

A quantitative investigation of narratives: recycled drinking water

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Abstract

Recycled drinking water represents one of the most obvious and technologically reliable sources of urban water. Yet it is one of the least implemented solutions. Blame has often been laid on the emotional and psychological difficulties of persuading people that recycled drinking water is safe to drink. This ‘yuck’ factor has been empirically identified as a statistically significant variable. But how are such factors perceived? And more importantly – can these perceptions be changed? This study attempts a quantitative study of public perceptions and norm formation in recycled drinking water. Using the Q methodology, which reveals the subjective perceptions of key stakeholders, we uncover the following discourses: (1) technology can change current paradigms; (2) ensuring a safe water supply is a problem that has an economic cost; (3) environmental and global realities make it imperative to recycle water. These findings confound two prevailing views – that the debate in recycled drinking water is one of science over emotions, and more information can ‘overcome’ the apparently irrational norm formation. Instead, we find no new information in this case. Rather what was present was a new interpretative frame that allowed a new narrative enabling the bridging of two previously contradictory positions – in this instance, the pro- and anti-water reuse discourses.

Keywords: Q methodology; Recycled drinking water; Singapore; Water policy; Yuck factor

1. Introduction

There is broad agreement among water experts today that the current lack of water is less a physical limitation than the result of poor management or water governance. This, in turn, is a function of other factors such as pricing, management, and infrastructure. Within this broad area of water governance, however, there remains a relatively unexplored issue – why do people in cities still face a water shortage when they can use recycled water for drinking?

A United Nations report in 2012 on water states that: ‘While most cities would refrain from using treated waste water as a source of drinking water, this avenue is also available and has been implemented, for example, in water-scarce Singapore and the International Space Station, without ill

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effects' (WWDR4). The UN has also recommended the strategy of recycling waste water to water-stressed countries, citing the particular case of Singapore.

But implementing recycled drinking water is a notoriously intractable problem.

The most commonly cited obstacle is what has been called the 'yuck' factor; in fact, this factor has been found to be the only statistically significant factor in empirical studies (Po *et al.*, 2005). Although this human aversion, the visceral yuck, is a well-recorded psychological fact, little has been written about it in connection to the use of water-reuse policies (Po *et al.*, 2003; Leong & Yu, 2010). The case of Singapore presents a *prima facie* counterfactual to the prevailing view that the psychological barrier is an immutable one, a 'social fact' with its own logic that cannot be overcome by science and reason. But investigating this change is not easy because of the challenges inherent in applying a quantitative analysis to such subjective factors as public perception, discourses, and narratives.

This paper relies on institutional studies of perceptions, informal institutions, and institutional change, working off the premise that ideas are the key drivers of change. In current research on institutional change this hypothesis is not new, and indeed is well published; the current impasse, however, is on the level of operationalizing research in this area – quantifying such amorphous things as 'ideas' and 'narratives'. This paper takes a quantitative approach by utilizing the Q methodology which allows the examination of subjective viewpoints and perceptions, in the specific case of Singapore in implementing its water-reuse policy.

It pulls together these different theoretical and methodological approaches to give an exposition of how norms are formed in water-reuse policies, how the 'yuck' factor is presented in public discourse, and finally, how they affect the implementation of such policies. Overall, the aim of this paper is to tie the issue of water-reuse implementation to research on informal institutions and use this framework to examine how such informal norms change.

2. The narrative of recycled water

One often mentioned perception of reused water is the 'yuck' factor. This feeling of distaste is a well-known effect in water reuse and has been variously defined as a 'psychological repugnance', 'disgust', or 'profound discomfort' (Marks *et al.*, 2008). This is well captured in what can be thought of as an 'irrational' rejection of drinking recycled water. While technology can eradicate every microcosm of dirt and urine from sewage water, it cannot wipe out the mental association. There may be no rational basis for the 'yuck' factor, but it is a very real impediment (Steneke *et al.*, 2006) as one of the few statistically significant factors in influencing water-reuse policies (Po *et al.*, 2005).

Under this frame, changing this norm is a necessary condition for successful implementation of recycled drinking water. Given this, a question which arises is thus: can the natural visceral reaction be erased or ameliorated by science and rationality? The answer is unclear, although there is some evidence that public communications have an effect on acceptance (Dingfelder, 2004).

A finer examination of the problem therefore requires that we look at constraints objects such as culture and social norms. In the water sector, these are often invoked to explain the lack of success in otherwise 'rational' or sensible water reforms (see Table 1). For example, in explaining the lack of success in implementing urban stormwater management, Brown (2005) points to the 'inertia' caused by technocratic norms and 'institutional power and expertise' as well as values and leadership. Meinzen-Dick (2007) in her

Table 1. Review of research on norms.

Author (year)	Methods	Variables/unit of analysis	Findings
Meinzen-Dick (2007)	Two-stage logistic regression, to identify variables for collective organization and the use of such organized activity as a predictor for lobbying and maintenance	Data on 48 water units in two Indian states, including area irrigated by outlet, distance to markets, existence of groups such as temples and cooperatives	Norms such as the authority from religious figures, affect the success of irrigation projects in India
Brown (2005)	Stormwater management in Sydney, Australia	Content analysis, more than 60 interviews with stakeholders	Technocratic norms and leadership values impede the implementation of new stormwater harvesting arrangements
Miller & Buys (2008)	Case study of South East Australia's water recycling programme	Survey of perceptions of 408 residents of the affected area, with 111 questions on a 5-point Likert scale	Perception is that there is a serious water crisis with support for implementing water, despite existing norm of personal revulsion against drinking recycled water
McKay (2005)	Case Studies Australia's 1995 reform programme		Corroborates a stage-based approach. Factors are both endogenous and exogenous to the water sector
Pahl-Wostl (2007)	Case study: European NEWater project on water management in response to climate and global change	Water management regimes and transition processes	Change is due to 'adaptive management' from social and collective learning. Change impeded due to a set of 'interconnected' factors for the status quo

discussion on Australia's Murray-Darling basin wrote about the impact of norms that water is a free good or a 'gift from God' as inhibiting factors in the adoption of market-based policies. Conversely, a 'fit' with the physical, institutional, and cultural environment was therefore a reason for successful institutional change. In her examination of water organizations in two states in India, [Meinzen-Dick \(2007\)](#) found that the social capital generated by religion seems to have a stronger influence on organization for natural resource management than social capital created by cooperatives, despite the fact that organizing water user associations has been largely entrusted to the cooperatives.

The problem with this sort of 'history matters' assertion is that it does not allow us to ask 'how'; even with incorporating norms, we do not go very much beyond description. Take for example [Levy & Spiller's \(1994\)](#) seminal study of infrastructure, which is often taken as a starting point for exploring how public utilities succeed in implementing difficult reforms. They write: 'Regulatory incentives cannot be implemented in an institutional vacuum. The country's institutional endowment, the character of distributive politics, and the nature of its regulatory governance all affect the potential for the successful design of regulatory incentives' ([Levy & Spiller, 1994](#): 208).

Whereas there is widespread agreement that the context of a country matters, the question is *how* they in fact do. Levy and Spiller's own assertion that 'performance can be satisfactory within a wide range of regulatory procedures as long as arbitrary administration action can be restrained' is unhelpful.

Table 2. Recurrence of antithesis in primary text.

Antithetical pairs	Explanation
Toilet/tap	Juxtaposition of purity and danger
Secrecy/information	Juxtaposition of open and closed
Visceral reaction/science	Juxtaposition of expert and folk knowledge

Institutional settings and their variability appear to resist typology or generalizations. Given this, some appreciation of the polarization arising from this initial discourse analysis may be helpful. In the case of recycled drinking water – introducing a psychological distasteful element into something that needs to be pristine and clean, something that is essential to life is naturally controversial. The various antithetical pairs are presented in [Table 2](#).

Key elements of ‘thin’ discourse have the key narrative that drinking recycled water is an activity supported by science but rejected by the public because of psychological, non-rational reasons, as illustrated below:

1. People do not accept recycled drinking water because of the emotional factor.
2. They do not understand the science.
3. They need more information.
4. The problem can be treated as a matter of science and technology.
5. The problem can be solved by more explanation, communication and better public relations or education.

In using norms to explain the success or failure of institutional change, the main problem appears to be an enduring agnosticism about both the cause and the dynamics of institutional change. Given all the above, for water managers to persist in testing, quantifying and measuring public acceptance for water-reuse policies, with a sort of ‘census approach’, is unhelpful. Instead, this paper opens to advance the understanding of norms of recycled water via narratives and discourses. To do so, we undertake a discursive institutional analysis of Singapore’s case, using the Q methodology, which allows us to construct the key narrative elements. Because the Q shows collections of discourse coalitions, the results will show how the empirical narrative differs from the usual intractable pro- versus anti-reuse positions. Before the analysis, a quick note on method. Although it is often used in social psychology, here the Q method is used as a tool for narratology to investigate participants’ viewpoints. This methodological premise differs markedly from those most commonly used in social psychology, the ‘R’ method of regression to find co-relations of traits. Rather than hypothesized traits, the ‘variables’ in a Q are the persons who take part in the study. As the originator of the method explains, the Q explores ‘correlations between persons or whole aspects of persons’ (Stephenson, 1953: 345).

Hence, the ‘factors’ that emerge from a Q analysis are groups of discourse coalitions, or people holding a similar set of discourse beliefs. This method is especially suited to this paper because the results of a Q describe a population of viewpoints (Risdon *et al.*, 2003), which then helps us to uncover the perceptions, sentiments, and motives of the stakeholders – all these subjective elements that influence behaviour but are so often under-investigated (Smith, 2001).

3. The place of water in Singapore

Singapore has been importing water since 1927. During the water crisis of September 1961 to January 1962, water rationing meant some hardship for its people (Public Utilities Board Singapore, 2002). In 1961, the City Council signed the 1961 Water Agreement with the State of Johor in Malaysia. Under this agreement, Singapore had the ‘full and exclusive right and liberty to take, impound and use all the water’ within the Gunong Pulai and Pontian catchments, and Tebrau and Scudai Rivers, up till 2011. In 1962, another agreement was signed ‘for the supply of up to 250 million gallons of water per day (mgd) from the Johor River, until 2061’ (Tan *et al.*, 2009).

Singapore achieved full internal self-government (from the British) in 1959, and became part of Malaysia in 1963. Three years later, it was clear that the political merger of Singapore with Malaysia had failed. There was a deep divide, because of differences in beliefs over racial equality – Malaysia wanted a country where Malays had special rights, whereas Singapore wanted one in which all races were equal. This was captured in the trenchant choice between a ‘Malay Malaysia’ and a ‘Malayan Malaysia’.

This failed merger led to difficult bilateral relations, especially over the essential to life resource – water¹. This was *realpolitick*, notwithstanding the legal standing of the 1961 and 1962 Water Agreements. This foreign relations dimension to water security had a key impact on how people felt about water in Singapore and provided a special place at the policy-making table for it.

At the time, there were about 1.6 million people² living on the island, mainly crowded into the city centres. Public health provision was poor, and waterborne disease such as cholera was common because of poor sanitation facilities. The Singapore River, which runs through the heart of the city, was an open sewer. During the wet season, many parts of the city were underwater, whereas during the dry months, water had to be rationed. So from the very beginning, the place of water in Singapore was a matter of high public interest, and its scarcity was a fact of social life.

Water demand grew exponentially in the 1980s and 1990s. Even as catchment areas and the supply from Malaysia increased, consumption levels drove the Government to launch an education drive. It was at that time that institutional incentives and measures were put in place – water saving devices such as constant flow regulators and self-closing delayed action taps were made mandatory in all non-domestic premises. Fortunately for Singapore, this was a period of amicable relations, during which Singapore was increasing water imports from Malaysia through water agreements, Memorandums of Understanding to construct reservoirs and agreements to construct more dams (see Table 3).

But it was not to last. Soon after the start of the Asian Financial Crisis in 1997–1998, relations between the two countries deteriorated. In 1999, three meetings were held between Singapore and Malaysia at the top officials’ level to try and make progress on water and other bilateral issues³. In the early 2000s, Malaysia itself suffered water shortages and some quarters in Malaysia argued that water should go to Malaysians rather than being sold to Singapore.

¹ Dialogue with Minister Mentor Lee Kuan Yew at the Singapore International Water Week, June 2008.

² In 1960 as in Department of Statistics.

³ NEWater Case Study Page 2, 16 June 2003, Y.P. Chua (PUB), A.K. Nayar (MFA), A. Kam (MTI), H. Seah(PUB), C.J. Tan (Mindef), H.K. Wong (MHA).

Table 3. Water agreements between Malaysia and Singapore.

Year (Tenure)	Agreement details
1927	Singapore draws water from Malaysia. Johor buys back 800,000 gallons of treated water from Singapore at 25 cents per 1,000 gallons (1 gallon = 3.78541 liters). Also permits Singapore to rent 2,100 acres of land for 30 cents per acre in GunongPulai, where the waterworks were located (1 acre = 4046.86 m ²). Cost of waterworks, dams, pipelines, and reservoirs built by Singapore
1961 (50 years)	Expired in 2011. Singapore has the 'sole and absolute right to draw off and take all water available in, under or upon any part of the land'. Singapore shall pay three cents for every 1,000 gallons of water drawn. Malaysia to buy back 12% of the total water supplied to Singapore in treated form at 50 cents per 1,000 gallons
1962 (99 years)	Expires 2061. Singapore can draw from the Johor River, a maximum of 250 million gallons per day at three cents per 1,000 gallons. Johor can buy back 2% of the water at 50 cents per 1,000 gallons
1990	Supplements the 1962 agreement. Singapore can construct water infrastructure such as the Linggiu dam. Singapore paid the Johor Government RM 320 million as compensation for the permanent loss of the use of land referred to in the agreement, the loss of revenue from logging activities in the form of premium, royalty and cess payment and for leasing the land

It was at that time that the Singaporean leaders felt that they were under serious blackmail⁴. It was clear that a crisis had been reached and Singapore had to move into something that it had been putting on the backburner for decades – recycled water.

Singapore had been experimenting with recycled water since 1974. Singapore's first pilot water reclamation plant, a \$1.3 million project with a capacity of 381,360 l of water a day, had problems such as a strong smell of ammonia. It was subsequently shut down in late 1975 after the trial, and never released to the public (*The New Paper*, 2002; *The Straits Times*, 2002). But by the 1990s, there were better quality membranes and the cost had halved⁵.

Hence government officials revisited the idea to recycle water⁶, going to the United States, including Southern California, Orange County, to study recycling methods. After the visit, the government constructed a demonstration plant to test recycled water. By May 2000, a \$6.5 million plant had started operations (*The New Paper*, 2002; *The Straits Times*, 2002). By 2001, the Public Utilities Board (PUB) released recycled water for non-potable use – wafer fabrication processes, non-potable applications in manufacturing processes as well as air-conditioning cooling towers in commercial buildings. In September 2002, the name NEWater was given to recycled drinking water, an additional source of drinking water⁷. The next year, the PUB introduced NEWater (about 1% of total daily water consumption) into its water reservoirs. The amount was increased progressively to about 2.5% of total daily water consumption by 2011.

So far, the description of Singapore's lack of water, its urbanization as well as the increasing demand for water, are all nothing unique. These are experiences faced by many emerging cities. What then makes the narrative of Singapore amenable to recycled drinking water?

⁴ Dialogue with Minister Mentor Lee Kuan Yew at the Singapore International Water Week, June 2008.

⁵ Today 28 August 2002 Page 3, 'NEWaterAn Old Idea'. Channelnewsasia documentary 28 August 2002 'Thirsting for New Sources'.

⁶ Background Brief on NEWater Page 1, PUB.

⁷ Background Brief on NEWater Page 1 and Page 2, PUB.

4. Methodology

The Q methodology (or Q sorting) is employed in this investigation because it allows us to have a quantitative handle on narratives. The method provides the researcher with a ‘systematic and rigorously quantitative means for examining human subjectivity’. This method is based on the assumption firstly that subjective viewpoints can be communicated, however imperfect, and secondly that such viewpoints are presented from a self-referent position. As long as these two assumptions are taken on board, and the resulting analysis can tolerate both, there is no reason to believe that such perceptions cannot be the subject of objective, quantitative analysis.

This method has been increasingly used by policy analysts in recent years for its ability to uncover and represent stakeholder positions and their interrelations (Durning, 1999; Lynn, 1999; Pelletier *et al.*, 1999). Durning (1999) argues that Q methodology is primarily employed by post-positivists in their analysis, because it goes beyond the usual quantitative tool bag. In this case, Q methodology can be seen as a tool to capture qualitative responses quantitatively. The interviewees come from three main groups: first, community leaders, second, water managers, planners, consultants, and last members of the public who were affected by the policies.

For a Q sort, numbers are not important. Barry & Proops (1999: 339) refer to this as a ‘finite diversity’ of a particular issue. According to Brown (1980: 5), there is only a limited number of distinct viewpoints that can exist on different topics. If a Q sample is well structured, it must represent all these viewpoints. The Q methodology provides the researcher with a ‘systematic and rigorously quantitative means for examining human subjectivity.’

This method was picked primarily for this empirical virtue because it allows us to appreciate the particulars of the case, without losing the generalizations that policy analysis requires. Van Eeten (2001) writes: ‘Q methodology condenses the variation of views, opinions and ideas into a set of basic positions, problem definitions or dimensions underlying the debate.’

Given this, I use the Q methodology to generate data allowing us to examine specific ideational elements leading to the norm change.

An examination of the national newspapers provides a proxy of the public understanding of the time. A time frame of 1997 to 2008 was chosen to represent the 10 years of the policy cycle, from the planning stage in 1997, to implementation in 2001, to the 10-year mark of evaluation, when the largest water recycling plant was treated. Altogether there were 223 reports about recycled water in Singapore’s newspapers, namely The Straits Times, The New Paper, and The Business Times. Reports had both positive and negative tones about recycled water. Many of the negative reports were related to how NEWater would affect bilateral relations with Malaysia. Politicians in Malaysia took pot-shots at NEWater, warning their people that the water in Singapore could be unclean and even suggesting that Malaysia should sell sewage and not water to Singapore. There was one report in The New Paper that said more had to be done to promote NEWater as there was not much awareness about it in the heartlands.

From these newspaper reports, some 200 statements were extracted of which 50 non-repetitive statements were then subjected to a Q sort with 25 participants. This records the number of statements that the respondents score with ‘strongly disagree’ on the one end and ‘strongly agree’ on the other; and in between a distribution that usually takes the form of a roughly normal distribution (Brown, 1980).

How did we choose these participants? First, all the participants were Singaporeans as the narrative investigated is the local narrative. At the same time, the Q reveals important and pivotal viewpoints, so the constituent groups were important – we chose representatives from the community, water sector and

general public because these were the key stakeholders in the policy change. The interviewees were recruited based on their ability to understand the 50 statements, their interest in water issues, and the ability to construct and articulate their views.

The responses were inputted into the PQMethod software. The results generated are summarized below in Table 4, with eight key factors identified as forming the key parts of the dialogue (see Table 5).

5. Institutional change: yuck to NEWater

From the analysis, we see that there are eight factors, but thematically, they fall into three broad areas, which are discussed below. The factors which discuss the same issue, for example, technology, are grouped together under the same theme. In this discourse, technology is understood not just as a matter of application of science, but also as the inventions of new processes of water governance.

In the second group of factors, on security, we see that in Singapore's case, the notion of an ensured water supply is tied inextricably with the use of water – which is then tied to pricing. So economic and security issues are interlinked.

The third theme has do with the 'larger' issues, beyond the immediate water policy – issues of climate change, long-term scenarios and the human, psychological aversion to drinking recycled drinking water. More than the two first themes, this last demonstrates that the implementation of recycled drinking water does not mean that the human aversion has been erased, rather that there is a new frame or meta-narrative about water that makes drinking water more acceptable. This is discussed further below, with the number in parenthesis showing the numbering of the statements in the initial list of 50.

5.1. Discourse 1: technology can change current paradigms

Factor 1 Technology can overcome water shortages.

Factor 2 Innovations in water management, such as pricing and recycling, help ensure a good supply of water.

The introduction of a new source of water supply was unprecedented for Singapore, which had relied on two traditional sources of water – local catchments and imported water. Within the discourse, the use of technology was perceived to be a key component in the effort to ensure a sustainable water supply. ('There is a need for better technology and engineering solutions as the demand for a secure water supply rises with a growing global population' (17).)

In this, the discourse showed that a deliberate attempt was made to shift the attention away from the source by focusing on the treatment process, which involves using advanced, state-of-the-art membrane technology. The discourse was also partly shaped by the terms that the water utility chose for these new water products. The water managers did not use internationally recognized terms such as 'wastewater' or 'sewage'. Instead, they called it 'reclaimed' or recycled water, terms which had made their way into public perceptions.

Overall, Factor 1 highlights the role of technology and reason; rather than pitching 'yuck against science', it is 'science against water scarcity'. Water reuse is not new and has been used quite extensively and successfully in other countries, including the USA. In short, instead of downplaying the 'yuck' issue, the discourse was about how different countries dealt with their water problems differently and the results of these policies. ('Water shortage was once a headache for Singapore but NEWater has

Table 4. The opinion continuum for the Q-sort.

Number of statements	5	10	20	10	5					
Statement scores	–2	–1	0	1	2					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree					
<i>Factor scores for factor 1</i>			Factor							
Factor 1: Technology can overcome water shortages			1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)										
1. There is a need for better technology and engineering solutions as the demand for a secure water supply rises with a growing global population. (17)			2	2	0	0	1	0	2	2
2. It is a responsibility for all Singaporeans to keep water not only clean but also not to waste it. (39)			2	1	0	0	1	2	1	1
3. Water shortage was once a headache for Singapore but NEWater has increasingly allowed Singapore to be less reliant on Malaysia. (26)			2	–1	1	–1	–1	0	0	–1
4. NEWater is a key part of self-reliance. (37)			2	0	0	1	–1	0	0	1
5. Water conservation projects, such as installing water saving thimbles on taps to reduce water consumption, are not enough to meet Singapore's increasing water needs. (2)			2	2	1	0	–2	–1	0	0
<i>Factor scores for factor 2</i>			Factor							
Factor 2: Innovations in water management, such as pricing and recycling, help ensure a good supply of water			1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)										
1. Water conservation projects, such as installing water saving thimbles on taps to reduce water consumption, are not enough to meet Singapore's increasing water needs. (2)			2	2	1	0	–2	–1	0	0
2. Water security is a real problem that should not be glossed over as an unnecessary worry. (35)			1	2	1	0	1	1	1	1
3. There is a need for better technology and engineering solutions as the demand for a secure water supply rises with a growing global population. (17)			2	2	0	0	1	0	2	2
4. Even with the increased supply of water from NEWater, it is important to treat water as a security issue. (19)			1	2	1	0	1	0	1	2
5. The flow of clean, plentiful water is essential to our economy and society so it should not be taken for granted. (23)			1	1	0	0	2	1	2	0
6. Government support is needed to help companies in research and development as well as exporting their products. (43)			0	1	0	–1	0	0	0	0
<i>Factor scores for factor 3</i>			Factor							
Factor 3: Water should be priced to reflect the cost of supply			1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)										
1. Water is a precious commodity and should be priced as such to ensure no one wastes it without feeling the pinch. (4)			0	–2	2	0	2	–2	0	0

(Continued.)

Table 4. (Continued.)

Number of statements	5	10	20	10	5					
Statement scores	–2	–1	0	1	2					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree					
2. The price of water has to take into account its scarcity as well as the cost of supplying and cleaning it. (29)			–1	–2	2	1	1	0	0	1
3. NEWater is reclaimed water that has undergone purification and treatment processes. (11)			–1	0	2	–1	0	1	–1	1
4. NEWater helps to ensure Singapore's water supply is not affected during dry months, which we may see more of as climate change causes rainfall to become unpredictable. (1)			–1	0	2	2	0	1	0	2
5. NEWater is part of Singapore's efforts to manage the entire water loop of water usage, collection and production. (6)			0	1	1	1	0	1	–1	0
6. NEWater is one of Singapore's four 'taps' and an important part of its water supply. (12)			1	0	1	–2	–2	1	1	2
<i>Factor scores for factor 4</i>			<i>Factor</i>							
Factor 4: Innovations in water management ensure a good supply of water			1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)										
1. NEWater helps to ensure Singapore's water supply is not affected during dry months, which we may see more of as climate change causes rainfall to become unpredictable. (1)			–1	0	2	2	0	1	0	2
2. Singapore applies the same pricing to industry as well as domestic users up to a certain level of consumption of water because both sectors have an equal responsibility to conserve water. (31)			–1	–2	–1	2	0	–1	0	0
3. Singapore is now recognized as a global hydro hub for its innovative water management. (25)			0	–1	–1	2	–1	0	–1	0
4. The drive to be self-reliant has given Singapore the room to be totally self-sufficient if there is no new water agreement with Malaysia in 2061 when the second water agreement expires. (28)			0	0	0	2	0	2	2	0
5. NEWater shows that environmental sustainability is not incompatible with economic development. (16)			–1	1	–1	2	–2	0	1	1
6. The price of water has to take into account its scarcity as well as the cost of supplying and cleaning it. (29)			–1	–2	2	1	1	0	0	1
<i>Factor scores for factor 5</i>			<i>Factor</i>							
Factor 5: Singapore needs to choose the most cost-efficient way to produce water			1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)										
1. Singapore is simply too small to collect enough water for its domestic and industrial needs. (3)			0	1	–1	1	2	–1	1	0

(Continued.)

Table 4. (Continued.)

Number of statements	5	10	20	10	5					
Statement scores	–2	–1	0	1	2					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree					
2. Water is a precious commodity and should be priced as such to ensure no one wastes it without feeling the pinch. (4)			0	–2	2	0	2	–2	0	0
3. NEWater is a strain to Singapore's energy network as it requires more energy to process than reservoir or imported water. (7)			–1	–1	0	–2	2	–1	0	0
4. Energy consumption in desalination and reclamation technologies has to be reduced. (8)			0	–1	0	–2	2	–2	1	–1
5. The flow of clean, plentiful water is essential to our economy and society so it should not be taken for granted. (23)			1	1	0	0	2	1	2	0
<i>Factor scores for factor 6</i>			<i>Factor</i>							
Factor 6: Recycling water ensures independence and growth			1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)										
1. The drive to be self-reliant has given Singapore the room to be totally self-sufficient if there is no new water agreement with Malaysia in 2061 when the second water agreement expires. (28)			0	0	0	2	0	2	2	0
2. Water-related issues can harm business – everything from drought to pollution to increased water tariffs. (49)			0	0	–1	–1	0	2	–2	0
3. Business opportunities in water management are abundant as developing countries such as China, India and the Philippines have huge potential for water technology investment. (20)			1	–1	–2	0	1	2	0	1
4. It is a responsibility for all Singaporeans to keep water not only clean but also not to waste it. (39)			2	1	0	0	1	2	1	1
5. Water reclamation is a long-term investment entailing huge costs in the short term but yielding benefit in the long term. (14)			1	0	0	0	–2	2	–1	1
6. NEWater is more energy-efficient than desalination. (13)			–1	0	1	–2	0	1	1	0
<i>Factor scores for factor 7</i>			<i>Factor</i>							
Factor 7: The 'yuck' factor still exists and the science of recycling needs to be better known			1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)										
1. The science of NEWater needs to be made better known to the general public. (9)			1	–1	0	0	0	0	2	–1
2. There is a need for better technology and engineering solutions as the demand for a secure water supply rises with a growing global population. (17)			2	2	0	0	1	0	2	2

(Continued.)

Table 4. (Continued.)

Number of statements	5		10		20		10		5			
	–2		–1		0		1		2			
Statement scores	Strongly disagree		Disagree		Neutral		Agree		Strongly agree			
3. The flow of clean, plentiful water is essential to our economy and society so it should not be taken for granted. (23)					1	1	0	0	2	1	2	0
4. The drive to be self-reliant has given Singapore the room to be totally self-sufficient if there is no new water agreement with Malaysia in 2061 when the second water agreement expires. (28)					0	0	0	2	0	2	2	0
5. There is still an element of instinctive repulsiveness in drinking recycled sewage water. (40)					–2	1	0	–1	–1	–1	2	–2
<i>Factor scores for factor 8</i>					Factor							
Factor 8: Because of climate change, recycled water is the way to go					1	2	3	4	5	6	7	8
Statements (original statement numbering in parentheses)												
1. NEWater helps to ensure Singapore's water supply is not affected during dry months, which we may see more of as climate change causes rainfall to become unpredictable. (1)					–1	0	2	2	0	1	0	2
2. NEWater is one of Singapore's four 'taps' and an important part of its water supply. (12)					1	0	1	–2	–2	1	1	2
3. There is a need for better technology and engineering solutions as the demand for a secure water supply rises with a growing global population. (17)					2	2	0	0	1	0	2	2
4. Developing NEWater is strategic asset management at a time when global water scarcity is undermining economic progress. (18)					0	0	0	0	0	0	–2	2
5. Even with the increased supply of water from NEWater, it is important to treat water as a security issue. (19)					1	2	1	0	1	0	1	2

increasingly allowed Singapore to be less reliant on Malaysia' (26). 'NEWater is a key part of self-reliance' (37).)

Scientific tests and technology were a key part of the policy change. The Government conducted a comprehensive study to ensure that NEWater was within the World Health Organization Drinking Water Guidelines and United States Environmental Protection Agency (USEPA) Drinking Water Standards.

The Government was also transparent about the quality of NEWater, releasing technical data. This compares with international quality parameters as shown in Table 6.

The public was also kept informed of highly technical details such as the process by which Singapore reclaims its water⁸.

⁸ Background Brief on NEWater Page 1 and Page 2, PUB.

Table 5. Narratives of NEWater.

Factor	Ideational element
Factor 1	Technology can overcome water shortages.
Factor 2	Innovations in water management, such as pricing and recycling, help ensure a good supply of water.
Factor 3	Water should be priced to reflect the cost of supply.
Factor 4	Innovations in water management ensure a good supply of water.
Factor 5	Singapore has severe physical and energy constraints and needs to choose the most cost-efficient way of producing water.
Factor 6	Recycling water is a way of preserving independence and continued growth.
Factor 7	The science of recycling still needs to be better known and there is still an instinctive rejection of drinking sewage water ('yuck' factor).
Factor 8	As climate change and global water scarcity take root, recycled drinking water is a way to ensure water supply.

5.2. Discourse 2: water security is a problem with an economic cost

Factor 3 Water should be priced to reflect the cost of supply.

Factor 4 Innovations in water management ensure a good supply of water.

Factor 5 Singapore has severe physical and energy constraints and needs to choose the most cost-efficient way of producing water.

As has been pointed out by North (1990) and Culpepper (2001), a coherent communications message is needed to formulate 'agreed ideas' and create genuine knowledge. Discourse 2 shows both the existence of a crisis at the time, and the need to address this crisis in the most cost-efficient way.

In 1997, when the idea of recycled water was first mooted, it was at the time of the Asian Financial Crisis, as well as rising tensions with Malaysia. Rather than the highly politicized 'there is no alternative' scenario, Singapore's discourse is a rather more cold-blooded one, of opting for recycled drinking water because it was the most cost-efficient option. The discourse shows an open comparison between desalination and recycling water. This is shown in the following statements: 'Water is a precious commodity and should be priced as such to ensure that no one wastes it without feeling the pinch' (4) and 'The price of water has to take into account its scarcity as well as the cost of supplying and cleaning it' (29).

It is illustrative to see how this perception was formed. The pricing of NEWater was a subject that was openly discussed, together with the price of alternatives such as desalination. Before NEWater, Singapore had already established the principle of price recovery for its water tariffs. The same principle was applied to NEWater with a resulting tariff of \$1.30/m³⁹. In determining the price of NEWater when it was mixed into the potable water supply system, it was thought that all end users should pay NEWater cost as the marginal cost of water¹⁰. NEWater was a cheaper option than desalination¹¹. This economic comparison with desalinated water allowed recycled water to be framed as merely one option, weighed against others in terms of economic cost. NEWater was not so much an ultimatum, as a policy choice that was taken because it was the most cost-efficient at the time. The building of large and expensive

⁹ Water & Used Water Pricing (2009), Y.H. Wah, W. Yang.

¹⁰ Note to Pre-cab Ministers on Pricing of NEWater, 28 August 2001, DPM Lee Hsien Loong.

¹¹ Report on Desalination Study Visit to Saudi Arabia, Abu Dhabi and Malta (27 July to 8 August 1995), Y.K. Chan, Director Water Department, 21 December 1995.

Table 6. Comparison of water qualities.

Water quality parameter	PUB tap water	NEWater	USEPA/WHO Standards
Turbidity	<0.1	<0.1	5
Total dissolved solids (mg/l)	149.5	48.5	500
Lead (mg/l)	0.002	<0.0005 to 0.002	0.01
Mercury (ng/l)	<0.00003	<0.00003	0.001
Hormones (synthetic and natural) (µg/l)	ND	ND	Not specified
PCBs (µg/l) (polychlorinated biphenyls)	ND	ND	0.5
Dioxin (pg/l)	ND	ND	30
Total organic carbon (mg/l)	1.9–3.5	<0.1	Not specified
Total coliforms (cfu/100 ml)	ND	ND	ND
Enterovirus	ND	ND	ND

desalination plants showed that there were other options that could join the water supply puzzle as and when they became viable. While it was true that water was essential to life, and held a strong security and strategic dimension, the economic dimension was also strongly ingrained in the Singapore discourse.

This is not to say that the political confrontations with Malaysia did not feature. In fact as can be seen in the statement ‘Water security remains a real problem for Singapore’ (Statement number 2), the public perception is still that Singapore remains vulnerable to Malaysia because of its reliance on Johor water.

5.3. Discourse 3: environmental and global realities make it imperative to recycle water

Factor 6 Recycling water is a way of preserving independence and continued growth.

Factor 7 The science of recycling still needs to be better known and there is still an instinctive rejection of drinking sewage water.

Factor 8 As climate change and global water scarcity take root, recycled drinking water is a way to ensure water supply.

Discourse 2 had created a sense of vulnerability to reduced water supply from the strained bilateral relations with Malaysia. There is, however, a more general threat from climate change and weather events which is demonstrated in Discourse 3. The statement ‘NEWater helps to ensure Singapore’s water supply is not affected during dry months, which we may see more of as climate change causes rainfall to become unpredictable’ shows that recycled drinking water is not merely for drinking but part of a larger climate change resilience or business continuity plan. This links back to the economic incentives present in Discourse 2. Indeed, we see that all three discourses have many linkages to enable them to hang together in a coherent whole, although within themselves, there may be conflicting principles or ideas. For example, the ‘yuck’ factor has not been eliminated by the scientific and technological elements in Discourse 1 and has surfaced again in Discourse 3. There is here an explicit recognition that there remains an ‘instinctive rejection’ but clearly, instinct is something that can be overcome. It is weighed against the larger need to cope with global environmental challenges as well as imperatives stemming from nationalistic sentiments. Rather than one side of the issue invalidating another, there is a weighing of different sides, with a resulting narrative that acknowledges the existence of both, but giving more weight to one.

Discourse 3 is significant because it has a wider relevance for other cities which face water shortages from change in climate patterns. If the need for recycled water is tied to a crisis stemming from personal survival (drinking water) or purely economic incentives such as use for industry, there is a danger for support falling when the sense of crisis is weakened. For example, if the crisis is caused say, by a drought or some short-term event, such incentives for accepting recycled drinking water may disappear when the rains appear. But with the sense of imperative emanating from a long-term event such as climate change, the need to recycle water becomes more sustained.

As Discourses 1 to 3 have shown, the basic narrative in recycled drinking water has been transformed from a purely 'norms-based' approach, focusing on the prevailing psychology reaction to drinking recycled water, to a more complex one, incorporating economic interests as well as national security. The narrative is no longer an either/or dichotomous discourse that pits the pro- against anti-water reuse camp (a thin narrative), but one that is thicker, making room for both camps, but allowing a principled stance for the acceptance of recycled water.

6. Conclusion

This paper has analysed the perception of the 'yuck' factor as part of the social norms and customs – the informal institutions surrounding water issues. Through a discursive institutional analysis, it illustrates how the construction of water reuse has had implications for its ability to move beyond the 'experimentation' crisis phase of institutional change. The paper also outlined how the discourse of water-reuse policies can be located within a wider literature of informal institutions, and suggests some preliminary institutional changes that will help the implementation of water-reuse policies.

It can be seen that the discourse was not one that eschewed the 'yuck' idea completely, or overturned it. Rather the new narrative allowed the 'yuck' element to exist, but provided a larger pro-reuse policy that was coherent with this element. In this, the various organizational and formal institutional forms were key partners in shaping public perception, public learning and, hence, institutional change in water norms.

Overall, this paper argued that ideas could impact perceptions of norms by affecting the relative attractiveness of different discourses. Discourses about recycled drinking water, we have shown, are affected not just by the 'logic of social appropriateness' or an immutable visceral aversion, but also include the role of technology, the incentives presented by the prices, as well as less rational factors such as national pride. These all played a part in justifying the switch to the new narrative.

At the same time, this simple test brings forward two other questions.

First, what is the status of these ideas? From our discourse analysis, we have shown that these are ideas that ultimately find their footing with the new narrative. But is there something special about the ideas which made it, compared to the ones which did not? Second, if ideas cause institutional change by eroding the power of norms, are the same dynamics at play when we look at other elements of institutional change – such as path dependencies and interests? Clearly, these are interesting areas for future research.

Within the limits of this paper however, we have some useful insights. First, contrary to common perception, public acceptance in terms of recycled drinking water need not be cast in a 'thin' narrative that pits pro- and anti-recycled water positions against one another. Rather, we can accept that there are many reasons for people agreeing to the policy. The experience of Singapore indicates that, relating to

water institutions at least, economic and security considerations played a large role. This finding adds a richer dimension to the common explanatory variable of the ‘yuck’ factor as a physiological norm against the implementation of recycled drinking water.

In short, we see that institutional change will be successful if the narrative constructed by the interpretive community is a rich one that provides some legitimacy for the change. Moreover, these elements cannot be merely read off from a disinterested observer’s point of view, but must be interpreted by the community to which they apply. This process of interpretation allows a narrative to emerge – one which provides a way to tolerate conflicts between existing and newly introduced rules, principles and norms. Institutional change is successful when a new and more powerful narrative appears, that allows the bridging of two previously contradictory positions – the pro- and anti-water reuse discourses. In short, the recycled drinking water policy was a narrative not to win the war, but to end it.

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