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Harmony of Behavior and Environment: The Role of Risks, Attitudes, Norms, Abilities, Self-regulation Models in Optimizing Sustainable Water Management

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Abstrak

Akses terhadap air bersih tetap menjadi isu krusial di kawasan urban fringe, di mana pertumbuhan penduduk, keterbatasan infrastruktur sanitasi, dan pola perilaku masyarakat saling berinteraksi. Penelitian ini mengkaji peran faktor-faktor psikososial berdasarkan model Risks, Attitudes, Norms, Abilities, and Self-regulation (RANAS) dalam memengaruhi perilaku pengelolaan air bersih pada tingkat rumah tangga di Kelurahan Tahunan, Kecamatan Umbulharjo, Yogyakarta. Dengan menggunakan desain penelitian *cross-sectional* dan teknik multistage random sampling di beberapa lingkungan perwakilan, data dikumpulkan dari 97 rumah tangga dan dianalisis menggunakan regresi linier berganda. Hasil penelitian menunjukkan bahwa persepsi risiko (β = 0,229, p = 0,035), norma sosial (β = 0,229, p = 0,028), dan kemampuan (β = 0,321, p = 0,003) berpengaruh signifikan terhadap perilaku pengelolaan air bersih, sementara sikap dan regulasi diri tidak menunjukkan pengaruh yang signifikan secara statistik. Temuan ini menekankan pentingnya mengintegrasikan intervensi berbasis perilaku dengan perbaikan struktural, terutama di wilayah yang memiliki keterbatasan infrastruktur sanitasi. Studi ini merekomendasikan edukasi masyarakat yang terarah, pengembangan infrastruktur, serta intervensi kebijakan yang memprioritaskan norma sosial dan penguatan kapasitas sebagai strategi untuk mendorong praktik pengelolaan air yang berkelanjutan.

Abstract

Access to clean water remains a critical issue in urban-fringe areas where population growth, inadequate sanitation infrastructure, and behavioral patterns intersect. This study investigates the role of psychosocial factors based on the Risks, Attitudes, Norms, Abilities, and Self-regulation (RANAS) model in influencing household water management behavior in Kelurahan Tahunan, Umbulharjo District, Yogyakarta. Using a cross-sectional design and multistage random sampling across representative neighborhoods, data were collected from 97 households and analyzed through multiple linear regression. Results show that perceived risk (β = 0.229, p = 0.035), social norms (β = 0.229, p = 0.028), and abilities (β = 0.321, p = 0.003) significantly affect household behavior in managing clean water, while attitudes and self-regulation were not statistically significant. The findings underscore the importance of integrating behavioral interventions *with structural improvements, particularly in areas with limited sanitation infrastructure. This study advocates for targeted community education, infrastructure development, and policy interventions that prioritize social norms and capacity-building to foster sustainable water practices.*

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INTRODUCTION

Clean water and sanitation are fundamental human rights, yet billions of people worldwide still face difficulties accessing these basic services. This challenge is exacerbated by the impacts of climate change and increasing population growth rates that significantly increase pressure on the availability and quality of clean water resources (United Nations, 2023). In developing countries such as Indonesia, people generally still rely on groundwater as the primary source to meet their daily domestic needs (Putri et al., 2024). However, the management of water resources in Indonesia still faces various problems, including groundwater pollution due to increasing anthropogenic activities such as residential development, industry, and inadequate sanitation practices (Anatoly et al., 2024; Aslam et al., 2021). These activities create the potential for new contamination pathways, increasing the risk of declining groundwater quality, both physically, chemically and microbiologically (Putri et al., 2024). Therefore, efforts to manage clean water sustainably require a technical approach and a transformation in the behavior of communities as the main users of water resources.

The appeal of Yogyakarta City as a center for tourism, education, and culture also contributes to the annual population increase. The population of Yogyakarta City is recorded at 375,770 people with a population growth rate of 0.12%. With a population density of 11,562 people/km^2, Yogyakarta City ranks highest in terms of population density compared to other districts in the Special Region of Yogyakarta Province (Central Bureau of Statistics[a], 2025). Based on the National Socio-Economic Survey, at least 45.89% of households in Yogyakarta City still use water sources from wells (groundwater) for cooking, bathing, washing and so on (Central Bureau of Statistics[b], 2025). Meanwhile, based on 2021 data collected from the Yogyakarta City Public Works and Public Housing Agency, 82.4% of the people of Yogyakarta City use the Domestic Wastewater Management System (SPALD) in the form of a local system. In addition, 34.58% of households in Yogyakarta City have a distance between the location of the clean water source used for cooking, bathing or washing and the waste/excrement/feces storage area of less than 10 meters (Central Bureau of Statistics[c], 2024). This condition raises concerns regarding the potential for groundwater contamination, especially considering that most of the waste is managed locally and the close distance between the clean water source and the waste storage area. Total coliform is used as an indicator of environmental quality because it includes various species of bacteria, both from fecal waste and non-fecal sources, which have the potential to endanger human health (Curl et al., 2022). Under natural conditions, undisturbed aquifers usually have very low coliform levels (Sworobuk et al., 1987). Therefore, the presence of total coliform in groundwater is an indication of infiltration of groundwater pollution from the ground surface into the aquifer system, considering that the concentration of Total coliform in groundwater is generally 100 times lower than that of surface water (Dey et al., 2022).

Factors influencing microbiological contamination of groundwater include local environmental conditions, the functioning of clean water and sanitation infrastructure, and spatially varying hydrogeological characteristics (O'Dwyer et al., 2018; Poulin et al., 2020; Widiyanti, 2019). Pathogens from human and animal domestic waste can enter the water system through leaks in sanitation pipes or impermeable clean water distribution systems (Manga et al., 2020). This situation shows that groundwater pollution is a multidimensional problem that is not only related to technical aspects, but also to the behavior and social systems of the community. Human behaviour is one factor contributing to inefficient water use (Moncelano and Rietveld, 2021). However, technical policies and interventions alone are not effective enough in dealing with this problem if they are not accompanied by a comprehensive understanding of the behavioral and psychosocial factors of the community in sustainable water management (Rahmania, 2024).

Several studies have shown that there is still a gap in understanding the role of psychosocial factors in sustainable water management, especially in urban fringe areas. Habits, social norms, and risk perceptions are often ignored in the planning of clean water and sanitation systems, even though these factors influence the sustainability of long-term facility use (Tilley et al., 2013). An approach that does not take into account attitudes, individual abilities, and social influences will result in less effective and short-lived interventions (Mosler, 2012). On the other hand, the urban fringe is often a socio-ecological transition zone with dynamic community structures, uneven infrastructure conditions, and heterogeneous population characteristics, requiring a more contextual and participatory approach (Sahin et al., 2020). The absence of mapping of psychosocial factors such as community norms, self-regulation, and perceptions of benefits-difficulties, often inhibits behavioral changes that support clean water management at the household and community levels.

Several studies have begun to apply the components of the RANAS psychosocial model—Risk, Attitude, Norm, Ability, and Self-regulation to understand environmental resource management behavior. Handwashing and using household water treatment technology are two examples of behaviours related to water, sanitation, and hygiene (WASH) practices assessed using the RANAS framework (Mosler, 2012; Dreibelbis et al., 2013). The RANAS model has also been used to study sanitation behaviour, and the results showed that attitude and self-regulation factors had a significant impact (Nastiti et al., 2025). Meanwhile, behavior related to water conservation is influenced by attitude, perceived control (ability), and social norms (Azizah et al., 2023). In addition, attitudes are very important in shaping water-saving intentions, although there is a gap between awareness, motivation, and actual behavior (Mulyana et al., 2024). Although these studies are in-depth in the context of RANAS, most focus on large urban environments or non-water sectors (solid waste) and rarely include all five RANAS components comprehensively in one comprehensive model for clean water management (Dean et al., 2021; Diaz et al., 2020; Singha et al., 2022).

Most previous studies on behavior-based clean water management still focus on rural areas or large urban areas, while urban fringe areas have been overlooked. Urban fringe areas such as Umbulharjo District, Yogyakarta City are transition areas that experience demographic pressures, land conversion, and rapid infrastructure development. These pressures increase the risk of declining groundwater quality, especially due to inadequate sanitation systems and uncontrolled land use (Setiawan & Suharyanto, 2020).

This study aims to analyze the contribution of each component in the RANAS Model to sustainable clean water management behavior at the household level, identify the relationship between psychosocial factors and physical environmental conditions, and develop recommendations for appropriate behavior-based interventions to support participatory and sustainable clean water management. With the RANAS model approach, this research is expected to be a reference for formulating government programs in clean water and sanitation education that are more effective because they take into account the social conditions of the local community.

METHODS

This study uses a descriptive-quantitative approach with a cross-sectional survey to analyze the relationship between psychosocial variables in the RANAS Model and clean water management behavior at the household level.

Research Location

This study was conducted in Umbulharjo District, Yogyakarta City (Figure 1). This district was chosen because it has the highest target for finding diarrhea cases, which is indicated by several risk factors such as poor sanitation levels, limited access to clean water, low clean and healthy living behavior, and high population density (Yogyakarta City Health Office, 2024). The focus of further studies was directed to Tahunan Village, Umbulharjo District, Yogyakarta City considering that the results of groundwater quality sampling in Tahunan Village were all contaminated with coliform bacteria. All groundwater samples showed total coliform values above 0 CFU/100 ml and E. coli values above 0 CFU/100 ml. This indicates that all groundwater samples exceeded the quality standards set by the Indonesian Ministry of Health (Table 1).

Table 1. Groundwater Quality Data Tahunan Village in 2024

No.	Coordinate		Parameter (CFU/100 ml)	
	Latitude	Longitude	Total Coliform	E. Coli
1	-7,804566022	110,38575	138*	8*
2	-7,804882416	110,38570	>200*	51*
3	-7,805388286	110,38552	>200*	>200*
4	-7,805589697	110,38466	>200*	>200*
5	-7,805710217	110,38359	>200*	180*
6	-7,80589871	110,38025	>200*	>200*
7	-7,807472948	110,38046	>200*	>200*
8	-7,8107025	110,38168	>200*	12*
9	-7,809583514	110,38436	118*	6*
10	-7,808975701	110,38422	55*	6*

**Exceeding the Water Quality Standard according to Indonesian Minister of Health Regulation No. 2 of 2023*
Source: Yogyakarta City Environmental Service, 2024

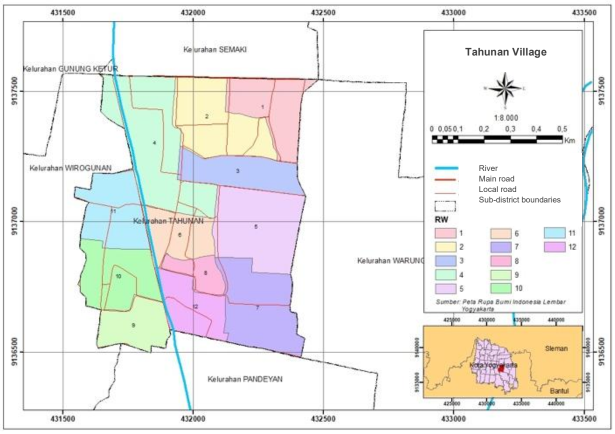

Figure 1. Research Site Map

Data Collection

The unit of analysis in this study was the community of Tahunan Village, Umbulharjo District, Yogyakarta City. The sample was determined using a multistage random sampling technique where the selection of Tahunan Village was purposive due to the high level of groundwater pollution. Furthermore, the respondent sample was selected using simple random sampling in each Community Unit (*Rukun Warga—RW*) in Tahunan Village. The number of respondents was determined based on the Slovin formula with a margin of error of 10% based on 3.118 total head of households in Tahunan Village. This study was conducted in 2023 among a total of 97 respondents.

Research Variables

The independent variables used the RANAS Model: Risks, Attitudes, Norms, Abilities, and Self-regulation (Table 2). The instrument was a closed questionnaire with a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), which was compiled based on the RANAS model guidelines from Mosler (2012). The dependent variable was household clean water management behavior which consists of water source security behavior, water storage behavior, drinking water treatment behavior, domestic waste management behavior, and water conservation behavior. The instrument was a closed questionnaire with a 5-point Likert scale (1 = never to 5 = always).

Data Analysis

The questionnaire data were analyzed using IBM SPSS 29 software. A validity test was used using Pearson Product Moment correlation analysis to ensure that the questionnaire instrument can be used to measure the variables studied with consistent results. Cronbach's alpha was calculated to assure consistency. Furthermore, this study use Multiple Linear Regression Analysis to identify the most dominant RANAS Model factors influencing household clean water management behavior. The multiple linear regression model will be expressed in the following equation:

$$Y=\beta0+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\beta5X5+\epsilon$$

where:

Y = Clean Water Management Behavior
β0 = Constant
β1,β2,β3,β4,β5 = Regression coefficient
X1 = Risks
X2 = Attitudes
X3 = Norms
X4 = Abilities
X5 = Self-regulation
ϵ = Error term

Table 2. Operational Variables

Aspect	Variable	Code	Indicator	Statement
Risks	X1	X1.1	Perception of vulnerability	I am worried that the groundwater in my neighborhood is polluted and could cause family members to get sick.
		X1.2	Perception of severity	If the groundwater at home cannot be used because it is polluted, the cost of buying clean water from outside will be very burdensome.
Attitudes	X2	X2.1	Attitude towards safe practices	Properly managing household waste is very important to prevent groundwater pollution in my neighborhood.
		X2.2	Attitude towards drinking water treatment	Although groundwater from wells looks clear, treating it for drinking is an action that needs to be done.
Norms	X3	X3.1	Social norms	Most of my neighbors in my neighborhood care about and maintain the cleanliness of the water sources in their respective homes.
		X3.2	Social responsibility	I feel responsible for ensuring that the water my family uses is safe and clean.
Abilities	X4	X4.1	Financial and technical capability	I know how to manage household waste so that it does not pollute groundwater.
		X4.2	Technical knowledge	I have access to information or technology to check and treat the groundwater I use.
Self-regulation	X5	X5.1	Self-control	I often plan and try to reduce the use of chemicals that can pollute groundwater at home.
		X5.2	Action plan	I routinely evaluate whether my household practices are safe for the quality of groundwater in my neighborhood.
Household Clean Water Management Behavior	Y	Y1	Water Source Security Behavior	I ensure that the distance of the septic tank or waste reservoir from the clean water well meets the standards.
		Y2	Water Storage Behavior	I always tightly close the water reservoir at home to avoid contamination.
		Y3	Drinking Water Treatment Behavior	I boil water before using it for drinking or cooking.
		Y4	Domestic Waste Management Behavior	I dispose of household wastewater into the proper drain, not into an empty lot or gutter without treatment.
		Y5	Water Conservation Behavior	I turn off the tap when it is not in use, for example when brushing my teeth or washing dishes.

RESULT AND DISCUSSION

There were 97 respondents, consisting of 53.3% male and 46.7% female. At least 90.5 % of respondents in the research area used groundwater as their main source of clean water and the remaining 9.5% use water from the Regional Drinking Water Company (*PDAM*). The reasons for its cheapness and easy accessibility make groundwater still popular in the research area. People use groundwater for bathing, washing, toilets, and cooking. As many as 52.4% of people use groundwater as a source of drinking water, 28.6% use bottled drinking water, 4.8% use water from PDAM for drinking water, and the remaining 14.3% use two sources for drinking water, for example from groundwater and bottled drinking water.

Based on the observations, the distance from the septic tank to the clean water well owned by residents is an average of 6.65 meters and statistically has a standard deviation value of 3.33, which means that the average value is acceptable. The shortest distance from the septic tank to the well measured in the observation is 1 meter and the furthest distance is 14.3 meters. The variable of the distance of the septic tank to the well is categorized based on SNI 2398:2017 where the septic tank must be placed at a location far from the clean water well at least 10 meters. The results of observations related to the distance of private septic tanks to clean water wells are 55.3% of households have a distance of septic tanks to wells <10 meters; 23.7% of households have a distance of septic tanks to wells ≥ 10 meters; and 21.1% of households have used the Communal Domestic Wastewater Management System (SPALD) so they do not have septic tanks.

The validity test results showed that all statements had a significance value of <0.05, indicating that all questionnaire items were valid. The reliability test results showed that all variables had a Cronbach's alpha value greater than 0.60, indicating that all variables are reliable. (Table 3).

Table 3. Validity and reliability test results

Variabel	Item	Validity p-value	Reability Cronbach's Alpha
Risk (X1)	X1.1	<0.001	0.697
	X1.2	<0.001	
Attitudes (X2)	X2.1	<0.001	0.699
	X2.2	<0.001	
Norms (X3)	X3.1	<0.001	0.654
	X3.2	<0.001	
Abilities (X4)	X4.1	<0.001	0.699
	X4.2	<0.001	
Self regulation (X5)	X5.1	<0.001	0.778
	X5.2	<0.001	
Household Clean Water Management Behavior (Y)	Y1	<0.001	0.616
	Y2	<0.001	
	Y3	<0.001	
	Y4	<0.001	
	Y5	<0.001	

Source: Analysis, 2025

Regression analysis

The multiple linear regression analysis conducted to assess the influence of psychosocial factors based on the RANAS model: Risk (X1), Attitudes (X2), Norms (X3), Abilities (X4), and Self-regulation (X5) on household clean water management behavior (Y) yielded several insightful findings. The model showed a strong explanatory power, with an R value of 0.677, indicating a moderate-to-strong correlation between the independent variables and the dependent variable. The R^2 value of 0.458 suggests that 45.8% of the variance in household water management behavior can be explained by the five RANAS components (Table 4). Furthermore, the model was statistically significant as indicated by the ANOVA F-statistic ($F = 15.386$, $p < 0.001$), confirming the overall model's goodness-of-fit (Table 5).

Table 5. Cofficient of Determination Results

Model	R	R Square	Adjusted R Square	Std. Error
1	.677	.458	.428	1.733

Source: Analysis, 2025

Table 4. F-test Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	230.918	5	46.184	15.386	<.001
Residual	273.143	91	3.002		
Total	504.062	96			

Source: Analysis, 2025

Although the contribution is statistically significant, the magnitude of the influence is moderate, indicating that there are other factors outside the RANAS model that may also play an important role in influencing clean water management behavior, such as structural factors, policies, or physical environmental conditions (Sahin et al., 2020; Anatoly et al., 2024). Effective and sustainable groundwater management requires not only behavioral change but also strong regulatory frameworks, licensing systems, monitoring, conservation zoning, research investment, and active stakeholder collaboration to support implementation.

Table 6. Multiple Linear Regression

Model	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	10.725	1.998		5.367	<.001
X1	.486	.154	.259	3.162	.002
X2	-.108	.191	-.047	-.566	.573
X3	.343	.154	.229	2.233	.028
X4	.516	.167	.321	3.097	.003
X5	.251	.163	.142	1.543	.126

Source: Analysis, 2025

The Risk variable (X1) demonstrated a positive and statistically significant influence on household behavior (β = 0.259, p = 0.002). This indicates that households with higher perceived vulnerability to waterborne diseases or environmental degradation due to poor water quality tend to adopt more proactive and protective water management practices. This is aligned with the risk component of the RANAS model, which posits that increasing awareness of consequences is critical to initiating behavioral change (Mosler, 2012).

Surprisingly, the Attitude variable (X2) showed a negative and non-significant effect (β = −0.047, p = 0.573). This result deviates from many previous studies where positive attitudes toward hygiene behaviors significantly influenced WASH-related practices (Contzen & Mosler, 2015; Savari et al., 2022). One possible explanation is the existence of an attitude-behavior gap, where favorable opinions do not translate into consistent actions, especially when structural barriers or habitual inertia are present (Dreibelbis et al., 2013). For instance, Nugroho et al. (2022) found that attitudes toward water conservation were not significant driving forces of residents' intention to engage in water conservation initiatives in West Java, Indonesia. This suggests that, particularly attitudes alone may lack sufficient motivational force to drive action without complementary enabling conditions such as infrastructure, economic feasibility, or social reinforcement. In addition, Mulopo et al. (2020) highlight that many community members in South Africa held negative attitudes toward the use of safe water sources, viewing them as inconvenient and time-consuming. This points to a cost-benefit evaluation that residents often undertake where positive environmental attitudes may be overridden by perceived physical, temporal, or economic burdens.

The study found that norms (X3) had a significant positive effect on household clean water management behavior (β = 0.229, p = 0.028), highlighting the critical role of social influence in promoting sustainable practices in urban-fringe areas like Umbulharjo. This aligns with behavioral theories such as the Theory of Planned Behavior (Ajzen, 1991) and the RANAS model, which emphasize the power of both descriptive and injunctive norms. Prior studies support this, showing that norms significantly influence water conservation behaviors either directly or through behavioral intentions (Savari et al., 2021; Azizah, 2024). Moreover, community leader involvement and public commitment strategies can strengthen normative influence (Mulopo, 2020), while social modeling and peer approval have been shown to reinforce sustainable behaviors, particularly among younger populations (Rahmania, 2024). These findings suggest that fostering positive social norms and collective responsibility is essential for enhancing clean water practices at the household level.

Abilities (X4) emerged as the strongest positive predictor of household clean water management behavior (β = 0.321, p = 0.003), emphasizing the central role of individual capacity such as knowledge and technical skills in enabling effective action. This aligns with the concept of RANAS model that practical ability is a prerequisite for behavioral change (Mosler, 2012). Mulopo (2020) notes that low adoption of safe water practices often stems from limited access to infrastructure, making it difficult for individuals to sustain new habits, thus highlighting the need for not only skillbuilding but also structural support. Furthermore, subjective well-being—a dimension closely linked to perceived ability—was found to be a consistent predictor of both present and future water conservation behavior (Diaz et al., 2020; Aslam et al., 2021). These findings suggest that beyond knowledge and technology, individuals' perceptions of their own stability and resilience can shape their willingness to engage in water-related sustainable practices. Future research could explore how ability levels vary across financial and educational backgrounds, thereby clarifying the extent to which these structural and cognitive resources moderate the influence of abilities on water management behavior.

Although Self-regulation (X5) was not statistically significant ($\beta = 0.142$, $p = 0.126$), its positive coefficient suggests a potential role in supporting clean water management behaviors through mechanisms such as goal-setting, self-monitoring, and behavioral adjustment. This aligns with previous findings that self-regulation contributes to behavior maintenance when combined with strong motivation and supportive environmental cues (Dreibelbis et al., 2013). The absence of statistical significance in this study may reflect contextual constraints, such as limited external reinforcement or competing priorities within the household. Moreover, Moncaleano et al. (2021) emphasize that cultural factors like ingrained beliefs, traditions, and daily routines often shape how water is perceived, used, and managed, potentially overriding internal regulatory efforts. We assume the efficacy of self-regulation may depend heavily on how well it is supported by culturally appropriate interventions and community norms especially in Indonesia. These findings indicate that while self-regulation alone may not be a strong predictor, it remains an important complementary factor in designing behavior change strategies that are both context-sensitive and sustainable.

The multiple linear regression model indicates that household clean water management behavior is significantly influenced by risk perception (X_1), social norms (X_3), and abilities (X_4). These findings highlight the importance of practical capacity and communal expectations in shaping water-related practices. Although attitudes (X_2) and self-regulation (X_5) showed positive or negative trends, their effects were statistically insignificant, suggesting the presence of an attitude–behavior gap and the need for supporting structural conditions. The multiple linear regression analysis produced the following equation:

$$Y=10.725+0.486X_1 -0.108X_2+0.343X_3 +0.516X_4+0.251X_5$$

Sustainable Water Management at Household Levels

The findings of this study underscore the need for a more integrated approach to sustainable water management, particularly in urban-fringe communities like Umbulharjo, where behavioral interventions alone are insufficient. While attitudes are often emphasized in theoretical models, their non-significant effect in this study highlights the limitations of attitudinal change in isolation. This gap suggests that structural constraints such as lack of access to safe sanitation, poor infrastructure, and socio-economic disparities can inhibit the translation of positive attitudes into effective household water management behavior (Nastiti et al., 2025; Nugroho et al., 2022). Therefore, improving sanitation infrastructure, especially through the enforcement of septic standards and safe containment systems is crucial. The government must regulate and monitor household construction and promote technologies that ensure faecal sludge is safely managed, as unsafe tanks continue to threaten groundwater quality and public health.

Equally important is fostering household-level water conservation through education, awareness-building, and behavioral empowerment. As emphasized by Singha et al. (2022), knowledge about conservation techniques and the environmental importance of water saving behaviors must be disseminated widely. Increasing residents' awareness and confidence in conservation practices can significantly influence their willingness to adopt water-efficient habits (Nugroho et al., 2022; Rahmania, 2024). Additionally, policymakers should invest in the development of social norms that promote water saving behaviors. Successful cases of community level water curtailment should be amplified and used as models for behavioral diffusion (Savari et al., 2021). These efforts must also involve influential community figures through public campaigns, training programs, and local media to trigger normative shifts and collective commitment to sustainability. Ultimately, institutions and water users alike play a critical role in ensuring sustainable water use by making informed decisions that promote efficiency across the water-use chain (Moncaleano & Rietveld, 2021).

CONCLUSIONS

This study provides empirical evidence that psychosocial factors, particularly risk perception, social norms, and abilities play a significant role in shaping household behavior regarding clean water management in urban-fringe settings. Among these, abilities emerged as the strongest predictor, highlighting the importance of access to knowledge, skills, and supportive infrastructure. Although attitudes and self-regulation did not exhibit statistically significant effects, their positive direction suggests potential for influence when coupled with enabling conditions and supportive environments.

The implications of these findings emphasize the need for integrated strategies that combine behavioral change approaches with structural interventions. Programs that enhance community awareness, promote water conservation, and build technical capacity especially through the involvement of influential social actors and regulatory enforcement are essential for long-term sustainability. As urban expansion continues to place pressure on water resources, efforts to align individual behavior with environmental goals must address both psychosocial and systemic determinants. This study contributes to the growing body of knowledge on sustainable water governance and offers valuable insights for policymakers, practitioners, and researchers working in similar contexts.

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