

PARTICIPATORY, ADAPTIVE AND INTEGRATED URBAN WATER MANAGEMENT: TENSIONS AND POTENTIAL SOLUTIONS

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ABSTRACT

Across the water industry there have been calls for current urban water planning and management to become more integrated, adaptive and participatory. An analysis of the challenges associated with combining these approaches has not, however, been documented. Recent research in metropolitan areas on the South Eastern Australian seaboard revealed the perspectives of urban water professionals on these three approaches, and the associated tensions. Key challenges found were the: complexity of communicating concepts to stakeholders and the public, need for collaboration, overlapping nature of planning systems, large spatial and long temporal scales, and a resistance to change. Ways forward are suggested.

INTRODUCTION

The urban water sector in Australia is grappling with the unexpected future trends and shocks regarding stressors such as population growth, rapid urbanisation, and climate change related impacts. Commentators in the field of urban water planning and management have stressed the need for the current planning model to transition to a more sustainable, robust and flexible paradigm in order to provide efficient, reliable services that are resilient to unexpected future trends and shocks. Such a paradigm would embody integrated urban water management (IUWM), adaptive management (AM) and participatory approaches.

It has emerged from the literature, and also from the outcomes of this research, that current urban water planning and management in the Australian is on a transformative journey from the predominant conventional approach to a more integrative and inclusive one in both theory and practice. It has reached the point where the conventional way of planning and managing urban water is believed to be ill-suited in dealing with complexity and uncertainty,

but at the same time, there is little information or knowledge on how to adopt new thinking and implement new approaches.

This paper reports the outcomes of research that aims to inform this transition by exploring the insights of urban water professionals and how they perceive the three approaches, as well as drawing from their experience to identify key challenges and tensions.

METHODOLOGY AND PROCESS

The research employed a nested case study approach utilizing semi-structured interviews to gather qualitative data. The research focused on metropolitan areas on the South Eastern Australian seaboard. The aim was to extract respondents' personal and organisational perspectives on the adoption of the three approaches (IUWM, AM, and stakeholders and wider public engagement), their experience in carrying out the associated practice, and the challenges and tensions that they faced.

Eleven interviews were conducted with urban water professionals representing organisations in Sydney, Melbourne, and Brisbane. Since there is a limited pool of people that are working with these three approaches, the recruitment process initially relied on our professional network, and was then based on the snowballing technique.

The findings has been synthesised and captured into two main parts below. In the first part, the main implications regarding respondents' perspectives on the adoption of the three approaches (PP, AM and IUWM) are identified. In the second part, data is broken down and regrouped into twelve key themes.

PERSPECTIVES ON THE THREE APPROACHES

Integrated urban water management

While literature on IUWM is vast and covers a range of topics, the body of knowledge is fragmented and therefore, somewhat ambiguous (Furlong et al. 2015). Thus, this subsection aims to extract key

elements and concepts of IUWM approach, as well as the acknowledged difficulties in applying and incorporating the approach with the others from the interviewees' point of view.

First of all, the vital 'ingredients' for a successful implementation were acknowledged as being the collaboration between stakeholders, and public engagement.

Since IUWM is concerned with '*multiple systems at multiple scales*' and '*collaboration between key organisations involved is a key point*', as shared by participants V1 and V2 from the state of Victoria. However, even though it is a key feature, discussions about collaboration usually focused on there being unclear authorities and responsibilities among stakeholders. An interviewee from Queensland shared that IUWM projects usually involve '*cross jurisdictional boundaries*' and '*there are more than one entity that is responsible for elements of the integrated system*' (Q?). The fragmented governance system was also reported to be a major hurdle in integrating stormwater management into water supply, sewerage management and flood control strategies in Melbourne and Sydney. Moreover, it is suggested by many of the respondents that there are difficulties in organisations with regard to shifting the culture from focusing on dealing with ad-hoc, standalone issues using technical/structural solutions to a holistic proactive approach, and that lack of transition has also hindered collaboration. One of key reasons explained by interviewee N2 is that there are people in major organisations or 'water utilities' who are 'not comfortable with the complexity' that stemmed from the holistic approach. The point was further reinforced by respondent Q1 who suggested that '*[the ability to share knowledge and information about innovative approach across the water industry] is all boiled down to the individual people who just work within their frames of preference*', '*so it's an inherent limitation due to the individual's inability to truly think holistically*'.

The interviewees painted a vivid picture of how community engagement is a critical element that supported IUWM implementation in different regions. Examples on 'effective' engagement were described by various interviewees. One of such was the public participation that contributed to the development of Melbourne's healthy waterway strategy where 12 community meetings were held over a 12 months period (V2). The other one which was highlighted by interviewee N2 where various workshops were held in Sydney for the community to play a part in managing environmental flows and

to determine the water restriction thresholds, both under the framework of the Sydney Metropolitan Water Plan. Also, respondent Q2 mentioned a massive and intensive public participation program for integrated servicing strategies in Brisbane and Ipswich carried out by Queensland urban utilities.

It is interesting to observe the mismatch between the findings in this study and those in the literature. In the literature, while it is undeniable that community engagement plays an important role in IUWM and other similar approaches (Van De Meene & Brown 2009; Bahri 2012), it has been found previously that community engagement had not been well adopted in real life. Even in cases where it was implemented, the community's values and perceptions have not been incorporated into decisions (Ferguson, et al 2013; Furlong 2016). This mismatch might suggest that as the benefits of the participatory approach are beginning to be realised, people are trying to take it up and refine its implementation. Nevertheless, despite these examples, there are still some practitioners who remain sceptical about community engagement. Interviewee N1 and Q3 suggested that not only do programs use up a lot of money and time, but also involve the risk that the community will be biased about the matters under discussion.

Secondly, through the interviews, the participants' perceptions were analysed, based on the key elements of the approach, together with their judgement on how well IUWM has been carried out to date. While IUWM approach was discussed and analysed extensively in literature, it has been reported that its real life execution falls short and the idea has not been picked up as '*common practice*' or '*business as usual*', as emphasised by respondent N2. From the authors point of view, the integrated water management framework for Victoria (2017) might be the most progressive effort toward mainstreaming IUWM approach recently. The most notable feature of the framework might be the comprehensive platform and structure for coordinating and collaboration between different level of planning and management authorities and working groups.

While in other areas, for example the Integrated Water Cycle Management guidelines in NSW (NSW Office of Water 2014) and the Total Water Cycle Management framework in Queensland (Dept. of Infrastructure and Planning 2009) have articulated an integrated approach, the more recent thinking around IUWM has still not yet been captured.

Public participation

Public participation has been well discussed in the context of natural resources management, water

management and integrated water management (at the basin scale). However, it has been less well articulated in integrated water management or adaptive management in an urban settings, especially in ways that reflect real-life practices in Australia. Hence, this section explores such insights from the point of view of practitioners.

Overall, as discussed briefly in the previous section, matters related to community engagement was of concern to the interviewees, some of whom believe that it is the requirement for both IUWM and AM to be successfully adopted (participants N1 & Q3). It is reported that in real life it is still not a standard practice or 'business as usual' (N2). However, not only was there much attention paid to the public participatory approach throughout the interviews, people in the sector also described its relative importance and recalled numerous examples of effective practices. Also, it was mentioned by various participants (V1, V2 & Q2) that the IAP2 framework for public participation was frequently used as a guideline for engagement programmes. Moreover, there seems to be an aspiration to be 'further to the right' (V1) on that spectrum (which means higher levels of engagement) or, 'it is great to be into the higher end of the spectrum' (V2).

The views of interviewees about community engagement can be grouped into the benefits that the approach might bring, such as the right to inform and being informed, the diversity in decision making, and the challenges in terms of resources requirement, as well as the complexity of the concepts that it operates around.

Public engagement was found to play a vital role in fulfilling the human right to know and being provided opportunities to have input into decisions that will change things around their neighbourhood, as shared by respondent V2 and Q2:

An opportunity to have input into the things that they will see in their neighbourhood and into the way that this infrastructure will be built and operated, how will this look (V2)

We were not just consulting by telling, but we were also listening and reflecting (Q2)

These notions align well with the 'normative claims' highlighted in the literature on the participatory approach to natural resources management, environmental decision-making, and water resources management (Reed & Curzon, 2015). Associated with these theoretical-induced claims are the concepts of equity: where no marginal community is left out, public trust through transparent processes, confidence in Governance

system, empowerment of lay people who are capable of using the shared/co-generated knowledge via social learning process (Beierle & Cayford 2002; Reed & Curzon 2015). Those normative values can be inferred from conversation with participants N2, V2, Q2 and Q3 under the umbrella term 'informing better decisions'. For example, respondent Q3 suggested that engaging the community in the process might '*get the community really on board with what you're doing*' and interviewee N2 shared that '*you get people's buy-in in the beginning of the process*'.

Furthermore, public engagement was sought after by the participants as a means to improve the quality of decision making processes and their implementation by introducing diversity. Interviewee Q2 suggested that community engagement holds the potential to resolve conflicts and to have '*more brain muscle available for dealing with uncertainty*'. Similarly, respondent N1 stated that engagement programmes can '*broaden the thinking, and the options*' in the plan in which '*groups of people [stakeholders and the community] were involved in the early stages of the process*'. Moreover, participant N2 mentioned the potential to foster a social learning process among members of the community along the process. Those findings from the interviews also resonate with the 'pragmatic claims' where community engagement as an instrument can improve efficiency, the effectiveness of decisions, and their implementation (Rowe & Frewer 2000; Dietz & Stern 2009; Koontz & Newig 2014).

Besides these advantages, interviewees also raised concerns about issues that emerge with adopting the public participation together with IUWM and AM. The first key concern is how costly and time consuming the engagement process might be. To be able to include lay people in the process in a meaningful way and to move toward the right-hand side of IAP2's spectrum (level of engagement), there is a need to educate participants about various aspects of the integrated system. Respondent V2 pointed out that: '*when you start talking about IUWM with so many different organisations with so many different types of infrastructure, so many different funding model, it gets really complicated to communicate with people*'. In addition, the conflicted points of view might or might not reach consensus, and may potentially '*drag the process off-track*', as suggested by participant N2. The authors believe that in such cases, the role of the mediator, which could be the authorities, should be to organise knowledge sharing events and to present the information in the way that

best describes the practical benefits thoroughly. Furthermore, as opposed to the one-off manner characterising the IUWM approach, one vital feature of AM is the ongoing practice of monitoring, evaluation and adaptation over a long time span. However, continuous public participation and engagement is difficult to maintain in terms of time and resources.

Secondly, the inherent complexity of the concepts related to IUWM and AM, as pointed out by interviewees, has not only worsened the resources requirements, but also introduced the challenge of communicating the complexity to lay people in a beneficial way. Interviewee Q3 believed that, due to the complex nature of the systems when adopting integrated and adaptive management approaches, *'planning has become even more complex, and much harder to explain to the community (than when adopting IUWM alone)'*. Holding a similar view, interviewee V1 expressed concern about the capacity of the public to understand the complex decisions that they are influencing, stating: *'we can not expect the public to have the same level of understanding as the professionals'*.

Adaptive management

The adaptive management concept has been around for more than four decades but it is 'less common' in the water sector and is only gaining traction in urban water sector in Australia in recent years (Brown & Farrelly 2009; Mukheibir et al. 2012, N2, V1, Q1). Recently, the approach appeared in city plans and strategies such as the Sydney Metropolitan Water Plan (2017), Melbourne Water's sewerage strategies (2018b) and Melbourne Water's healthy waterways strategy (2018a), where adaptive pathway planning approaches have been used for delivering sustainable strategies. However, examples of investments based on these plans could not be found. In this study, interviewees' views on the concept were varied, favouring different approaches to AM, and much of the time it was unclear how the concepts were defined and how they felt it should be adopted in urban water management. This section discusses adaptive approach from a range of standpoints, including the meaning of the terms of use, and from both operational and strategic points of view.

Firstly, most of the interviewees used adaptive management and adaptive planning interchangeably, however this did not sit well with some. Interviewee V2 argued that AM is to respond to changes as soon as possible given that the understanding of the system and the information at hand are sufficient to adapt to these changes. On the other hand, they

suggested that adaptive planning is more related to thinking about the future, and how to set up the system to be resilient to future changes and shocks.

From an operational point of view, the utilisation of data was highlighted. Interviewee V2 considered AM to be heavily dependent on the *'ability to utilise data in terms of technology in a productive way'*. It is believed that better access to data of all types can lead to more resilience and responsive adaptation of the system. Also, participant Q2 described the use of data as a highly recommended element for *'testing options against different uncertainties'*.

From a decision-making perspective, there needs to be a readiness to change, and all kinds of solutions need to be considered. According to interview N1 and N2, options should not be *'locked-in to any infrastructure options'*. The delay in large-scale investments might create opportunities for innovations to emerge along the way. As interviewee N1 suggested: *'you might have something come along that is better than the past and you might therefore have cheaper or more resilient options than you had before'*. Also, respondents N1 and V2 believed that the avoidance of path dependency will help *'lessen the economic burden on future generations'*.

From a practical standpoint of developing an urban water plan, the most widely agreed idea seems to reference the concept of adaptive planning pathways, as mentioned by participants N2, V1, V2, Q2, and Q3. This idea draws on concepts such as adaptation pathways (Bosomworth et al. 2015, 2017), from the climate change adaptation literature and dynamic adaptive policy pathways (Haasnoot et al 2013; Lawrence & Haasnoot 2017). According to interviewee V2, adaptive planning pathways is an approach, a methodology and a method in itself in which scenario planning is taken to a whole new level. Moreover, respondents V2 and Q3 explicitly used the term *'adaptive pathways planning'* and described part of the idea as developing a roadmap of different future situations via scenario building. Participants V1 and Q2 implicitly referred to the important roles some considerations played in determining the preferred pathways of these developed scenarios, such as system thresholds or system limits and sets of actions. Other interviewees including N1, N2 and Q1 referred to adaptive approaches in planning at a more conceptual level in which a proactive approach and an ongoing process of adapting through monitoring and evaluating were highlighted.

The issues associated with the complexity and uncertainty of the adaptive management approach

emerged from various interviews. As indicated by respondent V1: *'IUWM is always complex, by adding the AM elements - it's just added more complexity'*. The issues that are intrinsic to the adaptive approach relate to the ongoing nature of the adaptive project, the understanding of the involved parties, the lack of confidence due to uncertainty.

In brief, in contrast to the one-off implementation that characterises conventional approaches to urban water management, even the integrated approach, adaptive planning and management requires significant expansion of the timespans of ongoing projects. Participants V1, Q1 and Q2 suggested that the collaborations, coordination, knowledge and data sharing, as well as the agreed-upon priorities among organisations, are much harder to maintain for long period of time due to changes of staffs and people in charge. Since AM/AP projects should happen over longer time periods, there is also a risk that political changes could hamper the process.

As discussed briefly above, the complexity of AM is something that is hard to convey to the community, however, it is not only challenging for the lay people but because there is no precedents, it is also difficult for the stakeholders to picture how AM/AP would look like in practice on the ground.

Furthermore, the concept of uncertainty is something that most professional planners have never been fully exposed to and are *'not comfortable'* with (N1, N2 and Q2). In addition, as mentioned repeatedly by respondents N2 and V2, uncertainty makes it very difficult for authorities to make decisions and take action, since there is a lack of confidence in the data for both them and the community. Also, when the community understands the uncertainty and risks involved in the investment decisions, this becomes another critical challenge because people are then uncomfortable with uncertainty as it makes them have doubts about the whole process (Q2). Furthermore, interviewees N1 and V1 specified that while the majority of the customers do not want to spend more money on water, keeping options open for the future to gain more resilience in the system may require investments that are higher than expected, and this can create tensions between planners and those that control the finances.

KEY CHALLENGES DUE TO THE COMPLEXITY WHEN ADOPTING THESE APPROACHES

In this section, the analysis process focused on utilizing ground theory coding technique in order to

identify key themes of issues that emerge across the three approaches (IUWM, PP, and AM).

Based on how frequently the ideas emerged throughout the interviews (looking at both the number of quotes and number of interviewees), twelve themes have been identified (see Table 1). Those that were raised the most are discussed below: the consideration of uncertainty, issues with community engagement, the complexity of the concept, and the scale of the problem. While the categorisation brings the sense of clarity, it is noteworthy that the themes of issues are interconnected with others.

Table 1: Overview of the themes

	1	2	3	4	5	6	7	8	9	10	11	12
1 : Certainty - Uncertainty - worldview	20	1	6	6	0	1	0	1	0	0	0	0
2 : Collaboration of organizations	1	6	1	1	0	0	0	1	0	0	0	0
3 : Community engagement	6	1	29	8	0	0	1	0	0	0	0	0
4 : Complexity of Concept	6	1	8	27	0	1	1	1	1	0	0	0
5 : Cost and benefit	0	0	0	0	4	0	1	0	0	0	0	0
6 : Importance of champion - leadership - personnel	1	0	0	1	0	10	0	1	0	0	0	0
7 : Opinions on scale	0	0	1	1	1	0	14	0	0	0	0	0
8 : Political influence- power play	1	1	0	1	0	1	0	8	0	0	0	0
9 : Sectors integration	0	0	0	1	0	0	0	0	1	0	0	0
10 : Technical - technology related	0	0	0	0	0	0	0	0	0	2	0	0
11 : Temporal scale	0	0	0	0	0	0	0	0	0	0	1	0
12 : Time and resources	0	0	0	0	0	0	0	0	0	0	0	4

The community engagement theme attracted the most attention from the interviewees. The main issues in this themes related to how people's worldview accommodate uncertainty, the complexity of IUWM and AM, and the 'appropriate' scale to implement. These issues share many similarities with the discussions on public participation above. Firstly, uncertainty was described as something that most participants found difficult to engage with, *'most people cannot deal with uncertainty'* since they are used to and *'comfortable with certainty'* in problem analysis, and with having clear answers to issues at hand (Q2). Moreover, this restricted worldview not only makes it harder to communicate and explain the concept of uncertainty associated with the AM approach (V1 and Q3), but also potentially leads to a hesitation in supporting decisions to invest more money now for future resilience (N2, V2 and Q2). Furthermore, the complexity of the concepts and processes of IUWM and AM approaches puts more stress in the system in terms of resource investment and the level of detail required when delivering engagement programme. The third sub-theme of community engagement is the spatial scale of participation. While the idea that public participation should be rolled out at the local scale where the decision directly affect people's lives was shared by interviewee V2, there is no common method or

guideline on how wide the engagement should be, who should be involved, or what the boundaries should be for the engagement.

The second-most popular theme was the 'complexity of the concepts'. The term 'complexity' was frequently referred to and describes processes and knowledge regarding IUWM and AM. It was not only the lack of knowledge and experience on IUWM and AM, and the issues related to the scalar dimensions, but also 'the challenge about IUWM and AM is getting people to understand the approaches' (Q1). Regarding engaging the public in IUWM processes in Victoria, respondent V1 indicated that: '*for IUWM to be successful, there needs to be some understanding and appreciation of the challenges and choices that are available within the community*'. Also, interviewee V2 said:

People can probably comment pretty easily on what their waterways look like, and they probably understand that runoff from the road that is not treated well impacts on the waterway. But then when you start talking about IUWM with so many different organisations, with different types of infrastructure, so many different funding models, it gets really complicated to communicate with people in this collaborative space.

It was a widely agreed perception that adding the AM approach makes it even harder to help the public to understand the complexity and uncertainty:

'[Adaptive] planning has become even more complex, and much harder to explain to the community [than the IUWM]' and 'I think there is great benefit in integrating it all but translating and communicating with people is sort of a complex area at the moment' (Q3, Queensland)

The third key theme involved how people's worldviews perceived different types of uncertainty that influenced the process of adopting the three approaches. It was suggested in the interviews that one of the main problem in adopting the three approaches (IUWM, PP & AM) is actually figuring how to shift the technocratic, deterministic, top-down approach that was engraved in people's mindset (both stakeholders and the community) after so many year in place. There appeared to be a certain level of resistance to adopting a new way of thinking that accommodates uncertainty and complexity, and this in itself further contributes to the overall complexity of the system. It can be seen in the literature on 'complex' or 'wicked problems' that uncertainty and complexity are closely intertwined, and that different types of uncertainty can emerge

from complexity (Head 2019; Kirschke et al. 2019;). It seems to be a common notion among respondents that the resistance might come from the entrenched habit or culture of organisations where the conventional approach is rooted in:

People are comfortable with certainty within their discipline-specific way of doing things over the years (Q2)

If the planning process 'is led by the engineering section of the council, it will have that engineering flavour and the lack of a broader understanding to it (Q1)

It is difficult to shift from ordinary practice operations [the conventional approach] ... and it takes time and leadership (V1)

They [the government bureaucracy] want to think about what is here now, how the management is now and how to make it through the next few year (N1)

The fourth theme relates to the spatial and temporal scales of problems/projects. The way participants in this study perceived scalar scale also relates to the level of complexity. Interviewees N1, N2 and Q2 believed that the level of complexity is proportional with the expanding of spatial and temporal boundaries of the project due to the nature of overlapping planning systems, as well as the fragmented Institutional arrangement.

Concerning the layering of different spatial and temporal scale, interviewee N1 described:

The thing with the level of complexity is that there is range of players, range of scale and trying to bring together the different planning scales to make decisions that are based on economic considerations brings out benefits to the community at all of those levels

Pointing specifically to the city-wide scale, respondent N2 added that '*they [local managers] would manage it [IUWM projects] as a whole project, the scale is smaller, and the responsibility and number of players is so much more simple than [in a] large city*'. Hence, the implementation process is also simpler according to interviewee N2. On the other hand, participant N1 argued that in large cities, such as Sydney, the complexity might also come from the overlapping planning system where the IUWM plan at city scale is developed by the state Government, while district level wastewater planning strategies might be done by the utility, and regional strategies for water supply was done by both.

Furthermore, concerns about the unclear authorisations and responsibilities among institutions emerged from numerous discussions. This kind of complexity appeared to surface when carrying out large scale IUWM implementation. Within this circumstance, interviewee N2 contended that *'we have got a huge number of different players in that debate. There's often silos, they don't speak with each other'*. An typical example is stormwater management where multiple entities share the responsibility. For instance, in Queensland, interviewee Q2 shared that:

Within a services provider, you have different departments looking after stormwater management, different units looking after catchment quality and waterway quality, and the state government which looks after the drinking water supply, the dam, long-term water, development approval, planning schemes and town planning aspects of the city... it creates a lack of clarity in the responsibilities.

Moreover, the fragmented institutional arrangement may create further conflicts due to the different priorities from different organisations which are in charge of different parts of the urban water system. As respondent N2 reported: *'they [organisations] are driven by different drivers, business drivers, environmental drivers, commercial drivers'*.

POTENTIAL WAYS FORWARD

The urban water sector is enduring a changing period and the authors' view is that those challenges identified in this study are part of the bigger issues of managing complex systems that are inherent in approaches such as IUWM, PP and AM, particularly when combined. This research is by no means aiming to solve all the problems raised by complexity for the water sector, instead, it aims to explore what complexity means in the context of applying different approaches and striving for sustainable futures.

From the authors' point of view, based on the interviews, it appears that the complexity and associated uncertainty stemming from adopting the three approaches is the key challenge. It raises issues such as:

- Difficulties in communicating complexity and uncertainty to the community in a way that is meaningful to them and allow them to engage with planning issues. Shifting people's mindset to accommodate complexity and uncertainty
- The lack of a framework to support and coordinate collaboration between multiple

organisations managing parts of a complex system

- The overlapping nature of various planning systems and the fragmented institutional arrangements

The authors' view is that there should be tools and processes developed to accommodate the complexity and uncertainty. The tools should be able to include multiple objectives in planning, and accommodate multiple uncertainties in the assumptions about the future. Also, they need to have mechanisms which help engage with stakeholders and the wider public in respectful and meaningful ways. Moreover, the tools need to be transparent enough for the stakeholders, the public and the decision-makers to be able to follow the project in sufficient detail. That being said, even though the tools might be engineering-intensive or technically complex, there should be a mechanism to effectively communicate the nature of the complexity to the involved parties at the appropriate level, especially the decision-makers in order to enable them to make better informed decisions.

The adaptive pathways planning approach, which is recently gaining attention from urban water professionals, can arguably contribute to the communication of uncertainty and complexity to authorities and the community. It might also help gradually shift officials' mindset away from conventional deterministic approaches. The core component of an adaptive pathways plan is the 'metro-map' style pathways diagram that build on the 'transient scenarios' in which a full range of plausible futures and the associated uncertainties and their development over time are explored (Haasnoot et al 2013; Bloemen et al. 2017). The method for developing 'transient scenarios' or the definition of all the tipping points, setting of lead-times, and the testing of portfolios of options might in some cases be too complex to convey to the community or even the decision makers. However, the intuitive visual representation of the transient pathways in the form of 'route-maps' or 'metro-maps' might potentially be useful to communicate complexity and uncertainty to technical planners in organisations. Further, as various stakeholders are brought along the adaptive planning process, it might stimulate a shift in the worldviews of 'the old-school' water professionals who prefer linear and deterministic outcome. However, while the pathways approaches can be intuitive it also has risks. Stakeholder who prefer linear and deterministic outcome can want to select their preferred pathway and follow it. This loses a key purpose of adaptive planning in keeping options

open as a means of managing with uncertainty and within complexity. The water industry should continue to look for method to communicate complexity and uncertainty.

With respect to the lack of a framework to support and coordinate collaboration between organisations, the authors believe that a comprehensive collaborating structure, such as the one outlined in the IWM framework for Victoria (2017), provides one example that other jurisdictions could look at for experience and lessons learnt. Key is having a structure that outlines what collaboration should be undertaken, with whom and when. While less developed in the Victorian framework, a key element is how to integrate water services planning with land use planning at the onset. This would remove much of the later ad hoc planning which limits alternative and flexible solutions, which would ensure common goals and the consideration of similar uncertainties, and therefore a complementary adaptive planning approach.

Issues related to fragmented institutional arrangements are commonly an issue with complex systems and these governance questions still need further considerations and the development of collective trust, since it involves politics and power distribution. There are some good examples of this, but these are the exception (Mukheibir et al 2014).

CONCLUSION

The complexity of the transition of the Australian urban water industry toward a more sustainable planning and management approach has been highlighted in this paper, and is consistent with the concept of 'complex' or 'wicked' problems. To integrate these three practices will require water planners to develop tools and processes to understand, engage with and plan for the inherent complexity of the problems that will, inevitably, confront organisation seeking to provide resilient urban water services into the future.

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