Article

Framing Two Environmental Flow Trials in the Murray-Darling Basin, South-Eastern Australia

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Abstract: We make sense of the world around us through mental knowledge structures called ‘frames’. Frames, and the metaphors that help to form and maintain them, can be studied through examining discourse. In this paper, we aim to understand the framing of two trials with environmental water by analysing interview-derived discourse. Two separate flow trials, involving changes to river operating rules and practices, were undertaken in the Edward/Kolety-Wakool river system in Australia’s Murray-Darling Basin in 2017 and 2018, as part of the adaptive delivery of water for the environment. Semi-structured interviews with 18 actors in the Edward/Kolety-Wakool river system were undertaken in 2019, in which they reflected on the trials and the use of environmental water in the area. Analysis of the interviews suggest four framings of environmental water, which we have labelled business, engineering, science and medical. Each frame privileges expert practice, potentially marginalising other ways of experiencing and knowing the river system. ‘Participants’ in the social learning/adaptive management occurring in this situation, especially those with authority or influence, should be open to exploring alternate framings of situations. We present this small research project as a practical example of how a focus on revealing and considering discourse can provide interested actors with avenues for co-creation of new understandings and practice.

Keywords: environmental water; Murray-Darling Basin; adaptive management; flow trials; frames; metaphor

1. Introduction

We make sense of the world around us through frames; mental knowledge structures located in our memories that store ‘typical’ data [1] that provide connection between cognition and culture [2]. Framing a topic accentuates one view of a particular situation over other possible views, drawing on background knowledge to do so [3]. Metaphor plays a key role in developing and reinforcing frames [4,5]. Metaphor is understanding one kind of thing through reference to another [6], and as such it is an embedded human action rather than a linguistic choice [7]; that is, we live metaphor, rather than ‘use’ metaphor. The way situations are ‘framed’ can, however, be studied through paying attention to the discourse (words and images) in the situation [8], with a focus on metaphors and their entailments [9,10]. Entailments are the package of related ideas that come with a metaphorical concept [11]. For example, when life is understood as (i.e., framed as) a journey, there is internal logic in calling a birthday a ‘milestone’, and death the ‘end of the road’. This framing brings expectations of destinations to be reached, distance to be covered, barriers to progress, and many of the trappings of being a good traveler.

Many studies of metaphors related to environmental and natural resource management have been undertaken over the past 30 years [12]. These have included exploration of metaphorical concepts ranging from specifics, for example the health of farm animals [13], to broader ideas such as nature [14] and sustainability [15]. Reflection on metaphors and
frames has been particularly useful in relation to freshwater management. When individuals, groups, organisations and governments manage freshwater situations they bring their historical framing choices to it [16].

Understanding the frames in use in a given situation encourages and supports the social learning necessary for managing the complexity and uncertainty that characterizes water management [17].

Social learning, the collective creation of new knowledge and understanding that generates collective responses to challenges, is recognized as essential for adapting to complex environmental realities [18], including freshwater governance and management internationally [19]. Social learning may be encouraged through actively reflecting on frames and metaphor [20], revealing and considering the frames in use, and how these and their entailments might influence projects and programs. For example, the author of [21] suggests that the ‘bank’ and ‘machine’ metaphors in sustainability discourse are part of the ‘expansionist industrial order’ approach to environmental management. While there is much to learn by collectively considering the details of each metaphor in use, consideration of the range of metaphors is also valuable. For example, [22] warns of the dangers of ‘hypocognition’ (the lack of ideas); environmental policy and management involve multiple parts, actors, feedback loops and uncertainty, and there is risk of failure if there are insufficient frames through which to explore their complex and dynamic realities.

There has been much examination of discourse around freshwater use, often focusing on policy (e.g., [23,24]). This exploration has extended to discourses (e.g., [25,26]) related to the policies of water use in the Murray-Darling Basin (MDB), Australia’s largest river system. The MDB is Australia’s most valuable agricultural region, has significant natural environments, is of great importance to traditional owners, and also supports tourism, cultural, and social values. The amount of water used from the rivers of the MDB increased substantially over time, resulting in declining health of the MDB ecosystems. The Murray-Darling Basin Plan (MDB Plan) [27] was created to improve the health of the MDB while continuing to provide water to support agriculture and other industries. While there have been studies of the discourse related to MDB Plan and water policy, there are fewer studies focused on the discourse around water management in the MDB.

In this paper, we consider the adaptive management of ‘environmental water’, including the social learning that is an essential component of successful adaptive management [28]. Specifically, we aim to understand the framing of two trials with environmental water by analysing interview-derived discourse on using and experimenting with environmental water in a river system in the southern MDB.

2. Materials and Methods

2.1. Study Area and Context

The MDB is a large dryland river system of great biophysical variability but with generally high evaporation and low runoff [29], and there are multiple calls on its limited water [30]. The MDB Plan was developed to achieve the aims of Australia’s Water Act 2007, and includes provisions for ensuring some water is held and used specifically for environmental outcomes. Its aim to restore water dependent ecosystems is partially pursued through purchasing water entitlements from irrigators to be managed by the Commonwealth Environmental Water Holder (CEWH) to improve the health of the rivers and wetlands of the MDB [31]. Usually this is through the mechanism of environmental flows.

Environmental flows are used to mitigate some of the negative impacts of water storage and river regulation, partially restoring ‘natural’ or ‘key components’ of flow regimes [32], with an aim of protecting the future [33]. Specifically, environmental flows are “the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems” [34]. This definition, from the 10th International River symposium, reflects that while an ‘environmental flow’ began as a scientific/technical concept, it is now “transitioning from an era of aquatic conservation and ecological integrity to a period of explicit
‘social-ecological sustainability’ [32]. Successful implementation of environmental flow programs requires the cooperation of many entities, and this can only be achieved through shared commitment and collaboration [35]. Additionally, environmental flows are constrained by the amount of environmental water available, physical aspects of river systems, and also by established river management practice, including the operating rules that control the timing, duration or magnitude of river flows. Because of this complexity, adaptive management is considered important for learning how best to implement environmental flow programs. Indeed, the MDB Plan (Section 8.11) requires adaptive management of the environmental water, so monitoring the various impacts of use of environmental water is essential [36].

From 2014 to 2019, the Long-Term Intervention Monitoring (LTIM) program was the primary means by which the Commonwealth Environmental Water Office (CEWO) undertook monitoring and evaluation of the ecological outcomes of the use of Commonwealth environmental water. LTIM was succeeded and continued by the current Monitoring, Evaluation and Research (Flow-MER) project [37]. This paper focusses on one of the LTIM ‘Selected Areas’, the Edward/Kolety-Wakool river system. This large anabranch system is part of the central Murray River in New South Wales (NSW) in the southern MDB (Figure 1). The system has considerable biophysical (Figure 2) and social/institutional complexity. The area is important for its species diversity, has a rich and diverse Indigenous history, and supports a productive agricultural community and recreational activities such as fishing and bird-watching. Like many rivers of the MDB, the flow regimes of rivers in the Edward/Kolety-Wakool system have been significantly altered by river regulation [38,39]. Prior to regulation the average daily discharge in this system was higher in winter and spring than in summer and autumn. River regulation, in addition to other factors, has had negative impacts on the ecosystem health and water quality in this system.

Figure 1. Map of the Edward/Kolety-Wakool river system, a complex anabranch of the Murray River system in south-eastern Australia.
2.2. Methods
This study takes a hermeneutic phenomenological perspective—that is, it seeks to understand individuals’ experiences of a situation [50,51]. The situation in this case is of the two environmental flow trials described above, and the broader concept of experimenting with environmental water in the Edward/Kolety-Wakool river system. Data were created through single or small group in-person interviews with author Allan between February and July 2019. Purposive sampling guided the recruitment of people with an interest in the Edward/Kolety-Wakool river system. The purpose of the sampling was to be able to engage with a range of people regarding the trial events. Thirteen interviews, involving 18 individuals, were undertaken, as summarized in Table 1.

Environmental flows have been delivered to the Edward/Kolety-Wakool system since 2009 [40]. The governance of delivery of water for the environment is complicated, involving federal, state, and local agencies and community organisations. The CEWH is responsible for managing the environmental water owned by Australia’s national (Commonwealth) government, assisted by the CEWO. The Department of Planning, Industry and Environment—Environment, Energy and Science (DPIE–EES) manages the delivery of water for the environment in New South Wales, working with government agencies, private organisations, advisory groups, community organisations, and individuals. Monitoring and evaluation of the ecological outcomes of Commonwealth environmental watering has been undertaken since 2010, initially through short-term intervention monitoring projects, then by the LTIM and Flow-MER programs [41,42].

The Edward/Kolety-Wakool river system is situated in an important physical locality in the central Murray River, in terms of delivering water to South Australia at the ‘end’ of the Basin, and as a source of some of the water entitlements purchased for the environment. The area’s human population have therefore been exposed to much communication from the MDBA about the Basin Plan and its implementation, particularly since 2011 [43], and about environmental watering in the past decade [44]. Over time, the conversations around environmental water in the Edward/Kolety-Wakool river system have moved from initial conflict around the development and implementation of the Basin Plan and water ‘buy-backs’ [45] towards a more focused, collaborative discourse around delivering environmental water to local systems. In 2016 the Edward/Kolety-Wakool Environmental Water Reference Group (EKWEWRG) was established by the CEWO to increase local participation in planning and learning about use of environmental water in the Edward/Kolety-Wakool river system [46]. Members of the EKWEWRG represent a number of local groups, facilitating involvement of a wide range of interested actors. The growing relationship among government agencies, the EKWEWRG and other interested actors has developed into a kind of social learning that supports the adaptive management [28], although that term is not used specifically.

This study considered two environmental flow trials implemented in the Edward/Kolety-Wakool river system in 2017 and 2018. ‘Trials’ are part of the scientific approach to understanding the world through observation to provide evidence to support or refute hypotheses or ideas [47], and monitoring the outcomes of these trials was undertaken in addition to the regular LTIM monitoring. The 2017 flow trial was a continuous base environmental flow delivered during winter to maintain connectivity at a time of year when regulating structures would normally be closed [48]. The flow trial in the spring of 2018 delivered a pulse of environmental water that exceeded the maximum daily discharge...
under regulated operating rules [49]. These trials could not have proceeded without consultation with, and support from, the landholders identified as potentially impacted by the flow pulse, a process facilitated by the history of engagement and participatory planning described above. During and following the trials, biophysical monitoring was undertaken to examine hydrological connectivity, extent of inundation, water quality and river productivity [48,49]. The trials also provided an opportunity to explore how a range of interested actors framed the management of environmental water in the Edward/Kolety-Wakool river system.

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Table 1. Interview participants by category. The total is >18 as some respondents have multiple roles.

| Category          | Number |
|-------------------|--------|
| Landholders       | 6      |
| Irrigators        | 2      |
| Traditional owners| 2      |
| Agency staff      | 9      |
| River operators   | 3      |
| Flow managers     | 4      |

A very loosely structured interview format was used, an approach that enables a relatively free flowing discussion within a predetermined structure [52]. The interview participants were encouraged to reflect on their experience of the flow trials—loosely based on the questions shown in Table 2.

Table 2. Interview guide.

| Question                                                                 |
|--------------------------------------------------------------------------|
| What is your connection with/interest in the Edward-Kolety/Wakool river system? |
| What do you remember about the two trials with environmental water?          |
| What do you think the trials were for?                                    |
| What do you think the trials achieved?                                    |
| What do you think about this use of environmental water?                   |
| Is there anything else about the trials or environmental water that we should discuss? |

The discussions frequently extended into reflections on river and water management in the area more broadly, but the politics of purchasing environmental water from irrigators, and the Basin Plan more generally, were explicitly avoided by agreement.

Each interview was audio recorded, and the data rendered into text through transcription by professional transcribers. The transcriptions were unfocused, attempting to represent what was said through a turn taking structure and simple punctuation [53]. Because the interviews were loosely structured, and the data are stories and anecdotes rather than ‘answers’, they provide an opportunity to explore the discourse of the issue. There is no single approach to analysing discourse [54]; we took an inductive, technical approach that focused on the conversations of participants. Our analysis involved repeated close reading of the transcripts and noting of key language elements, such as words and phrases, that could be read metaphorically. After these metaphoric language elements were
identified across the entire interview data set, we placed them in categories of similarity. We called these categories of similar ideas and entailments ‘frames’, and labeled them with a term that encompassed all of the elements used within that frame during the interview. Our data analysis and presentation are consistent with our ethnographic, in-depth approach to exploring discourse, focusing on the stories being told, and the implications of these.

3. Results

Within the interviews exploring the intent of experimenting with environmental water, including trialing specific watering actions, we identified four frames that we have labeled business, engineering, science and medical, as summarized in Table 3.

Table 3. A synthesis and summary of the four frames apparent in the interview data from interviews of eighteen participants from the Edward/Kolety-Wakool system. The frame labels are subjective, and chosen to encompass all the language elements—for example, ‘medical’ includes recovery, and monitoring, as well as the commonly used element ‘health’.

| Frame     | Key Language Elements                                                                 |
|-----------|----------------------------------------------------------------------------------------|
| Business  | Managing assets within the river system via ownership, distribution, accounting, balancing and optimisation (win–win situations). |
| Engineering | Controlling aspects of the river system so that it operates to deliver water and achieve desired states. |
| Science  | Understanding and knowing, achieved by learning through purposive testing of ideas and seeking of proof. |
| Medical  | River and ecosystem health is an aspiration, environmental water is part of treating ecosystem ill health and monitoring is used to track its recovery. |

The evidence for the articulation of the four frames presented in Table 3 is provided below. This evidence is primarily segments of conversation from the interviews. Direct quotes from the interviews are presented in *italics*, and the interview participant indicated by a unique label, e.g., Person 1. There is no identification of the category of speaker in relation to Table 1, indicating organisations or roles could make participants more easily identifiable in the small community of the situation of this study, and the aim was to examine the discourse, rather than the speakers.

3.1. Business

Some descriptions of the flow trials suggest a business frame, apparent from the focus on water ownership, and accounting for its use, for example:

“We’ve got some hundreds of gigalitres of account on the Murray/New South Wales side. . . . it’s been a significant amount of environmental water in the held accounts or portfolios, that you can call and manipulate like this.” Person 8

Ownership implies agreed boundaries and rules, and systems to manage and account for what is owned and used, for example:

“. . . the MDBA and the river operators . . . have got to agree on an accounting method. . . . So, basically how much environmental water is used and how much water is used for that particular event...” Person 2

Moving beyond actual holdings of water, the business frame highlights that environmental water is used to maintain things that are considered assets, for example

“So all of those water holders get together regularly and think about ‘well, what are all the environmental assets along the river and what are the water demands for them: do they need a spring fresh, do they need inundation of wetlands to get new trends back into the system, do they need a fish breeding pulse, what are all the things that are needed?’ And then you map out a year or two of water requirements for the river for the environmental assets that we know we have, and they can be prioritised then . . . ” Person 8
Less overt as a term of business, but linked with accounting and ledgers, is the concept of balance—that is, accounting for costs and benefits and seeking some sort of fairness.

“... all the water they let go this year, it hadn't worried us ... and look, it's got to be good for the system. But I sort of feel sorry for farmers that are relying on water and can't get none, and they're letting it all run down the river ... when the farmers should be getting water too.” Person 14

“Environmental water used wisely is a good thing. It's a win-win. It can be a real win-win, and whether you love the idea of it or not or how it was ever put into the environmental bucket, that's another argument.” Person 15

The key element of the business frame of environmental water evident in these examples is management of assets within the river system via ownership, distribution, accounting, balance and optimisation (Table 3).

3.2. Engineering

Some of the interviewees described how water was managed and moved around, with the rivers, creeks and human-made structures all enabling that movement and allowing experimentation. For example, the irrigation system, with its channels and escapes are considered as part of a large water handling system.

“... we can control flows into that Wakool, Yallakool and Colligen with these regulating structures. The way this worked in the trial was we lowered the Stevens Weir pool. We lowered it sufficiently that Wakool River didn't run. Gates were fully open, it didn't have any flow. Yallakool Creek, we opened the structure fully so there was fish passage, and we managed the flow into the Yallakool Creek by simply holding a steady weir pool... and we controlled the flow at around 200 megs a day through the ... Colligen Creek.” Person 3

“There are a lot of escapes ... that actually drop into natural systems, be it permanent rivers or creeks, or ephemeral creeks. So ... we've actually got one of the best systems to target water delivery in any natural systems efficiently ... if you've got command, especially with water, with gravity on your side, you can target specific water delivery to any of these systems quite efficiently.” Person 4

“But at that point, that [the 800 trial] was really just taking the hydrograph from there and moving it to there.” Person 10

We have labelled this frame as ‘engineering’, because, within it, the Edward/Kolety-Wakool river system was approached almost as a machine, as indicated in the quotes below that highlight terms such as ‘operation’ and ‘keeping systems ticking over’. Considering the river system through the engineering frame is to focus on control, and operating, in relation not only to the water, but the system as a whole, for example:

“... I think it’s getting delivered from the channel systems rather than the rivers; because the way we operate the rivers has changed obviously.” Person 12

“... and this is the value of the Basin Plan, I think, and all of the water that’s been recovered for the environment plus the research is basically trying to keep the system ticking over in-between those big [flooding] events.” Person 2

The key elements of the engineering framing of environmental water are about controlling aspects of the river system so that it operates to deliver water and achieve and maintain desired states (Table 3).

3.3. Science

Science as a word or term was rarely raised explicitly by interviewees. When it was used, it was related to knowledge, for example:

“... there is a lot of science around large bodied natives [fish] in the system and what their requirements are. That is fairly well—it is a known. You will never know everything,
of course. We are all learning all the time, but there is enough science out there over the years to say what is important.” Person 1

“... So, you know, we have got science backgrounds, we know the systems really well, we know how they operate.” Person 2

The need for science to help to know or understand the situation appears to be accepted by most of the interviewees in this research, and they were generally positive about the idea of experimenting with environmental water, for example:

“I think trialling with the environmental water is critical to start to get a better understanding of what’s required to get vegetation and species re-established in landscapes.” Person 7

“... it was about trying to connect river systems that, I guess, disconnect through the winter period ... And it was a trial, a trial to see what happened. ... From my understanding the idea is a trial, you need to learn something.” Person 6

This positivity was cautious at times, with some suggesting that experiments and trials needed to be carefully considered. For example:

“So provided it’s not reckless, and there’s a bit of investigations about, you know, a risk analysis of what it could or couldn’t mean, I’d be generally supportive of those initiatives, if it meant, the principles are, trying to achieve an ecological outcome with less volumes of water, it’s worth having a look at.” Person 4

“I would say if they’ve got principles and purpose as to why they believe they’re delivering the flow, then give it a go.” Person 5

While generally, if cautiously, positive about experimenting with environmental water, the understanding of the benefits of the two specific trials was wide ranging, including that it was about testing assumptions, providing proof, and achieving actual in stream benefits, as this large selection of quotes indicates:

“You need to test the hypothesis to be able to work out whether it’s right or wrong. So they’re testing hypotheses. So from that perspective, yes there is good use of Environment Water because they’re trying to test the hypothesis of how you provide fish outcome or whether you can provide fish outcome.” Person 3

“We’re meant to adapt to whatever the research and monitoring tells us, whatever the science tells us ... trials like the 800 meg a day should help to inform that process ...” Person 2

“Somewhere along the track, someone’s got to have proven to know ...” Person 14

“Oh, I’m all for the 800; that worked really well, in my opinion ... for the fish breeding and that. Because we get fisheries that come out here and do all the electric fishing and all the larvae counts and that, so I’ve been sort of catching up with them when they’ve been out here, and to see the results that came out of this year compared to the last two years is definitely things are going ahead.” Person 11

“I’ve got a letter ... that they’ve sent me, from the university when they were doing their tests... Yeah, I was rapt to get it. You can sort of read it and see what was around and what’s not around.” Person 14

“I mean, there’s fish there that are in the river that we never knew were there.” Person 13

Demonstrating the benefits of experimentation was also mentioned, for example:

“I think it probably performed a good ecological function through the system... But I think what it also did, it probably showed the community out there the opportunities of looking outside the square and maybe trialing different things, and the benefits by doing that.” Person 1

Focusing on understanding as an outcome of science raises questions about knowledge, and expertise, who holds these and on whose behalf, for example:
“... one of the other issues really is about who becomes an expert, has knowledge ... But often there’s more non-traditional owner people ... who hold a lot of the knowledge and have collected the knowledge along the way for a whole range of reasons and it’s how that relationship about whose knowledge and where that sits.” Person 18

Taken together, the key elements of the science framing of environmental water are of understanding and knowledge, mostly held by experts and achieved by learning through purposive testing of ideas and seeking of proof (Table 3).

3.4. Medical

Examples of considering environmental water and the flow trials through the medical frame were sparse compared with those from the other three frames, and they were often associated with other frames, for example the following that combines health with science:

“... as far as sort of in-stream health or condition, we sort of look at native fish, especially the large bodied species as an indicator species.” Person 2

The medical frame was most apparent in relation to river health, and ecosystem health via statements that drew attention to the death of specific elements of the river, such as mass fish kills from low oxygen events, or frost damage of rhizomes of water plants. Otherwise health appeared as an assumed goal for the river system, for example:

“... our guys are really mainly interested in is how healthy is the river now ... Well it’s a health benefit of the system and the health of the system then goes back to all the things that actually come back from it ... ” Person 15

In this frame, adaptive use of environmental water can be considered as a form of evidence-based medicine for river system ill health, for example:

“Every hydrograph is we push through the river that time of year with the community’s support is testing something. It captures the learning of what we have done in the past and what we think is best for the health of the system ...” Person 9

Additionally, monitoring forms part of the treatment:

“It’s something that, if we get the mandate to continue, we should be monitoring over a long period of time to see if we can track a recovery in those systems.” Person 8

The key elements of the medical frame of environmental water are about river and ecosystem condition and health, treating ill health and monitoring condition and recovery (Table 3).

4. Discussion

The frames identified above are not necessarily associated with particular categories of respondents; these frames emerged across the interviews, with each participant using words and ideas from a range of frames, often within one story or sentence. We suggest that these frames were used unconsciously by the respondents, and reflect current normal framings of the use of environmental water in the Edward/Kolety-Wakool river system. These frames have become the norm in speaking of the situation through multiple shared spoken and written interactions. The four frames through which the respondent group perceive and reflect on the two trials with environmental water raise some tantalizing questions in relation to the social learning/adaptive management situation. The following discussion will firstly expand on the frames by proposing some likely entailments, before considering why these four frames, and not others, dominate the discussions in this study.

4.1. Some Entailments

We have shown that a business framing of the Edward/Kolety-Wakool river system emphasises water ownership, highlighting water as a capital asset. The entailments of this frame include the necessity for valuing, costing, charging, bookkeeping and auditing of both the water and the money it represents, and the broader environment. These processes are
usually undertaken by experts (e.g., accountants and auditors), and there is an expectation that balance can be achieved. Different entailments come along with the engineering frame, including consideration of the whole system as something that can, and perhaps should, run smoothly if the parts (the water, physical infrastructure, weirs, regulators, escapes) are understood and maintained; again something that is best undertaken by experts (e.g., engineers). Entailments of the science frame reflect the Enlightenment expectation of a superior form of knowledge that is accumulated over time through experiments and data analysis, undertaken by experts (e.g., ecologists and hydrogeologists). The entailments of the medical frame include the expectation that illness has symptoms that can be diagnosed, and treated, by experts with the right surgical tools and medicines (in the absence of river doctors, this role presumably falls to policy makers?) Considering these entailments together presents the Edward/Kolety-Wakool river system as a well audited and balanced, smoothly operating machine or entity that is checked and serviced/medicated at times, to achieve a common goal of health and wealth. This picture suggests a meta-frame, in which ‘experts’ are relied on to understand and manage the system, and it is probably not accidental that the four frame titles we assigned could just as comfortably be the names of faculties at a 20th-century university.

4.2. Why These Frames?

There are two noteworthy features of the frames that emerged; their focus on expert areas of practice, as suggested above, and the low number frames compared with the findings from other environmental studies that consider frames and/or metaphors, see, for example, [55]. We have presented the only four frames to emerge from close reading of the interview data. Searches of the interview data were made for framings identified elsewhere, but there was little or no evidence of their being used. For example, sport and/or war frames are often used in discussion around climate change [56] but in these interviews a war reference was only used once, by Person 4, who referred to managing water as ‘when you’re in battle’. Other metaphoric framings that shape environmental discourse, including journeys [57], complexity [58], and bodies [59], were absent from the conversations. In this small study, we conclude that these four expert framings are a reasonable representation of how the respondents are shaping and sharing their reflections on the flow trials.

So why these few frames? Firstly, it is likely that the design of the research has already limited the number and range of potential frames by selecting people with an interest in the management situation, focusing their discussion on the two trials of environmental water, and deliberately avoiding reflection on wider water planning and policy.

The low number of frames in use may also reflect the physical and historical context of using and learning about environmental water in the Edward/Kolety-Wakool river system. We speculate that these four frames may be a consequence of the forms and content of communication directed at communities associated with the Edward/Kolety-Wakool river system over many years. Approaching social learning as an ‘engaging and educating’ activity may have contributed to privileging, reifying and normalizing these expert focused ways of framing experience of the river system. While speculation, this idea is not without precedent; for example, the authors of [24] refer to the development of ‘sanctioned discourse’ in relation to water policy.

Once made aware of the frames used within the interviews, we superficially reviewed the past decade or so of efforts made by national and state water agencies and their partners to involve local community members in the management of environmental water. As noted, these efforts included encouraging local actors associated with the river system to be informed, accepting and part of, the monitoring and experimenting associated with the allocation of environmental water in the area (e.g., [40,60]). Communication from water managers to individuals and groups in the area has been through written, oral and visual means, and in general has emphasised science, engineering, accounting and river health. In Figures 3–6, we present examples of typical visual communication (discourse) used to explain environmental flows to people interested in the river system. These examples
demonstrate one way in which the ‘expert’ frames described above may be reinforced, as experts seek to share their particular approaches to, and images of, the complexity of rivers and managing them. Figure 3 accounts for the water owned and used in a flow event, and is typical of hydrographs provided to the EKWEWRG as part of their regular meetings. Figure 4 depicts the southern MDB, and the Edward/Kolety-Wakool river system as an engineered artefact; this type of schematic is often used in public reports about the area. Figure 5 is one of many similar communications used to inform local groups of the science related to planned environmental water use, with images of fish and plants to underline expected ecological outcomes of environmental flows. Figure 6 shows the ecosystem health of sub basins within the MDB, a type of figure commonly used in public discourse about the health of the MDB system.

![Hydrograph of the Wakool River at Wakool-Barham Rd (gauge 409045) from 1 May 2017 to 30 June 2018. The portion of the hydrographs coloured black is attributed to the delivery of Commonwealth Environmental Water and the portion coloured white is the operational water (non-environmental water). Grey shading indicates the duration of the 2017 winter environmental water flow trial. Reused with permission from Ref. [48]. Copyright 2018, CEWO.](image)

**Figure 3.** Hydrograph of the Wakool River at Wakool-Barham Rd (gauge 409045) from 1 May 2017 to 30 June 2018. The portion of the hydrographs coloured black is attributed to the delivery of Commonwealth Environmental Water and the portion coloured white is the operational water (non-environmental water). Grey shading indicates the duration of the 2017 winter environmental water flow trial. Reused with permission from Ref. [48]. Copyright 2018, CEWO.

![Schematic map of the Edward-Wakool River system, showing location of weirs, regulators and irrigation escapes. Reused with permission from Ref. [38]. Copyright 2011, CEWO.](image)

**Figure 4.** Schematic map of the Edward-Wakool River system, showing location of weirs, regulators and irrigation escapes. Reused with permission from Ref. [38]. Copyright 2011, CEWO.
Figures 3–6 are typical examples of the communication about environmental water to the range of actors in the Edward/Kolety-Wakool river system, each one potentially reinforcing and normalizing one or more of the expert frames that emerged in the interview discussions. It is interesting to compare these representations with the snapshots in Figure 2, and to reflect that while none of these representations are ‘wrong’, all, including those in Figures 1 and 2, are partial. Partial understanding has only limited value in managing complexity. The engineering schematic is, for example, a useful way to understand the main options for moving water around the river system, but using it as the only representation would lose information and understanding about river system ecological processes and its
beauty, not to mention cultural understandings, and potential for ecosystem and human system services.

4.3. Implications for Social Learning and Adaptive Management

One of the traditional owners interviewed for this research noted that

“One of the challenges has been actually having Aboriginal voices . . . consistently within the different decision makers and different levels, . . . and if you’re going to actually understand the water stuff, you almost have to be in it every day because it’s so complex and we listen to people that we do call on for advice, and it’s their bread and butter. It’s what they do and they’re all over it . . . And they speak a totally different language. Irrigators’ language or hydrologists’ language isn’t normal everyday English . . . ”

CEWO staff have recognized that the words and terms they use may have excluded some people from contributing to conversations and planning, and are now seeking to involve a wider range of people in the new Edward/Kolety-Wakool Environmental Water Reference Group [46]. They will also offer training to allow members to better understand the technical information with which they will be provided. While well intentioned, our findings suggest that this wider involvement and training may be insufficient, and that it may even accelerate hypocognition. The risk is that by normalizing and privileging expert frames, other ways of understanding the situation may be ignored, reducing opportunities to work with the rivers system’s complexity and adapt well. To avoid this, we suggest that seeking and using alternate framings of the situation, in a self aware and reflective way, is needed. In particular, all people with an interest in the situation, including the scientists and managers, will do well to learn to reflect deeply, and regularly, on the implications of their practice, including their communicating. Learning to seek and recognize metaphors and frames, and to collectively reflect on the implications is, we believe, as important as understanding the ecological impacts of the environmental watering actions. Practitioners and other community groups wishing to support adaptive management of environmental water should actively seek ways to broaden the range of frames through which the situation is experienced. The participants of the social learning/adaptive management, especially those who have authority or influence, need to be open to exploring alternate framings of situations. Our suggestion of the need for reflecting on practice, and that identifying frames can help focus that reflecting, is not novel; see, for example, [62], but such practice is yet to become part of regular managing, even when engagement and participation is genuinely sought. This may be because of a societal emphasis on measuring actions and outcomes against objectives, at the expense of reflecting on processes and consequences.

5. Conclusions

We present this small, local research project as a practical example of how a focus on revealing and considering discourse can provide interested actors with avenues for co-creation of new understandings and practice. The actual ‘outcomes’ of the discourse analysis are less important than their potential to catalyze new shared understandings for the actors in the situation. Providing the analysis is undertaken with rigor, whether the frames are complete, or perfectly labelled, is less important than the fact that once tentatively named and described they can become the focus for further discussion and improved insight. Such examination of practice through attention to discourse is a skill that can—and we argue should—be learned and practiced by any group of people involved with managing complex social-ecological systems.

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