


Urban water security priorities – an Australian industry perspective

Julie V. Allan, Steven J. Kenway  and Brian W. Head

ABSTRACT

Urban water security is a critical element of sustainable development, and sustainable water management requires a participatory and collaborative approach across all stakeholders. However, the literature suggests that there can be diverse and potentially conflicting views within community and expert groups. This research aimed to understand the extent of views within a group of industry professionals on objectives, themes and definitions of urban water security. Using 22 semi-structured interviews with participants from Queensland, Australia, we found that, for the group, the priorities for urban water security are water quality and human health, quantity of supply to meet efficient demand, and reliability and resilience of supply systems. We also found diverse views on the importance of sustainability, water-related hazards, environment and ecosystem health, affordability and risk to water security in the urban context. We conclude that there is agreement within the water service provider group on priority needs, and suggest there is potential for community and service providers to agree on urban water security needs. The research findings support operationalisation of security concepts, highlight potential barriers to achieving urban water security, and provide insights for further engagement with urban water stakeholders.

Key words | industry, interviews, objectives, priorities, stakeholders, urban water security

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HIGHLIGHTS

- Industry professionals agree on urban water security priorities.
- Priorities are quality, quantity, efficient demand, reliability and resilience.
- Policy frameworks, political stability and institutional capacity are key enablers.
- Views on sustainability, hazards, environment, affordability and risk are diverse.
- Urban water security needs can potentially be agreed between stakeholders.

INTRODUCTION

Establishing water supply access and security have long been core objectives of water management and sustainable development (Brown *et al.* 2009). Yet urban water security remains an acknowledged global challenge (UNESCO 2019). Research into the field continues to grow, but common frameworks and language are lacking and there is a need to improve

operationalisation of the ideas and concepts (Cook & Bakker 2016; Gerlak *et al.* 2018; Hoekstra *et al.* 2018).

A recent systematic review identified 25 unique definitions of water security in academic and institutional literature (Allan *et al.* 2018). Using a thematic analysis, Allan *et al.* (2018) found that a stable suite of 11 themes has developed, but definitions continue to evolve with increasing complexity. The 11 themes are: water quality and human health; quantity of supply; reliability and resilience of supply systems; affordability of water

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services; economic productivity of water; environment and ecosystem health; sustainability of water security (including integrated urban water management and integrated water resource management techniques); water-related hazards; liveability and wellbeing; policy frameworks, political stability and institutional capacity; and risk and certainty.

Allan *et al.* (2018) built the case for a tailored urban water security definition and proposed that it could be defined as ‘*sustainably meeting the agreed water needs of a community*’, where the agreement should be between the water service provider and the community. This proposed definition is well aligned with the long-held principle that a participatory and collaborative approach is required across all stakeholder levels to achieve sustainable water management (Gorre-Dale 1992; UN-Water 2013). However, it is unclear if such collaboration can extend to achieving agreement between water service providers and the community on the needs and objectives of water security.

While a community is commonly understood to comprise people living in the same place or having certain characteristics in common, there should be no assumption that a community has a cohesive sense of identity, cooperation or inclusiveness. Indeed, a community may comprise groups with diverse and potentially competing attitudes, beliefs and interests (Head 2007). Likewise, it is common to find diverse and even conflicting views amongst experts in a field, particularly on complex issues (Marshall *et al.* 2012).

To understand if water service providers and the community can agree on water needs, it is necessary to first understand the extent of agreement within each of these groups. While the urban water stakeholder group is broad (including direct and indirect customers, water service providers, communities sharing water resources, property owners, traditional land owners, special interest groups, regulators and other government agencies), the onus is on water service providers to drive and facilitate engagement (Queensland Water Supply Regulator 2014; Moore *et al.* 2016).

Consequently, this research project aimed to understand if there was sufficient agreement of views within a group of water industry professionals to enable water needs to be agreed between these service providers and the community. It achieved this aim by investigating the views of industry professionals on key aspects of urban water security, including:

- whether a definition of urban water security is useful;
- the meaning of urban water security;
- the importance of water security themes in the urban context.

The research used a program of semi-structured interviews with invited water industry professionals working in the urban water service delivery chain across the State of Queensland, Australia. The focus of the research was on participants who were expert in the provision of water supplies to urban communities, including drinking water and non-drinking water supplies. (Although it is noted that some of the professionals interviewed had experience working across both water and wastewater management.) The participants were selected to represent a single regulatory jurisdiction to minimise externalities, but in a jurisdiction of adequate size to have potential diversity of views derived from local hydrology and demographic contexts, as well as different roles within the service delivery chain. So, while the detailed interview data is of particular interest to an Australian audience, the research findings provide general insights into the extent of alignment and divergence of views among urban water industry professionals.

Ultimately, effective and efficient policy and public investment in urban water security relies on having clearly articulated objectives that are aligned with stakeholder expectations. This research provides an improved understanding of the potential for achieving that alignment. When taken in conjunction with the findings of complementary research into community views, there will be an enhanced understanding of the practical realities and challenges of participatory approaches to urban water security planning and implementation.

METHODS

Methodology

The research framework leans towards constructionism, proposing that the social perspectives and interpretations of individuals determine their priorities and preferences for action. There was an expectation that the findings and outcomes would vary according to the group of actors

engaged and be dependent on their particular reality, including socio-cultural and bio-physical characteristics such as demography, hydrology, climate and other characteristics of their community. However, the research framework also takes the realist philosophical world view that there can be consistency in how data are gathered and analysed, and a common approach can be adopted that is grounded in the current knowledge base.

The research method selected was a semi-structured interview program using a purposive approach to recruitment of participants. Guiding questions were used to focus the collection of views but allowed both the interviewer and the interviewees to diverge and explore particular ideas in more detail while staying broadly aligned with the research objectives (Gill *et al.* 2008).

We used a mixed-method approach to design of the guiding questions. The yes/no, Likert scale and open ended questions yielded both qualitative and quantitative data for analysis. Close attention was paid to the framing of questions, the language used and the question order, to avoid leading the participants or influencing the views they expressed (King *et al.* 2018).

Ethics approval was granted for the interview research program by the University of Queensland Ethics Committee. All participants provided consent prior to the interviews. To maintain anonymity for participants and the organisations they worked for, the data and findings are presented in a consolidated format only.

Identification and engagement of participants

The provision of water supply services to an urban community involves a range of skilled professionals undertaking diverse roles, including government policy-makers, regulators, compliance officers, water service business owners, strategic and operational planners, designers, project managers, plant operators and maintainers, industry professional groups and advocacy groups. A purposive approach was adopted to recruit participants with particular expertise in water supply, with consideration given to current and previous water industry experience, as well as the size, nature and geographical location of current and past employers.

The literature suggests that as few as 12 interviews can provide an appropriate sample size for non-probabilistic

analysis for an initial study to gain an understanding of a topic, and a group size of 16–24 will provide greater depth of understanding of why views are offered (Guest *et al.* 2006; Hennink *et al.* 2017). Ideally, interviews will be conducted until a saturation point has been reached, where no new insights are gained. For practical and logistical reasons, 22 participants were recruited, based on their positional experience and insight from across the urban water service delivery chain, operating in different local areas, at different scales, in a range of roles including water policy, strategic planning, operational planning, operations and advocacy. All participants were drawn from a single regulatory environment (Queensland), which aligned with the community-based focus of the proposed urban water security definition from Allan *et al.* (2018). There was a 100% acceptance rate from the invited professionals.

The participant group represented more than 240 years of collective urban water industry experience. There was a mix of male and female representatives across 14 organisations with a spread of educational status, years of experience, professional roles, and management levels (Table 1).

The organisations represented by the participants included: state government (policy and regulatory agencies), water service providers, and professional and industry associations. The distribution of communities serviced by the water providers ranged in size from less than 10,000 to more than 3.5 million people, spread geographically across the western inland, coastal east and south east corner of Queensland. The professional and industry associations represented water interests at national, state and local scales.

Interview protocol

The interviews were guided by a standard set of questions. Not all participants answered all questions, either due to the interview design or by their choice, which is consistent with the flexible nature of semi-structured interviews (Table 2). The percentage of responses for each question was noted, where 100% signifies that useful data related to the question were gathered from all participants ($n = 22$).

To provide context for each participant's views on the potential usefulness of an urban water security definition, they were first asked if their organisation had a definition (Question 1). The participant's views on the potential

Table 1 | Summary of interviewees' characteristics

Characteristic	Count
Gender	
Male	17
Female	5
Highest qualification	
Diploma	4
Bachelor's	7
Master's	8
PhD	3
Water industry experience	
≤ 5 years	7
6–10 years	5
11–15 years	4
16–20 years	4
20 + years	2
Role (primary activity)	
Operations	5
Strategy and planning	8
Policy and oversight	5
Advocacy	4
Role level (in organisation)	
Executive	4
Senior manager	4
Skilled professional	7
Total number of interviewees	22

usefulness of an urban water security definition were then sought directly (Question 2). Given that the focus of the research was on participatory approaches, a third question was asked in this cluster regarding level of service (LOS) objectives (Question 3). The LOS approach to setting urban water security objectives establishes long-term statistical targets for security in terms of the frequency, severity and duration of restrictions that the community can expect to experience. One of the drivers for using this approach is a desire to communicate with the community and the associated need to express service objectives in terms that are easily understood by the community (Erlanger & Neal 2005). Water service providers for many large Australian cities have adopted the LOS approach to describing water security objectives and the State of Queensland has gone

further by prescribing LOS objectives for the South East Queensland region (Allan 2018; Killen 2019). This interview question also provided an opportunity for participants to provide their views on the relationship between definitions and objectives.

The meaning of urban water security was investigated through the use of a single, simple, open question (Question 4). Participants were asked to provide their personal view based on their experience. The interviewees were then presented with 11 themes of water security identified from a previous systematic review of definitions (Allan *et al.* 2018). They were asked for their views on the importance of each theme to planning for urban water security (Question 5). Finally, they were asked if there were any themes they considered important to urban water security that were not in the suite that had been provided (Question 6).

Twenty interviews of approximately 1 hour each were undertaken face to face ($n = 19$) and over the phone ($n = 1$), and all recorded with permission. Two participants provided written responses to the guiding questions, with follow-up phone discussions for clarification. A written summary of each interview was provided to the participant to allow for any modifications they deemed appropriate. The final interview records provided the data for analysis. To maximise consistency of approach, the same researcher conducted all the interviews and prepared all the interview records. The interviews took place from September 2018 to May 2019.

Data analysis

The participants' views and responses provided both qualitative and quantitative data in the form of discrete responses, strength and relativity of views, and general commentary on urban water security matters. Various techniques were used to analyse the participants' views, including coding, thematic analysis and deductive analysis (Table 3).

RESULTS AND DISCUSSION

The authors recognise that the 22 participants interviewed in this study do not represent all water industry professionals, even though they were selected to represent a

Table 2 | Guiding questions and validity of responses

Research aim	Guiding question	Responses % (n/22)
Is a definition of urban water security useful?	1. Does your organisation have a definition for urban water security?	100% (22/22)
	2. Would a definition provided by the State or other institution be useful? (Not asked if answer to Q1 was 'yes'.)	73% (16/22)
	<i>In South East Queensland, the desired level of service objectives (LOS) for water supply security are set by the State^a, paraphrased as:</i>	100% (22/22)
	<i>The bulk water supply system must be able to supply an average of 185 litres per person per day (residential) and be able to supply enough water so that medium level restrictions will not happen more than once every 10 years on average, will not restrict average use to less than 140 litres for each person for each day and will last no longer than one year on average.</i>	100% (22/22)
	3a) Do you understand the LOS objectives as described above? 3b) Do you think the community understands LOS as a way of describing urban water security?	
The meaning of urban water security. The importance of water security themes in the urban context.	4. What does the term 'urban water security' mean to you?	100% (22/22)
	5. To what extent do you think planning for urban water security should consider the following themes: water quality & human health; quantity of supply; reliability & resilience of supply systems; affordability of water services; economic productivity of water; environment & ecosystem health; sustainability of water security (including the use of integrated urban water management and integrated water resource management techniques); water-related hazards (such as floods); liveability & wellbeing; policy frameworks, political stability & institutional capacity to underpin the delivery of urban water security; risk & certainty?	95% (21/22)
	6a) Do you think there are any themes missing?	68% (15/22)
	6b) If yes, what? (Flexible question not asked in cases with time constraints.)	

^aSummarised from *Water Regulation 2016* (Queensland Government 2019).

range of urban water experience and expertise. We also note that the water security views of people can change over time depending on circumstances, for example in response to prolonged or severe drought. With these caveats in mind, we explore the results of the interviews and what could be inferred as being generally representative of urban water industry professionals.

Our initial observation regards the 100% acceptance rate of participants into this study. This suggests that this group of water industry professionals values the opportunity to contribute to research that could improve urban water security outcomes. This high level of engagement provides a positive environment for stakeholder engagement and bodes well for reaching agreement on community water needs.

Is a definition of urban water security useful?

The majority of participants (13/22) worked in an organisation that did not have a definition of urban water security, although almost half of the group that answered

positively (4/9) considered objectives synonymous with a definition (Table 4). Some particularly noted that objectives should be specific to a community, but could be based on agreed principles.

About half the interview group (13/22) considered a common definition could be useful, with some suggesting a definition could support consistency and clarity of message during communications. In contrast, a small number ($n = 3$) indicated that a definition would not affect how they planned for or made decisions related to water service provision. Six of the nine participants from organisations that had a definition considered Question 2 not relevant. When their results were removed from the analysis, 13 of the 16 respondents (81%) thought a common definition of urban water security could be useful.

A definition of urban water security was seen as useful to industry professionals, but we infer from the responses, and limited number of organisational definitions, that the absence of a definition is not considered an impediment to achieving security outcomes.

Table 3 | Summary of analysis approach, by question

Guiding question	Analysis approach summary
1. Does your organisation have a definition for urban water security?	Coded to: no or yes (including those who adopted LOS objectives established by the State). All associated comments were noted as free text, including the definition itself and how it is applied.
2. Would a definition provided by the State or other respected institution be useful?	Coded to: yes; no; maybe; not relevant.
3a) Do you understand the level of service (LOS) way of describing water security?	Content of free text coded to: yes, understand ok; do not understand well; do not understand.
3b) Do you think the community understands the LOS way of describing urban water security?	Content of free text coded to: yes, understandable; possibly understand or understand some aspects; very difficult to understand; no, they do not understand.
4. What does the term ‘urban water security’ mean to you?	Content of statements were recorded directly, grouped according to their complexity and themes identified. The prevalence of themes determined; 100% corresponds to all respondents mentioning the theme when describing urban water security, either in direct response to this question or prior to this point in the interview. Analysis was aligned with the 11 themes used in Q5.
5. To what extent do you think planning for urban water security should consider the following themes? (Refer to Table 2 for full details).	Deductive analysis based on 11 themes with responses noted against a five-point Likert scale: 5 = critical or very high importance; 4 = high importance; 3 = medium/secondary importance; 2 = low importance; 1 = very low importance. Analysis of entire group, and then according to the participants’ roles, broken into: <ul style="list-style-type: none"> • operational ($n = 13$): roles in operations, operational strategy and planning; aligns with water service provider organisations • non-operational ($n = 9$): roles in policy and oversight, and advocacy; aligns with state government and representative organisations.
6a) Do you think there are any themes missing?	(a) Coded to: yes; no.
6b) If yes, what?	(b) If yes, expanded content of response was noted.

The usefulness of any definition was seen largely as a communications tool and to support the establishment of objectives. However, views on the relationship between a definition and objectives varied. For many in the group, establishing objectives was a priority compared to establishing a definition, showing a focus on operationalisation that is not surprising for a group of industry professionals. Regardless of the distinction, there was a common desire to engage with the community to understand what constitutes a secure water supply and what is an acceptable, affordable price to pay for that.

When asked about the LOS approach to describing water security objectives, the interview participants overwhelming indicated they understood LOS objectives (Table 5). However, more than half the group thought that

the concept was very difficult for the broader community to understand, contrary to its intended purpose.

The statistical LOS approach to framing security objectives in terms of the frequency, severity and duration of restrictions is well understood by industry professionals and could be considered for broader adoption outside Australia. However, objectives framed in these terms were considered by many participants to be complex and lacking in context, failing to make it useful for communicating with the community. This is a significant finding of this research, and one that requires verification from the community stakeholder group.

It is essential that the manner of describing water needs is understood by both industry and community stakeholders if a participatory approach to water planning is to be

Table 4 | Summary of responses to questions 1 and 2

Response	% (Count)	Notes
1. Does your organisation have a definition for urban water security?		
Yes	40.9% (9)	1 × formal definition (not published), 4 × working definition focused on supply reliability, 4 × LOS objectives (1 × service provider, 3 × State set)
No	59.1% (13)	
Total	100% (22)	
2. Would a definition provided by the State or other respected institution be useful?		
Yes	45.5% (10)	Consistency and clarity of message is important. Objectives will be different for every community, but key principles should apply to all.
Maybe	13.6% (3)	May be useful if legislated or regulated.
No	13.6% (3)	Would not affect planning or decisions.
Not relevant	27.3% (6)	Deemed not relevant since have organisational definition.
Total	100% (22)	

Table 5 | Understanding level of service (LOS) objectives

Response	% (Count)	Key comments from interviewees
3a) Do you understand the LOS way of describing water security?		
Yes, understand ok	86.4% (19)	
Do not understand well	9.1% (2)	Needs more context, not intuitive
Do not understand	4.5% (1)	Very technical
Total	100%	
3b) Do you think the community understand the LOS way of describing urban water security?		
Yes, understandable to community	18.2% (4)	
Possibly understand some aspects	22.7% (5)	Complicated, averages are difficult to understand, needs context around current usage.
Very difficult to understand	13.6% (3)	
No, they do not understand	45.5% (10)	
Total	100%	

successful. The presentation of urban water security objectives should be aligned with their purpose, for example to reflect community expectations about access to water, to improve education and awareness as part of a demand management program, or to support a shared understanding of the risks to water supply. Ideally, security objectives will be articulated using concepts and language that are easily understood by the community, in a way that integrates with the approach used by the professionals in the service delivery chain. If objectives are difficult for the community to understand, there is a challenge for policy-makers, strategic planners and researchers to identify a more meaningful presentation approach. However, further work is required to establish the level of community understanding. The findings of such investigations will provide direction on future communication improvement activities.

What does urban water security mean to industry professionals?

When participants were asked the meaning of urban water security directly (Question 4), the group's views were most strongly focused on the quantity of water to be delivered, followed by quality, reliability and meeting efficient demand. When analysed against the known 11 water security themes (Table 6), there was no mention of water-related hazards or policy frameworks, political stability and institutional capacity; and two new themes were identified for the urban context – demand management and community engagement.

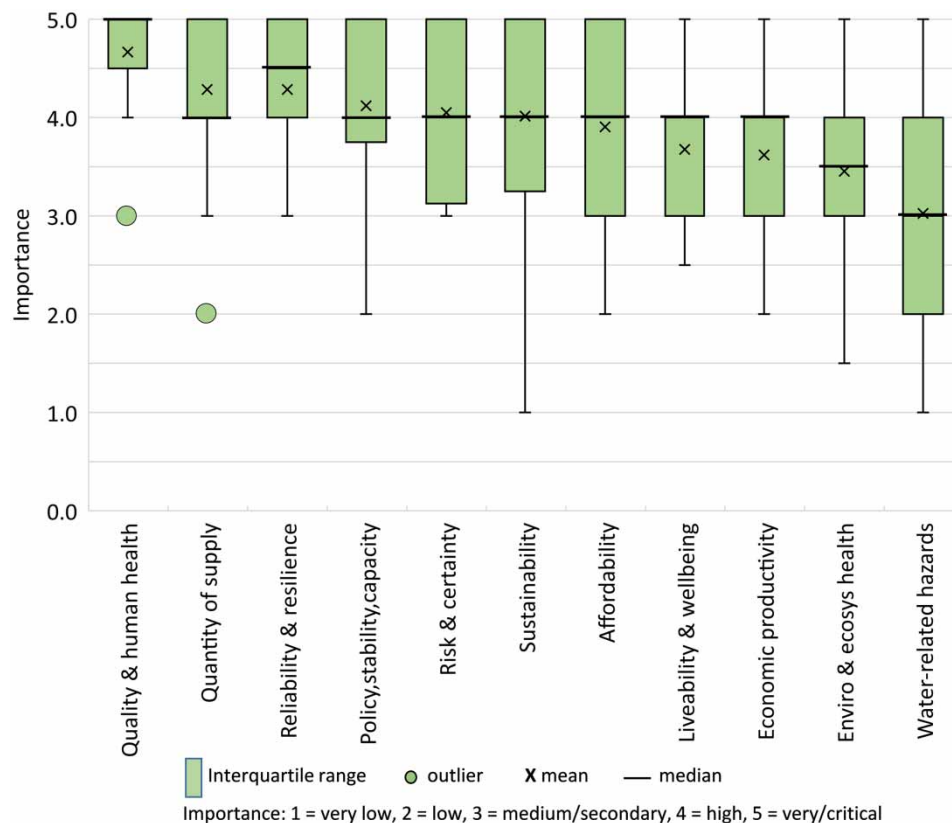
All participants mentioned quantity of supply as an element of urban water security. This was the only theme with this prevalence, which may be partly due to the focus of the research on water supply security and the selection of industry professionals aligned with this scope.

There was a consistent view that water demand (consumptive water use) will vary according to the circumstances of a community, but it is important that the demand is efficient and water is not wasted. Effective demand management is considered to be an increasingly important tool in achieving urban water security. Community engagement is considered a prerequisite to understanding and meeting community needs, particularly with respect to what is an acceptable, affordable price to pay for water and

Table 6 | Prevalence of themes in urban water security

Water security themes	Prevalence	
	n	(%) ⁴
Quantity of supply ¹	22	100.0
Water quality & human health ¹	13	59.1
Demand management ²	12	54.5
Reliability & resilience ¹	11	50.0
Affordability ¹	8	36.4
Community engagement ²	8	36.4
Liveability & wellbeing ¹	7	31.8
Sustainability ^{1,3}	5	22.7
Environment & ecosystem health ¹	4	18.2
Economic productivity ¹	3	13.6
Risk & certainty ¹	3	13.6
Water-related hazards ¹	0	0.0
Policy frameworks, political stability & institutional capacity ¹	0	0.0

Notes: (1) Previously identified in literature as a water security theme (Allan et al. 2018). (2) New theme of urban water security. (3) Includes total water cycle management. (4) 100% = 22/22.

**Figure 1** | Importance of themes of water security in the urban context.

what the community perceives as a secure water supply. Community engagement was also tied to communications to support effective demand management.

The importance of water security themes in the urban context

When the focus of the interviews moved to specifically considering the importance of the 11 water security themes in the urban planning context (Question 5), the most highly ranked element shifted from quantity of water to water quality and human health, which was considered by many to be a fundamental 'non-negotiable' feature (Figure 1).

The importance of each theme was analysed in terms of the mean, median and interquartile range (IQR). Given the small size of the data set and the presence of a number of outliers, the median is the preferred measure of central tendency. However, for completeness both median (\bar{x}) and mean (\bar{x}) statistics are provided. The IQR was used as an indication of the spread of views. Consideration was also

given to the range between minimum to maximum values (excluding outliers).

Of the water security themes examined, quality & human health was the most consistently important theme to the group ($\bar{x} = 5.0$, $\bar{x} = 4.7$) and with the greatest agreement as reflected by the narrowest interquartile range (0.5) and min/max spread (1.0). This theme is closely followed in importance by reliability & resilience ($\bar{x} = 4.5$, $\bar{x} = 4.3$), quantity of supply ($\bar{x} = 4.0$, $\bar{x} = 4.3$), the cluster of policy frameworks, political stability & institutional capacity ($\bar{x} = 4.0$, $\bar{x} = 4.1$), risk and certainty and sustainability ($\bar{x} = 4.0$, $\bar{x} = 4.0$) and affordability ($\bar{x} = 4.0$, $\bar{x} = 3.9$). This cluster group had not been mentioned at all prior to this point in the interviews. But when asked to consider it directly, the common (median) response was that it was of high importance.

The themes of liveability & wellbeing ($\bar{x} = 4.0$, $\bar{x} = 3.7$), and economic productivity ($\bar{x} = 4.0$, $\bar{x} = 3.6$) were considered by many to be sub-elements of the quantity of supply theme, connected through adequacy of supplies. It was also noted there was a strong connection between quality & human health, and environment & ecosystem health, extending also to sustainability.

The only themes not considered to be very important/critical or important in the urban context ($\bar{x} \leq 4.0$ and $\bar{x} \leq 4.0$) were environment & ecosystem health ($\bar{x} = 3.5$, $\bar{x} = 3.5$), and water-related hazards ($\bar{x} = 3.0$, $\bar{x} = 3.0$). These were viewed as less related to the urban context and more to dam safety and water resource management.

In terms of consistency of views, the themes with the greatest agreement after quality & human health were reliability & resilience and quantity of supply (both: IQR = 1.0, min/max = 2.0). The largest divergence in views was associated with sustainability and water-related hazards (both: IQR = 2.0, min/max = 4.0).

Differences in operational and non-operational views

The importance of themes was analysed according to the sub-groups of operational ($n = 13$) and non-operational roles ($n = 9$) of the interview participants (Figure 2). The operational group aligns with water utilities and includes roles directly related with operations, operational strategy and planning. The non-operational group aligns with state government policy and regulation agencies, and

representative organisations focused on advocacy and professional support.

The most and least important themes for the two sub-groups aligned well with the findings of the interview group as a whole. However, comparing the two groups shows that the operational group (by median response) placed more importance on reliability & resilience, risk & certainty, affordability and economic productivity; whereas the non-operational group placed more importance on environment & ecosystem health, sustainability and liveability.

For the operational group, there was a very high level of agreement on the importance of water quality & human health ($\bar{x} = 5.0$, $\bar{x} = 4.8$, IQR = 0), making this theme the most important to the group, noting there was one outlier who ranked it as medium importance (3.0). This theme was closely followed in importance by: reliability & resilience ($\bar{x} = 5.0$, $\bar{x} = 4.6$) and risk & certainty ($\bar{x} = 4.8$, $\bar{x} = 4.4$). The least important themes to the operational group were: water-related hazards ($\bar{x} = 3.5$, $\bar{x} = 3.2$) and environment & ecosystem health ($\bar{x} = 3.0$, $\bar{x} = 3.3$). There was a number of themes with good consistency of views (IQR = 1.0): quantity of supply; reliability & resilience; policy frameworks, political stability & institutional capacity; risk & certainty; liveability & wellbeing; and economic productivity. The themes with the most divergency of views were water-related hazards (IQR = 3.5), sustainability (IQR = 2.5), affordability (IQR = 1.75), and environment & ecosystem health (IQR = 1.4).

As with the operational group, the most important theme for the non-operational group was also water quality & human health ($\bar{x} = 5.0$, $\bar{x} = 4.4$), with good agreement (IQR = 1.0), noting that this group also had one ranking of medium importance (3.0). This theme was closely followed in importance by sustainability ($\bar{x} = 4.3$, $\bar{x} = 4.5$). The least important themes to the non-operational group were: water-related hazards ($\bar{x} = 3.0$, $\bar{x} = 2.8$) and economic productivity ($\bar{x} = 3.5$, $\bar{x} = 3.4$). Views were most consistent on the low importance of water-related hazards (IQR = 0.5), with the views on all other themes showing an IQR from 1.0 to 1.75.

The least significant water security theme in the urban context was water-related hazards, for both the operational and non-operational sub-groups ($\bar{x} \leq 3.0$). This theme was considered by many to be very important in its own right, but not central to urban water security. Drought management was noted as an element within water-related

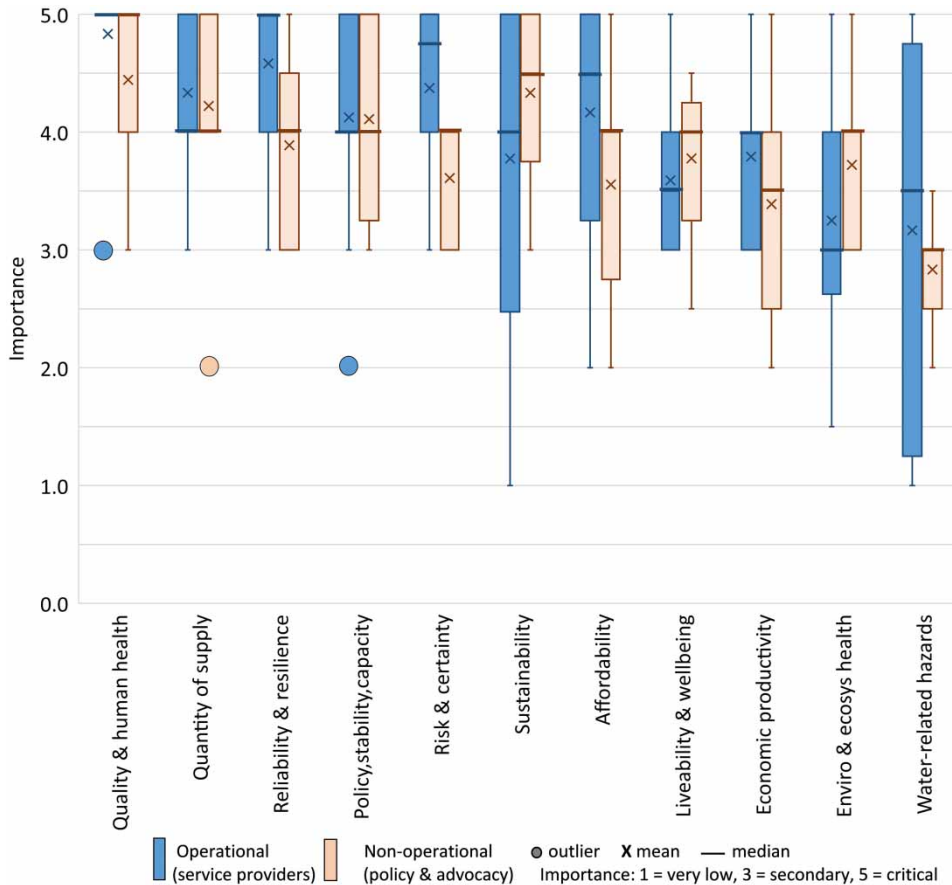


Figure 2 | Differences in operational and non-operational views of themes.

hazards, but considered by most of the group to be an integral component of the quantity of supply theme.

Considering the consistency between the two groups, the difference between medians was used as the measure ($\Delta = |\bar{x}_1 - \bar{x}_2|$). The themes that were most consistent ($\Delta = 0$) were: quality & human health ($\bar{x} = 5.0$), quantity of supply ($\bar{x} = 4.0$) and policy frameworks, political stability & institutional capacity ($\bar{x} = 4.0$). The themes that were viewed most differently by the two groups were: reliability & resilience ($\Delta = 1.0$), environment & ecosystem health ($\Delta = 1.0$) and risk & certainty ($\Delta = 0.8$). All other themes had a difference in median values of 0.5.

Urban water security priorities

While acknowledging there was a spectrum of views observed, the priority aspects of urban water security for water industry professionals are consistently: providing

appropriate quality water to support human health, delivering an adequate quantity of supply to meet efficient demand, and ensuring supply systems are reliable and resilient.

There was also general agreement (in the combined group and the operational/non-operational sub-groups) that policy frameworks, political stability and institutional capacity are highly important to planning for urban water security. These aspects were seen as key enablers of security, as distinct from objectives. Interestingly, there is very little published academic literature on the enablers for water security. If enablers create an environment that makes something possible, then it could be argued that identifying enablers is a critical requirement for progressing operationalisation of water security concepts, in any context. It seems that further research in this area is warranted.

There was also consistency in what the group considered are not priorities for water security in the urban context. Water-related hazards and environment &

ecosystem health were both considered important in their own right, but the group did not consider them very important with respect to urban water security. This was possibly due to the Australian context, since the management of dams and weirs is highly regulated with respect to both safety and water resource management, and there is a strong regulatory framework to protect environmental values at both State and national levels of government (McGrath 2017; Allan 2018). In different jurisdictions or for different groups of industry participants, these themes may be considered more important. This aligns with the idea that objectives need to be tailored for a community, according to their circumstances and priorities.

However, there is substantial divergence in views, both as a whole and across the operational and non-operational subgroups, on the importance of many secondary aspects of water security. This does not in itself prove that community water needs cannot be agreed, but it does suggest that the starting points are varied. Acceptable and agreed outcomes could readily result from discussions and negotiations. This reinforces the importance of engagement, communication, participation and collaboration to achieve urban water security, both within and across stakeholder groups.

Overall, the results indicate there is agreement within the industry stakeholder group on priority water needs and there is the potential to reach agreement on all water needs. As such, there is also the potential to reach agreement on water needs between a water service provider and a community.

New themes and opportunities for improving security

When the interviewees were asked if any themes of urban water security were missing, they suggested: climate change; energy consumption and greenhouse gas emissions; community engagement and customer education; level of service objectives and use of restrictions; willingness to pay; integration across human-made borders, urban and rural connections, surface and groundwater interactions; and public and workplace safety.

Throughout the interviews the group also articulated a range of issues they considered were significant risks to achieving urban water security, which included: the relatively short historical weather record that underpins assessment and planning; access to adequately skilled professionals,

particularly in rural and remote locations; and the need for policy innovation, particularly with respect to recycled water.

Limitations and implications for future research

To understand if there is potential for water service providers and communities to agree on water needs, it is necessary to understand the positions of each group. While this research shows there is potential to achieve agreement on priority water needs within the water industry stakeholder group, further complementary investigations are required to understand the views and priorities of community stakeholders. This will greatly enhance the benefits of the research reported here.

The urban water professional group interviewed included a range of roles, organisations, experience and locations with a focus on water supply services. However, all worked within the regulatory jurisdiction of Queensland, Australia. Industry professionals working in other Australian states or other countries could have different professional perspectives that have not been captured here. A larger sample across more locations could provide additional perspectives and views, particularly with respect to different national and international jurisdictions, water landscapes and policy backdrops. An expanded study might also allow for more detailed statistical analysis and a better understanding of the relationship between views expressed and different characteristics of the interview group, including any bias between water supply and wastewater managers. However, it is also important to note that planning for urban water security at a community level needs to remain at a scale aligned with the scope of service provision.

The research findings presented here would be valuable in the design and framing of a wider analysis of industry views, an exploratory analysis of community views or a bespoke assessment of industry or community needs at a targeted local level.

CONCLUSIONS

This research assists in understanding the extent of stakeholder participation and collaboration that can be achieved, as a pathway to sustainable water management. More specifically, it contributes to understanding if there is

potential for agreement between water service providers and the community on urban water needs.

This research investigated how water industry professionals view urban water security to determine if there is sufficient agreement within this key stakeholder group to support engagement with the broader community. The focus was on understanding what urban water security means to the group, including the importance and relevance of definitions, objectives and themes. With consideration of the water industry stakeholder group, the findings were that:

- a definition of urban water security could be useful, particularly to support consistency and clarity of messaging to water users (81% of valid responses);
- there was a consistent view that urban water security means providing appropriate quality water to support human health, delivering an adequate quantity of supply to meet efficient demand, and ensuring supply systems are reliable and resilient ($IQR \leq 0.5/5.0$, $\bar{x} \geq 4.5/5.0$);
- there was a consistent view that policy frameworks, political stability and institutional capacity are highly important to planning for urban water security ($\bar{x} = 4.0/5.0$ for all), and are key enablers of security, as distinct from objectives;
- there are diverse views on the importance of sustainability, water-related hazards, environment & ecosystem health, affordability and risk to achieving urban water security.

Additionally, this research suggests that water industry professionals generally value and desire meaningful engagement with community stakeholders to understand their water security expectations. They also value the opportunity to contribute to an improved understanding of urban water security concepts.

We conclude from our analysis that:

- a consensus can be reached amongst water industry professionals on the priority water needs for an urban community, and as such
- there is potential for urban water needs to be agreed between water service providers and their community stakeholders.

We have provided contextual insights that apply to engagement with urban water professionals in any jurisdiction. We have highlighted potential barriers to achieving

urban water security with respect to differences in terminology, expectations and beliefs for a group which operates within a single regulatory framework. We have made findings that align with the need for participation and collaboration between stakeholders to achieve water security. More broadly, the research findings support the operationalisation of water security language and concepts in the urban context.

To maximise the value of this research, further complementary work is required to better understand community views on key aspects of urban water security, including LOS objectives as a communications tool and priority water needs. Only by understanding the expectations of all stakeholders and clearly stating the objectives can urban water security be achieved, with all the accompanying social, economic and environmental benefits of sustainable development.

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DATA AVAILABILITY STATEMENT

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CONFLICT OF INTEREST

None of the authors are aware of any conflicts of interest, financial or personal relationships that could inappropriately influence or bias their work.

AVAILABILITY OF DATA AND MATERIAL

To maintain anonymity for participants and the organisations they worked for, data and findings are presented in a consolidated format only.

AUTHOR CONTRIBUTIONS

Julie Allan: conceptualisation, methodology, investigation, formal analysis, writing (original draft). Steven Kenway: supervision, writing (review and editing), visualisation. Brian Head: writing (review and editing).

COMPLIANCE WITH ETHICAL STANDARDS

Ethics approval was granted for the interview research program by the University of Queensland Ethics Committee. All participants provided consent prior to the interviews.

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