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Integrating wastewater reuse into water management schemes of Caribbean SIDS: A Trinidad and Tobago case study

Ronald Roopnarine [a,*], Kervelle Baird[b], Mikella Hosein[c], Renee Jackson[c], Shehnaaz Salim[c], Anisha Cephas[c], Oral Daley[a], Samantha Gangapersad[c], Sara-Jade Govia[d], Adrian Cashman[e], Akil Crichlow[a] and Federick Pinongcos[f]

[a] The University of the West Indies, St. Augustine Campus, St. Augustine, Trinidad And Tobago
[b] Université Côte D'Azur, Nice, France
[c] Economics Research, Policy and Planning Division, Ministry of Public Utilities, Port of Spain, Trinidad And Tobago
[d] Caribbean Water and Wastewater Association, St. Joseph, Trinidad and Tobago
[e] AKWATIX Water Resources Management, Bridgetown, Barbados
[f] Trussell Technologies, Solana Beach, California, USA
*Corresponding author. E-mail: ronald.roopnarine@sta.uwi.edu

RR, 0000-0003-2905-8700

ABSTRACT

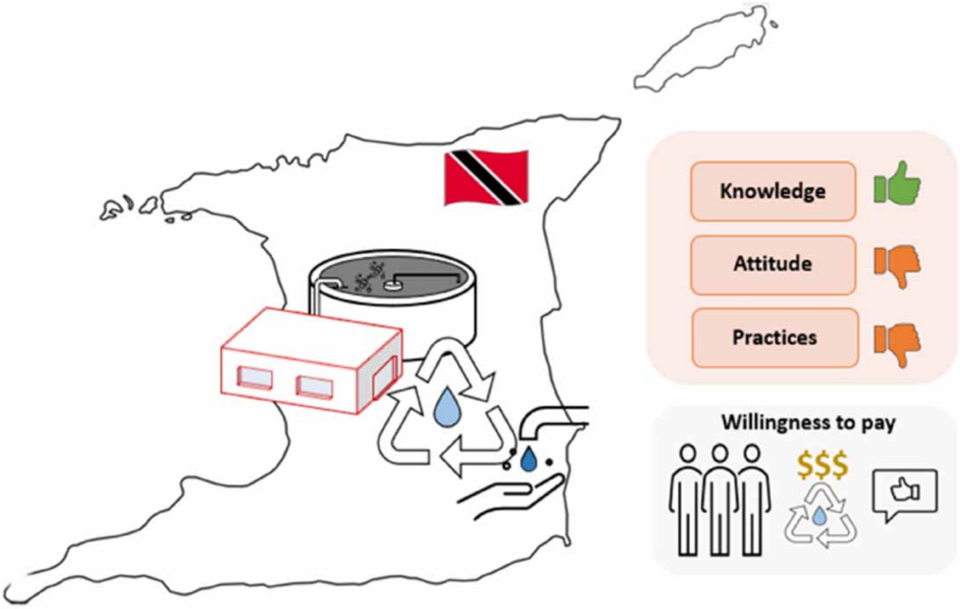
Integrating Wastewater Reuse (WWRU) into national Water Management Schemes (WMS) is crucial as Small Island Developing States (SIDS) attempt to cope with water resource constraints in a changing climate. In 2022, the Global Environment Facility Caribbean Regional Fund (GEF CReW+) on Wastewater Management, the Ministry of Public Utilities (MPU), Trinidad and Tobago and the Trinidad and Tobago Bureau of Standards (TTBS) spearheaded the development of a national voluntary standard for treated wastewater reuse focused on agricultural and landscaping uses. During the process, the MPU conducted a Knowledge, Attitudes and Practices (KAP) and Willingness to Pay (WTP) assessment to inform the standard and subsequent implementation. Results indicated `good' knowledge on wastewater and WWRU (59.3%), however attitudes and practices were considered `poor'. Inferential Statistics performed on numerically coded survey response data revealed no statistically significant relation with the demographic factors assessed; 84.1% of respondents were willing to use treated wastewater with health concerns identified as the main barrier; 27.3% of respondents were willing to pay the same price as conventional water, while 31.2% were willing to pay 25 -50% less. This assessment can inform the implementation and pricing process and provide valuable insights to increase the uptake of WWRU in the region.

Key words: Caribbean, Public Awareness, Wastewater, Wastewater Reuse

HIGHLIGHTS

- Explains the regional dynamics associated with WWRU.
- Examines knowledge, attitudes, practices and Willingness to Pay (WTP) in the context of WWRU in Trinidad and Tobago.
- Outlines the key barrier in terms of public perception related to WWRU.

GRAPHICAL ABSTRACT



INTRODUCTION

Wastewater presents a risk of fluvial, lacustrine, and edaphic pollution to urban and rural environments (Rojas-Valencia *et al*., 2011). Guerra-Rodríguez *et al*. (2020) noted that current technologies to recover nutrients from wastewater have not reached their full potential. Poor wastewater management practices also have debilitating effects on coastal ecosystems which are vital socio-economic resources (Scalley, 2012). Naidoo & Olaniran (2014) added that minimizing the discharge of wastewater into aquatic environments can maintain the oxygen content and water and energy cycles for organisms that inhabit these ecosystems. Globally, water resources are under pressure due to economic growth and development, population growth, urbanization, industrialization and agricultural activities and more recently climate variability and change (Mishra, 2023). As urban water shortages worsen and water purification technology develops, wastewater is increasingly being recovered in larger quantities and for more diverse purposes (Asano & Levine, 2004). Wastewater reuse, also known as water recycling or water reclamation, involves treating and repurposing wastewater for various applications such as irrigation, industrial processes, environmental restoration, and with advanced wastewater treatment systems, for potable use. In recognition of the potential benefits of wastewater reuse and in attempts to address water scarcity and ensure sustainable water management practices; international organizations, governments, and water management bodies have been actively working towards establishing common policies and guidelines.

The United States developed the largest number of water reuse projects of any country, supported by policies and regulations that promote safe reuse of water from recycled wastewater. In 2017, 14 states had policies to address indirect potable reuse and three to address direct potable reuse, compared with eight and none, respectively, in 2012 (Tortajada, 2020). California is the most progressive state regarding indirect potable water reuse. It has the most developed regulatory frameworks. For more than 50 years, several cities have implemented planned replenishment of groundwater basins with reused water. Regulations were adopted in 1978 and revised in 2014.

Indirect potable reuse regulations of surface water augmentation were adopted in 2018. They allow treated/ reclaimed water to be discharged to surface water reservoirs which are used as sources of drinking water (Tortajada, 2020). Reused water has also been used in countries such as Namibia and Singapore. Windhoek, Namibia began direct potable reuse 55 years ago to manage droughts and water scarcity (Van Rensburg, 2016). Singapore began treating wastewater for reuse, called 'NEWater', two decades ago to boost sustainability (Tortajada, 2020). NEWater accounts for two-fifths of daily water consumption and this is expected to grow by 15% in the next four decades (Tortajada, 2020). Williams (2016) illustrated that Singapore's water management portfolio includes industrial reuse of almost one third of its supply. Wastewater forms part of the flow of the Seine River which is treated and fed into the aquifer that supplies drinking water in France (Binnie & Kimber, 2008). Additionally, Israel demonstrated the use of reclaimed municipal wastewater in agriculture and groundwater recharge (Peters, 2015). Technology and private sector participation emerged as essential to guarantee the socio-economic and environmental merits in a pilot study in Athens, Greece (Gude, 2017). Well-developed technologies for irrigation in agriculture and landscaping have been noted in countries such as Bahrain where chlorine is used for disinfection while ultraviolet radiation is used in Kuwait, Tunisia, and the United Arab Emirates (Binnie & Kimber, 2008). Maturation ponds are used in Morocco while ozonation is used in Saudi Arabia. Waste stabilization ponds (WSPs) and aerated lagoons are used in Jordan and Tunisia (Binnie & Kimber, 2008). Kihila *et al*. (2014) noted that WSPs effectively eliminate contaminants. Bartone & Arlosoroff (1987) determined that WSPs are affordable and eliminate odour. Libhaber & Orozco-Jaramillo (2013) documented other methods of wastewater treatment such as rotational microscreens, vortex grit chambers, anaerobic, facultative and polishing lagoons, up-flow anaerobic sludge blanket reactors, anaerobic filters, piston anaerobic reactors, anaerobic baffled reactors, and activated sludge.

Climate change is posing a growing threat to the Caribbean region, with one of its most concerning impacts being the significant reduction in rainfall and the subsequent decline in available water sources. Rising global temperatures and changing weather patterns are contributing to prolonged droughts and altered precipitation patterns across the Caribbean islands (Roopnarine *et al*., 2021). These shifts disrupt the delicate balance of freshwater availability, exacerbating water scarcity issues. As less rainfall replenishes freshwater reservoirs and aquifers, the region faces a critical challenge in maintaining a stable and reliable water supply, putting both ecosystems and the livelihoods of local communities at risk. Co-occurring disasters have also impacted the water sector as seen with COVID-19 and the volcanic eruption in St. Vincent and the Grenadines (Roopnarine *et al*., 2023).

Ault (2016) highlighted the need for long-term policies that cater for future changes in climate to manage water for food production and public use. Access to freshwater in the Caribbean is variable among islands. Geomorphology largely influences supply. Retention is subject to factors such as topography and size (Scalley, 2012). Ahmad (2015) documented an increased demand for water as temperatures rise. Scalley (2012) listed Trinidad and Tobago among islands in the Caribbean where rural inhabitants lack reliable access to water. Ekwue (2010) documented an unreliable supply in Guyana. Gude (2017) determined that the region faced economic water scarcity which required means to access available sources and listed contamination of surface storage and reliance on one source among factors that contribute to shortages. Dependable access to a sufficient supply is a pillar of water security (Amadio *et al*., 2014). Ekwue (2010) noted high per capita consumption in Trinidad and Tobago, Barbados, and The Bahamas. Jones *et al*. (2021) recognized a combination of influences on wastewater reuse for which data are required. Cashman (2011) highlighted the socio-economic importance of water. Nations like Saint Lucia and Saint Kitts and Nevis lack the resources to support irrigation while Trinidad and Tobago can irrigate more land with greater access to water (Ekwue, 2010). Ekwue (2010) documented Antigua and Barbuda as a water-scarce nation with high water stress.

Some Caribbean islands are low-lying and do not have perennial streams such as Antigua and Barbuda and Barbados. Alternative solutions such as desalination have demonstrated stark economic and environmental implications (Scalley, 2012). Scalley (2012) found wastewater reuse as an integral part of the management of water resources in the Caribbean. The treatment and reuse of rainwater is considered one of the two main resolutions to challenges of water availability and suitable for Small Island Developing States (SIDS) which have limited surface (Tota-Maharaj & Paul, 2015). Gleick & Cooley (2021) suggested that reusing treated wastewater is both cost-effective and innocuous to the environment. Treatment reduces contamination below quality thresholds which vary by sector for the purpose of reuse (Jones *et al.*, 2021). In the Caribbean, a critical reason that wastewater reuse is gaining momentum is because there is an increasing demand for potable water across different sectors such as tourism and overall domestic needs. In Barbados, recycled water is mainly used for landscaping purposes in the tourism industry (Peters, 2015). Conversely, in Antigua and Barbuda wastewater is reused for irrigation which is similar to the application in Jamaica, and St. Kitts and Nevis where water is reused for golf courses (Peters, 2015). The Government of Grenada recognized the potential for integrated water resources management on the island in their roadmap developed in 2007 but reuse practices were limited to the household at the time of the study (Peters 2015). Similarly, wastewater reuse in St. Vincent is limited to domestic reuse for applications such as backyard gardening. On the other hand, 39% of the resorts in the Grenadines, according to George *et al.* (2007), used treated wastewater similar to Anguilla where all hotels practice some applications of wastewater reuse in the absence of municipal wastewater reuse. Overall, Antigua and Barbuda and St. Vincent have the highest percentage of municipal wastewater being reused however in both cases it is still below 10% (Peters, 2015). Janson *et al.* (2021) noted that for many Caribbean islands precise figures on treated wastewater is not available. There have been significant efforts around the region however, particularly in Trinidad and Tobago and Jamaica to increase the coverage of existing centralized wastewater treatment plants as well as efforts to establish new facilities.

Although wastewater reuse is not prevalent in Trinidad and Tobago, several broad policies relevant to wastewater reuse exist in the country. Vision 2030: The National Development Strategy of Trinidad and Tobago 2016–2030 includes the implementation of water pollution and wastewater management programmes and regulations as a strategic initiative in achieving the country's environmental goals (GoRTT, 2016). Priority 2 of the National Environment Policy (GoRTT, 2018) also aims to 'encourage water conservation through recycling and wastewater reuse…'. Of added importance is that the Environmental Management Act, Chapter 35:05 (GoRTT, 2001), legislates achieving and maintaining the goals of the NEP 2018 (GoRTT, 2001). The Water Pollution Rules (GoRTT, 2019) also require standards to be met in order to discharge effluent into various aquatic environments. More specifically, in 2022, the Government of Trinidad and Tobago approved the National Integrated Water Resource Management Policy, which states that the Government will 'promote the actual provision of water and wastewater services with the participation of communities and the private sector', wherever practicable (GoRTT, 2022).

Despite this, the legislative and policy framework for Trinidad and Tobago does not speak explicitly to the use of wastewater for various applications, such as agriculture. Hence, the Trinidad and Tobago Bureau of Standards (TTBS) in collaboration with the Ministry of Public Utilities (MPU) and a group of stakeholders from various governmental and non-governmental organizations, created a standard for wastewater reuse in 2022, entitled 'Wastewater Reuse – Agricultural and Other Applications' (TTS 664:2022). This endeavour was a component of the Global Environment Facility (GEF) Caribbean Regional Fund for Wastewater Management (CReW+) project, 'An Integrated Approach to Water and Wastewater Management Using Innovative Solutions and Promoting Financing Mechanisms in the Wider Caribbean Region.' Therefore, treated wastewater (from domestic sources) that complies with TTS 664:2022 is safe for the purposes listed in the standard, such as irrigation of different types of crops (including those intended for raw consumption), irrigation of green spaces, and washing of animal enclosures (TTBS, 2022).

The reuse of wastewater for agricultural purposes is not foreign to the agricultural stakeholders of Trinidad and Tobago, mainly in the districts of Caroni and Maloney, where unregulated wastewater reuse in agriculture occurs (Warrick & Ekwue, 2014). This unregulated use, which may be unintentional, occurs due to the discharge of treated effluent from wastewater treatment plants into rivers. There are about 250 wastewater facilities in Trinidad and Tobago (T&T), according to the Wastewater Condition Assessment Report by GENIVAR (2007). About 30% of the population is connected to sewerage systems, while the remaining 70% of the population is served by septic tanks and pit latrines. The Water and Sewerage Authority (WASA) provides direct service to about two-thirds of the sewered population. According to the report, 70% of the current facilities are small-scale wastewater treatment facilities that are poorly maintained, have reached the end of their useful lives, or have been abandoned by private developers, causing the discharge of poorly treated sewage into the environment.

Public perception for pro-environmental initiatives such as wastewater reuse is critical for successful implementation. Peters & Goberdhan (2016) found through a survey that although the public in Trinidad was not comfortable with direct reuse of wastewater, most persons accepted the use of wastewater for non-potable purposes like irrigation of public lawns. The study indicated that the perceptions of wastewater were influenced by public mistrust of the local water authority, lack of knowledge of the treatment process; and perceived health risks associated with using treated wastewater. Conversely, Martin & Alexander (2014) found that support for wastewater reuse varied significantly when overlaid with various factors, including age, gender, education, income, and area of residence. This research paper examines the Knowledge, Attitudes, and Practices (KAP) as well as Willingness to Pay (WTP) and Barriers to Reuse of treated wastewater in Trinidad and Tobago.

METHODOLOGY

Data collection

Qualitative and quantitative data were collected from 145 respondents across Trinidad and Tobago via convenience sampling. Specifically, aKAP survey was deployed in July 2022 to gather stakeholders' understanding about treated wastewater, their attitudes towards its reuse and current practices. The target audience for the survey was stakeholders who would be able to utilize or contribute to the utilization of treated wastewater in the ways outlined by the standard. This therefore included technocrats/academics in the wastewater field, landscapers, hotel owners/recreational facility personnel, and farmers. The questionnaire was drafted by the MPU and then revised using feedback from the WASA, the University of West Indies (UWI), Trinidad and TTBS and other relevant stakeholders, including farmers. A pilot survey was launched within the MPU on July 14, 2022, and feedback was used to finalize the questionnaire. The final questionnaire consisted of 22 questions in total, split into four sections; demographics, KAP. The questions in the knowledge and attitudes section targeted all respondents, while those in the practices section were directed primarily towards farmers and other agricultural entrepreneurs or home gardeners.

The finalized questionnaire was disseminated online via Google Forms from July 21, 2022 to August 21, 2022, and physically at the Caribbean Community's (CARICOM's) Second Agri Investment Forum and Expo on August 19–21, 2022. Physical distribution was facilitated by the Agricultural Society of Trinidad and Tobago (ASTT). To improve accessibility to persons who could not read, the questions were read aloud while administering the survey.

Data analysis

The data gathered from the survey were subjected to both descriptive and inferential statistical assessment in the Statistical Package for Social Sciences (SPSS v19). Data were collated based on demographic attributes (age, gender, region (North, Central, South and Tobago)), KAP, WAP, and Barriers to Wastewater Reuse. All multiple response questions were disaggregated and then combined using the define variables function in SPSS. All data were coded dichotomously to allow for quantitative statistical analysis. KAP questions were combined, totalled, and categorized into poor and good (Table 1). Cross-tabulation, χ^2, and ANOVA were conducted using knowledge categories, attitude categories and practices categories against all demographic data to identify any existing relationships.

RESULTS AND DISCUSSION

Demographics

The age category with the highest number of the respondents was 27–40 years old (36.6%), followed by 41–55 years old (29.7%) (Figure 1). The 56–70 age category contained one-fifth of the respondents while 2.8% were 71 years or older. Eleven percent of respondents were in the 18–26 years old category (Figure 1). While different age categories were compared to a previous local study by Peters & Goberdhan (2016), the distribution remained generally similar. The distribution of these categories reflects the national age distribution (CIA, 2023). It may be attributed to the professions represented which were predominantly technocrats/public servants.

Table 1 | Summary of the survey.

KAP	# of question	Score range	Category and score
Knowledge	5 (multiple response)	21–42	Poor: 21–28 Good: 29–42
Attitudes	2 (multiple response)	8–17	Poor: 8–13 Good: 14–17
Practices	2 (multiple response)	3–8	Poor: 3–5 Good: 6–8

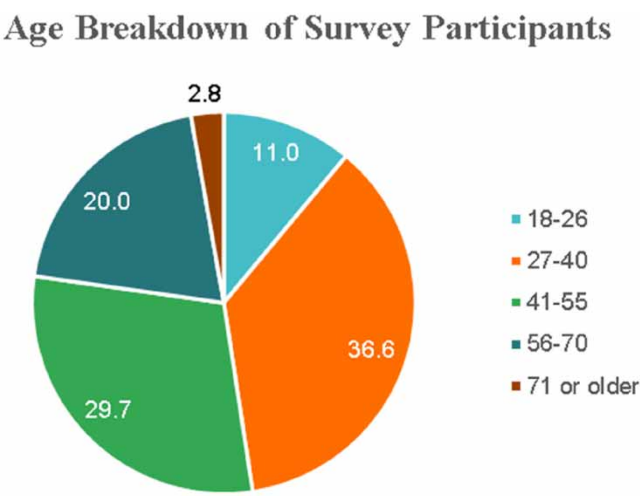


Fig. 1 | Age distribution of respondents (%).

While male participants constituted 85.29% of private agricultural holders in the agriculture census of 2004 (CSO, 2004), they accounted for the 54.5% of responses while 44.1% were female. Participants who did not reveal their gender comprised 1.4% of the respondents (Figure 2). Greater gender parity was attained in this study compared to the previous local study by Peters & Goberdhan (2016).

Respondents with tertiary education comprised 82.8% of the participants while 17.2% had secondary education. These results differed from the agriculture census of 2004 which reflected that the highest level of education of 27.90% of private agricultural holders was secondary and that of 2.09% was tertiary. Education among the participants reflected similarity to the sample surveyed by Peters & Goberdhan (2016).

Consistent with the agriculture census of 2004 which indicated that 94.9% of private agricultural holders were from Trinidad, the majority (84.8%) of respondents in the sample population were also located in Trinidad. Participants from northern areas of Trinidad accounted for 42.1% of respondents while 28.3% were from the central areas. Respondents from southern areas of Trinidad comprised 15.2% of the participants while 14.5% of respondents were from Tobago (Table 2). Virjee & Gaskin (2010) sampled a larger survey population and found that the respondents who relied on public water supply were distributed in these regions. This classification presents a clearer representation of the national distribution of the sample population than previous local studies which used delineations that do not engender immediate universal spatial understanding (Martin & Alexander, 2014). The Environmental Management Authority (1998) documented the largest surface storage in the northwest. The CIA (2023) noted that 53.4% of the population lives in urban areas. The capital city, located in the northwest, is home to 38.7% of the population.

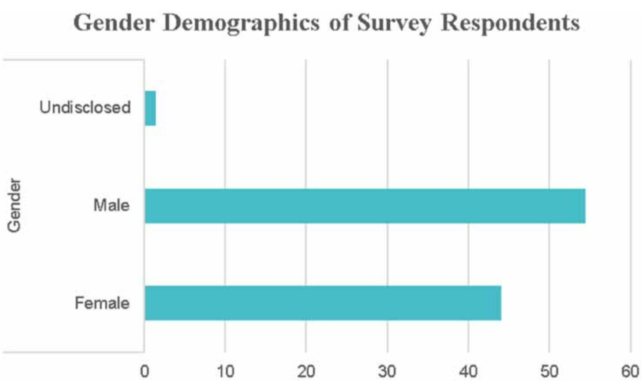


Fig. 2 | Gender distribution of respondents (%).

Table 2 | Geographic distribution of respondents.

Region	Frequency	Percentage (%)
Central	41	28.3
North	61	42.1
South	22	15.2
Tobago	21	14.5

Participants engaged in arable farming comprised 60.7% of respondents while 13.1% raised livestock or practiced other forms of agriculture, which included mixed agriculture, apiculture, ornamentals, and more. Respondents who were engaged in hydroponics or aquaculture comprised respectively 9.3 and 3.7% of participants (Figure 3). This distribution allowed a choice of focus to determine suitability for wastewater reuse. It also presents gaps where innovation can be achieved. Wastewater reuse in the agricultural sector possesses economic benefits which can improve the livelihood of farmers. Jiménez *et al.* (2011) reported a doubling of revenue with wastewater reuse in the sector. Michetti *et al.* (2019) warned that dissonance between demand and supply affects expenditure and market stability. Moreover, spatial requirements for the facilities may be beyond the capacity of small islands (Bunting & Edwards, 2018). Prazeres *et al.* (2017) proposed hydroponics can mitigate the adverse consequences of wastewater reuse in agriculture. Lallo *et al.* (2017) noted that nutrition in pastoral agriculture in the region depended on water availability.

Knowledge, attitudes, and practices

The responses indicated that 59.3% of the respondents had good knowledge of wastewater while 40.7% of responses reflected low knowledge (Figure 4). These findings tend to favour acceptance of wastewater reuse as reported in previous studies (Pham *et al.*, 2011). Attitude towards wastewater reuse was favourable among 16.8% of respondents but unfavourable among 83.2% of participants. Public support for wastewater reuse is indispensable to policy implementation apart from expert consensus (Michetti *et al.*, 2019). Contrary to Pham *et al.* (2011), attitude towards wastewater reuse was inversely related to the knowledge depicted by participants. This finding suggests that the factors that engender hesitation against wastewater reuse are more dominant (Po *et al.*, 2003). Practices in wastewater reuse were favourable among 8.5% of respondents but unfavourable among 91.5% (Figure 4). These findings may suggest that valuation of water may be low and a challenge to reformation in water management. The findings may also represent an opportunity for increased reuse with the development of an enabling environment. Michetti *et al.* (2019) proposed the facilitated adoption of alternatives to enhance positive perception.

Willingness to use treated wastewater existed among 84.1% of respondents. There was refusal among 4% while 11.9% remained unsure if they would be willing to use treated wastewater (Table 3). These findings support the influence of education identified by Tsagarakis & Georgantzis (2003). These results contrast to Massoud *et al.* (2018) which had a similar age demographic but a larger sample size and a gender disparity favouring women.

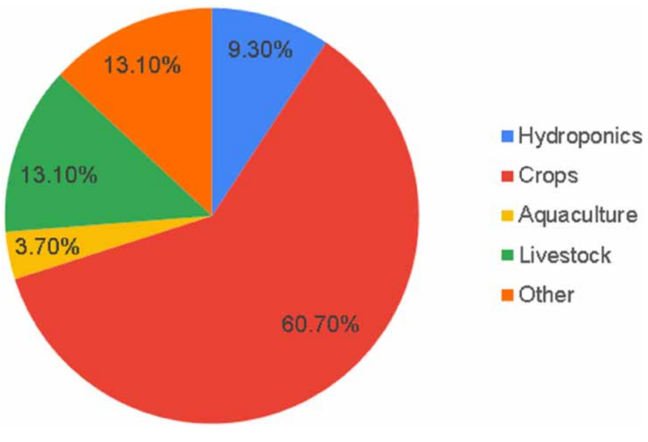


Fig. 3 | Agricultural practices among survey respondents.

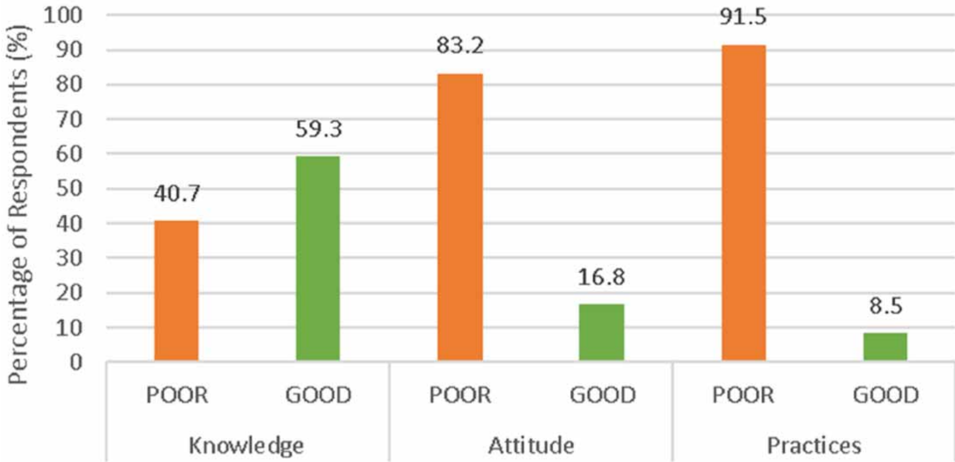


Fig. 4 | Ratings of Knowledge, Attitudes, and Practices of respondents (%).

Table 3 | Willingness to use treated wastewater among respondents.

Willingness to use treated wastewater	Frequency	Percent
No	4	4.0
Not sure	12	11.9
Yes	85	84.1

Health concerns figured as a barrier to wastewater reuse among 32.8% of participants (Figure 5). This is prominent among perspectives of wastewater reuse as also identified by Peters & Goberdhan (2016). Colour and odour posed a barrier to 19.5% of respondents. These findings indicate a lack of awareness of the wastewater treatment process (Naidoo & Olaniran, 2014). Conversely, access was a barrier among 19.9% of respondents while lack of knowledge was flagged among 15.6% of respondents. These findings suggest potential for change through knowledge awareness campaigns. While the survey respondents in Akpan *et al.* (2020) showed poor knowledge of wastewater reuse, they valued support from health personnel and academics.

Religion was a deciding factor for 2.3% of participants while 7% indicated that they would not reuse wastewater because of their personal preference (Figure 5). These responses represent controlled factors that do not appear to pose a significant challenge to policy development. Chfadi *et al.* (2021) also found that religion was not a dominant influence on willingness to reuse wastewater. However, the opposite was supported by the findings of Massoud *et al.* (2018). This suggests a need for communal considerations in the national context which may pose a challenge to the capacity of Trinidad and Tobago as a small island nation. It further indicates a particular factor around which public awareness and education campaigns should include. Emphasis should be placed on strategies that build favourable receipt of this information. Other reasons posed a barrier for 3% of respondents. These responses accord with previous findings that support a hypothesis on trends of public perception towards wastewater reuse (Kelly & Morar, 2014).

Participants who indicated that they were willing to pay 25–50% less than the cost of conventional water accounted for 31.2% of responses while 27.3% indicated that they would pay the same (Figure 6). Participants

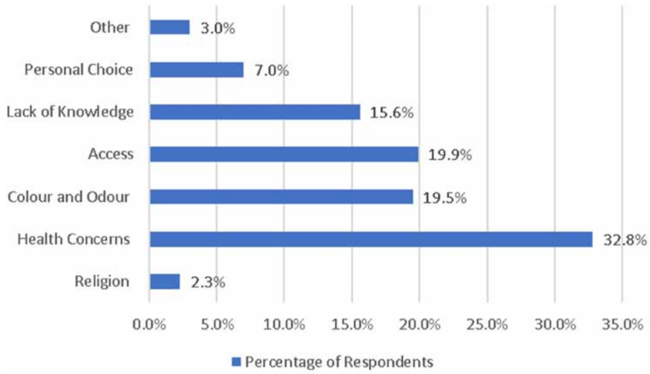


Fig. 5 | Barriers to using wastewater among survey respondents.

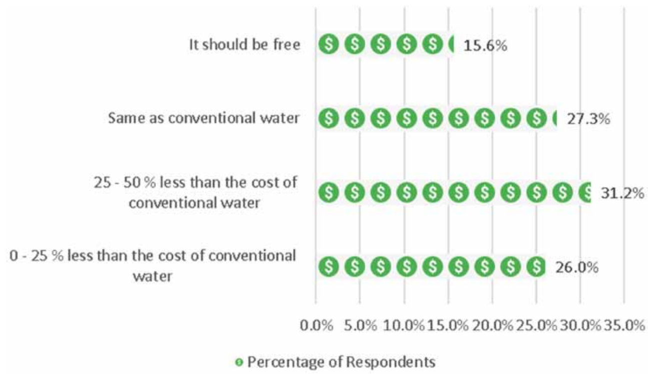


Fig. 6 | Willingness of survey respondents to pay various prices for treated wastewater.

who indicated that they were willing to pay up to 25% less than the cost of conventional water accounted for 26% of respondents. Participants who believed treated wastewater should be available at no cost accounted for 15.6% of the respondents. Similar to Massoud *et al.* (2018), willingness to pay understandably followed the tendency of willingness to use. Bakopoulou *et al.* (2010) found that more participants among a smaller surveyed population of farmers in an agricultural region of Greece supported halving the cost when the need for a supplemental water source arose.

Results of the χ^2 and ANOVA revealed no statistically significant ($P > 0.05$) relationships between frequency and means for KAP, WAP and Barriers to Wastewater Reuse against demographic factors (Table 4). This is consistent with the findings of previous studies (Miller & Buys, 2008). In contrast, Msaki *et al.* (2022) suggested the need for public education to facilitate implementation of wastewater reuse following findings of demographic influence in perceptions. It can be argued that a lack of significance may indicate the absence of bias, but it flags a need to further investigate the reasoning behind the responses. This study built on the previous local study by Peters & Goberdhan (2016) by investigating additional factors and highlighting a need for strategic engagement and education campaigns.

Table 4 | Results of the χ^2 tests.

	χ^2 tests	Value	df	Asymptotic significance (twosided)
Attitudes	Age	29.111	24	0.216
	Gender	5.384	6	0.496
	Education	6.732	6	0.346
	Polling division	20.129	18	0.326
Practices	Age	25.889	16	0.056
	Gender	4.923	8	0.766
	Education	2.304	4	0.680
	Polling division	18.998	12	0.089
Knowledge	Age	52.146	52	0.468
	Gender	21.497	26	0.716
	Education	9.300	13	0.750
	Polling division	36.759	39	0.573

CONCLUSION

Concerns regarding wastewater reuse primarily revolve around the potential for inadequate treatment processes and the presence of contaminants. Once the necessary measures are effectively employed to ensure there are no impacts on human health, the use of treated wastewater can serve as an effective means of supplementing supply primarily for non-potable use but also with some potential potable use. While traditional remediation methods are expensive there are emerging technologies that are less labour intensive and costly that could be adopted across the region. Some countries, like Trinidad and Tobago have made significant investments in wastewater treatment plants, and therefore it would be prudent to extend the efforts to facilitate recovery and reuse through planned investment in treatment upgrades. There are clearly opportunities for beneficial reuse and the potential to supplement existing supplies.

The findings of this paper demonstrate the need for increased public awareness and capacity building as it relates to WWRU in Trinidad and Tobago as it can serve as effective means of supplementing supply for non-domestic uses. It also identified the major barriers to WWRU and therefore facilitates the development of targeted interventions. To promote the necessary culture change with respect to WWRU, capacity building and awareness raising strategies can be incorporated into and linked with existing water conservation campaigns. Given the potential for increased water scarcity associated with climate change and variability, it is crucial that Caribbean SIDS seek to identify and integrate alternative sources of water. Generally, there is a need to shift attitudes, perceptions and practices as the country attempts to incorporate WWRU as a national resource option. Considering the barriers identified and the willingness to pay and willingness to use, a strategic approach that considers mechanisms to address barriers, particularly health concerns and access to appropriately priced treated wastewater, can lead to increasing uptake on a national scale. This study can inform actions across the region and serve as a baseline to guide demonstration pilots which can determine implementation feasibility.

Limitations and recommendations for further research

One key limitation of this study was the sample size. However, spatial coverage across both islands was achieved and the target was mainly persons who had interest in utilizing treated wastewater for agricultural and landscaping purposes. Responses were also voluntary and subject to self-report and recall bias. A similar study soliciting respondents from the general population may prove useful to gain an understanding from the complete spectrum of water users. Demonstration pilots furnished with monitoring assessment components are also recommended. Quantitative studies that outline precise demand and supply information on a sectoral basis would also be useful to inform the extent to which treated wastewater can supplement traditional supply.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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