Knowledge–Behavior Gap in Tap Water Consumption in Puerto Rico: Implications for Water Utilities

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Abstract: The impacts of climate-related hazards are becoming a major concern for many people worldwide, especially those in vulnerable areas such as Puerto Rico. In September 2017, Hurricane Maria caused severe disruption to the island's drinking water supply due to power outages, causing major problems for utility companies. This led to water insecurity, particularly among residents, who could not access safe, reliable, adequate, and affordable drinking water. Disaster-related water insecurity challenges are coupled with widespread public mistrust of tap water, yet some residents still consume tap water despite the mistrust. Alternatively, a portion of those who trust the tap water quality choose not to consume it. This knowledge–behavior gap needs to be explored to understand tap water consumption behaviors in the context of mistrust and insecurity. This study's main goal was to identify why residents mistrusted their tap water and their behaviors in response to or despite mistrust. Data collection included household surveys and interviews with residents ($n = 154$) from May 2022 to July 2022. Thematic qualitative analysis shows residents generally mistrust tap water because of its poor quality over the past decade based on its palatability properties (taste, color, and smell). In addition, people trust or mistrust tap water because of their lived personal positive or negative experiences with the water utility service in Puerto Rico. This study can be used to develop strategies to address water insecurity and understand public trust in the tap water supply provided by water utilities. Ultimately, this research emphasizes the need for more studies to explore the knowledge–behavior gap in order to understand why some people consume tap water despite the mistrust and vice versa.
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Introduction

Climate-related hazards are an increasingly common experience for people around the world, especially in vulnerable areas. The effects of climate-related hazards have been a focal point of international research, particularly their impact on public utilities and health. The issue of safe and reliable water supplies is becoming increasingly critical, given these extreme climate events. Puerto Rico and its water utility have historically faced tremendous challenges in providing potable water to its citizens (Jain et al. 2014). In September 2017, Puerto Rico was hit by Hurricane Maria, a devastating storm that caused widespread damage to the water infrastructure and made it difficult to access safe and clean drinking water from the water utility, the Puerto Rico Aqueduct and Sewer Authority (PRASA), which serves approximately 97% of the island's population (Ghosh et al. 2021; Keenum et al. 2021; Miller et al. 2019). The rivers that serve as the primary drinking water sources were polluted by debris from the hurricane, threatening the quality of tap water provided to consumers (Cortés 2018; Lloréns and Stanchich 2019). The damage to the water infrastructure and piping systems resulted in water service disruptions for close to 5 months in the aftermath of Hurricane Maria (Yabe et al. 2021). Repair works on water infrastructure after Hurricane Maria have been stalled, delayed, or abandoned due to the government's slow and inadequate early responses, logistical stumbles (e.g., the delayed opening of ports), slow delivery of supplies to municipalities, and other response factors (Roque et al. 2021). Most of the electrical infrastructure that provides power for the water distribution systems was affected, giving rise to a prolonged

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posthurricane recovery (Brown et al. 2018; Kwasinski et al. 2019; Lin et al. 2020; Subramanian et al. 2018). About 44% of Puerto Rico's inhabitants lost access to safe drinking water in the aftermath of the hurricane (Ghosh et al. 2021).

On the other hand, an estimated 40,000 Puerto Ricans faced water contamination in 2015, 2 years before Hurricane Maria (Keenum et al. 2021; Lin et al. 2020). A significant portion of PRASA-connected small communities in Puerto Rico exceeded the total fecal coliform limits set by the Safe Drinking Water Act and are still struggling to date (Fischbach et al. 2020). Although some PRASA water plants did not have efficient disinfection capability before Hurricane Maria, the situation has been exacerbated in the aftermath of the disaster, with fecal contamination on the rise, because the local population has primary and secondary contact with water bodies and may still use them as a source of untreated drinking water (Sánchez-Colón et al. 2022).

Challenges to public health and water safety concerns in Puerto Rico were documented before Hurricane Maria. For instance, a high incidence of *Salmonella* sp. in the water systems in Puerto Rico was recorded 7 years prior to Hurricane Maria (Hunter et al. 2010). However, these issues have become more prominent in the hurricane's aftermath. The uncertain quality of tap water supplied by PRASA has caused concerns about the potential health risks for residents in Puerto Rico (Jain et al. 2014). These health problems are attributed to many water system challenges, including climate change, contamination, and damaged infrastructure (Hunter et al. 2010; Keenum et al. 2021; Lin et al. 2020). Furthermore, during the water shortage periods in the aftermath of Hurricane Maria, Puerto Rico recorded many health complications, such as leptospirosis alongside diarrhea, pink eye, and skin rashes (Lin et al. 2020; Michaud and Kates 2017). However, despite the concerning reports about the state of water systems in Puerto Rico, the exact reasons for the public's mistrust of tap water from PRASA remain unclear (Preston et al. 2020).

In understanding the public mistrust and consumption behaviors of tap water in Puerto Rico, it is also crucial to shed light on the actual quality of the tap water. Generally, the US Environmental Protection Agency (EPA) regulates public water systems and sets legally enforceable standards on the maximum levels of certain contaminants in drinking water (CDC 2022; USEPA 2015b). PRASA, as a public water utility, is required to comply with these standards. However, compliance and actual safety can vary due to different factors, including the aftermath of a natural disaster like Hurricane Maria.

Following Hurricane Maria, PRASA and other stakeholders have made significant efforts to restore and improve the water system (Delilah Roque et al. 2020; Preston et al. 2020). In ideal conditions, when the water infrastructure is functioning properly, the water treated and supplied by PRASA should meet EPA's Safe Drinking Water Act standards. However, infrastructural damage, contamination risks, and delays in restoration efforts postdisaster may compromise the water quality temporarily, leading to advisories for citizens to boil water before use or rely on bottled water.

This study attempts to address these gaps by asking, "What are the tap water consumption behaviors in Puerto Rico?" We also ask, "Why do residents mistrust tap water in Puerto Rico despite recovery efforts after Hurricane Maria?" (Jain et al. 2014; Yu et al. 2015). Beyond the specific context of Puerto Rico, the issues explored in this study are applicable to other regions worldwide facing similar climate-related hazards and their impact on water utilities and public health. By using this new theoretical lens, we hope to contribute fresh insights to the water-sector literature and provide practical recommendations for water utilities dealing with similar challenges.

To contribute to the knowledge of public mistrust of tap water, we used mixed research methods to study residents' tap water consumption trends and their perceptions of tap water and their lives after Hurricane Maria. We conducted household surveys ($n = 154$) and interviews with residents ($n = 154$) from May 2022 to July 2022 in Loíza, Comerío, and Aguas Buenas. The interviews ascertained their experiences, thoughts, and suggestions on the water quality in Loíza, Comerío, and Aguas Buenas after Hurricane Maria.

Literature Review

Public Mistrust of Drinking Water

Public mistrust is sometimes treated as synonymous with distrust or misplaced trust (Breakwell 2020) and refers to the uncertainty about whether trust should be offered. Public mistrust, in this paper, refers to a lack of confidence and belief in the safety and quality of the water provided by public water utilities such as PRASA. Without trust or belief in a system, every effort made by water utilities to provide potable water that end users will consume would prove futile. Public mistrust affects social behavior by creating a sense of risk; however, there may not be conclusive evidence of the effects of these risks (Breakwell 2020; Calman 2002). Literature shows examples of promising water interventions that proved ineffective because there was public mistrust of project engineers from water utilities (Borland 2014; Harvey and Reed 2006). Some studies have found a direct correlation between the mistrust of tap water providers or bottled water companies and the public consumption rates from these sources (Doria 2006). A separate study also found that university students who trusted their local water utility to deliver safe drinking water were likelier to drink from tap water sources. In contrast, those who mistrusted their government and university were more likely to drink bottled water (Grupper et al. 2021; Saylor et al. 2011).

The sources of public mistrust of tap water include individual and household indicators of socioeconomic status such as education level, household income, and racial or ethnic minority status (Pierce et al. 2019; Pierce and Gonzalez 2017). However, regardless of individual and household indicators of socioeconomic status, people are more likely to mistrust their tap water when it is unpalatable than when it is unsafe (Pierce and Lai 2019; Spackman and Burlingame 2018). The palatability of tap water is measured by its aesthetic characteristics, such as color, odor, and taste. A slight change in the color, odor, or taste of drinking water may raise suspicion (Young et al. 1996). In the United States, water quality is governed by primary and secondary regulations (CDC 2022). Primary regulations limit contaminants that may impact human health (USEPA 2015b), while secondary regulations guide parameters associated with aesthetic qualities such as taste, color, and odor (USEPA 2015a). Traditionally, it is expected that adequately treated water should not only meet primary standards for health safety but also align with secondary standards, thereby presenting little to no color, taste, or unpleasant odor (Kearns et al. 2015). However, even when health-based standards are met, aesthetic issues can still arise because secondary standards may not be regulated or enforced. These aesthetic qualities can significantly influence public perception and trust in water utilities, even when the water is safe to consume from a health standpoint. The palatability ratings drive alternative drinking consumption, particularly bottled water consumption preferences over tap water (Huerta-Saenz et al. 2012). These palatability perceptions are important in distinguishing between tap and household filtered water drinkers,

even when respondents have similar perceptions about unfiltered tap water safety, contamination, and health risks (Triplett et al. 2019). While literature assesses some sources of public mistrust for drinking water, there is a gap in why Puerto Ricans may express mistrust in tap water, especially after the post-Hurricane Maria recovery process. Puerto Rico's vulnerability to climatic events such as Hurricane Maria, which damaged its water infrastructure managed by PRASA, coupled with the socioeconomic vulnerabilities of residents who rely heavily on tap water from PRASA, makes it essential to study why there is public mistrust of tap water in Puerto Rico.

Knowledge–Behavior Gap

Puerto Rico tends to perform worse in providing safe drinking water than the mainland United States due to a combination of a lack of investment in infrastructure, maintenance, testing, and the effects of natural disasters (Hunter et al. 2010; Karim et al. 2020; Keenum et al. 2021). Hurricanes and tropical storms have made it difficult to ensure water quality meets USEPA standards on the island (Ferré et al. 2019; Kaufman 2019; Keenum et al. 2021; Sánchez-Colón et al. 2022). In 2021, of the 78 municipalities in Puerto Rico, 17 were considered severe violators of the Safe Drinking Water Act by the USEPA. On the other hand, 400 out of the 456 drinking water utilities in Puerto Rico have had some violations within the last 3 years (Mueller and Gasteyer 2021). It is not uncommon to find tap water with high levels of fecal coliform contamination (Holman et al. 2014) and heavy metals (Apeti et al. 2012; Ortiz-Colón et al. 2016) in conjunction with unappealing palatability characteristics such as foul odor and color (Gonzalez 2002; Jain et al. 2014). While the water quality in some municipalities may be better than others, the available studies demonstrate that water quality in many municipalities is not up to USEPA standards. Researchers have linked poor water quality to severe health implications for residents. Water-related diseases such as diarrhea have increased because of the poor water quality on the island (Ferré et al. 2019; Ghosh et al. 2021; Hunter et al. 2010). While there is extensive knowledge among scientists about the poor piped water conditions supplied by PRASA, it is unclear to what extent the population of Puerto Rico is aware of the health implications of the poor water quality. Moreover, although a survey has not been done to measure the population's awareness, it is possible to infer that people may be aware but choose to consume tap water regardless of the potential health risks, because more than half the population on the island has used tap water as a drinking water source as of 2017 (Lin et al. 2020; Michaud and Kates 2017).

In the literature on mistrust in the water sector, the predominant theory has often focused on the concept of trust and its erosion (Grupper et al. 2021; Pierce et al. 2019; Pierce and Gonzalez 2017). Trust has been considered a vital element in public perceptions and behaviors related to tap water consumption (Grupper et al. 2021). Previous studies have explored the factors contributing to the breakdown of trust, such as water contamination incidents, challenges with water infrastructure, and perceived inadequacies in water management practices (Grupper et al. 2021; Pierce et al. 2019; Pierce and Gonzalez 2017).

Trust, conceptually speaking, can be understood as the belief or confidence that a person or entity is dependable and will act in a manner that aligns with expectations (Blomqvist 1997; Gedge and Abell 2020; Pierce and Gonzalez 2017). It involves a willingness to be vulnerable and place faith in something or someone. However, trust may not always lead to the expected behaviors, as demonstrated by the example of people trusting tap water but not consuming it. While trust theories have been valuable in shedding light on tap water mistrust, they have not fully addressed the knowledge–behavior gap. This gap refers to the disparity between what individuals know about water safety and their actual behaviors regarding tap water consumption. The disconnect between awareness and behavior implies that trust theories have primarily focused on exploring the psychological and social factors influencing trust in tap water (Grupper et al. 2021; Pierce and Gonzalez 2017). While these factors are essential in shaping people's attitudes, they might not be the sole determinants of whether individuals actually act on that trust (de França Doria 2010). By highlighting the knowledge–behavior gap, our study seeks to bridge this theoretical limitation.

The knowledge–behavior gap theory, on the other hand, is a concept in the field of public health that posits that individuals may have knowledge about healthy behaviors, such as the importance of regular exercise or eating a balanced diet, but they may not engage in those behaviors (Ajzen 1991; Michie et al. 2011; Sligo and Jameson 2000). The literature on this theory has been growing in recent years, with many studies focusing on identifying the factors contributing to the gap between knowledge and behavior. Some of the key factors that have been identified include social and environmental factors, such as access to healthy food options or safe places to exercise, and individual factors, such as lack of self-efficacy (confidence in one's ability to carry out a behavior) or time constraints (Jones et al. 2009; Sligo and Jameson 2000). Additionally, the knowledge–gap behavior may be fueled by health beliefs, such as perceived susceptibility to a particular health problem; health literacy, including the understanding of health information and ability to use it in decision-making; and psychological factors, such as lack of motivation or habit formation (Jones et al. 2009; Sligo and Jameson 2000).

In this study, our primary objective was to investigate the factors contributing to the mistrust of tap water among residents in Puerto Rico, as well as to examine their behaviors in response to or despite this mistrust. The context of Puerto Rico after Hurricane Maria presents a compelling backdrop for exploring the knowledge–behavior gap phenomenon. The island has experienced previous incidents of water contamination and challenges with water infrastructure (Ghosh et al. 2021; Michaud and Kates 2017; Preston et al. 2020), which may have eroded trust in the safety and quality of tap water. Considering the existing literature on climate hazards and water management, there remains a critical gap in comprehending public mistrust of tap water, particularly in the aftermath of a disaster. Our study seeks to address this gap by specifically focusing on the post-Hurricane Maria context in Puerto Rico, where the devastation severely impacted the island's water infrastructure (Marcos 2022). We employ the theory of the knowledge–behavior gap within the water management sector context.

The theory of the knowledge–behavior gap, often utilized in health behavior research, explores the disconnect between individuals' knowledge and their actual behaviors. By integrating the knowledge–behavior gap theory with trust/mistrust perspectives in the context of tap water mistrust in Puerto Rico, our research aims to provide a more comprehensive understanding of the factors influencing attitudes and behaviors. This approach recognizes the importance of trust in shaping perceptions and actions, while also considering the role of knowledge and behavior alignment in the postdisaster setting. By exploring the reasons behind the persistence of tap water mistrust in Puerto Rican residents, despite efforts to restore water quality after hurricane Maria, we aim to shed light on the unique experiences, perceptions, and challenges faced by the population in relation to their attitudes and behaviors toward tap water. This knowledge can inform targeted interventions and strategies that address both trust dynamics and the knowledge–behavior

gap, ultimately promoting healthier water consumption practices in Puerto Rico.

Furthermore, our research contributes to the broader field of interdisciplinary research. By examining tap water mistrust from various perspectives, including public health, sociology, psychology, environmental science, and engineering, we embrace an interdisciplinary approach. This collaboration allows us to gain a comprehensive understanding of the multifaceted factors influencing tap water mistrust and the knowledge–behavior gap. By integrating insights from different disciplines, we develop more holistic and effective strategies to address tap water mistrust and promote behavior change. This contribution highlights the importance of interdisciplinary research in tackling complex issues related to water mistrust and emphasizes the need for collaboration across diverse fields to achieve meaningful and impactful outcomes.

Our study contributes to the broader literature on mistrust in the water sector by providing a comprehensive understanding of the intricate relationship between perceived knowledge and behavior, particularly within the context of tap water consumption. We aim to address the limitations of existing trust theories by shedding light on these interconnected factors and their implications. First, our research focuses on understanding the knowledge–behavior gap related to tap water consumption behaviors. By investigating this gap, we offer insights into the reasons for mistrust in tap water and how this mistrust impacts actual behaviors. We explore whether trust in tap water sources consistently translates into tangible actions, such as consumption, or whether there are other factors that hinder this translation. Second, our research focuses on residents in Puerto Rico, who represent a vulnerable population heavily reliant on public utilities, especially in the aftermath of disasters like Hurricane Maria. By studying this specific context, we gain valuable insights into the unique challenges faced by this population and their responses to tap water mistrust. This knowledge is crucial for developing targeted interventions and strategies to address the issues surrounding mistrust in tap water, particularly in vulnerable communities.

We applied mixed research methods to explore the tap water consumption behaviors and perceptions among residents of three municipalities in Puerto Rico. By combining surveys and interviews, we aimed to capture a comprehensive understanding of the residents' experiences and views. In sum, our study contributes to a more nuanced understanding of public mistrust in tap water, addressing a critical gap in the water sector literature. The insights gained from our study have the potential to inform policy and practice, improving water security for communities grappling with climate-related hazards and aging infrastructure.

Methods

This study follows mixed–methods research to address the literature gap by reporting on water consumption behaviors in Loíza, Comerío, and Aguas Buenas, Puerto Rico. Surveys and semistructured interviews ($n = 154$) were conducted with respondents from households in all three communities from May to June 2022. A mixed-methods approach is crucial to comprehensively understand the knowledge–behavior gap in water consumption in Puerto Rico because it provides a deeper analysis while identifying trends and patterns in a large data set (Snelson 2016; Tashakkori et al. 2020). For example, the quantitative aspect can help establish the extent of the knowledge–behavior gap by measuring the discrepancy between what people *know* about tap drinking water and their actual water consumption behaviors by answering the quantitative questions; "What percentage of people consume tap water?" and "What percentage of residents in Puerto Rico mistrust tap water despite recovery efforts after Hurricane Maria?." This information helps in quantifying the size of the knowledge–behavior gap and understanding its pervasiveness across different communities or demographic groups. On the other hand, the qualitative aspect offers a deeper insight into the reasons behind the knowledge–behavior gap. Using qualitative research, we can answer *what* and *why* questions such as "What are the tap water consumption behaviors in Puerto Rico?" and "Why do residents mistrust tap water in Puerto Rico despite recovery efforts after Hurricane Maria?" Through methods like interviews or focus groups, individuals' perceptions, beliefs, and experiences regarding water consumption can be explored (Snelson 2016; Starr 2014). For instance, in the Puerto Rican context, qualitative data might reveal the impact of historical experiences, trust issues with PRASA, or cultural practices affecting water consumption behavior.

In essence, the mixed–methods approach offers the depth and breadth needed to tackle the complexities of the knowledge–behavior gap. By integrating both quantitative numerical data and qualitative narrative information, it provides a more comprehensive, balanced, and nuanced understanding of the problem, which is invaluable for developing effective solutions.

Study Area and Research Context

Our three study areas are Loíza, Comerío, and Aguas Buenas. Loíza is a densely populated, predominantly Black-Hispanic municipality about 39 km (24 mi) east of the capital city, San Juan. Comerío and Aguas Buenas are predominantly White-Hispanic municipalities about 44 km (27 mi) and 32.7 km (20 mi), respectively, south of San Juan. The three municipalities were chosen based on the considerable damage to the water infrastructure from Hurricane Maria. After Hurricane Maria, all three communities spent close to two months without access to safe drinking water. Furthermore, these communities still experience an unsteady supply of safe drinking water to their homes due to faulty piping infrastructure and frequent power outages (Laskow 2018; Marcos 2022).

Data Collection

We conducted the surveys and interviews simultaneously. To qualify for an interview and survey, participants had to have: (1) been 18 years old and above; and (2) experienced Hurricane Maria with flooding on their streets or property with a subsequent change in their drinking water quality. Both requirements were to ensure that residents had experienced how tap water quality was before Hurricane Maria. We went through a comprehensive process of explaining the informed consent form in the language the research participants were most comfortable with. Research participants were also provided a $25 gift card. One of four research assistants trained in research methods administered all surveys and interviews in Spanish and in person. The Institutional Review Board (IRB) of Iowa State University approved our project methods.

Surveys

To ensure that our survey adequately captured the demographics and water-use behaviors of the population, we employed proven techniques for survey dissemination and participant recruitment. Door-to-door and snowballing techniques have been shown to be effective in recruiting research participants, particularly in community-based studies (Perez et al. 2013). For our participant selection, we used a combination of quota and purposive sampling, methods that have been endorsed for their balance of statistical rigor and flexibility in field conditions (Emmel 2013; Tashakkori

et al. 2020). Quotas proportional to the respective population size in each barrio helped ensure that our sample was representative, while purposive sampling allowed us to focus on those at home and willing to participate. We combed through the neighborhoods in Loíza, Comerío, and Aguas Buenas, moving door-to-door to explain our research scope and inviting all who met our criteria to participate voluntarily in our surveys. This active engagement approach has been linked to higher response rates in survey studies (Dillman et al. 2014).

The surveys included 46 major questions and were completed in an average of 50 min. The surveys collected data on the demographics of the research participants, including age, gender, income, educational levels, years of residency, and race. In addition to demographics, the surveys were used to collect data on the types of drinking water sources (tap, filtered tap, well, stream, harvested rain, and bottled water) that residents used and whether or not they trusted these drinking water sources. The research assistants asked questions about the people's drinking water sources and whether or not they trusted these water sources. A total of 154 surveys were conducted. The full survey used for this study may be found in Appendixes S1 (English) and S2 (Spanish).

Interviews

We used a semistructured interview guide to collect in-depth insights from the research participants. This approach, characterized by its balance of predetermined questions and opportunities for open-ended responses, has been widely accepted as effective for exploring perceptions, attitudes, and behaviors in qualitative research (Starr 2014). By employing an audio recorder and note-taking, we ensured that participant responses were accurately captured, a recommended strategy for minimizing data loss and researcher bias during interviews (Breakwell et al. 2006; Ranney et al. 2015). The interviews typically lasted about 15–30 min per participant. Following each interview, participants were then asked to complete the survey, aligning with the *sequential explanatory design* of mixed-methods research that starts with qualitative data collection followed by quantitative data collection (McKim 2017). During the interviews, we asked specific questions to draw out tap water consumption behaviors by asking about drinking water perceptions, impacts of water contamination, and responses or adaptation measures to respond to the perceptions. To capture tap water consumption behaviors, we asked, *Do you drink water from a tap water source?* followed by, *If no, why do you not drink from the tap water source?*. Similarly, to capture perceptions about trust and mistrust, we then asked, *Do you trust water from the tap water source?* followed by, *If yes, why do you trust the water from the tap water source?* or *If no, why do you mistrust the water from the tap water source?* Finally, we asked, *If you mistrust the water from the tap water source, what do you do to make it feasible for drinking?* These questions helped us to understand the drinking water realities and the adaptation measures taken by residents in response to the mistrust situation in Loíza, Comerío, and Aguas Buenas. After our interviews and surveys had been conducted, we gave each participant a $25 gift card for the time taken and willingness to share, in some cases, personal and sensitive details about their experiences, thoughts, and comments with us. We conducted 154 interviews in total. All recordings were then transcribed following the IRB requirements of making the participants anonymous.

Qualitative Narrative Analysis

We adopted a narrative analysis approach to analyze the data collected from the interview transcripts (Bamberg 2012). This approach, known for its capability to locate narratives in context and extract meaningful insights from them, was apt considering the unstructured and open-ended nature of our interviews. Our unit of analysis was each individual participant's account regarding their water consumption behavior and their trust or mistrust in tap water. Following an inductive analysis approach, we allowed themes to emerge naturally from the data instead of relying on predetermined categories (Yilmaz 2013). We utilized a qualitative coding framework to categorize and group these emergent themes. The initial codes were developed based on patterns observed in the data and then refined iteratively throughout the analysis process. The central themes from the interviews were grouped based on whether or not people drink tap water. These two groups were further divided into those who trust tap water and those who mistrust tap water.

In our study, three individuals were involved in the coding and analysis process. The initial coding and translation of the interviews from Spanish to English were conducted by two of the authors. One of the authors, a professor in urban planning, is a native Puerto Rican. Additionally, a professor in civil engineering and their PhD student in civil engineering who collected the data in the field also participated in this phase. Regarding the coding process itself, we employed a mixed approach to coding, with PhD student coder utilizing NVivo, a qualitative data analysis software, while the other two professor coders opted for manual coding. The coding across the three coders allowed for a comparison between the two methods and added an additional layer of rigor to the coding process. The first coder who used NVivo leveraged the software's features to organize, code, and analyze the interview data. NVivo facilitated a systematic and efficient approach to coding, enabling the coder to assign codes, link-related segments, and visualize patterns and themes within the data set. On the other hand, the other coders chose to manually code the transcripts without using NVivo. This approach involved reading through the transcripts, identifying key concepts, and manually assigning codes to macro- and microcodes. The manual coding process required a closer and more intimate engagement with the data, as the coder familiarized themselves with the content and carefully selected appropriate codes based on their interpretation of the interview responses.

To assess the agreement between the coders, a systematic approach was adopted. In the initial meetings, the team members reviewed a subset of the coded data to compare their coding decisions and identify any discrepancies. Through this collaborative process, consensus was reached on the coding framework, and any discrepancies were discussed and resolved (O'Connor and Joffe 2020). The team continued to refine their coding approach until a high level of agreement was achieved (Hallgren 2012). Ultimately, the decision was made to consider all codes aligned, and substantial agreement was reached on both the assigned codes and the corresponding quotes.

The coding and analysis of the data continued until no new codes and themes emerged, and theoretical saturation was achieved, following the approach outlined by Glaser and Strauss (2017). The concept of theoretical saturation refers to an analytical technique that indicates that the existing interviews provide sufficient information for theory development. Throughout this process, instances of negative cases or interviews that did not align with the overall coding framework were carefully considered by the authors, leading to reflection and subsequent modifications to the coding scheme. Saturation was deemed to have been reached when the identified codes and themes demonstrated repeated occurrences during the analysis of new interviews.

Results

A total of 154 surveys were collected from Loiza, Comerío, and Aguas Buenas. Of that number, 55 surveys were collected in Loiza, with 57 surveys from Comerío and an additional 42 surveys from Aguas Buenas. Furthermore, 154 interviews were conducted in Loiza, Comerío, and Aguas Buenas. Of that number, 56 interviews were from Loiza, 61 from Comerío, and 37 from Aguas Buenas.

Sample Characteristics

Table 1 summarizes the distribution of the demographic information across the interviews. It also shows each community's percentages of tap water trust and consumption patterns. Table 2 shows the distribution of the qualitative themes from the interviews across all three communities.

Group A: Residents Who Mistrust Tap Water

Group A represents the broad category of residents in Puerto Rico who mistrust the quality of tap water provided by PRASA. Out of the 154 interviewed, 99 (64%) residents expressed mistrust toward their tap water. Out of that number, 85 (86%) did not drink tap water entirely. This observation is expected as mistrust in water sources is associated with nonconsumption (Juran and Lahiri-Dutt 2017; Kooy and Walter 2019). Of residents who expressed mistrust in tap water and did not drink it, Loiza had 33 (39%), while Comerio observed 27 (32%), and Aguas Buenas, 25 (29%) (Table 1). This difference in mistrust levels could be attributed to the fact that Loiza, located near the coast of Puerto Rico, has faced challenges with water quality in the past. The municipality has had issues with contamination and infrastructure problems, particularly after hurricane Maria. These events can erode trust in the local water supply and make residents more cautious about consuming tap water. Comerio and Aguas Buenas, both mountainous areas, on the other hand, might have had fewer reported incidents or a better track record in terms of water quality. The coding framework shown in Table 2 for Group A revealed that for residents who did not drink the tap water as a result of their mistrust, their primary reasons for mistrust were the aesthetics of tap water characterized by bad taste, color, and smell and the perceived health risks associated with drinking tap water. On the other hand, for residents who drink tap water despite expressing their mistrust, their primary reasons for mistrust were the utility's poor treatment processes and the substandard piping systems of the utility.

Group A1: Residents Who Mistrust Tap Water and Do Not Drink Tap Water

The residents in Group A1 display an alignment between their knowledge and behavior concerning the quality of their drinking water. They demonstrate a typical and appropriate reaction to

Table 1. Interview sample demographics

	Trust tap water but do not drink it		Mistrust tap water and do not drink it		Trust tap water and drink it		Mistrust tap water but drink it		Total	
Demographic	Obs. (*N*)	%	Obs. (*N*)	%	Obs. (*N*)	%	Obs. (*N*)	%	Obs. (*N*)	%
Age (years)										
18–34	3	2	1	1	2	1	3	2	9	6
35–54	3	2	11	7	5	3	1	1	20	13
55–64	0	0	20	13	8	5	4	3	32	21
65+	9	6	53	34	25	16	6	4	93	60
Gender										
Male	3	2	21	14	11	7	5	3	40	26
Female	12	8	64	42	29	19	9	6	114	74
Residency (years)										
0–10	1	1	8	5	4	3	2	1	15	10
11–20	0	0	1	1	2	1	0	0	3	2
21–30	1	1	5	3	1	1	4	3	11	7
31–40	2	1	6	4	4	3	2	1	14	9
40+	11	7	65	42	28	18	7	5	111	72
Education										
Elementary	1	1	7	5	3	2	1	1	12	8
Middle	1	1	10	6	4	3	0	0	15	10
High school	8	5	46	30	13	8	8	5	75	49
Bachelors	5	3	25	16	16	10	4	3	50	32
Other/missing	0	0	1	1	1	1	0	0	2	1
Race										
AI/AN[a]	0	0	2	1	1	1	0	0	3	2
Asian	0	0	0	0	0	0	0	0	0	0
Black	0	0	25	16	13	8	3	2	41	27
NH/PI[b]	0	0	0	0	0	0	0	0	0	0
White	5	3	25	16	14	9	2	1	46	30
Mixed	5	3	18	12	8	5	6	4	37	24
Other/missing	5	3	15	10	4	3	3	2	27	18
Community										
Loíza	3	2	33	21	16	10	4	3	56	36
Comerío	8	5	27	18	19	12	7	5	61	40
Aguas Buenas	4	3	25	16	5	3	3	2	37	24

[a]American Indian/Alaska Native.
[b]Native Hawaiian/Pacific Island.

Table 2. Qualitative thematic framework of interviews

Trust	Consumption	Knowledge–behavior gap	Number of observations (N)	Qualitative reasons for mistrust/trust of tap water
Group A: Mistrust tap water	A1: Mistrust and do not drink tap water	No	85	1. Aesthetics of tap water (bad taste, smell, and color) 2. Perceived health risks associated with tap water
	A2: Mistrust but drink tap water	Yes	14	1. Perceived substandard treatment process 2. Poor piping system of utility
Group B: Trust tap water	B1: Trust and drink tap water	No	40	1. Good experience from decades of usage 2. Perceived excellent treatment process
	B2: Trust but do not drink tap water	Yes	15	1. Good experience from decades of usage 2. Perceived excellent treatment process

their perceptive knowledge of the substandard quality of the water by avoiding its consumption. This group of residents, having had direct experience with the challenges associated with the water quality, abstain from drinking it.

Aesthetics of Tap Water

Across the three communities interviewed, our discussions made it apparent that most residents did not trust their tap water because of how it looked to them (Table 2). Many consumers in the United States have negative perceptions and mistrust their water quality due to its aesthetic appearance (de França Doria 2010; de Doria et al. 2009; Doria 2006). The aesthetic aspects of tap water, including its taste, smell, and color, play a significant role in shaping people's perceptions and decisions about drinking it. In the case of Puerto Rico, these aesthetic characteristics can be categorized into three main factors: color, smell, and taste. It is worth noting that the experience of bad taste, smell, and color in tap water can often be related (de França Doria 2010; de Doria et al. 2009; Doria 2006). These factors can combine to create a negative overall aesthetic experience. However, it is important to recognize that the presence of one aesthetic issue does not necessarily imply the presence of others. In other words, tap water can have problems with taste, smell, or color individually, and these issues may not always occur together. For example, tap water might have a bad taste without any noticeable odor or discoloration, or it could have an off-putting smell without any visible color changes. The separation of these factors in the analysis allows for a more nuanced understanding of residents' concerns and preferences.

Bad Taste of Tap Water. The taste of tap water in Puerto Rico has been reported by our interviewees to not be palatable. The frequent water shortages may have led to increased pollutants that alter the taste of the tap water (Apeti et al. 2012; Michaud and Kates 2017). As a result, tap water provides a bad taste for residents in Puerto Rico.

Resident 53 said: "I think the water has a lot of chemicals, making it difficult to drink. I can taste the chemicals when I drink it. I have to put it in the fridge for a while before I can drink it."

Resident 152 from Loiza said: "The water tastes like the ocean, it tastes like salt, like the seawater is getting in there somehow."

Resident 145 noted that, "the water tastes heavy, like it has minerals, it is hard to drink. I like the bottled water because it goes down smoothly, is light, easy to drink. This is how it supposed to be."

Resident 149 added, "it doesn't happen for months, but sometimes it tastes like Clorox. When I see this, it makes me think that it had a lot of bacteria and this was the quickest way to clean it."

Smell of Tap Water. The smell of drinking water is no more appealing than its taste, according to the interviewees. Routine disinfection practices can lead to an unintended production of by-products in tap water that cause pungent smells that may make consumption difficult for end users (Froese et al. 1999; Richardson and Postigo 2012). The smell of tap water played a substantial role in deciding whether to drink water from the taps. Residents recounted that tap water smelled terrible, making it impossible to consume. A direct quote from Resident 20 explained the situation: "The water keeps going on and off and comes back after hours. There is lots of chlorine in the water, which gives it a strong smell."

Similarly, Resident 77 said: "There are times when the water comes out very white and smells like chlorine. I have to put it down for about 15 min for the smell of the chemicals to reduce before I can drink it."

Resident 151 added, "After the last big storm (Maria), the water smelled like dead organisms when you open the faucet. There were a lot of fish that died and a lot of other animals like chickens, dogs, and cows. First, there was no water, but when it came back, you open the pipes and smelled like all those dead animals that drowned and decomposed in the waters for weeks and months."

Resident 142 commented, "When there was a lot of problems with the water after Maria, it smelled like when you leave the clothes in the washer, and you forgot to put them on the sun to dry, and they started to dry inside the washing machine. They smell so bad you need to wash the clothes again! I knew I could not drink water that smelled like that."

Resident 154 said: "I am not sure if it is my bathroom or it is the water, but to me, it smells like urine. I close the doors of the bathrooms and make sure there is no leakage on the sink to avoid that smell."

Color of Tap Water. The color of the primary source of tap water is also a prominent challenge for all three communities. We understood that the water could sometimes change color and become unappealing. We were also told that this issue has become much more prominent after Hurricane Maria.

Resident 33 lamented, "The tap water is cloudy. It became cloudy after Hurricane Maria. Whenever it rains now, the tap water is cloudy."

Resident 148 said, "Besides the odor when the water has Clorox is noticeable, this off-white color, sort of cloudy, not clear like the bottled water."

Resident 151 commented, "At times, it has some sort of dirt, kind of brown or reddish sediment and cloudy."

Perceived Health Risks Associated with Tap Water

The literature has consistently demonstrated the negative impacts that substandard drinking water can have on human health. Adequate levels of water quality, as established by drinking water standards such as the USEPA's Safe Drinking Water Act, are essential for the maintenance of good health (Bain et al. 2012; Buor 2004). While previous studies have primarily examined the long-term health implications of water-quality issues by analyzing patterns of disease incidence (Cooper-Vince et al. 2018; Hunter et al. 2010; Kangmennaang et al. 2020), it has been observed that residents in Puerto Rico often experience immediate and noticeable reactions upon consuming tap water, which is a cause for concern. This is particularly true in the aftermath of natural disasters such as Hurricane Maria, where instances of waterborne illnesses such as leptospirosis and diarrhea have been reported. Furthermore, residents have reported feeling nauseous after consuming tap water, leading to a loss of trust in the safety and quality of tap water. This sentiment is exemplified by Resident 12, who stated, "The water comes out oddly colored, and when I drink, it makes me feel sick in my stomach. If I continue to drink it, I will contract a serious illness."

Resident 148 explained, "I was very cautious after Maria, I boiled the water, but I still got diarrhea, and I will not forget how sick I was since then. I am just scared of the water."

Resident 145 said, "I do not drink the water from the tap. I am afraid it will make me sick."

Group A2: Residents Who Mistrust Tap Water but Drink Tap Water

The residents in Group A2 demonstrate a gap between their knowledge and behavior regarding the consumption of drinking water. Despite expressing skepticism toward the quality of tap water, these residents continue to consume it for a range of reasons, resulting in a paradoxical knowledge–behavior gap.

Perception of Substandard Treatment Process of Tap Water. Perceived poor treatment of their tap water is a reasonable reason for residents to mistrust tap water. However, the enigma in Puerto Rico is that although residents are armed with perceptions about the poor treatment of tap water, some still drink it regardless. The phenomenon was confusing because we expected that mistrusting tap water meant no or limited consumption. Resident 82, who does not trust his tap water but still drinks it, is quoted as saying, "I have the impression that the tap water is not well treated. That it brings a lot of harmful chemicals and many contaminants. I still drink it sometimes."

Resident 141 added, "I do not like the tap water because it is improperly treated, but I drink it many times just because I run out of bottled water. I do not have a car, and I depend on my kids to bring me food, water, and all the things I need. I do not want to inconvenience other people."

Perception of Substandard Piping Systems. Residents consistently expressed concerns about Puerto Rico's water utility service, PRASA. Despite documented efforts by PRASA to fix the problems associated with water utility services on the island (Bisbal-López 2021; Caribbean Business 2021), there is still a public outcry about the challenges with the water distribution systems in Puerto Rico. Broken distribution lines, faulty valves, and in some cases, broken pumping stations characterize the water distribution systems on the island. These distribution systems have become damaged and have been under repair and maintenance over the years, especially in the aftermath of Hurricane Maria. Hearing about broken distribution lines or pumping stations regularly has caused residents to mistrust the tap water that the failing system provides their homes. Nevertheless, although all the mistrust is harbored toward the tap water because of the piping system of PRASA, some residents drink tap water regardless. Resident 132, who mistrusts the tap water but still drinks it anyway, explains why by saying, "I drink the tap water. I also use it for washing and cleaning, but I do not trust it because the pipes are broken, and sometimes the water changes color when it rains. It is not safe for drinking."

Resident 143 stated, "I heard the water had lead because of all of the old pipe system. I know lead is not good for anyone, but I am an older person, and it is not as bad as if I were a kid. So, I drink the water because although it might be bad is not that bad for me, personally."

Group B: Residents Who Trust Tap Water

Group B represents the broad category of residents in Puerto Rico who trust in the quality of tap water provided by PRASA. A total of 55 (35.7%) residents out of the 154 interviewed trusted their tap water. A total of 40 of the 55 residents who trusted their tap water consumed it. The coding framework shown in Table 2 for Group B revealed that for residents who trust and drink their tap water, their primary reasons for trusting it are good experiences from decades of usage and the utility's excellent treatment of the tap water. Similarly, residents who did not drink tap water despite reporting that they trusted it had the same reasons as their counterparts who drank tap water. These residents also trusted their tap water because they had good experiences from decades of usage and believed that the utility treated the tap water excellently.

Group B1: Residents Who Trust Tap Water and Drink Tap Water

Group B1 exhibits an alignment between their knowledge and behavior regarding tap water consumption. These residents demonstrate normal and optimal behavior in regard to their trust in and consumption of tap water provided by PRASA. They exhibit a reaction that aligns with their positive perception of tap water.

Good Experience from Decades of Drinking Tap Water. Having excellent and reliable tap water is what most Puerto Ricans fight for. However, some residents on the island believe that their tap water is of outstanding quality and trust in its standards. These residents demonstrate their trust in the water by drinking it and using it for decades as their primary water source. These residents who have been living in Puerto Rico for a long time and using tap water for more than four decades with no issues have allowed the formation of positive perceptions about the quality of tap drinking. It could be inferred that the changes by the water utility company over the years have helped bolster the trust and consumption of tap water among these residents. These residents do not foresee any adverse consequences in using tap water and thus have unwavering faith and trust in it. Resident 39, who trusts in her tap water and drinks it, said: "I have been drinking this water for a long time. It is not contaminated or anything, and I do not have to use a filter."

Resident 153 said, "I never had any problems drinking the water, I have never gotten sick, why I would not trust it? I have been drinking this water since I was a kid, no one had water filters and none of these fancy things you have now. Bottle waters were a luxury! I am an old person already, so obviously, this water is not going to kill me, it is fine. The water is just fine."

Perception of Excellent Treatment Process of Tap Water. Residents of Puerto Rico who consume tap water and trust in its quality do so due to their belief in the effectiveness of the treatment processes implemented by PRASA. These residents may perceive that their water is treated in accordance with federal water standards and believe in the safety of the water. Furthermore, some residents may associate the presence of chlorine in their tap water, as

indicated by its smell and taste, with good water quality. Resident 47 is quoted as saying, "And I drink water from the tap. Okay. Moreover, I would say it is pretty good, and it is treated properly."

Resident 146 said, "I worked with PRASA for a while, and I know they are doing a good job because I worked there. They treat the water well, and it is safe for people to drink."

Group B2: Residents Who Trust Tap Water but Do Not Drink Tap Water

Group B2 displayed a paradoxical pattern in their drinking water consumption behaviors. Despite professing trust in the quality of the tap water, these residents reported not consuming it. Even if they trust the quality of the water, residents talked about how convenient, affordable, and reliable it is to drink bottled water compared with tap water. Some mentioned not drinking it because of the stigma associated with drinking it and not wanting to fight with family members who did not trust the water.

Resident 147 said, "I trust that the water is safe for people to drink, but I do not drink it because is just easier to drink bottled water. I put the bottled in the fridge and I do not have to be filling out containers that take a lot of space. My family is always fighting to see who fills out the containers, they are heavy to lift and no one wants to do it. Bottled water is just convenient, easy to pick up."

Participant 144 expressed, "Bottled water is now so cheap that why not drink that? It is not that the water from the tap is bad water, but it has a taste sometimes and is kind of unpredictable. I like predictability, something that tastes the same all of the time. So, I drink bottled water. And again, it is cheap so why risk the different tastes, colors, odors. I like it when it is the same."

Resident 150 added, "People in my family do not trust the water and they shame me for drinking it. They say I am going to get sick, asking why you drink water? It is bad!…that it tastes bad. They made me feel I am ignorant or uneducated for drinking it. They ask if I am being just cheap and that is why I drink it. I just do not want to fight with them, so I drink the bottled water."

Discussion

Residents in Puerto Rico have a wide range of reasons and unique situations for choosing whether or not to trust or mistrust their tap water. In addition to these reasons for trust or mistrust in their tap water, residents act on their trust or mistrust of tap water by choosing whether or not to consume it. The knowledge–behavior gap is evident when residents either trust in the quality of their tap water but, for some reason, do not drink it or when residents mistrust it with valid reasons but still go ahead to drink it.

Knowledge–Behavior Gap

The phenomenon of misaligned knowledge–behavior relationships among a group of residents among Group A2 residents presents a perplexing dilemma. Despite evidence of reasons for mistrust in the local water supply, such as poor piping systems, these residents continue to consume tap water. The context of Puerto Rico must be taken into consideration when examining this phenomenon. It is possible that financial constraints and lack of accessibility to alternative drinking water sources may play a role in this knowledge–behavior gap (Cortés 2018; Delilah Roque et al. 2020; Yu et al. 2015). It has been observed that residents are less likely to seek out alternative sources of drinking water due to mobility and logistical difficulties (Apt 2013; Banks et al. 2019; Wrisdale et al. 2017). These extenuating circumstances highlight the importance of ensuring that tap water quality meets acceptable federal standards and that the information is readily accessible to residents. Furthermore, this knowledge–behavior gap may have negative psychological implications, as residents are aware of the potential health hazards associated with the consumption of unsafe water yet continue to consume it due to a lack of feasible alternatives. Further research is recommended in order to understand and address this enigmatic behavior and ensure that residents are not forced to compromise their health due to financial constraints or other factors.

On the other hand, in an interesting reversal of the typical knowledge–behavior gap, some residents in Puerto Rico demonstrate trust in the safety of their tap water while refraining from consuming it. Despite having confidence in its quality, individuals may opt for alternative sources of drinking water due to the accessibility of other alternative water sources, such as bottled water, or external pressure from family or friends over the concerns of tap water-quality issues. This phenomenon highlights the complex relationship between knowledge, perception, and behavior and underscores the importance of addressing not only water-quality issues but also broader systemic challenges to ensure residents' access to safe and reliable drinking water.

Knowledge–Behavior Alignment

Group A1 consisted of residents who believed that their tap water was unsafe for consumption and, as a result, did not use it. This sentiment is shared by a significant portion of the Puerto Rican population, as evidenced by ongoing concerns about the injustices experienced in the aftermath of Hurricane Maria. The aesthetic characteristics of the tap water, specifically appearance, smell, and taste, were identified as primary concerns among residents of Loíza, Comerío, and Aguas Buenas. It can be inferred that if these characteristics had been improved, a larger portion of the population might have continued to consume tap water. This observation is significant as it suggests that negative public perception and mistrust of tap water may be largely influenced by first-hand experiences with the water's appearance, smell, and taste, a correlation that has been previously established in the literature (de França Doria 2010; Pierce and Gonzalez 2017). Additionally, residents' concerns about the potential health hazards associated with tap water consumption were found to be validated by the literature, with studies documenting a high incidence of waterborne diarrheal diseases in Puerto Rico and other Caribbean islands (Hunter et al. 2010). However, it is important to note that further research is needed to determine the accuracy of these negative perceptions and to understand the extent of water contamination in Puerto Rico.

On the other hand, Group B1 represents the situation where residents trust in tap water quality and use it as their primary drinking water source. This behavior is significant because, despite the challenges and issues faced, the tap water in most communities in Puerto Rico generally meets the established drinking water criteria as set by regulatory standards (Mueller and Gasteyer 2021). However, it is important to note that there have been instances where drinking water criteria have been violated, particularly in specific locations or during certain periods of time (NRDC 2017; Michaud and Kates 2017). Also, the way in which the public is informed of problems with water-quality when/if they occur plays a role in the types of perceptions formed about tap water (Kim et al. 2023; Lucier et al. 2020). This is particularly important because of the increasing number of vulnerable people in Puerto Rico, and therefore, the need for reliable information for tap water consumption decision-making is greater.

Opportunities and Recommendations for Utility Management

PRASA's monopoly status plays a significant role in water utility management in Puerto Rico. The lack of competition could result in a lack of motivation for PRASA to improve service quality and efficiency. Possible alternatives to this monopoly include decentralized water management or community-based water provision, which could offer more flexibility and adaptability, especially in rural areas. These decentralized systems have been successful across Añasco, Mayaguez, and Rincón, where water-sharing networks are used to overcome PRASA's inefficiencies (Roque et al. 2021). Such systems could potentially lead to more sustainable water practices and a smaller knowledge–behavior gap.

The issue of the knowledge–behavior gap, as identified in this study, is a nuanced problem that needs a tailored approach to resolve. This gap is essentially a divergence between consumers' understanding of tap water quality provisioned by water utilities and their behavior in relation to it. The findings of this study reveal that while consumers may exhibit trust toward tap water, their consumption patterns often tell a different story. This discrepancy indicates that personal experiences with water utilities are a significant factor in shaping consumer behavior. Therefore, it becomes essential to address this knowledge–behavior gap in utility management.

To address the knowledge–behavior gap, the first recommendation would be to augment public education on the potential risks associated with contaminated tap water. However, utility providers may be limited by budgetary and institutional constraints. Therefore, the emphasis should be on making the best use of available resources to maximize educational outreach. Second, the study suggests that community-wide initiatives should be fostered to tackle tap water-quality issues. However, it is crucial to be mindful of the practical implications of such efforts, because utilities often operate under tight constraints financially. Third, there is a need for policies that strengthen the protection of tap water quality. While formulating and implementing such policies, it is essential to consider the realities of limited revenue and governmental support. Policies should be designed in such a way that they are effective despite these constraints. Last, it is recommended that an improved, robust system of routine monitoring and reporting of water consumption behaviors and quality be instituted. This would hold PRASA and other responsible entities accountable. The complexities of such an undertaking should not be underestimated, but a system of checks and balances is crucial for effective utility management.

While it is important to acknowledge that water utilities often function in the context of complex settings, financial constraints, and environments, these strategies, while designed to tackle the identified knowledge–behavior gap, are also meant to take into consideration the realities and constraints of water utility management. By following these, utilities can not only bridge the gap but also ensure improved consumer satisfaction and efficient use of resources.

Limitations

While our study has provided insights into the tap water consumption behaviors and perceptions among residents in Puerto Rico, it is also important to acknowledge its limitations. One such limitation is potential respondent fatigue due to the length of our survey. The surveys, with 46 major questions, took an average of 50 min to complete. The length of the survey could have led to fatigue among the respondents, affecting their attention, accuracy, or willingness to provide comprehensive answers toward the end of the survey. Future studies may consider using shorter surveys or dividing the survey into several sessions to minimize this effect.

Another limitation is that our method of asking for permission to record interviews was met with resistance from some participants because of fear of the government redlining them. This limitation resulted in the loss of potential qualitative data that could have provided deeper insights into the reasons for mistrust in tap water among residents in Puerto Rico.

Despite these limitations, we believe that our study has shed new light on the issue of public mistrust in tap water, providing insights that can guide efforts to address this issue. We encourage future research to build upon our work, exploring this issue in different demographics and contexts and using methodologies that further minimize potential limitations.

Conclusion

The increased water contamination risks in Puerto Rico and the poor quality of tap water are very troubling. Extraordinary events such as hurricanes, earthquakes, and the COVID-19 pandemic have exacerbated the water contamination risks and, consequently, the residents' way of life in Loíza, Comerío, and Aguas Buenas in Puerto Rico. The drinking water quality has been characterized by high levels of arsenic, high sedimentation, and pathogenic *Leptospira* spp. contamination in the aftermath of Hurricane Maria.

Following the qualitative narrative model, to understand the relationships between residents of our study areas and their public mistrust of tap water, we explored residents' tap water–quality perceptions and their tap water consumption behaviors. We identified four major themes through a comprehensive coding framework derived from in-depth interviews ($N = 154$), demonstrated by repeating ideas representing the factors that catalyzed the positive and negative perceptions of tap water quality. We found a general public mistrust of the tap water provided by the public water utility service because of the impacts of Hurricane Maria on the water infrastructure and the palatability characteristics of tap water provided by the PRASA. We also found a knowledge–behavior gap among groups that either trust in the quality of their tap water but do not drink it for some reason or groups that mistrust the tap water with valid reasons but still go ahead to drink it.

This study demonstrated that it is essential to further develop evidence-based strategies to address the knowledge–behavior gap and to promote public trust in the safety and quality of tap water in Puerto Rico. Such strategies should be implemented in collaboration with local stakeholders, with a focus on improving the palatability characteristics of tap water and updating the water infrastructure. In addition, further research is needed to develop an understanding of the sociocultural and economic factors that influence the knowledge–behavior gap and the public mistrust of tap water in Puerto Rico.

Data Availability Statement

All data, models, and codes generated or used during the study appear in the published article.

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Supplemental Materials

Appendixes S1 and S2 are available online in the ASCE Library (www.ascelibrary.org).

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