

Water demand management: What lessons can be learned from Singapore's water conservation policy?

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Abstract: As water demand rises significantly in many countries, its supply continues to face serious pressures from climate change and water pollution. The need for effective water management, thus, becomes increasingly crucial. Singapore is a water-stressed country because of its limited catchment and high population density, yet it has earned itself accolades for prudent water management. This short communication elucidates factors underpinning the success of water management in Singapore by focusing on demand management. The study applies a qualitative research approach. It analyses and synthesizes various journal articles and government reports concerning water demand management. The findings show that the application of water non-pricing and pricing strategies is one of the main factors underpinning Singapore's success. The non-pricing strategies involve consistent and sustained public education campaigns to create a lifestyle and culture of water conservation and stewardship. The pricing strategies include charging full costs and implementing an increasing block tariff to reflect water's real value and scarcity. The combination of non-pricing and pricing strategies resulted in consistent decline in water consumption. Singapore's experiences provide three main lessons: the application of non-pricing and pricing strategies, strong public commitment, and pricing water to reflect its vulnerable and exhaustible value, with potential for adjustments to suit different contexts.

Key words: Sustainable water management; water pricing policy; water conservation; water security; non-pricing strategies; Singapore

1. INTRODUCTION

Water is crucial to all flora and fauna, and has connections to social, economic and environmental dimensions of sustainable development. Globally, water availability in terms of quality and quantity remains a great concern (Watkins 2006). While the demand for water rises by around 1% every year triggered by population growth, urbanisation and economic development, factors such as climate change and water pollution create challenges for water supply to meet its demand (WWAP/UN-Water 2018). Many countries across the world, such as China (Varis and Vakkilainen 2001), Jordan (Hadadin et al. 2010) and Western Asia (United Nations 2015) face water challenges, not only because of the limited physical availability of water, but also due to poor management which manifests itself in form of water quality being continuously compromised by pollution and lack of appropriate water policies.

Conversely, some countries have successfully managed limited water resources to meet increasing demands. For example, Singapore, a city-state with total area of only around 700 km² (Tortajada 2006), has sustainably managed limited water resources both in terms of quality-quantity and demand-supply, despite its limited catchment areas and high population density. From the supply side, all wastewater in Singapore undergo treatment, recycling and partly re-use (Tortajada 2006). The quality of its water is also proved to meet international water quality standards (Tortajada 2006). Besides, 100% of Singaporeans have access to safe water and sanitation (Luan 2010). On the other hand, while the demand is sufficiently met, daily water consumption per capita (PCD) is reducing because water is highly valued and efficiently used by the citizens (Tortajada and Joshi 2013). Through public education, the general public have actively participated in Singapore's

water conservation agenda (Tortajada and Joshi 2013), consequently leading to improved water security outcomes.

The success in sustainable water management calls for other countries to learn from Singapore's strategies. The intention of this paper, therefore, is to explore the factors underlying the success of water management in Singapore. Some of the factors contributing to its success include good policies, capable institutions, advanced technology and strong public participation (Tortajada 2006). However, this paper will focus on water demand management which involves non-pricing (the public education and campaigns) and pricing strategies. By focussing on these, we aim to draw critical lessons and insights about water conservation which may be beneficial for other countries to adapt. This includes the application of a comprehensive management approach that involves both non-pricing and pricing strategies, strong commitment of the government agencies and effective pricing structure.

2. LITERATURE REVIEW

Water management has received strong attention in the 21st century, more than ever before, due to increasing demand for water resulting from factors, such as rapid urbanisation, population growth and environmental deterioration that worsens the quality of available water (Nakagami et al.2016). Although water is sufficient for most countries to meet their demand, mismanagement of the limited available water resources lead to challenges related to the quantity and quality of water (Watkins 2006). For many years, approaches to address water problems, more often than not, come only from the supply side of the equation such as water diversion, recycling wastewater, desalinization, rainwater storage and imports of virtual water (Angelakis and Durham 2008, 5; Watkins 2006). For instance, in European countries, water reclamation and recycling have been applied as one solution to water scarcity (Angelakis and Durham 2008). Globally, in the early 2000s, there were roughly 3300 water recycling projects, of which 200 were in EU countries (Angelakis and Durham 2008). While desalinization offers a solution to water scarcity, the energy cost of this method is very high (Watkins 2006). In 2006, over 12,500 desalination plants were operated in 120 countries around the world. Even though various approaches have been applied, according to Watkins (2006), they could not be a panacea for the long-term water crisis because they do not minimise water overuse. Therefore, there is a need to conserve water and minimise its uses, an insight which can adequately be sustained through water demand management.

While there are other factors contributing to the effective water management apart from supply management, demand management cannot be ignored if efficient uses of water are to be achieved. Water demand management focuses on consumers' behaviour change towards more water conservative behaviours (Tortajada and Joshi 2013). According to Tortajada and Joshi (2013), demand management requires the application of instruments and strategies that encourage and enforce public participation in water conservation. Public policies and political decisions also shape water supply and demand management (Watkins 2006). Appropriate water pricing policies, for instance, can worsen or solve water problems (Watkins 2006). In some countries, such as in northern Africa, where water price is set below the water recovery cost, uses of water are likely to go beyond water scarcity line, as the real value of water is not realised (Watkins 2006). Furthermore, capable institutions and workforce, effective regulations and a strong political will are all necessary factors contributing to the successful water demand management (Tortajada 2006).

In Singapore, a holistic approach has been applied in water management with an integration of various factors including public involvement, effective public policies, demand and supply management, strong legal enforcement, strong institutions and capable workforce (Tortajada 2006). The effective combination of various factors in its practices has enabled Singapore to be highly successful in water management (Tortajada 2006). This paper explores the factors contributing to Singapore's successful water management, reviews pricing and non-pricing strategies and draws some critical lessons from it.

3. METHODS

This study applies a quantitative approach. Various journal articles, government reports and reports of the United Nations related to water management, particularly demand management were studied, analysed and synthesised. The initial focus was placed on materials related specifically to Singapore water management. Then, the authors expanded the scope to global (other countries') water management conditions to identify gaps that can be filled by this study. Finally, the paper focuses on water demand management as it has received less attention compared to other areas of water resources management.

4. RESULTS

Singapore, like many countries, encounters water security-related challenges, but the country has applied various strategies to overcome the challenges. According to Tortajada (2006), Singapore receives significant rainfall (around 2440 mm/year), but the limited catchments make it hard to store rainwater. Therefore, Singapore has been importing water from Malaysia under the Water Agreement signed in 1961-1962 which allowed Singapore to import water until 2061. Singapore has negotiated with Malaysia to import water beyond the year 2061, but the price proposed by Malaysia is between 15-20 times higher than the current price (Tortajada 2006). As such, the long-term water security has been a major concern of Singapore. With this stalemate position, a new and long-term plan to improve water self-sufficiency and water security has been developed (Tortajada 2006). Singapore has begun to address water challenges using a holistic approach which includes the solutions from both supply and demand sides (Tortajada 2006).

For the supply side, the approaches include investments in technology and infrastructure for rainwater collection and treatment, seawater desalination and water recycling and reuse (Timm & Deal 2018). Singapore's water supply strategies, according to the Public Utilities Board (PUB 2016), involves three parts. These include storing stormwater as much as possible by turning Singapore into a catchment, treating water as an endless reusable resource by reclaiming, retreating water and desalinating sea water through improved technology that will bring down desalination costs. Currently, Singapore's water supply comes from four sources: imported water, local catchments, recycled water (NEWater) and desalinated water (Luan 2010).

Although water supply management is equally important, this paper is focusing on water demand management. Water demand in Singapore is increasing and thus, the government realises that consumers' responsibility for water consumption is crucial (PUB 2016), hence puts in place the demand management strategies consisting of both non-pricing and pricing (Chen et al. 2009; Tortajada and Joshi 2013). The non-pricing strategies include public education and awareness raising while the pricing strategies involve charging full costs of water and increasing block tariffs (Chen et al. 2009). The main aims of the demand management are to help the public beware of the importance of water, to use water responsibly and ultimately reduce water consumption (PUB 2016).

4.1 Non-pricing strategies of demand management

Various public education schemes and campaigns on the value and importance of water are implemented as non-pricing (soft) strategies for water demand management in Singapore. These strategies are applied to both domestic and non-domestic sectors. Vast and constant efforts of have been invested in Singapore to educate and encourage domestic consumers to conserve water (Luan 2010). From 1990-2010, over forty schemes and policy initiatives/amendments have been made consistently to advocate the important value of water (Tortajada and Joshi 2013). The first public campaign was launched in 1972 with the slogan 'Water is Precious' (Tortajada and Joshi 2013). Since then, many projects have followed suit, for example, the '10-Litre Challenge' campaign

initiated by PUB to minimise household water consumption within 10 litres a day (Luan 2010); the Water Closet Replacement Project that tries to replace non-water efficient closets; the 'Friend of Water' initiative that stimulates communities' sense of shared ownership towards water; and the program called 'Active, Beautiful and Clean' (ABC water) which is being implemented to link waterways and parks together to create public spaces with the aim to increase the public appreciation towards water (PUB 2016). Furthermore, in collaboration with the Ministry of Education, PUB has introduced water conservation topics into formal education, grade schools curriculum (PUB 2016). PUB also put concerted efforts to study water usage patterns and behaviours, including the motivators that encourage people to save water and then design suitable programs that promote water conservation (PUB 2016). Currently, PUB is planning to provide real-time information on water usages for consumers by attaching smart devices that show water usage information such as 'very good' or 'too much'.

In addition, non-domestic consumers are also highly encouraged to save water in Singapore. In 2016, non-domestic sector accounted for 55% of total water consumption, which is expected to rise to 70% by 2060 (PUB 2016). With this potential increase in water consumption, water demand management has been prioritised by this sector. The strategies applied include both incentives and disincentives. For instance, the very first initiative was launched in 1983 when the government provided incentives in the form of tax allowance to non-domestic consumers who helped reduce water consumption (Tortajada & Joshi 2013). Another strategy is the 10% challenge scheme launched in 2008. The scheme aimed at encouraging non-domestic consumers to reduce by 10%, their monthly water consumption, which would in turn, allow them to reduce their expenditure on water (Luan 2010). Apart from incentives, mandatory measures have also been applied. For instance, since 2015, private water meters are required to be installed for the non-domestic consumers who use water up to 60,000m³ or more annually. They are also required to submit Water Efficient Plans to PUB in order to ensure that water has been used in a careful and efficient manner (PUB 2016). Furthermore, it is in the government's plan that large non-domestic water consumers have to send representatives to do a short-term training course on water efficiency from 2019 onwards (PUB 2016).

The strategies for both domestic and non-domestic sectors range from encouraging water conserving behaviours to designing efficient water appliances (Luan 2010). To ensure that consumers can save water, many schemes have been implemented in conjunction with the Water Efficiency Labelling Scheme (WELS). In this scheme, suppliers of water-related products are mandated to label the degree of water efficiency of their products such as taps, washing machines, showers, etc. (PUB 2016). The suppliers have to provide customers with information on water efficiency of their products through advertising and packaging. This aims to give consumers the power to make informed decisions about the products they are using (PUB 2016).

Through a learning process, currently, there is a shift towards creating a sense of community's stewardship in water management. Communities are now encouraged to be connected with water. According to Tortajada and Joshi (2013), despite restrictions posed in the past on accessing reservoirs, recently, reservoirs are open for public uses. The logic behind this is to reinforce the affinity between the public and water, hence, developing public ownership by promoting personal-relationship with water resources. The aim is to reinforce the sense of stewardship in water conservation (Tortajada and Joshi 2013). This shift is demonstrated in the core principle (slogan) of PUB called 'Water for All: Conserve, Value, Enjoy' which invites all stakeholders, referred as '3P' (People, Public and Private) to share ownership and together conserve water (Tortajada and Joshi 2013). It is believed that by establishing the value of water stewardship, water conservation will be a lifestyle and culture of Singaporeans.

4.2 Pricing strategies of demand management

A series of economic-based instruments have been put in place to manage water demand, the most important of which is pricing policy. In Singapore, water is used as an economic commodity

that is added full costs to reflect its precious value and scarcity (PUB 2016; Tortajada 2006; UNESCAP 2012). These costs cover not only production costs, but also the ecological costs (waterborne fee) accrued from the beginning to the end of the supply chain (PUB 2016). By incorporating ecological costs, the country is able to overcome water scarcity and has managed to become an innovative water hub, while continuously improving the availability and quality of water (UNESCAP 2012). According to Luan (2010), the components of water-pricing policy comprise water tariff, water conservation tax, waterborne fee and sanitary appliance fee (Luan 2010).

According to PUB (2018b), the costs, which accrue in various stages, such as collection of storm water, raw water treatment, and the supply of treated water through comprehensive distribution lines, are covered by the Water Tariff. Water Conservation Tax (WCT) is introduced to counteract with over consumption and to convey the message that water is precious and scarce (Tortajada and Joshi 2013). PUB ensures that the costs of water treatment, operation and maintenance of the country's sewerage systems are charged fully in the Waterborne Fee (Luan 2010). The implementation of Sewerage and Drainage Act (SDA) contributes to the collection of ecological costs which help control the quality of water discharged into watercourse (Luan 2010). SDA sets the limits of wastewater discharges into watercourses or public sewers. The industries that discharge wastewater must ensure that the quality of the wastewater complies with the limits set under SDA, otherwise industries must install treatment plants and pre-treat their wastewater before discharging it to sewer lines (Luan 2010). The industries can also discharge wastewater with high contamination to public sewers, but it is subjected to a fee (Luan 2010). Since 2017, according to PUB (2018b), the Sanitary Appliance Fee and the Waterborne Fee have been merged.

An increasing block tariff system has been introduced in Singapore to tackle over consumption of water (UNESCAP 2012). The first block is between 0-40 m³ and the second is above 40 m³. If water usage exceeds the first block, the higher rate is charged (Luan 2010). Water fees charged for domestic potable drinking water before 2017 (since 2000 to mid-2017), from 2017 and the planned fees for 2018 is hereby explained. From July 2018, water consumption below 40 m³ is charged SG\$ 2.74/m³ and above 40 m³ is charged SG\$ 3.69/m³ (PUB 2018b, p.3). Consumers often try to maintain their water usage at the first block (Luan 2010). In order to motivate consumers, recognitions are given for those who have high performance. For example, PUB offers the Water Efficiency Award to organisations who have outstanding performance on water consumption which is determined based on data collected such as water recycling rate (PUB 2016). The Watermark Awards and the Friend of Water (Awards) are offered to individuals and organisations to recognise their significant contributions to water conservation (PUB 2016).

As a result of public education, campaigns and the pricing policy, the PCD declined from 165 litres in 2003 to 156 litres in 2006 (Luan 2010), 148 litres in 2016 (PUB 2016) and continued to decline to 143 litres in 2017 (PUB 2018a). The impact of government interventions and the volume of water consumed in Singapore between the years 1985 to 2011 evidently worthwhile. By 2030, it is aimed that the PCD will reduce to 140 litres (PUB 2016). The result of the efforts is also evidenced by the fact that imported water from Malaysia had declined by 17% in 2008 (PUB 2018a). Tortajada and Joshi (2013) emphasizes that the positive results of Singapore water demand management are attributed to the vast and consistent efforts that have been invested to sensitize the public about the benefits of water conservation.

5. DISCUSSION

The findings show that Singapore has been highly successful in its water management discourse. Based on Singapore's experiences, it can be seen that although there are many good practices, three main lessons can be learned. Firstly, Singapore applies a comprehensive demand management approach that involves both non-pricing and pricing strategies. It can be observed that in order to encourage people to conserve water, consistent efforts on public education and awareness creation have been invested. At the same time, mandatory economic measures such as water pricing have been applied hand in hand to stimulate the needs for water conservation. This combination of

different strategies work out well as shown in the continuously declining amount of the PCD from 165 litters in 2003 to 143 litres in 2017 (PUB 2018a). The application of pricing and non-pricing tools is found effective not only in Singapore but also in other countries. For example, in the 2000s, Southeast Queensland suffered from drought which made water security a significant challenge. Therefore, the government of Southeast Queensland applied pricing and non-pricing measures to manage water demand and thus, the PCD declined from 282 litres to 143 litres between 2004 to 2009 (Queensland Water Commission 2010 cited in Hoque 2014). Therefore, it is deduced that pricing and non-pricing strategies, when implemented hand in hand, can be effective tools for managing water consumption.

Secondly, successful water demand management requires strong commitment and dedication by the government. This is evidenced by the fact that since 1990, many programs and policies have been implemented consistently to reinforce sensitization about the precious value of water (Tortajada and Joshi 2013). The government's commitment is also seen in the attempts by the relevant authorities to create an enabling environment that ensures consumers have options and motivation to conserve water. These include mandating industries to label water efficiency of water-related products and recognising high performers with different awards (PUB 2016). Furthermore, throughout the period of implementation, the relevant authority (PUB) has learned and improved for the better, particularly in the way they approach the public. This is seen in the effort to shift the public attitude from being implementers to being shared owners of water resources and to make water conservation a lifestyle and culture of Singaporeans (Tortajada & Joshi 2013).

Thirdly, the full water cost pricing in Singapore is worth noting. Charging full costs which reflect the precious value and scarcity of water in Singapore not only increases the government's financial capacity for funding water-related schemes and for research and development, but also encourages people to conserve and use water responsibly (UNESCAP 2012). In some countries, where water price is low because of subsidies, people tend to use water wastefully (Watkins 2006). Water pricing is crucial for sustainable water consumption, as the experience of several countries has shown. For example, in India and North Africa, water prices are subsidised below its recovery cost resulting in overexploitation of water resource (Watkins 2006). Furthermore, it is noticed that, environmentally, water pricing practices in Singapore that internalise ecological costs (in the form of waterborne fee) could help protect the quality of water as these costs are used for water treatment before discharging it to natural watercourses. UNESCAP (2012), based on the lessons learned from Singapore, stresses that water does not have to be cheap because of being a public good.

It is, however, important to acknowledge that the adoption and implementation of Singapore's experiences are context-dependent. Institutionally, UNESCAP (2012) states that the enabling factors contributing to the success of demand management in Singapore include institutional effectiveness, strong political will and capable workforce. Also, Singapore is governed by an authoritarian system, which makes it easy for the government to implement policies. Therefore, if the lessons learned from Singapore are meant to be implemented successfully elsewhere, it requires transparent and capable institutions, workforce and the state's power to ensure that effective schemes are set up and implemented and that the collected fees are prudently used to improve water security and for the betterment of society as a whole.

Economically, the internalisation of full costs, including ecological costs, would make water become very expensive. Thus, if an effective mechanism to protect poor people is not in place, this pricing could potentially deny the access to water of poor households. This idea is supported by Bluemel (2004) who states that the full cost recovery principle could charge water costs higher than affordability of the poor, which would effectively prevent them from obtaining clean water, hence, negatively affecting sanitation and hygiene outcomes.

In terms of social aspect, Tortajada and Joshi (2013), notes that Singaporeans are quick to implement practical programs, follow initiatives and the agenda of their leaders and leave all decision making to the leaders. However, this may not be the case in other countries. Jorgensen et al. (2009) state that, while there are various factors affecting water consumption behaviours of individuals, the trust that consumers have towards authority is an important factor determining

whether or not they will conserve water. Therefore, it could be reasonable to say that in the states where people do not trust the capabilities and commitment of authorities, it is not guaranteed that the implementation of Singapore's model would work.

Geographically, it should be noted that Singapore is a small city-state, which makes it easier for the government to sufficiently invest in its water-efficient infrastructure. However, in developing countries with various large and hard to reach areas, governments may not have adequate financial and technical capacities to do so. This view is supported by Massoud et al. (2009), who concede that establishment of water infrastructure in rural areas with low population density is expensive as the costs cover installation, operation and maintenance, etc.. Thus, although there are many good practices of Singapore that can be learned, the successful implementation of these practices would depend on various contexts.

6. CONCLUSION

The findings show that water demand management in Singapore has applied both non-pricing and pricing strategies. These strategies focus on encouraging consumers to conserve and use water responsibly. The non-pricing strategies involve consistent public education and campaigns to raise awareness around water conservation issues. The attempt also focuses on shifting public attitude towards water stewardship. The main purpose of this is to create lifestyles and culture of water conservation among Singaporeans. To facilitate water conservation, an enabling environment is created, such as the mandatory water efficient labelling to help consumers make informed decisions about water-related products. The efforts of consumers on water conservation are also recognised in the forms of awards in order to stimulate their motivation. Along with the non-pricing strategies, the pricing strategies have also been implemented to mainly control water wastage. Singapore charges full costs of water and implements an increasing block tariff to reflect water's precious value and scarcity. Because the higher rate is charged, if water usage exceeds the first block, consumers put efforts to maintain the usage at the first block. Due to the combination of various strategies, the PCD declined continuously from 165 litters in 2003 to 143 litres in 2017 and consequently water imports decreased (PUB 2018a).

Based on Singapore's experiences, three main lessons could be learned. First, positive results of water demand management can be achieved by applying a comprehensive management approach that involves both non-pricing and pricing strategies. Second, it requires the government's dedication and commitment to put consistent and repeated efforts for water demand management. At the same time, the government needs to learn and improve their practices over time. Third, charging full costs of water can be an effective tool to encourage water conservation, while generating revenues that can be used to improve water management. However, it should be noted that the successful implementation of Singapore's lessons depends on various contexts and factors, including institutional, economic, social and geographical contexts. For example, charging full costs of water could affect the poor in the countries, where an effective protection mechanism for poor people is not in place. Therefore, the application of these lessons should be adjusted according to different contexts.

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