Informing infrastructure planning processes for IUWM projects

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Abstract

Water infrastructure planning has been practiced in much the same way for the centuries since the construction of the first water supply dams and sewers. This process has generally involved reactive, segmented and centralised infrastructure upgrades to meet specified service standards. In the last decade increasing system stresses and new technologies are making traditional planning processes out-dated. There is a growing acceptance of an Integrated Urban Water Management (IUWM) ideology within both industry and academia worldwide. The IUWM approach pushes for proactive long term integrated planning of all water services including environmental protection and liveability. However there are large gaps in knowledge in regards to the best way to implement IUWM planning. The current study has set out to (1) analyse eight IUWM project planning case studies to determine issues affecting implementation of IUWM, and (2) develop conceptual models for IUWM infrastructure planning. Melbourne, Australia has been selected as the area of interest because Melbourne is recognised as a world leader in water management practices. The study has utilised a combination of primary data from interviews with 34 industry experts from 19 different organisations and confidential project planning documents, as well as secondary data from literature, government strategies and reports. Industry consultation, case study analysis and conceptual model development has uncovered an assortment of original findings which have not been considered in water-related academic literature previously. These newly identified issues pose a threat, and also a direction for growth as IUWM planning processes evolve into the future.
Keywords: Integrated Water Management; Integrated Urban Water Management; water infrastructure planning; water planning framework; water planning scales.

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1 Introduction

Water management in urban areas began with the construction of dams and river diversions for the purpose of transferring water to urban populations. After providing water supply to cities it became necessary to remove human waste to provide a sanitary environment. This process eventually developed into sewage transfer and later, treatment services. Drainage services were then required to prevent flooding, through a practice which is now often referred to as stormwater management.

An increasing interest in environmental protection across society and governments around the 1970s has led many countries around the world to start taking environmental considerations seriously [1], this has led to many cities treating their stormwater, and increasing their treatment of sewage in order to protect receiving environments such as waterways and bays. Stormwater management techniques in the modern age include Sustainable Urban Drainage Systems (SUDS) and Water Sensitive Urban Design (WSUD) practices of wetlands, rain gardens and pollutant traps [2].

Increasing world populations, pollution, and climate change are leading the world head-on into an ever worsening water crisis. The most recent research by the United Nations predicts that there will be a global water deficit of 40% by 2030 [3]. Due to the connection between fresh water supplies, food production, and drinking water has been described by some as the next oil [4].

The world is also experiencing population migration away from rural areas towards cities. As populations in urban areas rise, rainfall patterns change and suitable locations for new dams and river extractions become less available urban areas are beginning to face increasing water shortages [5]. New technologies are emerging to provide additional water supplies to urban populations. These technologies include desalination, recycled water, and stormwater and rainwater harvesting [6].

Water management in some countries is presently moving towards sustainable fit-for-purpose water management, such as decentralised stormwater and wastewater treatment and reuse [7]. However there is a simultaneous counter trend towards capital and energy intensive desalination plants. The direction in which urban water management moves will be highly affected by government policy directions and the planning processes utilised by planners and regulators [6].

1.1 Integrated Urban Water Management (IUWM)

Integrated approaches, in different forms and identified by different names, have begun to emerge in the water management field over the past few decades. This emergence escalated dramatically around the year 2000. This increase can be partially attributed to the 2002 World Summit on Sustainable Development, and subsequent actions taken by the UN and other international organisations, such as the Global Water Partnership, to promote the uptake of Integrated Water Resource Management plans throughout the world [8].

Integrated Urban Water Management, a term which has emerged since the year 2000, can be considered to be an urban-centric adaptation of broader ideological changes within water management and society at large. There are a number of concepts which are generally attached to the IUWM paradigm including [8, 9]:

1. Proactive, long term planning of water infrastructure
2. Active consideration of water supply, wastewater, drainage, environmental and liveability services, and their interactions
3. Fit-for-purpose water use
4. Collaboration between organisations and departments
5. Inclusion of water considerations into urban planning processes
6. Both centralised and decentralised planning and infrastructure
7. Recycled water, stormwater and rainwater harvesting and reuse

1.2 Water planning in Melbourne, Australia

Melbourne, Australia was selected as the location for this research on the basis that it is considered to be a world leader in sustainable and integrated water management practices [10], and has had dramatic upheavals to water planning practices recently, including the planning of many recycled water and stormwater harvesting projects [11].

Water infrastructure planning for Melbourne was traditionally conducted through centralised water supply and demand strategies. The 1997–2007 drought put Melbourne's water planning processes to the ultimate test. Five water supply and demand strategies were developed over this period, culminating in the final strategy recommending the construction of AUD$4.9 Billion (capital cost only) worth of infrastructure [12]. Since the construction of these projects – a major pipeline and desalination plant - neither has been used to supply water to Melbourne [13]. These planning processes and outcomes have resulted in widespread public outcry and the issue has become politicised [11]. It is widely believed that if IUWM infrastructure is supplemented to the grid then future desalination augmentations may be deferred and potentially avoided.

Since the end of the drought many decentralised stormwater harvesting and recycled water projects have been created. There are trends beginning to emerge in regards to how these IUWM projects should be planned. These relate to both the production of water servicing strategies for particular areas and spatial scales, as well as the planning and approval processes for specific infrastructure projects. A new government department entitled "The Office of Living Victoria" (OLV) was created to spearhead this planning reform. However the OLV was subject to extensive media criticism for not following its tendering requirements correctly and failing to achieve physical outcomes [14], and after a state election this institution was dissolved in 2014 [15]. IUWM infrastructure planning guidelines which were being developed have not been finalised or implemented.

1.3 This paper

There is widespread agreement within the literature that water planning processes need to become more proactive and integrated in order to achieve the best community outcomes [9]. Major works by institutions such as the World Bank and

SWITCH have begun to investigate IUWM planning [10, 16]. There is however a lack of detailed methodologies for IUWM infrastructure planning.

One set of IUWM infrastructure planning guidelines is the CSIRO IUWM manual [17], in the sense that it considers policy setting, through to strategy development, and selection of infrastructure options through a metropolitan/regional scale planning process.

The current research program has involved consultation with 34 industry experts and investigation into eight IUWM project planning case studies in order to determine issues which are affecting the implementation of IUWM projects, and develop models for IUWM planning.

Existing IUWM guidelines such as CSIRO [17] have been found to include significant conceptual gaps by not considering the following: (a) complexity of the modern planning environment including political and social dimensions, (b) different scales of planning and division of responsibilities between water planning organisations, (c) approval/regulatory processes, and (d) the connections between risk assessment and financial evaluation. This paper will address these points and draw some conclusions about the direction in which IUWM infrastructure planning in Melbourne is moving.

2 Research method

2.1 Industry consultation

For this research, thirty four water industry experts from 19 Australian water-related organisations were consulted. The process through which industry experts were identified was as a combination of snowball sampling and maximal variation sampling [18]. This means that industry experts were asked to recommend additional experts and that a conscious effort was made to include at least one expert from each identified organisational type category. This list includes government entities, local government, planning agencies, bulk water suppliers and water retailers.

2.2 Developing a planning framework

It was determined early in this research program that, before case study analysis could be conducted effectively, it was necessary to develop a planning framework in order to enable data recording on case studies and easy comparison between them. Researchers conducted a review of urban and infrastructure planning, and an evaluation of existing water planning frameworks. A number of inadequacies were identified, and an improved model was developed to address these flaws. This framework was refined and validated through consultation with industry experts and has been published in Utilities Policy Journal [19].

2.3 Case study selection and analysis

Through industry recommendation and in accordance with work by the Institute of Sustainable Futures [7] it was decided that eight project case studies should be investigated for this research. Case study selection was done through brainstorming to create a long list from which the final case studies were selected. Criteria through which selection was made related to a) interesting findings, b) availability of information, and c) independent/succinct planning processes. The final selection was also informed by a targeted workshop with the Water Services Delivery team of Melbourne Water Corporation in 2014. Industry contacts have indicated that this spread is representative of the issues faced by industry and also represent at least one case study from each of Melbourne's water retailers.

Two meetings were held in relation to each of the case studies, the first to establish background and gather documentation, and the second to confirm findings. Analysis of case studies was conducted in the style of Institute of Sustainable Futures [7], in which industry experts are given an opportunity to voice their opinions, as well an opportunity for researchers to study case study documentation including confidential business case documents.

3 Developing a planning framework for case study assessment

In recent times water infrastructure planners must navigate a mix of political, social and institutional dimensions in addition to the established technical requirements. Therefore researchers need to be aware of the complex nature of planning when investigating planning case studies. For the purposes of this research an original water planning framework was developed showing the main steps of water infrastructure planning and the nonlinear connections between them. Findings from industry consultation informed what features should be included in the developed framework.

Key factors that differ between the proposed framework and previous water planning frameworks include: (i) making explicit the iterative process between decision makers (planners) and decision takers (regulators), (ii) consideration of the need for cost-sharing arrangements to be in place before final recommendations are made, and (iii) consideration of the effects of project outcomes on future projects through the media and public perceptions. The framework is summarised in Figure 1.

The authors recommend the use of this framework to others attempting to either collect case study information on past planning case studies, or plan future water infrastructure projects [19].

4 Case studies

Once the planning framework was developed, it was then used to as the basis for conducting analysis on the selected case studies [20]. In this section a short summary of some of the interesting points on each case study will be given.

Altona Recycled Water Project Stage 2, which was intended to supply to industrial customers, was identified as necessary due to demands for recycled water in the region increasing above what the existing recycled water scheme in the area (Altona stage 1) could deliver. The project was planned by a water retailer directly with industrial customers at a local scale. The scheme is predicted to be Net Present

Value (NPV) positive but has been put on hold by the State Government for the stated reason of not being "time critical".

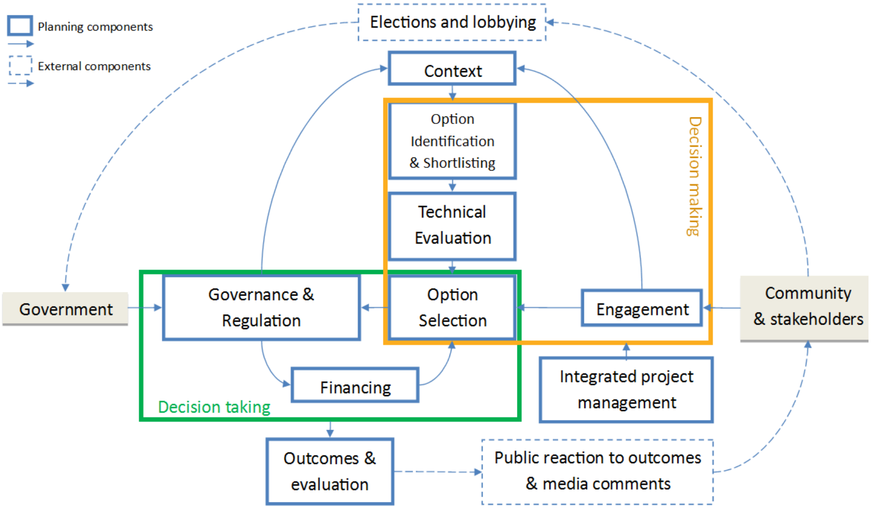

Figure 1: Proposed water infrastructure planning framework [19]

Boneo Recycled Water Scheme currently supplies to market gardens, golf courses and parks. The Boneo project was required to meet a 20% recycling target which came out of a city wide water strategy conducted in 2006, and so the project itself did not come under strict scrutiny by government and regulators.

Coburg Stormwater Harvesting Project, a stormwater to public open space scheme, received a federal grant for half its estimated cost, however later cost increases caused by stakeholder requirements and geological conditions led to the project being cancelled.

Coldstream Recycled Water Project, which intends to supply water to high value produce farms, is still in its planning phase. Farmers originally approached a retailer to own and operate this project so that they could use the recycled water for their farms in the Yarra Valley. The retailer has indicated that they do not wish to lead this project, and so the private consortium is progressing with the planning of this project on their own. The consortium has experienced considerable hurdles trying to achieve its objectives.

Table 1: Project case study summary

Case study	Water source	Intended use	Planning Outcome
Altona stage 2 Recycled Water	Major STP	Industrial customers	Put on hold by government
Boneo Recycled Water	Minor STP	Agriculture	In operation

Coburg Stormwater Harvesting	Transfer drain	Public open space watering	Cancelled due to cost increase
Coldstream Recycled Water	Minor STP	Agriculture	Continuing privately
Doncaster Hill Recycled Water	Minor STP	Residential non-potable	Planning permit refused by council
Fitzroy gardens Stormwater Harvesting	Transfer drain	Public open space watering	In operation
Kalkallo Stormwater Harvesting	Constructed wetland system	Residential non-potable/ potable	Constructed but surrounding development delayed
Toolern Stormwater Harvesting	Constructed wetland system	Agriculture	On hold due to no stakeholder agreement, pilot trial being planned

Doncaster Hill Recycled Water Project, a recycled water to residential apartments scheme, has experienced opposition from residents in the vicinity of the proposed recycling plant. The local council therefore refused the planning permit. The relevant water authority is considering other options.

Fitzroy Gardens Stormwater Harvesting Scheme was identified through a strategic planning process by Melbourne City Council looking at how to provide water for local parks. The project received funding through a government grant and was not subject to scrutiny by the State Government, so the final approval was given by the local council. Construction was recently finished, including the creation of an artificial stream through the gardens.

Kalkallo Stormwater Harvesting Project, a scheme which is intended to eventually use harvested stormwater for potable purposes, has been approved and built. However due to limitations on the relevant government grant it has been built prior to development in the area, and so currently sits with no supply and no demand. There is a risk that residential planning estimates in the area may have been over-optimistic.

Toolern Stormwater Harvesting Scheme has been conceived as way to supply a new development which is a large distance from the existing water grid and in a low rainfall area. It was designed to collect stormwater from the residential development for agricultural uses, and trade this for an upstream agricultural water entitlement, which would then be used for residential potable uses. A federal grant was received and planners were optimistic that the project would go ahead. However the public entity representing irrigators determined that they could not be confident of the quantity of stormwater produced, and therefore were not willing to accept the risk that their irrigation customers may be worse off. A pilot scheme is currently being planned to prove the reliability of the stormwater harvesting scheme.

5 IUWM planning recommendations

5.1 Strategy development across different spatial scales

Existing IUWM guidelines recommend the identification and planning of IUWM projects at the metropolitan/regional scale. It is acknowledged by other sources in the literature that planning are, and should be, conducted across multiple scales and actors [3]. Out of the eight project case studies considered, three were identified by a strategic planning process that took place at the sub-regional scale, one was identified by a strategic planning process that took place at the local scale, three were identified by a specific need at the local scale, and only one (the oldest) was identified through a centralised city-wide planning process [20].

This demonstrates that in practice IUWM projects are generally planned in a decentralised manner, with planning processes occurring across multiple spatial scales. Table 2 and Figure 2 demonstrate a proposed model for IUWM strategy and project planning across three planning scales: metro/regional, sub-regional and local, with each project planning process being preceded and informed by an infrastructure strategy of the same scale.

Researchers propose that metro/regional scale strategies should focus on policy directions and determining what volume of water is required from decentralised IUWM projects so that these projects can be properly evaluated independently at the sub-regional and local scale where appropriate.

Table 2: Focus of strategies at different spatial scales [20]

Scale	Focus of strategy
Metro/ regional	- Overall water resource balance and volume of water required - Frameworks/valuation techniques/guiding principles - Metro scale infrastructure options
Subregional	- Planning of sub-regional projects to meet calculated demand -Industrial, residential and agricultural reuse schemes
Local	- Planning of local projects to meet calculated demand - Public open space watering schemes for green spaces

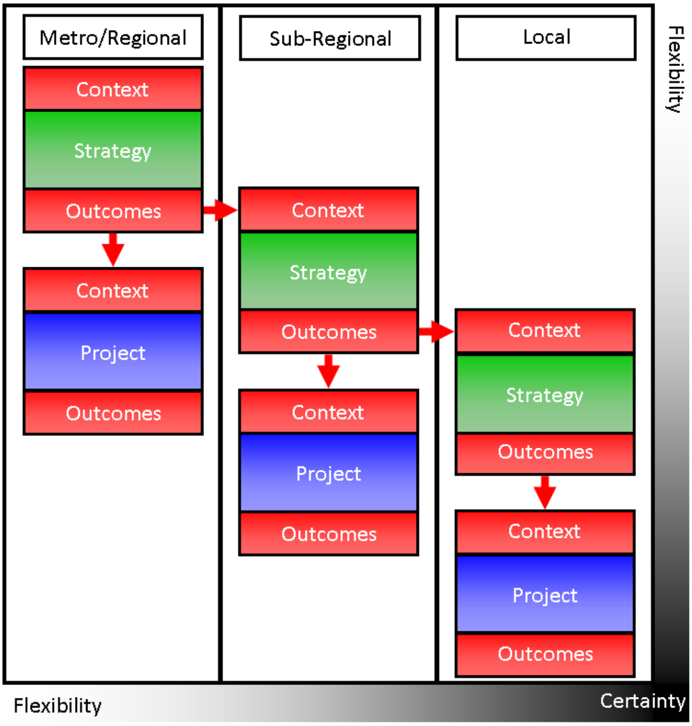

Figure 2: Model for IUWM infrastructure planning at different spatial scales [20]

5.2 Realising the importance of approval/regulatory processes

Out of the eight analysed project planning case studies three have been approved, three have been put on hold, one has been cancelled and one which was unsupported by the public sector is seeking to plan and operate privately. Final decisions/outcomes were issued by a wide array of sources internal and external, bureaucratic, and political. This issue was stressed by a number of consulted experts in relation to a lack of clarity about which government departments and ministers are making decisions regarding whether infrastructure should be built, and how these decisions were being made, as some NPV negative projects have been approved, and the one NPV positive project has been put on hold.

This represents a serious issue overlooked by previous research in the sense that planners do not have authority to implement their own recommendations. The authors of this paper propose a model of infrastructure planning within which it is understood that planning outcomes are achieved through a collaborative effort between planners and regulators which is designed to improve community outcomes. To implement this model a much increased level of collaboration between government, regulators (decision takers), and planners (decision makers) is required in order to determine policy directions and translate these into infrastructure outcomes.

5.3 Risk management and financial evaluation of projects

A major area of interest for this research relates to risk assessment and financial assessment of IUWM projects during project planning phases and how these were considered in combination. This is a very important issue considering that any losses accrued from the implementation of these projects are passed on to the public either through water bills or taxes.

Previous research had shown a strong bias towards over-optimism in public sector infrastructure projects [21]. Also Australian research has shown that specifically for IUWM projects outcomes do not always turn out as planned. Major work by the Institute of Sustainable Futures has come to the conclusion that "shifts happen" and that a much broader view of risk assessment needs to be incorporated, suggesting the use of the PESTLE matrix which includes political, economic, sociological, technological, legal and environmental risks [7].

Case study assessment has revealed that some IUWM projects have been constructed that, because of inaccurate planning estimates, are currently left unused, or not built due to community concerns, or not built due to stakeholder requirements and uncertainties.

Additional learnings were gained from narratives which came out of the industry consultation process. Experts discussed other water projects which have been constructed and never used due partially to political reasons, and others which have on-going financial issues where customer willingness to pay does not even cover operational costs.

All these issues constitute significant risks which should be considered in IUWM planning processes.

There is also a broader question of how economic evaluation should be conducted in terms of what market/non-market economic, environmental and social benefits should be included. Even within Melbourne, a city which has seen the widespread implementation of IUWM projects, there is no consensus emerging around this question. Some projects which are NPV negative are receiving government grants and being implemented, others which are assessed to be NPV positive are being put on hold with questionable futures.

According to previous research a significant proportion of IUWM projects will achieve outcomes less positive than what is forecast by planners. This leaves planners and regulators in a difficult position in regards to future projects.

6 The future of IUWM planning

There are major questions yet to be answered in relation to the planning of IUWM infrastructure. Some of the most glaring are: How should financial assessment of IUWM projects be conducted during planning? What market/non-market values should be included? How should risk assessment be factored into financial analysis considering that previous projects do not perform as predicted?

Planners and regulators are being left in limbo in regards to IUWM projects because (a) not all benefits are being quantified, and (b) planning forecasts/estimates are not turning out to be reliable. Therefore some benefits of IUWM projects are being undervalued and others are being overvalued.

However investigation into water planning in Melbourne reveals that some consensus is emerging on certain aspects of IUWM planning. Interviewed experts are in agreement about the fact that it is both possible and ideal to plan a variety of decentralised IUWM infrastructure projects in order to defer or replace future major centralised augmentations such as new dams and desalination plants. In line with recommendations from this research attempts are being made to assess the overall water resource situation of Melbourne at the metropolitan scale, and then use this information to put a value on alternative water source supplements to the grid, so that this value can be used in planning evaluation at sub-regional and local scales. IUWM projects are beginning to include what contribution they are making towards the deferral of future infrastructure in their financial assessments, making some benefits from these projects tangible and quantifiable.

These moves represent positive steps towards achieving what IUWM has always hoped to achieve: systematic planning systems which result in water infrastructure that improves economic, social, and environmental outcomes for the community, and increase system resilience to deal with increasing populations and changing rainfall patterns.

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