**EFB338** Contemporary Application of Economic Theory

**A TAX ON WATER AND CONSUMPTIVE USE OF RECYCLED WATER:**

**A POLICY PROPOSAL FOR WATER MANAGEMENT IN URBAN QUEENSLAND**

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*Urban Queensland currently faces the significant problem of water scarcity, which could result in an inadequate supply of water for Queensland’s growing population. This report introduces two economic policy options to address the issue of water scarcity– water recycling and a tax on the consumption of water. Through economic policy analysis, empirical analysis and consideration of policy implications for both options, this report will determine their validity to effectively and efficiently address the issue of water scarcity in Queensland.*

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1.0 EXECUTIVE SUMMARY

Water scarcity is becoming an increasingly serious issue in Queensland due to drought, climate change and population growth. The combination of these issues is causing the demand for water to substantially outweigh supply, which will have serious consequences on economic growth in the future.

The objective of this report is to improve water resource management in urban Queensland in order to minimise water scarcity. This report introduces two alternative economic policy options that aim to improve water resource management and consequently achieve this objective.

The first policy option is a tax on the consumption of water when Queensland is in a drought declared state. This policy targets consumer demand by reducing consumption of water across the state. Price based policies, such as a tax on water, are effective at influencing demand for water and can help avoid water shortages; however, there is a trade-off, as society suffers from having to pay for a higher price per unit of water. Additionally, there are operational risks for this option including urban residences not having access to the water they need, fraud/stealing water, technology flaws such as inconsistent data collection on water usage and expected cost pricing as well as other administrative control issues resulting from human error.

The second policy options is the use of water recycling in urban Queensland. This policy option would see Queensland upgrade existing water recycling facilities to increase the supply of water in urban areas. Water recycling would create a more sustainable and reliable water supply and lower water fees, however, it comes with a risk of consumer overconfidence who will start consuming more water. This type of policy has been successful in several countries for consumptive use, including other states in Australia. Investment in upgrading water recycling facilities would have significant operational costs as well as time and administrative delays. There could also be social problems relating to the stigma around water reuse.

This report recommends implementing both policies together, as complements, as they effectively target the two key pain points of urban water resource management, being a high demand with a low supply. This will provide a well-rounded approach to preventing water scarcity and ensuring future generations have an adequate supply of water.

2.0 PROBLEM AND CONTEXT

2.1 INTRODUCTION

Water is essential for modern developed societies, providing a vital resource for consumption whilst also facilitating economic growth. Urban Queensland faces constant challenges posed by water scarcity due to enduring drought. However, as climate change further limits the reliability and accessibility of water, while population growth simultaneously increases demand, this already prominent issue will become significantly more serious in Australia. As a result, the consequences for users, the economy and the environment will become more severe (Australian Government Productivity Commission “Productivity Commission”, 2020, p.2). Therefore, decisions made in response to the current and future risks of water scarcity will have major effects on water security for future generations (Productivity Commission, 2020, p. 3).

2.2 WATER SCARCITY IN QUEENSLAND

Due to its geographical location and other natural characteristics, Australia is the driest inhabitable continent on earth, receiving an average rainfall of 470mm annually (Heggie, 2018, para. 2). Currently, in Queensland, more than 67% of the state remains drought-declared (Stone, 2020) with the drinking supply capacity of the southeast water grid below 60% (Brisbane City Council, 2020, para 1,). Wivenhoe Dam, which supplies approximately half of southeast Queensland’s water, is close to its lowest level in ten years at just 40% capacity (Urban Utilities, 2021, para. 4). Despite the drought, residential water consumption in Queensland in March 2021, was approximately 155 litres of water per day per person (ABCDiamond, 2021).

Climate change will further limit water availability in Queensland by decreasing annual rainfall and increasing global temperatures (National Geographic Society, 2019, para. 1). This is already evident in the Murray-Darling Basin, where average winter rainfall has been below average for sixteen of the past twenty years (Productivity Commission, 2020, p.2). Consequently, Queensland will see an increase in the frequency, severity and duration of droughts throughout the state, which will intensify the already existing issue of water shortages (Productivity Commission, 2020, p. 2). In addition, Queensland’s population is predicted to increase by up to 1.5% each year (Australian Bureau of Statistics, 2018), with a similar growth in industrialisation and economic development throughout the state (Guarino, 2016, para. 3). The combination of climate change and population growth will ensure that demand for water substantially outweighs supply. This will worsen the problem of water scarcity in the state and will significantly affect people and the economy in urban areas of Queensland.

2.3 EFFECT OF WATER SCARCITY IN QUEENSLAND

In urban Queensland, water services are essential for economic growth and environmental conservation, but most importantly, consumption by users. Historically, water shortages in urban areas have forced towns and cities to introduce water restrictions (Productivity Commission, 2020, p. 1). However, a more severe consequence of water scarcity is the possibility that urban Queensland will not have an adequate supply of drinking water to support its rapidly growing population (Caldwell, 2021). Therefore, since current water resources are not sufficient to serve future populations and will inhibit economic growth, water regulation must be reformed to generate sustainable and affordable solutions for the problem of water scarcity.

2.4 HISTORICAL WATER REFORM IN QUEENSLAND

Several water reforms have been introduced nationally throughout the past several decades including the Water Act of 2007 and the Murray-Darling Basin Plan (Quiggin, 2019, para. 12). The 2004 National Water Initiative was introduced to secure Australia’s water supply by improving governance and sustainability across industry, the environment and the community (Grafton, 2021, para. 2). However, the most recent report by the Productivity Commission in 2020 suggests that this policy is outdated and does not adequately address the challenges posed by climate change and population growth.

2.5 OBJECTIVE AND POLICY OPTIONS

Our objective is to improve the reliability and sustainability of water resource management in urban areas of Queensland to prevent a growth in water scarcity. This objective will be achieved through the introduction of two alternative policies: a tax on consumers’ consumption of water and water recycling.

**3.0 POLICY OPTIONS**

The two policy options introduced in this report each target one side of the water scarcity issue: that is, reducing the demand for water and increasing the supply of consumptive water available.

3.1 TAX ON WATER CONSUMPTION

The first policy option is to introduce a tax on water when Queensland is in a declared drought state. This price-based policy would see consumption over a certain amount be taxed. To ensure that the tax takes immediate effect, the Water Tax will be introduced based on models and expectations to avoid time lags, and aid in extending life as an “in danger” dam. While, in the short run, water demand is deemed inelastic, price changes do affect the demand for water as consumers seek alternative or more efficient ways of using water. It is due to this that the increase in price would drive demand down as consumers seek to avoid the tax. The decreased demand means that more consumers can use the current supply of water in urban Queensland, which will ensure there is an adequate water supply in the future.

3.2 USE OF RECYCLED WATER FOR CONSUMPTIVE USE

The second policy option is to improve the existing water recycling infrastructure in Southeast Queensland and utilise it for consumptive use. The Western Corridor Water Recycling Scheme (‘WCWRS’) can purify recycled water to comply with *Public Health Act*, *Public Health Regulation,* the Australian Guidelines for Water Recycling and the Australian Drinking Water Guidelines.

The WCWRS recycles water by pumping treated wastewater through membrane filters to remove matter, protozoa and most bacteria. After this, the water is filtered again through a membrane, which removes contaminants larger than a water molecule. To remove any trace amounts of impurities, the water is then exposed to hydrogen peroxide and intense UV light. Finally, this pure water is used to replenish Lake Wivenhoe where it is treated again before consumptive use. Utilising the WCWRS would mean that the supply of consumptive water could effectively be increased to meet the growing population of urban Queensland by replenishing the existing water supply in Lake Wivenhoe before being distributed.

4.0 OPTION 1: ECONOMIC MODEL ANALYSIS

4.1 CURRENT REGULATION

The current Queensland regulations for water consumption are an example of Posner’s (1974) public interest theory of economic regulation as a “response to the demand of the public for the correction of inefficient or inequitable market practices”. Current regulation in place by the Queensland Government aims to restrict consumer behaviour surrounding water consumption. These restrictions (for example using a sprinkler without a timer) come into effect, and increase depending on the drought trigger level (Seqwater, 2017). These restrictions are clear and easy to understand but have weaknesses that limit their effectiveness. Firstly, as the restrictions are focused on water-saving strategies at home and therefore target consumers, they are only as effective as much as the consumers are willing to abide by them. Research conducted in 2016 showed that there is a positive correlation between water-related knowledge and everyday water-saving strategies and policy support (Dean et al., 2016). However, this study found that people who lived in urban areas had less water-related knowledge than those who lived further away. Therefore, considering this information, the efficacy of consumer behaviour related restrictions, specifically in urban areas, could be lower than projected (Dean et al., 2016). Another problem with the current restrictions are that they are also almost impossible to enforce.

4.2 PROPOSED POLICY: WATER TAX

The theoretical model in Figure 1 (see Appendix) describes demand and supply in the water market, and how a tax could help correct excess demand during a drought. In the creation of this model, there were key assumptions made. Figure 1 models water as an economic good in a free market, however, it is important to note that public supply of water is not produced for profit, but rather incurs a set cost to compensate for its production and distribution and as such does not increase in price based off of supply and demand. This marginal cost of production and distribution is set to Pe. Currently, restrictions come into place when dam levels fall below 50% and Queensland is declared in a drought. The tax on water consumption will apply in a similar fashion – where the tax is introduced when the available supply falls below a specified point. The supply curves for water have been modelled as perfectly inelastic, as the water source in question is from natural resources and production is unable to increase/decrease in response to demand. The demand curve D1 is also perfectly inelastic up to the point Qminimum, where it grows in elasticity as more water is consumed. Qminimum is the minimum quantity of water that the population requires for consumption including fundamental activities such as drinking, cooking and cleaning. As the population must have the minimum amount to live, they would theoretically be willing to pay any cost. The curved section of D1 from Qminimum onwards represents surplus activities involving water such as watering lawns and cleaning cars, as well as additional consumption of drinking and showering, etc (Renwick, 1998).

When not in a drought, the supply curve is S1 supplying Q1 of water to the market. S1 intersects the demand curve D1 at Emarket. This is the market equilibrium, and the price of water is set to Pe. When the supply of water drops below a set point and Queensland is declared to be in a drought, the supply curve shifts to the left from S1 to Sdrought. This lowers the quantity of water supplied from Q1 to Qdrought, creating a shortage of supply or excess in demand. In order to correct for this excess demand for water, the tax is introduced and the price of water is increased to Ptax where the new supply curve Sdrought intersects with the demand curve D1 at Etax. This is the new market equilibrium with the tax in place.

After the introduction of a tax there is an associated burden to both the consumer and supplier, as well as deadweight loss in the market. Before the drought and tax, consumer surplus was A+B+C+X+Y. After the drought, consumer surplus decreases by C, as demand is unable to be met at each price point. This is the consumer’s deadweight loss. A further decrease of B+Y occurred after the price increase from the tax. This is the tax revenue generated by the government (quantity consumed\*tax price increase) and is borne completely by the consumer. It is important to reiterate that the purpose of this tax is to mimic the natural movement of price in a free market along the demand curve due to a change in supply. This leaves the final consumer surplus as A+X.

Before the drought and tax, producer surplus was D+E+Z. After the drought, producer surplus was lessened by E representing the drop in quantity of water that could’ve been sold for price Pe. This is the producer’s deadweight loss. This leaves the final producer surplus as D+Z (Qdrought\*Pe) which must remain at minimum to account for production and distribution.

4.3 WEAKNESSES AND LIMITATIONS

The assumptions that were made to model Figure 1 allowed for a clean view of how a drought and tax would affect the market in isolation, however this is rarely the case. The model fails to take various considerations into account, which leads to a number of weaknesses. The curve of D1 from Qminimum onwards is the price elasticity of water. In general, demand for water is inelastic due to its fundamental importance and lack of substitutes. As such, the magnitude of a tax might have to be high for a noticeable decline in demand. A 2011 study surveying the residential price elasticity of demand for water in Sydney found that on average the short-term and long-term (after one year) elasticity was -0.05 and -0.11 respectively (Abrams et al., 2011). D1 is also modelled as static throughout the whole process, whereas that wouldn’t be true in practice. Consumer demand is not only motivated through price, but also education. For the same reason that current regulations are in place, consumers lower their demand when in drought in order to preserve the environment and maintain equitable distribution of water for society (Dean et al., 2016). Additionally, water supply is not perfectly inelastic in real life. While dam water levels were taken into consideration in Figure 1, there are alternate methods of increasing supply, including obtaining water from interstate if in need, or supply from private water distributors.

5.0 OPTION 1: EMPIRICAL ANALYSIS

Demand strategy management (DSM) policies are a viable short-term solution in managing existing water supplies via reducing water consumption. Organising an effective DSM policy that restricts demand during drought is an effective way to prepare urban Queensland for times of drought. This report proposes a DSM policy in the form of a tax on water consumption. This tax charges consumers an additional percentage rate on top of a fixed service charge with the overall cost of the bill being directly linked to the quantity of tap water used.

The price of water plays an essential role in demand management (Burdack, 2017). Economists generally advocate for residential water prices to reflect cost, specifically in circumstances of limited supply, to allow the market to correct itself (Renwick & Green, 2000). However, others argue that price is ineffective as a DSM policy as residential demand for water is price inelastic (Renwick & Green, 2000). Therefore, credible data reflecting the price elasticity of urban water demand is essential in determining the efficacy of price water policies intended to address market failures. The following empirical evidence analysis investigates such data, establishing whether residential demand for water is price inelastic. Such conclusions will assist in determining whether implementing a tax to manage urban water demand will be effective in Queensland. Price policies implemented in California and Korea in drought are the primary case studies in this report. Empirical data investigating residential water price elasticity within Australia is also discussed.

5.1 PRICE VS NON-PRICE POLICY

In practice, federal governments have traditionally opted for the command-and-control approach, in which regulations or quantitative limits are placed upon the use and consumption of water (Renwick & Green, 2000). Results show that substantial reductions in residential water use are achievable through regulatory and social awareness. However, evidence suggests that consumption-based pricing also contributes to a "consistent pattern of reduced water consumption" with a solid causal relationship between variable charges and reduced water consumption, regardless of other non-price DSM policies (Aither, 2017). Furthermore, past empirical research indicates that drought taxes are more economically efficient, resulting in more minor welfare losses (Burdack, 2017). When command and control approaches have proven effective in decreasing demand, they have also reduced sales to aquifers. Suppliers have to cover their fixed costs regardless of sales. Thus, when sales deplete, it is more challenging to cover costs (Burdack, 2017). Compared to command-and-control approaches, pricing policies create incentives to increase the economic efficiency of urban water demand while mitigating the lost utility revenue of those supplying water (Burdack, 2017). Overall, the public may accept significant price increases if such increases are understood and additional costs represent a smaller proportion of household expenditure (Renwick & Archibald, 1998). Aggregate water demand for a household equals the sum of individuals demand curves whose positions vary due to differing characteristics (Renwick & Archibald, 1998). These characteristics include income, the intensity of water use, and landscape area. Such characteristics prove essential when considering aggregate demand and elasticity of residential water within the two studies investigated.

5.2 CALIFORNIA IMPLEMENTATION PRICE POLICY

From 1985 to 1992, California experienced a severe state-wide drought that allowed for examining price and non-price policy approaches to conserving urban water. Renwick and Archibald (1998), conducted research and developed a model to determine the price-performance to reduce aggregate demand of urban water. Data was collected over six years, with a random sample of 119 single-family households in the Goleta and Santa Barbara region (Renwick & Archibald, 1998). Actual water uses and costs were obtained, and extensive interviews were conducted to determine usage and factors influencing water consumption. Overall, the data suggested that households were responsive to price changes (Renwick & Archibald, 1998). The model's marginal price (MP) coefficient was negative, showing that short-run price elasticity equalled -0.33. This implies that a 10 percent increase in the price of water would reduce aggregate demand by 3.3% (Renwick & Archibald, 1998).

The actual increase in prices for Barbara and Goleta resulted in the average household demand falling by 9.3% and 26.2%, suggesting significant increases were implemented to obtain results (Renwick & Archibald, 1998). Alternatively, combined efforts of both direct and indirect demand policies could have assisted (Renwick & Green, 2000). Furthermore, despite being price inelastic, changes in the price of water effectively decreased demand, suggesting that despite controversy, price policies may be an effective policy for urban water management. However, being inelastic indicates that very high prices are needed to see a significant reduction in consumption (Hoffmann, Worthington, & Higgs, 2006). Price responsiveness was found to vary among income groups, with lower-income households being more price responsive (Renwick & Archibald, 1998) and found to be more than five times as price responsive in comparison to wealthier households. Statistical significance indicates that a 10% increase in water prices would result in a 5.3% and 2.2% reduction in demand, respectively (Renwick & Archibald, 1998). Overall, the data corroborate notions that price policy affects consumers in a non-uniform manner concerning conservation burden. This leads to equity issues about price policy strategies, suggesting that lower-income communities will achieve a more considerable reduction in residential demand for water than wealthier households (Renwick & Green, 2000). Ultimately, this means that those poorest in society will suffer the most. Results are due to non-discretionary demands, such as drinking water, having a lower price elasticity than discretionary demands, such as water used for gardening (Park & Lee, 2019). Low-income households have a lower proportion of discretionary demands, which infers lower price elasticities (Hoffmann, Worthington, & Higgs, 2006). Season also indicated to impact price responsiveness, with demand being 25% more responsive in summer months (Renwick & Green, 2000). Such results suggest that price policy will achieve reduce consumption more during summer months or within larger irrigated landscaped areas, reflecting outdoor discretionary use of water (Renwick & Green, 2000).

5.3 KOREA PRICE POLICY SIMULATION

Considering the success of price policy implementation in California, researchers conducted studies to determine whether such an approach would have benefitted Korea during its drought in 2015 to 2017 (Park & Lee, 2019). The study simulated the same price policy implemented during the drought in California, aiming to conclude whether the higher water prices could have improved water usage and conservation efforts. The study found that price was ineffective in impacting demand as water prices were inelastic to a greater extent, with the price elasticity for water demand equalling between -0.156 and -0.189 (Park & Lee, 2019). Factors such as geographical volume of water and cultural difference were determined to be the main contributors to differing results. Park and Lee (2019), thus highlight the importance of developing drought mitigation policies considering the specific factors and context of the country in question. Thus, empirical data regarding Australian price elasticity and behaviours concerning residential water usage provides critical insight into whether a consumption tax would effectively reduce demand if implemented in Queensland.

5.4 AUSTRALIA URBAN WATER DEMAND ELASTICITY

Drought is not a new concept for Australia. In the past, both the Government and the public have collaborated to preserve diminishing water supplies. Additionally, past research indicates that the Australian public response to price changes is relatively positive considering that water is generally considered a social good. Strict limits on water consumption and heavy penalties for non-compliance were among the DSM policies introduced (Dorsey, 2018). Furthermore, prices significantly increased in most major cities in response to scarce resources.

In the millennium drought in Melbourne Australia, the introduction of a 5% ‘environmental levy’ and the modification of the block tariff from two to three tiers accompanied rising water prices (Grant, et al.. 2013). In this way, the first two block rates are designed to recover financial costs for aquifers while the additional tariff is used to discourage the exploitation of additional water usage (Lago, et al., 2015). These modifications both signalled the scarcity of water whilst maintaining fixed costs of suppliers. This concept of raising prices is referred to as scarcity pricing and has been promoted by the Australian National Water Commission as an effective means to reduce demand. Despite promotions, such pricing mechanisms are yet to be introduced to Australia’s Permanent Water Conservation Measures (Grant et. Al, 2013). This is due to the acknowledged equity concerns, with those poorest in society suffering the most. Such issues have been addressed in other countries via a subsidy or rate design in which the lowest tier is very inexpensive (Grant et. Al, 2013).

DSM price and non-price policies were always successfully implemented together in Australia, meaning it is difficult to gauge the true impact of the price increase alone (Renwick & Green, 2000). Thus, it is vital to consider the price elasticity of urban water demand. The elasticity of water, or rather inelasticity, will indicate whether the policy will be effective when implemented in Queensland. As stated previously, empirical data suggests that the consideration of household characteristics, geographical and behavioural factors impact elasticity. Hoffmann, Worthington and Higgs (2006) conducted a study using linear and non-linear regression techniques to model Australia's urban water demand and behaviour. The data was collected from Brisbane City council, Australia's largest local government area, and an ideal model for reflecting Australians and their demand. A two-part tariff was the price policy investigated (Hoffmann, Worthington, & Higgs, 2006). Brisbane uses a two-tariff policy, where a fixed access charge and a volumetric charge per kilolitre. Charges are separated and based on indoor and outdoor water consumption. This model is like the proposed policy, where a consumption tax is placed upon a fixed charge. The key findings from the analysis are that demand elasticity in the short-run, although inelastic, is more extensive than previously assumed and that price changes impact demand (Hoffmann, Worthington, & Higgs, 2006). The short-run price elasticity of demand for Australia across all households is -0.507, indicating that a ten percent increase in the price of water would result in a 5.07% decrease in water quantity demanded (Hoffmann, Worthington, & Higgs, 2006). Elasticity results are higher to that of California, suggesting that similar if not more substantial results will occur.

Furthermore, the demand elasticity is more elastic in the long run than in the short run, suggesting a lag in quantity demanded in response to a price change (Hoffmann, Worthington, & Higgs, 2006). Additionally, this indicates that price policies encourage technological improvements, such as low flow showerheads and more sustainable landscaping choices, as consumers find substitutes in goods and activities that save them water and thus money. Overall empirical results suggest that a price mechanism, like the one proposed, would effectively manage water demand, should it be implemented in Queensland and benefit both short-run and long-run water consumption management.

6.0 OPTION 1: POLICY CONSIDERATIONS

Queensland water management primarily penalises those who exceed predetermined limits after-the-fact (Business Queensland, QLD Govt. 2021). This section analyses the efficacy of a tax as a preventative measure to limit and reduce water usage in Queensland. The approach to implementing this tax will be similar to the Gillard Labor government’s carbon tax – however on a heavily reduced scale. The ‘Water Tax’ would encompass a standard fixed service fee, and upon an area being drought declared, a flat tax that would effectively reach the desired equilibrium.

6.1 BACKGROUND INFORMATION

6.1.1 Assumptions

A simulation of the effectiveness of a water tax implemented in Uganda will be the basis of assumptions and expected policy implications using local Queensland estimates of consumption to predict revenue streams from the tax itself and fiscal costs to the government, its people, and businesses (Dr Nicholas Kilimani et al, 2015). The key assumptions made by Dr Kilimani include a water tax’s impact on macroeconomic variables, and the environment – key attributes to estimating the potential of a water tax.

6.1.2 Current Consumption Estimates

As of the 15th of September 2021, the approximate average residential water consumption in Queensland was 181L/person/day (Figure 2), with households accounting for 15.84% of all water consumed in the 2018-19 financial year (Australian Bureau of Statistics, 2020). The basis of the following calculations will be made through the current state bulk water price of $3.122 per kilolitre, however private intermediaries and ‘middle-men’ prices may vary.

Theoretically speaking, the average person drinks 2.3litres of water per day (Better Health Victoria, 2020), uses 18litres for general, cleaning, handwashing purposes per day. In addition, a modern washing machine uses between 50-100 litres of water and a modern dishwasher from 15 to 25 litres per cycle. Consequently, using basic assumptions surrounding cleaning, hygiene, washing, and drinking practices it can be estimated that the average adult can sustain themselves by using between 50 and 120 litres of water per day - without feeling confined to the limitations of a drought. Moreover, the average adult wastes up to 110 litres of water per day, therefore households can effectively almost cut their water usage in half, and as such the tax will reflect this theoretical amount (Australian Infrastructure Audit, 2019). Therefore, the tax would reflect the 120litre minimum to a price whereby price will not affect consumption quantities. Based on current consumption with an adjusted average consumption of 181litres per day per person, the tax would be integrated to reach the new tax included equilibrium of 120litres per day, restricted by aforementioned assumptions.

6.1.3 Tax Pricing

The most effective tax price is based on “an analysis of 64 previously published residential water demand studies, household water consumption would fall, on average, by about 3.5 per cent for a 10 per cent price increase” (Dalhuisen, et al., 2003) Therefore, in order to achieve the new tax included equilibrium, the tax would effectively be an approximate price increase of 96.29% and a theoretical increase limit of 206.78%.

6.1.4 Fiscal Cost, Revenues and Reduction in Consumption

In achieving the new tax included equilibrium, the new price on water would be $6.128 per kilolitre based on the state bulk water price. Utilising water profits from the Queensland audit office in the 2018/19 financial year, the tax would generate $390.35m to $1243.72m *if* water consumptions continued to remain the same. Whereas *if* the tax scheme worked effectively to achieve the optimal outcome, it would reduce Queensland water consumption to between 244.187m to 586.049m litres- a reduction from approximately 883.957m litres per day.

6.2 IMPLEMENTATION

For the tax to take immediate effect on reducing water consumption levels and extend the life of an already *in danger* dam, preannounced tax adjustments will not suffice. The Water Tax’s official introduction must be predicted via models and expectations of consumption and dam levels during that time, with the expectation that during summer will be the primary period in which the Water Tax will be implemented. In this way, the Water Tax will be introduced significantly differently than previous similar tax proposals.

6.2.1 Announcement Methods

Warnings and indications of an upcoming drought are effective in decreasing consumption, therefore upcoming tax increases as a result will also, in premise, cause a decrease in water consumption. This is known as the announcement effect. The result of this uncertainty is that consumers will reduce expenditure and save, which in this case will further result in reduced water consumption levels, in attempt to reduce their future spending. Therefore, upon the first indication that the threat of drought is inevitable, the first step of implementation is to introduce warnings and indications that a drought tax will be introduced 1-day post drought confirmation.

6.2.2 Timing

Year-to-year, the exact date of the introduction of the tax will vary depending on dam levels, expected rainfall, consumption habits, temperatures, and water-using product efficiency (washing machines/dishwashers/toilets etc) (National Institutes of Health, 2017). The announcement effect will play a significant role in the timing of the tax, as the announcement of an impending drought will almost definitely alter the expected timeline or introduction of the tax in a drought declared region. A negative announcement, ceteris paribus, will result in an approximate 21% decrease in purchase levels, or a 21% drop in consumption levels of water (Raymond R. Burke et al. 1990). A 21% decrease in consumption levels could potentially result in dam levels being sustained for up to 3-4 additional weeks.

6.3 SOCIAL AND ECONOMIC IMPACT

6.3.1 Stakeholders

Key stakeholders for this proposal include; the government, the agricultural sector as a whole, Queensland residents and environment. The agricultural sector would benefit greatly, as the price of water would remain the same for their farming purposes, depletion of resources would become much rarer and opportunity to capitalise on water availability is high. Residents will be adversely affected as their current consumption habits are put into question, and households will be forced to find alternate areas of improvements to continue their lives without being detrimentally affected. Households will be forced to be resourceful in washing, cleaning and bathroom use, with a potential opportunity for more water efficient products to come to light. The Queensland Government will be under enormous pressure by residents as a dramatic change will cause conflicting opinions on current water consumption, and what level of consumption is deemed reasonable. It is due to this, upon initial introduction, intense analysis and monitoring of its effects, potential improvements and flaws must occur. The additional tax revenue would be a significant bonus for the government, which could be used for funding for future water management projects and innovations.

6.3.2 Assessment of Effectiveness

A water tax will eventuate the most drastic changes in an agricultural setting, however residential urban areas are the focus of this proposal to assess its effectiveness on reducing ‘Queenslanders’ high average water consumption per day. (Berritella, et al., 2008). Typical water price increases affect residents, however, at a greatly reduced scale to agricultural farming. The causality behind a water tax on agriculture, forces farmers to innovate and find more effective means of the same production levels, resulting in high technology advancement and improved allocation of resources. (Molden, et al., 2010).

6.3.3 Results and Improvements

Targeting agriculture and residential water usage and consumption will greatly assist in maintaining dam levels. “There is considerable scope for improving water productivity of crop, livestock and fisheries at field through to basin scale.” (Molden, et al., 2010). Forcing innovative practices as well as developing household awareness of water consumption will be essential for Queenslander’s to only use what they need out of necessity over habit. It must be noted however, that the agriculture sector cannot be pushed to unsustainable levels as to which shortcuts in key agricultural areas such as health, safety, hygiene, environment, animal welfare etc. Therefore, it can be evidenced that a water tax focussing on residents can and would be effective, however could be improved significantly by coinciding it with an agricultural water tax.

6.4.4 Risk Assessment

The risks associated with the effected stakeholders primarily surround operational, and business risks. While business risks are not the key focus of this report as residential water consumption is the emphasis of the Water Tax, it must be noted as a key factor if an agricultural targeted tax is to be included. The operational risks include; urban residences not having access or the money to access the water they need, fraud/stealing water, technology flaws such as inconsistent data collection on water usage and expected cost pricing as well as other administrative control issues resulting from human error (Deloitte, 2015).

6.5 CONCLUSION

In conclusion, the results clearly indicate that a ‘water tax’ in premise is sound and can be effectively utilised to reduce water consumption. However, there are several improvements that could potentially develop the proposal further to create a more socially viable option including, expanding the Water Tax to include the agricultural sector. The most adversely affected consumers are households themselves, and those that benefit the most out of a water tax are the government and the agriculture sector (assuming they are not subject to the tax). Timing is essential to its efficacy and must be evaluated precisely to create the most socially and economically viable regulation.

7.0 OPTION 2: ECONOMIC MODEL ANALYSIS

7.1 WATER RECYCLING

To resolve the problems of water scarcity and to enhance the overall reliability of water resource management in Queensland, water recycling will be implemented to administrate the supply of water. This section will highlight the theoretical outcomes of investing in the water recycling option with the application of economic models. These economic frameworks are identified as the supply and demand theory as well as behavioural economics’ game theory and overconfidence bias. The models will essentially demonstrate and predict the effects of implementing the water recycling option and how it weakens the burden of water droughts on top of the benefits that it adds to society.

7.2 SUPPLY AND DEMAND THEORY

7.2.1 The Problem

Supply and demand theory uncover the interaction between the sellers as well as the buyers for that resource (Fernando J, 2021). In Figure 3, the demand curve represents the consumer’s willingness to pay for the water fees. Furthermore, the demand curve is downwards sloping from the left to right revealing the diminishing marginal valuation of successive increments of water. In contrast, the upward sloping supply curve indicates that increasing demand will only be met by a rising cost of water price. With the increasing population and significant water extractions from the Australian Agriculture sector, the demand for water has increased whilst the supply will be insufficient to meet the demands in the long run (Piesse M, 2020). Furthermore, the consequences of increasing demand will result in incremental changes in water fees. Brisbane Times analysis presents that Brisbane residents are paying 26% more for water bills since the LNP took charge of Brisbane City Council’s budget in 2004 (Dennien M, 2021). Therefore, with the absence of reusing water, these issues of water drought and higher water fees will continue to worsen.

7.2.2 Expected Results

To break through the water supply plateau, the investment of recycling water will critically help to significantly reduce the pressure on water sources as it ultimately aims to increase the supply of water.

**Short Term Effects of Water Recycling**

Figure 4 unveils the effect of reusing water in the short run. With extra water resources to supply, this reinforces the supply curve to shift to the right from Supply1 to Supply2, thus transitioning the equilibrium from A to B. This change theoretically predicts that the price of water fees will decrease. The water price reduction acts as an incentive for society and drives households and agriculture industries’ confidence to consume additional water without worrying about water droughts and significant spending for a good with no alternative substitute.

**Long Term Effects of Water Recycling**

Figure 5 extends on examining the water recycling option by highlighting what needs to be considered in the long run. Identical to Figure 4, reused water influences the supply curve shifts outwards from Supply1 to Supply2. The supply shifts force the equilibrium to change from B to C which influences the price of water to drop back down from P2 to P3 for a couple of years. However, in the long run, greater than five years or a decade, we must consider the increasing population and inflation throughout the future. These factors will transition equilibrium C to D which influences the water price to shift back to the original price of P1, thus Queensland households are able to avoid the disutility of having to pay higher water fees. Ultimately, recycling water allows the supply of water to keep up with Queensland’s rising water demand throughout the future, therefore, this prevents the considerable consequences of water drought and expensive water fees from escalating any further.

7.3 BEHAVIOURAL ECONOMICS

7.3.1 Game Theory and Overconfidence Bias

Behavioural economics incorporates a framework to investigate the decision-making behind the economic outcome. One of the methods that analyse those strategic decisions and can provide additional insights on both the short term and long-term effects of the water recycling option is game theory (Stanford Encyclopedia of Philosophy, 2019). In addition, behavioural economics’ overconfidence bias captures the potential limitation associated with the water recycling option.

7.3.2 Application of Game Theory: Social Effects of Recycling Water

The decision tree presented in Figure 6 lists the eight possible outcomes of the game. For this, we have Player 1 as the society and Player 2 as the Queensland Government. The games start off at Node 1 with society having two options of whether they use water excessively or conserve water. In nodes 2 and 3, the government will have to either respond by prioritising water consumption or do nothing. Finally, at node 4, 5, 6, and 7 reveals the short term and long-term branches which then results in the payoffs for each scenario. The importance of reusing water is demonstrated in this decision tree as prioritising water recycling is the dominant strategy for the government regardless of how our society uses the water in the short or long run. In any scenarios where water recycling is prioritised by the government, both players will be rewarded with a positive payoff as our society will possess greater access to water supply whilst the government will have a positive reputation. In contrast, the absence of recycling water results in the expansion of potential threats including water droughts as illustrated in the negative payoff. These negative values represent the disutility that society suffers from a higher water fee and possessing limited access to water, as well as the government failing to manage water resources effectively.

7.3.3 Overconfidence Bias: Limitations of Recycling Water

As presented in Figure 4’s supply and demand graph, as there is an increase in water supply, a decrease in price will influence consumers to develop the overconfidence to consume additional water than required. Consumers will fall into the mindset of believing that they have minimal budget constraints when paying for water fees and the desirability effect that water is now a sufficient resource without droughts (Corporate Finance Institute, 2021). The overconfidence bias resulting in excessive water consumption may theoretically lead to water droughts again. Nonetheless, in practice, this does not apply when assuming that people are rational and that the government is constantly investing in resources that will help expand water recycling to supply the expected increase in water consumption.

7.4 SUMMARY OF ECONOMIC MODEL ANALYSIS

Ultimately, the supply and demand theory, as well as behavioural economics’ game theory, identifies that the recycling water option is the ideal solution to overcome water drought in both the short and long term. Moreover, overconfidence bias emphasises the potential limitations of investing in this option assuming that people are irrational. These economic models help explain the theoretical outcomes and expected results of recycling water.

8.0 OPTION 2: EMPIRICAL ANALYSIS

8.1 WATER SUPPLY IN AUSTRALIA

Currently, the total storage capacity for water in Australia is 81 000 GL, sitting at 46% capacity as at 30 June 2020 (Bureau of Meteorology, 2021b). If all total storage was full, this would supply the Australia population for approximately five and a half years, based on the water taken for consumptive use in 2019-2020 (Bureau of Meteorology, 2021b). Based on the Australian Bureau of Statistics population projection, within 10 years, this period of supply would drop by approximately 10 months (Australian Bureau of Statistics, 2018; Bekele et al., 2018). In the 2019-20 financial year, the total annual rainfall was over 100mm below, or 24% lower than, the median value for Australia (Bureau of Meteorology, 2021b, pg 11). Over 75% of the population live in major cities, making Australia highly urbanised and urban water management a key issue for policymakers (Bekele et al., 2018). With population increasing and annual rainfall declining, there must be an alternative supply of water, and with many cities not having the access to sea water for desalination plants, recycled water is something that will need to be considered in Australia’s future to meet the demand for water.

8.2 WATER RECYCLING IN AUSTRALIA

Drinking treated recycled wastewater has always been something that was not well accepted in Australia. The public have rejected multiple successive state governments’ proposals to build treatment plants to increase the supply of water in Australia in favour for desalination plants in many capital cities (Longbottom, 2018; Guest, 2010; Khan & Branch, 2019). However, the preferred desalination is not an option for inland cities due to the expense that it is to transport water as a heavy, non-compressible substance (Longbottom, 2018). Water Services Association of Australia executive director, Adam Lovell (2018), endorsed the importance of using recycled water to increase the supply of water for Australia. In Lovell’s opinion, for Australia to continue to grow and have liveable cities, the population needs to embrace reuse of water as a way to move forward (Longbottom, 2018).

8.3 THE GROUNDWATER REPLENISHMENT SCHEME

As a coastal town, Perth has utilised desalination to provide 47% of its annual water supply, but has also introduced and successfully implemented recycled water to increase their water supply (Bureau of Meteorology, 2021a; Water Corporation, 2021a). The Groundwater Replenishment Scheme (“GRS”) is an indirect potable reuse project that is located north of Perth and is managed as an aquifer recharge project to increase the supply of water to important drinking aquifers for the area (Khan & Branch, 2019). Water Corporation, who is the principal supplier of water, wastewater and drainage services throughout Western Australia, is the only utility which has implement treated recycled water as part of the drinking water supply (Water Services Association of Australia, 2019). The treatment occurs in a similar way to what is proposed for Southeast Queensland, but rather than the water being pumped to a dam with other stormwater to then be treated for drinking, it is pumped through recharge bores to be delivered to the aquifers which provide drinking water for Perth (Khan & Branch, 2019). This is then, again, treated at conventional water treatment plants prior to distribution to the residents (Khan & Branch, 2019).

The first stage of this scheme is able to produce an addition 14GL/year for Perth’s water supply, commencing operation in 2017 (Khan & Branch, 2019; WA Department of Health, 2020). The development of the second stage is set to commence in 2022, and is projected to produce another 14GL/year which would equate to approximately 4% of Perth’s annual water usage (Khan & Branch, 2019; WA Department of Health, 2020; Bureau of Meteorology, 2021a). It has been proposed that by 2060, 115GL/year could be sourced and recycled from Perth’s wastewater treatment plants (Khan & Branch, 2019).

8.4 THE WESTERN CORRIDOR RECYCLED WATER SCHEME

Most urban areas in Australia are connected to sewage, meaning the wastewater is collected in addition to the rainwater which makes its way into sewers (Hagare, 2012). Prior to any Australia cities or towns using recycled water for domestic consumption, the use for non-potable purposes, including gardening and industrial use, was very well-established, occurring all throughout the Eastern coast of the country (Hagare, 2012).

There is a major water recycling treatment plant in South East Queensland, completed in 2009 (Hagare, 2012). The scheme in place that was constructed in Brisbane is one of the largest in the world, but the water has never been released into the drinking supply as this is to be a backup for when dam levels fall below 40% (Longbottom, 2018). The WCRWS was designed to use the treated wastewater for six major wastewater treatment plants from across South East Queensland (Walker et al., 2007; Khan & Branch, 2019). This water was then to be delivered to advanced water treatment plants, to undergo the advanced treatments so the water would be at a standard which align with the Public Health Act 2005 (Qld) and its corresponding regulation, the Public Health Regulation 2018 (Qld), as well as the Australia Guidelines for Water Recycling and the Australian Drinking Water Guidelines (Seqwater, 2021b; Khan & Branch, 2019).

This is designed to supply a total of 230ML/day, or approximately 84GL annually (Khan & Branch, 2019). At its maximum capacity, WCRWS would be able to supply approximately 53% of the daily water consumption of Southeast Queensland (Seqwater, 2021c). However, modelling conducted in 2012 indicated that there was only a 5% chance that the scheme would be fully required by 2030 (Khan & Branch, 2019; Queensland Audit Office, 2012).

8.5 IMPLEMENTATION OF RECYCLED WATER IN URBAN CENTRES

In the past year, use of recycled water in major urban centres in Australia increased to 145GL (Bureau of Meteorology, 2021b). That equates to 8% of total water sourced in major urban centres (Bureau of Meteorology, 2021b). This increase occurred in all urban centres across Australia, apart from Melbourne and South East Queensland (Bureau of Meteorology, 2021b). Recycled water treatment costs approximately half compared to treating desalinated water, without considering any additional pumps or pipelines that would be needed to transport the water to the locations that it is required (Longbottom, 2018).

8.6 SUMMARY

Sustainable, climate independent urban water management is a key issue for consideration as the lack of water supply in inland Australia becomes more apparent. Looking at the GRS in Western Australia, it is clear that this is something that can be successfully implemented in Australia, and with the great expenditure on the WCRWS several years ago, there is significant infrastructure ready to be utilised to supplement supply in Southeast Queensland and upgraded where necessary to assist inland cities in the region and effectively shift supply to meet the increased demand for water.

9.0 OPTION 2: POLICY CONSIDERATIONS.

9.1 COST

The direct costs of water recycling can be estimated based on the costs of water recycling initiatives in other countries. Direct costs include the provision of infrastructure and ongoing maintenance (Frontier Economics, 2018). The bulk of the real-world costs revolve around the upgrade and maintenance of already existing water treatment plants in use which are estimated to cost between $25 million and $1.1 billion. However, Queensland already has many large-scale water recycling plants that supply water to local government areas and major dams and basins, therefore, it could be more cost effective to upgrade these existing facilities. Seqwater operates more than 30 water treatment plants across Southeast Queensland (Seqwater, 2020) and is currently upgrading a large treatment plant at Mount Crosby. This upgrade is estimated to cost $45 million. In Canada, the government is spending at least $215 million to upgrade one of its largest treatment plants (2021)/ In a 2019 report, Planning NSW suggests that investing and upgrading existing facilities is more beneficial for society than creating new capital investments, which will not have the manpower to maintain them (2018). In addition, water recycling is less expensive compared to other technologies such as desalination plants.

The Australian government established the National Water Grid Fund and has committed almost $3.5 Billion dollars over 10 years – with 20% of these funds being used for direct capital purchases and maintenance. In the 2021-22 Budget, the commonwealth government has announced States will be able to receive $20million a year with a further investment from the federal government of $5 million dollars, for smaller scale construction projects that are state focused (Australian Government, 2021). This new initiative shows the federal contribution to new projects, not existing and not maintenance funding. In addition, the State government has committed over a total $1.7 billion dollars since 2015, with a further bid in the next three years, to secure funding for local councils to target water networks and infrastructure (Queensland Government, 2021).

The initial budget allocation for water treatment programs was a mere $500,000 in 1998, but have increased exponentially each year – driven by the public’s enthusiasm for new innovative technology so that water shortages are prevented (Uhlmann & Head , 2011). However, some local residents and councils have indicated they would rather spend more money on desalination and water purity projects rather than water treatment initiatives due to the stigma around treating wastewater (2010).

There are significant costs associated with water recycling, however, all three levels of government are committed to bettering the Nation's water supply: this is evident through federal schemes and funding, state level grants and programs and local councils contributions. The funds relating to upgrading and maintaining current capital in Queensland would mostly be supplied by the state government, with allocations for smaller LGA’s, this seems to be the state government’s main goal in terms of funding involving water, the maintenance and upgrade of current installations.

9.2 IMPLEMENTATION

As stated previously the Queensland Government has many water treatment and recycling plants throughout the state. The major downfall to successfully implementing a strategy to upgrade the state’s water plans would be time: time lag and administrative hurdles are the key issues that arise before physical rollout begins. Downer group, which has secured a partnership with other firms and Queensland’s Logan City council, began trials to upgrade the water plant located there. Downer announced the upgrade would take place over the next 9 years with completion by 2030 and cost of up to $1 billion dollars (2021). Not only this, the LGA’s and the state government in a media statement have indicated that to secure money for water related projects rounds of funding are required which can take as long as three years to secure (2021). In addition, after these three years, a government may be voted out and the funding cut for such projects. However, further administrative hurdles occur even after the funding has been secured. The state Government’s business page states that an initial feasibility report must be generated to understand the costs, benefits and challenges of the project and after this is completed (which could take months if not years to accept) the government will then have to consult stakeholders relevant to them before any projects are undertaken (Queensland Government, 2021). In 2004 the Australian government established the *National Water Commission Act 2004* and through this, created the National Water Commission. The agency had many roles including the assessment and audit of rolling out upgrade/new projects across the nation; however, it was abolished in 2014. Reintroducing a similar body that focuses on just water, may be useful in overcoming administrative hurdles to make water recycling more viable.

9.3 IMPACT

The impact for water recycling can focus on different stakeholders, these being: The market (i.e. households, businesses and firms, and government), the community and even the environment. Water recycling is a growing trend and even has its foothold in the global economy. BCC Publishing released a report stating that the global market for wastewater and reuse technologies is currently at $21 billion and will increase to $40 billion by 2026: essentially, doubling its value and market capitalisation (2021). The US department of trade has stated the market between Australia and the US alone, has increased by just over $100 million in two years with imports and exports relating to water reuse technology increasing by $50 million. This further shows the impact water reuse and recycling has on the broader international economy. Local, state, and federal governments own most water recycling plants that are for public use; however, most of the technology behind these recycling plants are privately developed. With the anticipated growth in the industry over the next five years, water recycling provides the opportunity for established businesses in Queensland to develop and build upon current technology and information to drive innovation and become specialised in the industry. It also invites promotes healthy competition as it creates an opportunity for new players to enter the market which will have large economic benefits.

Investment in water recycling facilities will also create new jobs in the market, thus reducing unemployment in Queensland. In a media statement released in March 2020, the Queensland Government announced at least 100 jobs will be created as part of infrastructure upgrades to one water plant (2020). The state government has a list of already funded projects underway with a current 95 out of 270 involving the upgrade/creation of water infrastructure and technology to local government areas, totalling the creation of 700 full time jobs (2021). The state government also has partnered with many firms, such as Downer, Seqwater, Urban Utilities, HunterH2o in its attempt to develop and upgrade the state's water technology and capital investment.

Another hurdle for successfully using water recycling in Queensland is overcoming the stigma around this technology. Possible community consultation would be needed to first understand society’s looming suspicions around treatment, then education rollout would be required and could be in the form of online advertisements or physical pamphlets distributed within the communities that would be using recycled water. Another risk is the potential for rollouts of upgrades to plants to fall behind new technology which could make the upgrades redundant; however, this is a minor risk and can be easily overcome.

Overall, water recycling benefits many stakeholders in the market including individuals, businesses and firms who produce the technology for water recycling. The government would also benefit from this policy through the reduction in unemployment

10.0 COMPARISON OF POLICY OPTIONS

10.1 TABLE OF COMPARISON

|  |  |  |
| --- | --- | --- |
| ***Problem and Objective:***  The drought in Australia, worsened by global warming and overpopulation, is causing water scarcity across the country. Our objective is to improve reliability of water resource management/water supply in urban areas of Queensland by targeting water supply through water recycling and target consumer demand through taxation. | | |
| ***Analysis*** | ***Option 1: Water Tax*** | ***Option 2: Water Recycling*** |
| ***Economic theory*** | Water Tax increases the price of water which reduces excess demand and consumption.  The cut of water consumption can help avoid potential threats such as water shortage, however, there is a trade-off as society suffers from having to pay for a higher price per unit of water. | Water recycling increases the supply which results in a price decrease. This potentially increases demand for water.  Water recycling increases water supply and lowers water fees, however, it comes with a risk of consumer overconfidence who will start consuming more water. |
| ***Empirical analysis*** | Price-based policies are more effective when in comes to influencing demand for water when compared to non-price policies.  With demand for water more elastic in the long-run, price-based policies encourage technological improvement and consumers finding more sustainable substitutes to save water, and therefore money. | Water recycling has been successfully implemented for consumptive use in many other countries, including cities in Australia.  Utilising existing infrastructure of the WCRWS would produce enough water daily to supply over half of Southeast Queensland’s daily consumption. |
| ***Policy - Impact analysis (benefit & costs)*** | Contrary to typical tax schemes, the Water Tax attempts to imitate similar schemes such as the ‘carbon tax’ and ‘sugar tax’ that focuses on the issue itself rather than raising government revenue, implying that its impact is vastly different than an infrastructure project. The water tax’s policy considerations fundamentally focus on; current Queensland residential consumption estimates, tax pricing/revenue and expected reduction in consumption. | Most of the costs involved with water recycling come from rounds of funding from state and federal levels of government.  Budget allocation is the main source of funds for major upgrade projects in QLD  State budgets have gone up exponentially every year since 1998. |
| ***Policy - Implementation*** | The implementation strategy follows an announcement method in preparation for the upcoming drought, whereby the water tax is only ‘activated’ during a period of drought rather than year-round.  The announcement itself also may lead to consumption reduction and resulting in behaviour and society changes that could affect the original expected duration of the water tax’s implementation. | Implementation of a water recycling upgrade schedule to plants will face setback with major time and administrative lag.  Round of funding to secure budgets for upgrades, followed by approval, projects securement and physical rollout – time frame can stem from 3-10 years to completion of projects.  Cooperation between all levels of governments will also be a hurdle to overcome in terms of jurisdiction and approval of budget allocations. |
| ***Policy – risk management*** | The risks primarily surround operational and business risks. Operational risks include urban residences not having access to the water they need, fraud/stealing water, technology flaws such as inconsistent data collection on water usage and expected cost pricing as well as other administrative control issues resulting from human error. | Debt implications are favourable as water initiatives in Australia are favourable among the public and face no real pushback.  Stigma around water reuse may be an issue and community consultation will be needed, and probable education to ensure confidence in the public. |

10.2 POLICY OPTION COMPARISON

From the theoretical side, when comparing the supply and demand models of the Water Tax and water recycling, both options predict similar outcomes of reducing likelihood of our issue – water scarcity, nonetheless in a contrasting way. The Water Tax increases the price of water which reduces the excessive demands of water whilst water recycling aims to increase the supply of water. With the different approaches, the models uncover that both options have their own strengths and limitations when it comes to solving the water drought issue.

Both options would be able to be implemented, with the major considerations being on the impact to the public. It is key that the public is involved with the implementation of each option, as the major stakeholder. For the Water Tax, this would have to do with discussions around household consumptive use to ensure that the tax is not setting unrealistic expectations and ensuring that everyone has the access to water that is required, and education around exactly how the tax works and what that would mean for households. With water recycling, education is very important around how the treatment of water occurs and how this aligns with drinking water guidelines, as well as all the monitoring and controls in place to guarantee the water quality.

However, further research would be required before any final suggestion could be made. Greater research into the social impact of the Water Tax and community consultation would be vital to any policy option. For water recycling, it would be important to have more in-depth discussions with Government around what upgrades would be required for the WCRWS to be used at full capacity, and a more detailed implementation timeline to begin educational workshops with the community. Despite this, we do recommend that these policies be implemented together, as complements, as they effectively target the two key pain points of urban water resource management, being a high demand with a low supply.

11.0 CONCLUSION

Queensland must address the growing problem of water scarcity in the state. Driven by drought, climate change and population growth, this issue has the potential to seriously impact the economy in the future by ensuring demand for water far outweighs supply.

The objective of this report was to improve water resource management in urban Queensland in order to minimise water scarcity. This report introduced two alternative economic policy options that aimed to achieve this objective. The first policy option is a tax on the consumption of water when Queensland is in a drought declared state. This policy targets consumer demand by reducing consumption of water across the state. The second policy options is the use of water recycling in urban Queensland. This policy option would see Queensland upgrade existing water recycling facilities to increase the supply of water in urban areas.

This report recommends implementing both economic policies together, as complements, as they effectively target the two key pain points of urban water resource management, being a high demand with a low supply. However, further research is required into the social impacts of the Water Tax and what upgrades would be required to water recycling facilities. Further, community education and consultation would be necessary to ensure these policies are implemented effectively. Introducing both policies together will provide a well-rounded approach to preventing water scarcity and ensuring future generations have an adequate supply of water as the tax focusees on short term consumption and water recycling on long term supply.

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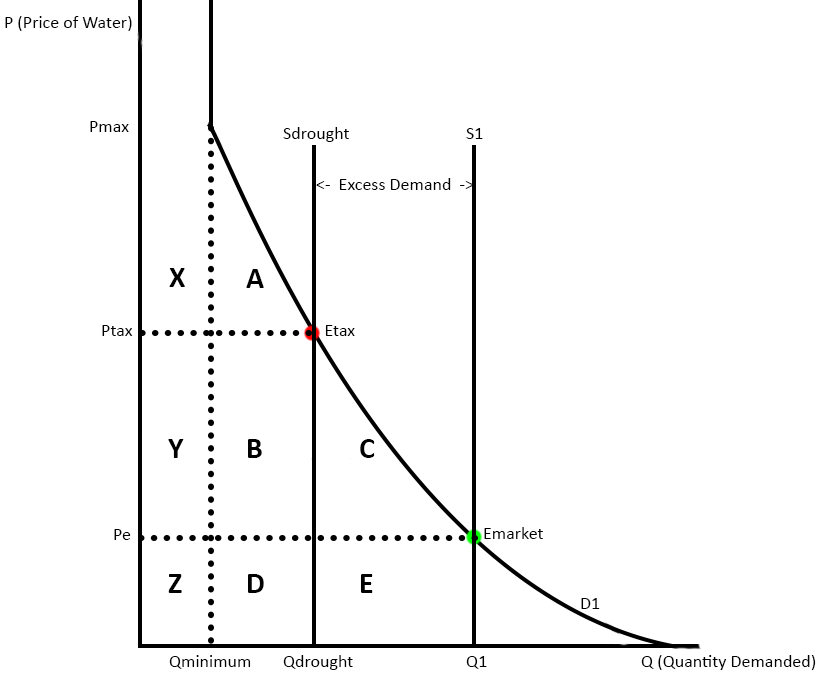
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13.0 APPENDIX

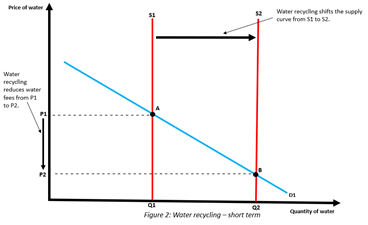
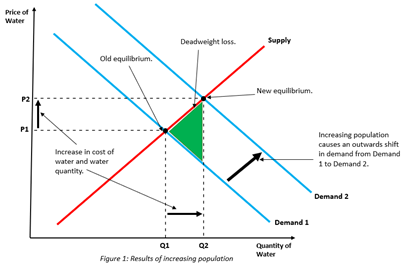


**Figure 1:** Water market pre-drought, post-drought and taxed.

**Figure 2:** Water Use in Queensland

|  |  |  |  |
| --- | --- | --- | --- |
| **Queensland Region** | **Litres per**  **person per day** | **% of population**  **in region** | **Weight**  **Adjusted** |
| SEQ | 163 (2021) | 0.6800 | 111.166 |
| Wide Bay | 244 (2016) | 0.034 | 7.8568 |
| Cairns & FNQ | 265 (2014) | 0.036 | 9.593 |
| Townsville & NQ | 167 (2020) | 0.052 | 8.684 |
| CQ | 276 (2021) | 0.050 | 13.8 |
| GW3 | 280 (2021) | 0.039 | 10.92 |
| Central West | 250 (2019) | 0.047 | 11.75 |
| South West | 124 (2021) | 0.059 | 7.316 |
| **Average Litres/**  **Person/Day** | **221** | **-** | **181** |

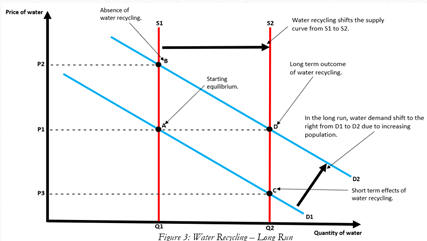
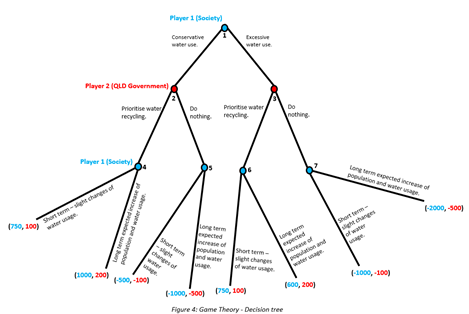
**Figure 3:** Impact of Water Recycling on Supply and Demand



**Figure 4:** Short Term Impact of Water Recycling

**·**

**Figure 6:** Game Theory Decision Tree



**Figure 5:** Long Term Impact of Water Recycling