of transition between crops, they take longer to deliver a return:

> … it's not like a wheat crop. A wheat crop or any cereal crop is approximately 90 days from harvest, from sewing to harvest. When you're looking at permanent plantings like your citrus, your trees, almonds, vines, whatever you grow, oranges, yeah, it takes years before they can produce an economic crop to go. Like vines

> it's about three years. Some you can do it a bit quicker, but yeah, and others you need the tree to grow and then produce the amount to make the dollars (Brian).

The spatial connections felt by farmers to their water are only partly local, as expressed in participants' frequent descriptions of Mildura as an 'oasis' in a desert or semi-desert landscape. (With a mean annual rainfall of 267mm (BOM, 2017), Mildura is close to the arid/semi-arid boundary, but the irrigated gardens and street trees of the city give it the feel of an oasis.) This spatial separation has been reinforced in recent years by the separation of water titles from ownership of land, making water tradeable throughout the system and across state borders. Richard, in Mildura, described the complacency that stems from being located adjacent to a weir pool, 'which means that the river is always at the same level irrespective of whether there's a lot of water coming down or not much at all'. Because of this high level of regulation, as Steve noted, the river

> generally stays, unless there's extreme drought or flooding, it stays the same sort of level. Um, you might notice a different flow rate. Sometimes it might be filling with more water, so you might notice it flowing through a bit more.

Steve, who with his brother Malcolm grows grapes for dried fruit, described how, during the Millennium Drought, they 'were actually monitoring [water levels] on the Murray-Darling Basin authority website, we were monitoring dam levels and inflows and seeing … what was going on' through the whole system. Malcolm acknowledged that they had 'certainly taken water for granted beforehand'; nevertheless the way in which they learned not to do so anymore was via a complicated technological assemblage rather than by engaging with the embodied local presence of water. Within that assemblage the separation of land and water

titles has exacerbated resentments against the potent figure in Australian agriculture of the 'Collins Street farmer':

> There's a lot of people that are sitting say in Collins Street in Melbourne … and they might have—I'll pull a figure out of me head here, 1000, 2000 megs [megalitres] of water and the water is a commodity, it's money, it's all for the money now … But really, what's a Collins Street 'farmer' need that much water [for] when I am desperate for water so then I've got buy it off him as temporary trade water … So you could own water and not have any land which is wrong. (Domenico)

As a consequence of the system of irrigation infrastructure, these farmers do not rely on, or even particularly monitor, local rain as an important source of water for their vines. Malcolm commented, 'We've never relied, we don't rely on rain here at all … That doesn't come into the equation, so it's all irrigation, yeah'. Rather, monitoring local rain is only important for determining when to turn on their irrigation on a particular day and thus provide their vines with water sourced from elsewhere: 'I mean if we get 20 mil, millimetres, of rain tonight say, it means we won't irrigate for the next few days' (Steve). The exception implied in Steve's phrase 'I mean …' indicates that this is an unusual occurrence.

In addition to overseeing computerised irrigation systems, farmers now spend much of their time examining water prices and upstream rainfall patterns on their computers (as noted also for wheat farmers by Head *et al.*, 2011). They are distanced from the physical water in ways that are not dissimilar to the Collins Street farmer, and there are several attitudes to this, from resentment (Domenico) to equanimity (Steve and Malcolm). Distanced from much of

the physical water, the irrigators are nevertheless deeply embedded in the wider assemblage that captures and stabilises the flow of water, facilitating its delivery to their crops with predictability and precision.

Risk of rain

Irrigators depend on local rain, but too much rain can be a bad thing, as Steve described:

> after we had the drought it rained, but it didn't just rain … we had record amounts of rain and that wiped out half the crop, as well, just through disease and that sort of thing.

Further, those who grow grapes to produce dried fruit products such as sultanas, muscats, and currants, consider rain as 'bad' or 'a pest' if it falls at the wrong time. As Keith explained:

> Well, in our industry, in growing dried grapes, if it didn't rain all year I'd be almost happy, as long as the water kept coming down the river. It doesn't work like that. But um yeah, I mean, I guess rain is just a threat in terms of when we're trying to dry fruit, because I mean obviously rain isn't conducive to drying. But we've worked around it for 35 years and never lost an entire crop.

Rain in late summer or early autumn plays havoc with the harvesting and drying process, increasing the risk of splitting the grapes and facilitating fungal growth. This issue will be an increasingly complex one in the wake of climate change, which is expected to result in an increase in intense summer rainfall events in this area; a change a number of our participants thought was already evident.

The risk of rain was a frequent refrain in these interviews: for example, 'I don't think we can ever get over the risk of rain' (Keith). Keith was the innovator of a rotational trellis to

mitigate against this risk. The trellis could successively lift lower-hanging vines to reduce humidity and increase air flow between bunches of grapes. He explained how early twentieth century drying techniques used in the region were imported from California:

> the way traditional stuff had been set up to grow, which was all Californian, it was all established through Chaffey's techniques. So they just transported the techniques for growing grapes over to here from California. And in California it doesn't rain at harvest time; they have almost an identical rainfall per year but it's all in the winter, so they don't have the issues we have with damaged fruit at harvest time. So trellis drying was an obvious answer to those sort of problems.

Keith and others described other innovations being used to deal with the risk of grapes splitting, including development of split-resistant varieties (moving away from sultana grapes), rapid harvesting techniques to minimise the time ripe fruit is on the vine, and in table grapes the installation of on-farm cool rooms to facilitate on-farm storage. A common sight across the region is the hectares of white plastic used as a 'raincoat' to protect the grapes from rain (Figure 3). The plastic provides a physical barrier between the grapes and the rain (a further spatial separation, in the framing of the previous section):

> [T]here must have been thousands and thousands of different materials used in a space of about five years, they were getting shipped from China from everywhere, Russia. And people were trying different clear shade cloths to plastic ones to biodegradable…until they come up with this cover they've got now and that seems to be working. It can rain three or four inches and [you can] still pick your fruit. (Anthony)

So, while the irrigators are spatially separated from rain as the main source of their water, they are finely attuned to its presence as a risk to their crops, and to levels of humidity at the scale of individual bunches of grapes.

<take in Figure 3>

The micro-scale of water knowledge

Participants' knowledge of water and its behaviour, as exemplified in the previous section, provides nuance to the wider discourses of irrigation water framed only around long-term scarcity. Detailed attention to water knowledge shows that these are relations that must deal with abundance as well as scarcity. While there was widespread acknowledgement that the older open irrigation channels, prone to high levels of evaporation, facilitated a 'big waste of water' (Malcolm), the following examples illustrate how effective use of scarce resources is not all about using less water. John B referred to the way the new irrigation infrastructure increased productivity by increasing water use per hectare. He described this as 'a bit counter intuitive'

> because we use a lot more water per hectare now than we ever have, in horticultural areas. But we grow more product per unit of water than we have. So our efficiency in terms of product per water use has gone up, quite dramatically. At the same time as our total volume of water per unit area has gone up. And to think we can grow horticultural crops suitable for world markets on less than the water we've had in the past, is just silly, it won't work, it won't happen.

John B's argument is that using less water is not always the right decision. Rather it is about mediating the needs of the crops with available water and concentrating that available water

in space and time. Similar arguments at much finer scales are illustrated by the micro-practices by which growers manage abundance and scarcity along the rows of grapes.

Taking us up and down his rows of grapes, wine grape grower Brian explained why he, like many other grape growers, uses low level sprinklers rather than drip irrigation.

> We've sow[n] a permanent pasture up the centre of the row [Figure 4] … it's ideal, it stops erosion if there's sudden rain. It has a vineyard cooling effect because you've got a green verge up there. And if you can put a bit of water on it again, ah, which we do when it's really hot like in the 40 plus degrees—especially if you get up to 42, 45 degrees Celsius in summer—a few hours of irrigation water even with low level sprinklers running underneath, you can just feel the ambient temperature in the vineyard change, it's cooler. And of course that's better for the plants, it's better for the vines and it's better for the product … it's a tall and short fescue. Um it's evergreen and it goes, lasts year in year out. It does require water and one of my mates said to me, you're mad planting that because with water being at a premium, it's a huge cost now for water. Um, but oh no, I looked for the long term benefits. The other thing with that pasture there is because we've got to keep it trimmed, keep it mown regularly, you create mulch from the mowing … we try and get that under the vine bank itself, under the canopy of the vines, so that also [facilitates] earthworms and … retention, and if it's thick enough it'll reduce weeds that that you don't want.

Brian contrasted his practices with those of drip irrigation, which concentrates the water so closely to the central vine that it is difficult to grow a green sward up the rows between the

vines: ‘And right’o you might be conserving water, but at the end of the day you’re not really being environmentally friendly for your plants with your heat or your cooling’. Some irrigators used to use the rows between vines to sow an additional cover or vegetable crop. This is almost impossible now:

> because there is no infrastructure to be able to water it … because of that … people have moved away from being able to do cover crops or cash crops because…you can’t do it … and it’s probably gone that one step further, most people have fertigation systems now. So a fertigation system is basically the nutrients that you put…into the pump and it pumps it through your drip system…So you don’t really get…the broad organic matter or even nutrients throughout the soil there, they concentrate at the, at the base of the plants. (Sam)

Whatever the irrigation practice, there is a lot of work for the grower in maintaining both small and large scale infrastructure, such as soil moisture sensors dug into the ground and read from the surface. Brian showed us at length how he had to manually check, and where necessary replace, each of his Nelson R10 sprinkler heads because they could become blocked by tiny black ants attracted to the water, especially in summer.

> when you start the pump ah whether it’s electric, diesel or whatever you have, the pressure of the water then will push the ant up and of course the ant body doubles over and it’s trapped and there’s no water coming out, or greatly reduced. So on a four wheel motor bike we go up and down. Every time we irrigate we always check. That also allows you to check what’s happening in the vines as well.

The understandings of water-soil-plant interactions that Brian, Sam and others shared with us, and the microscale of care for green sward or additional crops between vine rows, express a kind of environmental knowledge that is easy to overlook when irrigation relations are only examined at the macro-scale. The water that nurtures green sward, and thus cooling between rows of vines, simultaneously promotes soil health and minimises soil erosion into the river. It might be understood as 'environmental water' of sorts.

Environment as actor

As outlined above, an important feature of the Murray Darling Basin Plan was the institution of environmental flows, diverted from irrigation to serve purposes such as habitat protection. Diverse and sometimes contradictory views were expressed about environmental flows. Industry representative John A's view that most growers now acknowledge the value of environmental flows was shared in a number of interviews: 'Probably because of the drought, growers are aware um, that the environment really has to be looked after. If it doesn't we're all doomed' (John A). However John A did laughingly acknowledge that the perception that the environment needs water is widely shared 'while we've got water':

> And then it gets desperate…, when they [irrigators] need water and it's not available, you know that everything goes out the door. And that might sound pretty frivolous but I reckon it's pretty true. Um, why should we give water to the environment when we need it to grow our crops?

An example of how such tensions were experienced in the last drought is provided by Malcolm:

> During the drought there was a bit of tension because the environment was doing a lot of pumping of water into certain sites and yeah that was a bit controversial for a while because while we were being, had reduced allocations of water, we could see these great big pumps pumping water into billabongs and things …

In these discussions, 'the environment' is seen (and at times, resented) as an actor with almost human qualities, or at least those qualities of an irrigator. For example: 'the environment now is effectively an irrigator because they have to have an allocation … So all that environmental water is really irrigation water that … the … environment's bought, yeah' (Malcolm).

Two broad themes in the understanding of environmental water are evident here. First, Malcolm's quote that this 'is really irrigation water' encapsulates the understanding that irrigation is the default use or purpose of all water in the river. Second, both environment and irrigator are understood as separate, embodied agents. The broader context, in which the legal status of environmental water has been asserted and enshrined in law and policy by the concept of the Commonwealth Environmental Water Holder, is also influential. This point is exemplified by retired water policy manager John B's depiction of the environment as a rational actor which needs to make decisions about use; 'so for the first time the environment had a substantial amount of water to manage and to use'.

The personification of 'the environment' in this discourse, represented in the everyday shorthand speech of Malcolm and John B, and in law and policy by the concept of the Commonwealth Environmental Water Holder, is particularly interesting. It remains to be seen whether such personification, and the understanding of the environment as an independent actor, exacerbates competitive and separationist approaches to water use and allocation, or

provides a basis for conversations about different ways of sharing, and in different places. John B's description of environmental flows as 'just a big irrigation process' illustrates that it is all one system, since a complex array of pumps, diversions and structures is needed 'to lift that water out and in effect mimic the natural environment'.

It is perhaps not surprising that the modernist water assemblage would give rise to such a personification, drawing as it does on ecological sciences in which humans and environment are conceptually divided (Robbins & Moore 2013), as exemplified in the MDB plan and water buy-backs. Many of our participants, who see water mainly through the productivist lens, express attitudes to environmental water as being necessary but also wasted. It may sound contradictory to interpret these modernist framings as relational, but they are a clear expression of what Linton and Budds (2014) summarised as *constitutive* rather than *interactive* relations. That is, we understand both environmental and irrigation water as having been constituted by relations that include an ecological sciences framing, conditions of water scarcity, economic pressures in which water is an important cost driver, and the productivist mindset of irrigators, among others.

Conclusion

This study has revealed some of the diverse ways in which grape farm irrigators engage with water, as expressed in their experience and practice. As part of the wider assemblage of the Murray-Darling Basin system, individual irrigators are embedded in relations at multiple scales. Distant relations include an understanding of water stocks and flows hundreds of kilometres upstream, acknowledged to be much more 'real' to irrigator needs than the

observable level of the river in the Mildura weir pool. Farmers pay attention to local water in precise and embodied ways—for example, by reference to their detailed knowledge of humidity levels under the white plastic. At all scales these water relations are mediated by technology and infrastructure, from the heads of spray fixtures to computer representations of the total flow throughout the basin.

Although water is now understood as a scarce and expensive commodity, its abundance can be problematic. Abundant water in the form of rain is a risk to harvesting as it splits the fruit, and increases humidity that can rot it, prompting various socio-technical responses such as extensive use of white plastic. These results highlight the need for thinking about water in terms of abundance as well as scarcity. The need to think through both abundance and scarcity together provides challenges for future work, which might not just focus on dividing up fixed and dwindling stocks of water between different uses, but consider instead what wider social relations are made possible by different hydrosocial configurations, and how to grow them (Jackson & Palmer, 2014).

The current social relations that both underpin and are underpinned by irrigation water are evidently experiencing change on many fronts. Our participants do not always express it in these terms, but they are very conscious of the social value of water. Their angst and frustration shows how integral irrigation water is to the social fabric of the family farm and the wider regional society of which it is a part, expressed in a broader context of economically uncertain futures. Giving voice to that frustration during a period of transition has been an important contribution of this work. By building outward from the experiences of individual participants, the scale of our research focus has given visibility to environmental knowledge

that would often not have been noticed. Examples include the way watering the green sward between rows of vines cools the plants, promotes soil health and reduces soil erosion.

The concept of "the environment", understood as an embodied actor in both policy discourse and by our participants, is an emergent trend that warrants monitoring and ongoing research attention in our future work. If environmental water and irrigation water have been constituted in particular ways, they can also be configured differently. If only three decades or so of irrigation as we know it in the MDB remain, as suggested by climate change projections, then there is an urgent and important task to bring alternative modes of thinking and practice into being.

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[1] We follow Punch (2000) by using the terms 'Minority World' and 'Majority World' (rather than North/South, developed/developing world, First World/Third World) because they serve as a reminder that wealthy lifestyles are experienced by a minority of the world's population.

[2] Mildura refers to itself as a rural city because it is governed by the Mildura Rural City Council.

[3] Furrow irrigation, the previously dominant irrigation infrastructure, is particularly problematic because of evaporation losses from the open channels.

[4] The Sunraysia Irrigators Council describe themselves in the submission as 'a group of irrigators from the Mildura, Merbein and Red Cliffs pumped irrigation districts, as well as private diverter irrigators outside of the pumped districts. The SIC lobbies State and Federal Governments for fair outcomes for irrigators on all water and irrigation issues.'

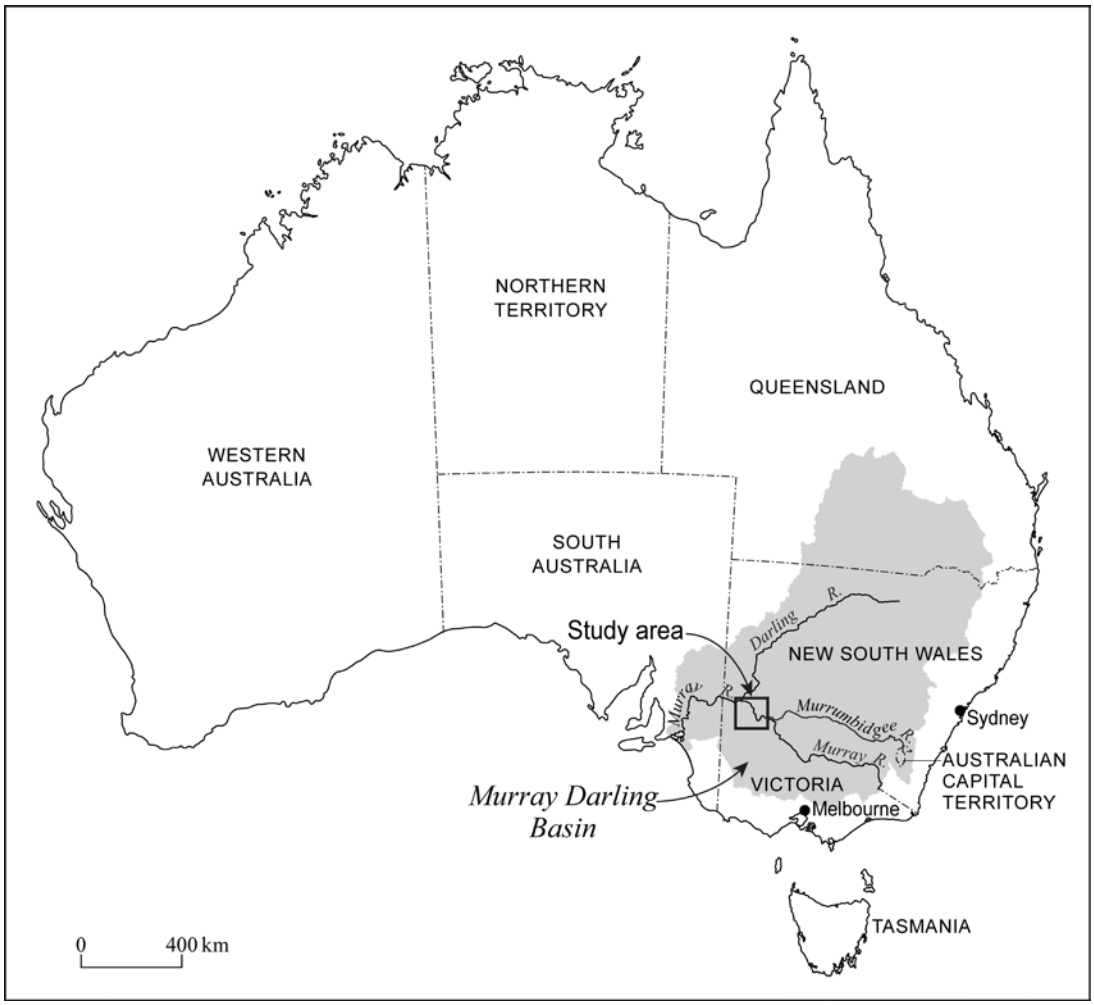
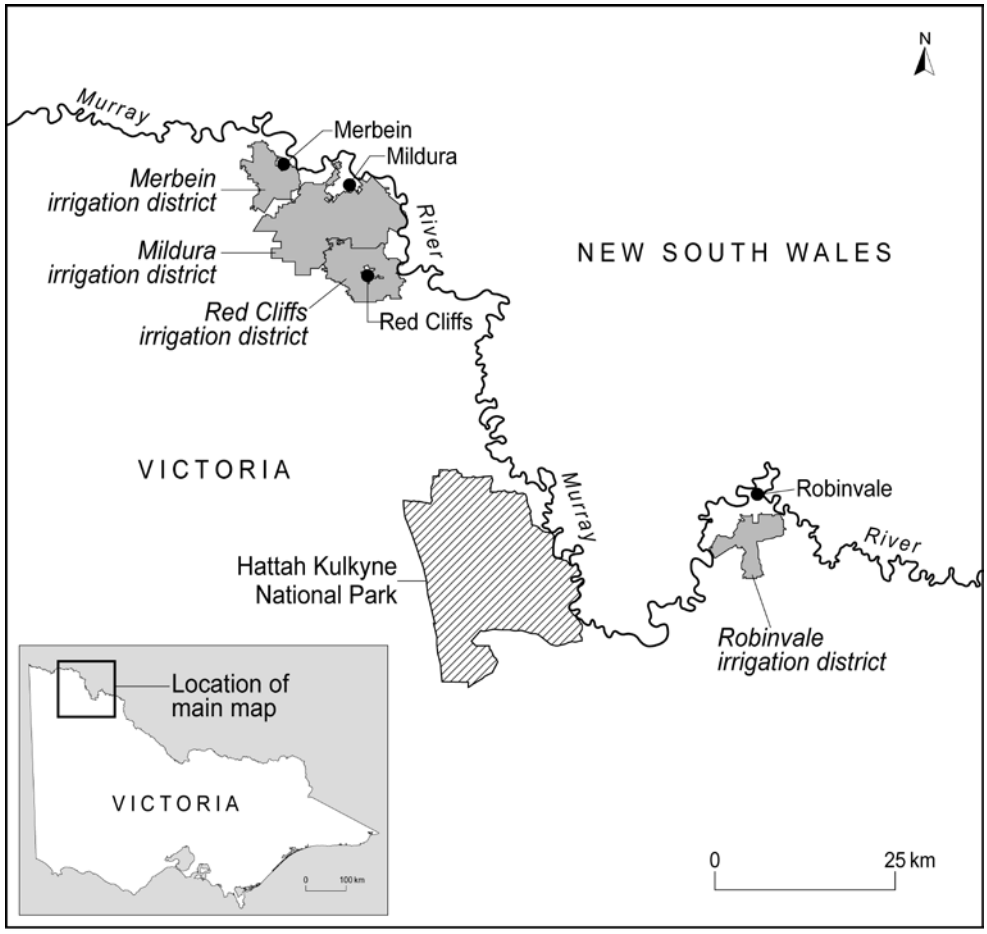


Figure 1. Study area location within the context of Australia's Murray-Darling Basin.



Source: Information on irrigation district boundaries of Victoria from Victorian Spatial Datamart, Land Victoria

Figure 2. Study area irrigation districts of northwestern Victoria within the Sunraysia region.

Figure 3. Grape ‘raincoats’: white plastic protecting grape vines in the Sunraysia region.

Figure 4. Permanent pasture sown in between grape wines and watered by sprinkler.