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Water awareness in Latin America: adaptation and validation of an assessment tool

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Abstract

Purpose – This study validates an adapted version of the Ecobarometer of Andalucia to assess perceptions, knowledge, practices and attitudes toward water management and pollution among university students in Latin America. It aims to provide a reliable tool for analyzing environmental awareness and behaviors related to water conservation.

Design/methodology/approach – A quantitative, cross-sectional and descriptive design was used. Validity and reliability were assessed through exploratory and confirmatory factor analyses (EFA and CFA), based on online surveys with 96 participants selected by non-probabilistic convenience sampling. Reliability was measured using Cronbach's alpha, McDonald's Omega and Jöreskog's Rho. Discriminant validity ensured distinct construct representation.

Findings – Six dimensions were validated: information on environmental issues, minimization of personal responsibility, daily environmental practices, perception of responsibility, participation and responsible consumption and domestic water management. While environmental knowledge correlated positively with sustainable practices, the effect was limited. Perceiving external agents as primarily responsible correlated negatively with personal engagement. The findings also revealed moderate concern for water pollution and a high commitment to sustainable practices at the household level. However, a tendency to externalize responsibility to institutions was observed, which may limit personal engagement in broader environmental actions.

Research limitations/implications – Self-reporting may introduce bias, and the sample limits generalizability. Future studies should use broader samples and indirect assessments. Longitudinal research is recommended to explore causality.

Practical implications – The instrument can support environmental education, assess public policy impact and monitor water sustainability initiatives.

Originality/value – The study offers a validated, context-specific tool for assessing water awareness in Latin America, addressing a regional research gap and enabling targeted educational and policy interventions.

Keywords Water awareness, Environmental perception, Water management, Environmental education, Instrument validation

Paper type Research article

Introduction

In Latin America, the environmental crisis is a structural challenge that deeply affects economic development and quality of life. Despite hosting some of the world's most biodiverse ecosystems, the region faces rapid degradation driven by deforestation, industrial

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pollution, and unregulated urban growth (Hubbard, Gelting, Portillo, Williams, & Torres, 2013). Combined with high vulnerability to climate change, these factors have intensified natural disasters, biodiversity loss, and the depletion of essential resources. In this context, effective environmental management is an urgent priority, requiring a balance between economic growth and ecological sustainability (Mogambi, 2025).

Among the region's many challenges, the water crisis is one of the most urgent. Latin America holds nearly one-third of the planet's renewable freshwater, yet its distribution is highly unequal, and management suffers from pollution, overexploitation, and inadequate infrastructure. Industrial waste, domestic sewage, and the growing demand from cities and intensive agriculture threaten public health and ecosystem balance. In arid and semi-arid areas, scarcity already affects millions, deepening inequalities and restricting access to a vital resource (Sasa, Ahmad, Khuzaie, Bahtiti, & Miri, 2024).

In this scenario, assessing public awareness and perceptions of environmental issues, particularly those related to water, is crucial. Reliable measurement tools help identify behavioral patterns, misconceptions, and areas that require targeted educational or policy interventions (Dlangalala & Mudhara, 2020). One such tool is the *Ecobarometer of Andalucía*, a survey developed by the Regional Government of Andalucía (Junta de Andalucía) to assess public perception and behavior regarding environmental issues. It has become a key reference in Europe, offering empirical data on knowledge, attitudes, and sustainable practices across various ecological dimensions.

However, its original design addresses environmental issues in a broad sense, making it necessary to adapt the tool for a more focused evaluation of water-related challenges and to transfer it to the Latin American context, with its own specific dynamics and demands.

The aim of this study is to validate an adapted version of the Ecobarometer of Andalucia focused exclusively on water perception and management. Based on a selection of items from the original instrument, a tailored tool has been developed to more accurately measure knowledge levels, daily practices, and beliefs surrounding water management. Validating this adaptation will not only provide a reliable instrument for assessing water awareness in the region but also offer valuable insights for the design of more effective educational strategies and public policies. Understanding how people value and perceive water will support the development of interventions aimed at promoting responsible consumption habits and strengthening water governance, with direct implications for both environmental and social sustainability.

Theoretical framework

The importance of environmental awareness and perception among younger generations

In a world increasingly affected by environmental degradation and climate change, younger generations are key to building more sustainable societies. Environmental awareness shapes both individual and collective decisions on natural resource management and is essential for adopting responsible behaviors (Corral-Verdugo, Aguilar-Luzón, & Hernández, 2019). Yet, despite greater access to environmental information, a gap persists between knowledge and action, hindered by apathy, lack of commitment, and skepticism (Stern, Dietz, Abel, Guagnano, & Kalof, 2016).

Recent decades have seen young people display greater sensitivity to environmental issues, as reflected in movements like Fridays for Future (Babutsidze & Chai, 2018). However, concern does not always lead to action, as economic constraints, social pressures, and media influence limit the adoption of sustainable practices (Ortega, 2021). In this context, environmental education, both formal and informal, plays a decisive role in connecting ecological knowledge with sustainability-oriented decisions.

Fostering strong environmental consciousness has individual and collective benefits. Societies more aware of ecological challenges are more likely to engage in conservation, recycling, and efficient resource use (Báez Gómez, 2016). An informed citizenry also

facilitates the acceptance of environmental policies, strengthening governments' ability to implement mitigation and adaptation measures. To turn awareness into action, young people must have the tools to participate actively and avoid the paralysis or apathy that can arise from information overload (Grønhøj & Thøgersen, 2017).

Despite advances in education and activism, major challenges remain. Persistent unsustainable consumption patterns normalize waste and pollution (Gomera, Villamandos, & Vaquero, 2013). Awareness must therefore go beyond superficial knowledge, becoming a driver of everyday behavioral change. Only by internalizing the link between personal actions and planetary balance will younger generations be able to lead structural transformations for long-term sustainability (Gifford & Nilsson, 2014).

The importance of water awareness

Water is essential for life and human development, yet its access is increasingly threatened by population growth, climate change, and pollution. Over 2.2 billion people worldwide lack safe drinking water, and by 2050, more than half of the global population will face severe water stress (UN, 2020). This crisis affects vulnerable communities and impacts economic and political stability, intensifying conflicts over resource management. Overexploitation of aquifers, deforestation, and industrial pollution have degraded water quality and availability, underscoring the urgent need to raise awareness about its conservation (Gleick, 2018).

In Latin America, the situation is paradoxical: the region holds about 30% of global renewable freshwater, but its distribution is uneven. While Brazil and Colombia enjoy abundant resources, countries like Mexico, Chile, and Peru face scarcity due to aquifer overuse and contamination. Poor infrastructure and weak management policies worsen the problem, restricting access for millions (Bertiz, 2022a). Urban expansion, intensified agriculture, and climate change, altering rainfall patterns, have accelerated ecosystem degradation and increased droughts and floods (Brouwer, van Aalderen, & Koop, 2021).

Water awareness is key to sustainable solutions. Despite initiatives by governments and international organizations, consumption habits remain a major challenge (Hussain, Hayat, Gong, Yang, & Lai, 2023). Many communities still perceive water as inexhaustible, hindering conservation efforts (Figueiredo *et al.*, 2024). This gap is particularly concerning among younger generations, whose awareness will shape future strategies. Environmental education can promote responsible consumption and the adoption of technologies for better water management (Bertiz, 2022b).

Assessing water awareness is crucial for identifying cognitive and behavioral barriers to sustainable practices (Pozo-Muñoz, Martin-Gamez, Velasco-Martínez, & Tójar-Hurtado, 2023). While informed individuals are more likely to adjust their consumption, concern alone does not guarantee action, calling for more effective educational and communication strategies (Lal, Sood, Thakur, & Kumar, 2023). Designing instruments to measure water awareness provides clear indicators to guide public policies and educational programs (Bassiouny, Awad, & Metry, 2024). Regular evaluation of these indicators can track the impact of awareness campaigns and enable timely adjustments, ensuring continuous social learning (Hein, D'Agostino, Donkor, Lin, & Sennema, 2023).

Theoretical models and empirical studies on water awareness in Latin America

Understanding how people move from knowing about environmental issues to actually doing something about them has long been a key concern in fields like environmental psychology and sustainability education. Over the years, several theoretical models have tried to explain this shift from knowledge to action. One of the most well-known is Ajzen's Theory of Planned Behavior (1991), which suggests that our actions are shaped by our attitudes, the social norms around us, and how much control we feel we have. Alongside this, the Value Belief Norm Theory proposed by Stern *et al.* (2016) highlights the role of personal values and ecological beliefs as drivers of environmental action. Both frameworks coincide on a crucial point:

knowing isn't enough. This mismatch between knowledge and behavior, often referred to as the knowledge–action gap, has been widely documented (Kollmuss & Agyeman, 2002).

In Latin America, this gap takes on particular importance, given the complex interplay of environmental, social, and political factors that influence water use and management. Research has explored how awareness and water-related behaviors are shaped by cultural values, access to information, and perceptions of institutional responsibility. For instance, Corral-Verdugo, Frías-Armenta, and González-Lomelí (2003) found that in Mexican communities, actions in favor of the environment tend to be more closely linked to moral obligation and ecological values than to purely technical knowledge. More recently, Sierra-Barón, Gómez-Acosta, and Saza-Quintero (2025) validated a tool in Colombia that measures water-saving attitudes and behaviors. Their findings point to a familiar pattern: while people express concern about water scarcity, their daily habits don't always reflect that concern.

Even with the growing academic interest in this topic, there is still a noticeable lack of solid, validated instruments in Latin America to measure environmental awareness, especially when it comes to water. Most studies continue to rely on ad hoc questionnaires, which often lack psychometric rigor and make it difficult to compare results across contexts. Bridging this gap means adapting instruments that are already well established, like the Ecobarometer of Andalucía, but doing so in ways that respect the linguistic, cultural, and conceptual specificities of Latin American settings. This study takes a step in that direction by validating a multidimensional scale that assesses knowledge, attitudes, practices, and perceived responsibility in relation to water management.

The Ecobarometer of Andalucia: context and characteristics

Several international instruments have been developed to assess environmental and water-related awareness and behavior, for instance, the New Ecological Paradigm (NEP) Scale (Dunlap, Van Liere, Mertig, & Jones, 2000), the Water Conservation Behavioral Intentions model (Trumbo & O'Keefe, 2001), and region-specific surveys in Asia (Hussain *et al.*, 2023). Additionally, recent methodological literature underscores the importance of cross-cultural validity and rigorous factor analysis in instrument design (Knekta, Runyon, & Eddy, 2019).

While these tools offer valuable insights, most lack a multidimensional and water-specific structure or lack cultural relevance for Latin American contexts. In contrast, the *Ecobarómetro de Andalucía* stands out for its conceptual robustness, psychometric rigor, and adaptability to new contexts, which justifies its selection for adaptation to assess water-related perceptions and behavior in Latin America.

The Ecobarometer of Andalucia, promoted by the General Secretariat for the Environment, Water and Climate Change of the Andalucia Regional Government (2018), has been a key tool for assessing environmental awareness and perception since 2001. Its objective is to analyze how citizens understand, value, and assume responsibility for environmental issues, providing empirical data to guide public policy and sustainability strategies. Over time, it has incorporated new variables and methodologies to address emerging challenges in climate change and environmental conservation (Borja & Garmendia, 2004).

Recognized for its methodological rigor, the EBA serves as a reference for environmental perception studies in Spain and beyond, identifying trends in ecological attitudes and behaviors and enabling longitudinal comparisons (Red2Red, 2021). It also examines information sources, trust in institutions, and perceptions of governmental sustainability measures.

Methodologically, it relies on a representative survey of the adult population in Andalucia, using stratified sampling to ensure demographic and geographic diversity. The 2021 edition surveyed 3,019 participants with a structured questionnaire combining closed-ended questions and measurement scales comparable to other national and international studies, ensuring reliability and consistency of indicators (Consejería de Sostenibilidad y Medio Ambiente de la Junta de Anadalucía, 2022).

The questionnaire assesses concerns about climate change, pollution, natural resource management, and the evaluation of local environments, as well as the frequency of pro-environmental practices like recycling, water and energy conservation, and responsible consumption. In 2021, it added questions on climate change management and trust in environmental policies (Junta de Andalucía, 2022). Technically, it employs tools like the New Ecological Paradigm Scale to measure ecocentrism and anthropocentrism, along with items on self-perceived environmental knowledge and perceived ecological impacts on quality of life.

Its methodology can be adapted for other regions, considering local conditions such as resource availability, public policies, and ecological awareness levels. Given the urgency of the global water crisis, an adapted Ecobarometer focusing on water perception and management could be especially valuable. In Latin America, where water availability and access are highly unequal, such an instrument would generate critical data for promoting sustainable water use and supporting targeted education and policy measures.

Methodology

This study aims to validate an adapted version of the *Ecobarómetro de Andalucía*, designed to assess perceptions, knowledge, practices, and attitudes specifically related to water management and pollution in a Latin American context. The adaptation involved selecting items from the original instrument based on two main criteria: thematic relevance to water-related environmental issues and conceptual alignment with the study's objective of measuring awareness, responsibility, and behavior. Items unrelated to water or focused on broader ecological topics were excluded to maintain focus and coherence. The selected items were organized into six conceptual dimensions, Information, Minimization, Practices, Perception, Action, and Responsibility, reflecting both the theoretical structure of the original instrument and the specific emphasis on hydric awareness. This structure was subsequently validated through exploratory and confirmatory factor analyses to ensure internal consistency and construct alignment.

This study focused primarily on practices and perceptions related to water and direct environmental responsibility; therefore, items that were too general, not explicitly related to water, or centered on environmental practices beyond the central purpose, such as specific recycling, energy consumption, or transportation, were excluded. This study focused primarily on practices and perceptions related to water and direct environmental responsibility; therefore, items that were too general, not explicitly related to water, or centered on environmental practices beyond the central purpose, such as specific recycling, energy consumption, or transportation, were excluded.

As part of the adaptation and validation process, some items were excluded due to low factor loadings (below 0.40) or cross-loadings that weakened the internal coherence of the dimensions. In particular, questions addressing broad environmental topics or presenting conceptual overlaps were removed to ensure the instrument's specificity and structural clarity. A complete list of excluded items and their corresponding statistical rationale is available upon request.

The reduction of the instrument resulted in a shorter and more focused tool, which improves parsimony and the quality of structural equation models (SEM) by reducing the number of free parameters, facilitating model identification, and minimizing the risk of overfitting with moderate sample sizes. Additionally, the exclusion of items with low item-total correlation contributes to greater internal consistency of the instrument, improving indices such as Cronbach's alpha, omega, and composite reliability. This methodological justification has been incorporated into the Methodology section of the revised manuscript.

Although no formal cultural adaptation protocol (cognitive interviews or expert panel review) was conducted, the selected items were carefully reviewed and modified by the research team to ensure conceptual clarity and contextual relevance for Latin American respondents. Adjustments focused on lexical clarity, cultural specificity, and alignment with

regional water-related concerns, while preserving the original intent and theoretical integrity of the items.

The study design followed a quantitative, cross-sectional, and descriptive methodology. Both exploratory and confirmatory factor analyses were conducted to assess the dimensional structure and reliability of the instrument. Data collection was carried out through online surveys using a non-probabilistic convenience sampling approach.

For validation purposes, the tool was applied to a sample of 96 participants from a higher education institution in Mexico. Participation was voluntary and anonymous, with an estimated response time of 15 minutes. Participants were undergraduate students between the ages of 18 and 25 ($M = 21.2$; $SD = 1.9$), with a balanced gender distribution (52% female, 48% male), and most were enrolled in social sciences or environmental studies programs. The invitation to participate was sent to approximately 200 students, yielding a response rate of 48%. Ethical principles were observed throughout the process, including informed consent and data confidentiality.

It is important to note that the sample was selected through non-probabilistic convenience sampling from a single university. While the instrument was conceptually adapted for broader Latin American use, the current findings are specific to a Mexican context and should be interpreted accordingly. This design decision aligns with the exploratory nature of the study, focused on evaluating the initial psychometric behavior of the adapted scale.

The language used in the questionnaire was carefully revised to ensure clarity and accessibility for university students, the target population of this study. Instructions were kept simple, and items were phrased in plain language to facilitate accurate responses.

Determining sample size is a key aspect in structural equation modeling (SEM) studies, as it ensures the validity and reliability of the results. According to the specialized literature, the required sample size depends on both the expected effect size and the structural complexity of the model (Cohen, 1988; Westland, 2010).

To calculate the minimum sample size required for SEM, the methods recommended in the literature were applied, including the cumulative distribution function (CDF) for the normal distribution, the error function, and the specific formula for minimum sample size in SEM (Westland, 2010). This procedure allowed for the consideration of the model structure, anticipated effect size, significance level, and statistical power, ensuring that the sample was adequate for the validity and stability of the results obtained.

In this study, under the parameters of a medium effect size (0.4), six latent variables, twenty-five observed variables, a significance level of 0.05, and a statistical power of 80%, a minimum of 77 participants is required to detect the expected effect. Furthermore, considering the structural complexity, the literature recommends at least 94 cases as the minimum sample size for proper estimation (Westland, 2010).

The sample used in this study consisted of 96 participants, exceeding the minimum recommended for the structure and complexity of the proposed model.

To evaluate the internal reliability of the instrument, Cronbach's alpha, McDonald's omega, and Jöreskog's rho coefficients were calculated. Factorial validity was assessed through exploratory and confirmatory factor analyses, considering data suitability using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. In addition, factor loadings were analyzed to verify the alignment of each item with its corresponding theoretical dimension.

Variables

The adaptation of the instrument resulted in a structured questionnaire comprising six key dimensions, defined through a theoretical and conceptual analysis of the selected items. These dimensions assess various aspects of environmental perception, ranging from the level of information and ecological awareness to individual and collective actions in response to the water crisis. The structure of the instrument facilitates the identification of behavioral patterns and the attribution of responsibility regarding water management.

In addition to the main dimensions, control variables were included to explore their potential influence on the relationships among the measured constructs. These variables include beliefs about environmental self-regulation, perceived environmental impact on daily life, assessment of the local water situation, and denial of human impact on climate change. Their inclusion allows for a more robust analysis by providing contextual insight into the factors that may shape water-related perceptions and practices.

Table 1 below presents the dimensional structure of the instrument, detailing the definitions and justifications for the items included in each category. This conceptual organization supports construct validity assessment and ensures the instrument's internal coherence, enabling its replicability in future studies on environmental perception and behavior in the context of water resources.

The adapted items used in this study were selected from the *Ecobarómetro de Andalucía*, an instrument developed and validated by the Junta de Andalucía (see Junta de Andalucía, 2022). The full version of the original questionnaire is publicly available and includes the complete set of items from which this adaptation was derived.

The questionnaire was carefully structured into six main dimensions, each based on the literature on environmental awareness and adapted to the water context. The first dimension, Information on Environmental Problems, includes items that assess participants' level of knowledge about the causes, consequences, and solutions to environmental problems related to water. The second, Minimization of Personal Responsibility, contains statements that explore the tendency to justify or shift environmental responsibility, such as believing that pollution is a natural process or that only companies are responsible. The third dimension, Everyday Environmental Practices, groups questions about daily sustainable habits, such as the use of biodegradable products or careful water consumption (Table 1).

The fourth dimension, Perception of Responsibility, includes items that analyze to whom participants attribute the responsibility for addressing environmental problems and their own level of environmental concern. The fifth dimension, Participation and Responsible Consumption, measures concrete actions of environmental commitment, such as reducing the use of plastics, researching the environmental impact of companies, and participating in cleanup initiatives. The sixth, Domestic Water Management, consists of questions about specific behaviors to reduce water consumption and pollution at home. Additionally, control variables were included to capture specific concerns (such as microplastics) and beliefs that may influence responses, such as the perception of personal impact or attributing responsibility to others (Table 1). This organization ensures that each section and each item have a clear purpose directly related to the study's objectives, facilitating both participants' responses and the subsequent data analysis.

Results

The factor analysis results confirm the instrument's validity and reliability, with all dimensions showing adequate factor loadings and acceptable internal consistency. In the *Information on Environmental Issues* dimension, items p1 (0.836), p2 (0.881), and p3 (0.924) displayed high loadings, while p4 (0.670) showed a moderate one. Reliability values were strong ($\alpha = 0.856$, DG Rho = 0.899, Rho_A = 0.999) (Table 2).

The *Domestic Water Management* dimension also showed a robust structure, with p9 (0.918) and p10 (0.932) exceeding 0.910 in factor loadings. Reliability was excellent ($\alpha = 0.832$, DG Rho = 0.922, Rho_A = 0.837) (Table 2).

In the *Minimization of Personal Responsibility* dimension, all loadings exceeded 0.685, and reliability was acceptable ($\alpha = 0.719$, DG Rho = 0.831, Rho_A = 0.865) (Table 2).

The *Daily Environmental Practices* dimension presented loadings above 0.810 across all items, with suitable reliability ($\alpha = 0.773$, DG Rho = 0.865, Rho_A = 0.792), confirming the internal coherence of the items (Table 2).

Table 1. Variables and dimensions

Dimension	Description	Items	Justification
Information on environmental problems	Knowledge about the causes, consequences, and solutions to water-related environmental problems	p1. I feel informed about the causes of environmental problems associated with water p2. I feel informed about the measures to deal with environmental problems p3. I feel informed about the effects of the problems p4. I feel informed about environmental problems	Understanding these issues can influence responsible behavior and environmental awareness
Minimization of personal responsibility	Tendency to minimize or shift responsibility for environmental issues to others	p7. The extinction of species is a natural process that should not worry us p20. I do not feel responsible for throwing chemical waste into the sewers p21. The climate crisis is so serious that it makes no sense to intervene	Explains barriers to proactive environmental action; helps understand beliefs that can hinder sustainability
Everyday environmental practices	Daily habits that reduce environmental impact, like using eco-friendly products and saving water	p13. I encourage the use of environmentally friendly cleaning products p14. I take care of water when washing dishes, clothes or bathing p15. I check that cleaning products are biodegradable	Measures actual sustainable behaviors in everyday life
Perception of responsibility	To whom and how strongly environmental responsibility is attributed (e.g. government, society)	p22. The responsibility for addressing climate change lies with governments p23. It is society's responsibility to address climate change p25. Level of personal concern for the environment (scale 0–10)	Clarifies participants' sense of personal vs. collective responsibility for environmental action
Participation and responsible consumption	Actions reflecting personal commitment, such as participating in clean-ups or researching companies	p11. I reduce water consumption in my home by using eco-efficient technology p12. I reduce the consumption of single-use plastic products p16. I investigate the environmental impact of the clothing companies I consume p17. I participate in river cleanup initiatives	Reflects real engagement with environmental protection and sustainability at personal and community levels
Domestic water management	Specific actions to reduce water use and pollution at home	p9. I take care of the amount of water consumed in my home p10. I avoid using chemical products that pollute water	Direct measure of how people conserve water and reduce pollution in their daily household activities

(*continued*)

Table 1. Continued

Dimension	Description	Items	Justification
Control variables	Additional factors that may influence perceptions or behaviors	p5. I am concerned about the effect of microplastics on the environment p6. The environment can eliminate pollution and waste on its own.p8. Environmental issues have a direct effect on your health and daily life p18. How do you assess the environmental situation in your locality? p19. Our lifestyle does not impact the environment p24. The responsibility for addressing climate change lies with companies/NGOs	These variables help contextualize and interpret the main results, capturing specific concerns and beliefs

Note(s): The control variables included in the instrument capture specific beliefs and concerns that, while not forming part of the validated dimensions, provide insight into the broader cognitive and perceptual context of participants • *Microplastics (p5)*: Reflects awareness of emerging pollutants linked to water contamination • *Environmental self-regulation (p6)*: Measures the belief that nature can recover without human intervention, potentially reducing perceived need for action • *Personal impact (p8)*: Assesses whether environmental issues are perceived as affecting one's own health or daily life, which may influence motivation • *Denial of human impact (p19)*: Captures rejection of anthropogenic responsibility for climate change, a known barrier to behavioral change • *Externalization of responsibility (p24)*: Indicates the tendency to delegate environmental responsibility exclusively to external actors (e.g. companies, NGOs), rather than adopting shared accountability

Source(s): Authors' elaboration using Stata (18)

For *Perception of Responsibility*, p25 (0.825) and p22 (0.830) showed high loadings, while p23 (0.589) was lower, suggesting variability in interpretation. Still, the model remained robust, with $\alpha = 0.633$, DG Rho = 0.797, and Rho_A = 0.687, indicating moderate internal consistency but acceptable composite reliability (Table 2).

The Perception of Responsibility dimension yielded a Cronbach's alpha of 0.633, which, while marginally acceptable, suggests limited internal consistency. This may be partially explained by the conceptual heterogeneity of the items, which include both individual and institutional responsibility statements. Although the factor structure grouped these items together empirically, future refinements might consider separating them into distinct subdimensions to enhance reliability and theoretical alignment.

The *Participation and Responsible Consumption* dimension showed high reliability, with $\alpha = 0.828$, DG Rho = 0.851, and Rho_A = 0.885, confirming solid internal consistency and adequate composite reliability (Table 2). Factor loadings were strong, with p17 (0.900) as the highest, highlighting participation in environmental initiatives as central to this construct. Items p16 (0.807) and p11 (0.710) also recorded high loadings, indicating that adopting eco-efficient technologies and researching corporate environmental impacts are key indicators of environmental commitment (Table 2). Overall, factor and reliability analyses confirm the instrument's validity, with well-structured and clearly differentiated dimensions.

Control variables were excluded from the main dimensions due to low factor loadings, indicating weak associations with the core constructs. These variables act as contextual or moderating factors rather than structural components. For example, *Concern about Microplastics* (p5) addresses a specific issue without aligning with general responsibility or

Table 2. Measurement model – standardized loadings

	Reflective Information	Reflective Minimization	Reflective Practices	Reflective Perception	Reflective Action	Reflective Responsible
p1	0.836					
p2	0.881					
p3	0.924					
p4	0.670					
p7		0.685				
p21		0.919				
p20		0.748				
p13			0.827			
p14			0.811			
p15			0.838			
p25				0.825		
p23				0.589		
p22				0.830		
p17					0.900	
p11					0.710	
p12					0.633	
p16					0.807	
p9						0.918
p10						0.932
Cronbach	0.856	0.719	0.773	0.633	0.828	0.832
DG	0.899	0.831	0.865	0.797	0.851	0.922
rho_A	0.999	0.865	0.792	0.687	0.885	0.837

Source(s): Authors' elaboration using Stata (18)

practice constructs. Likewise, *Environmental Self-Regulation* (p6) and *Denial of Human Impact* (p19) reflect beliefs that may condition actions but are not direct indicators of behavior. *Personal Impact* (p8) relates to well-being but does not integrate with perception or behavior dimensions, while *Local Environmental Situation* (p18) measures contextual perception. Finally, *Responsibility Externalization* (p24) focuses on delegating responsibility to companies and NGOs, distinguishing it from the broader *Perception of Responsibility* dimension. These variables were treated as control factors to evaluate their influence without compromising the instrument's validity.

The discriminant validity analysis confirmed that each dimension measures a unique construct without significant overlap. The average variance extracted (AVE) for each dimension exceeded its highest squared intercorrelation, meeting the established criterion. The *Responsible* dimension achieved the highest AVE (0.8566), indicating strong construct definition. *Information* (0.697) and *Practices* (0.681) also showed high AVE values, while *Perception* (0.619) and *Action* (0.592) had lower yet acceptable scores, still surpassing the threshold for discriminant validity (Table 3). Overall, the instrument demonstrates a clear, differentiated factorial structure with well-defined constructs.

As shown in Table 3, the average variance extracted (AVE) for each construct exceeds the squared correlations between that construct and all others, confirming discriminant validity. This means that each dimension captures a unique aspect of hydric awareness and is empirically distinct from the others. For example, the Information and Practices dimensions, despite both relating to water-related behavior, do not overlap conceptually, as evidenced by their discriminant separation. Similarly, Responsibility and Perception maintain statistical independence, supporting the theoretical assumption that holding institutions accountable is a separate construct from personal attitudes or beliefs. These results reinforce the conceptual coherence of the adapted instrument and its capacity to measure differentiated but related components of hydric awareness.

Table 3. Discriminant validity – squared interfactor correlation vs. average variance extracted (AVE)

	Information	Minimization	Practices	Perception	Action	Responsible
Information	1	0.062	0.112	0.084	0.024	0.005
Minimization	0.062	1	0.030	0.030	0.002	0.149
Practices	0.112	0.030	1	0.141	0.138	0.173
Perception	0.084	0.030	0.1416	1	0.116	0.062
Action	0.024	0.002	0.138	0.116	1	0.027
Responsible	0.005	0.149	0.1735	0.062	0.027	1
AVE	0.697	0.632	0.6815	0.619	0.592	0.856

Source(s): Authors' elaboration using Stata (18)

The correlation matrix analysis confirms the internal coherence and differentiation of the instrument's dimensions, supporting its structural validity. Within each dimension, items present moderate to high correlations, indicating alignment with their constructs. In *Information on Environmental Issues*, strong correlations were found between p1–p2 (0.654) and p2–p3 (0.782), reinforcing internal consistency. In *Minimization of Personal Responsibility*, the p7–p21 correlation (0.615) reflects a solid association with the construct. *Daily Environmental Practices* showed high coherence, with p13–p15 correlating at 0.727 (Table 4).

For *Perception of Responsibility*, item correlations were not directly reported, but low correlations with other dimensions indicate clear differentiation. In *Domestic Water Management*, p9–p10 showed a strong correlation (0.713), confirming structural adequacy (Table 4). A notable negative correlation was observed between externalizing responsibility and participation in environmental actions (p23–p17: −0.384), suggesting that delegating responsibility to others may reduce active engagement (Table 4).

Overall, the analysis demonstrates a coherent and well-differentiated factorial structure, with items showing appropriate internal correlations and dimensions reflecting independent constructs.

The analysis of relationships among dimensions reveals notable connections between environmental knowledge, perceptions, and practices. *Information on Environmental Issues*, which measures knowledge of water pollution causes and consequences, correlates positively with *Perception of Responsibility* (0.307), suggesting that greater knowledge fosters recognition of shared responsibility among individuals, corporations, and governments. Its correlation with *Daily Environmental Practices* (0.325) indicates that knowledge can influence sustainable habits, though not decisively (Table 5).

Minimization of Responsibility, reflecting the tendency to attribute the environmental crisis to natural causes or shift blame, shows a moderate correlation with *Domestic Water Management* (0.378). This suggests that some individuals may downplay responsibility yet still engage in responsible household practices, possibly viewing water management as a practical rather than moral concern (Table 5).

Daily Environmental Practices correlate moderately with *Participation and Responsible Consumption* (0.371), indicating that individuals with sustainable daily habits are more likely to engage in higher-impact actions. These practices also show a stronger correlation with *Domestic Water Management* (0.416), supporting the link between everyday ecological habits and reduced water use and pollution at home (Table 5).

The results also show that "Perception of Responsibility" has a differentiated relationship with other environmental variables. A moderate negative correlation (−0.475) with "Responsible Action" suggests that individuals who attribute responsibility for addressing climate change and pollution primarily to external actors, such as governments or corporations, are less likely to participate in direct environmental actions. This finding points to a phenomenon of responsibility externalization, in which individuals justify their

Table 4. Correlation of indicators

	p1	p2	p3	p4	p7	p21	p20	p13	p14	p15	p23	p22	p17	p11	p12	p16	p9	p10
p1	1.00																	
p2	0.65	1.00																
p3	0.65	0.78	1.00															
p4	0.57	0.47	0.47	1.00														
p7					1.00													
p21					0.62	1.00												
p20					0.31	0.46	1.00											
p13				0.32				1.00										
p14	0.40							0.44	1.00									
p15				0.31				0.73	0.43	1.00								
p23									0.41									
p22			0.33							0.35								
p17								0.36	0.31									
p11																		
p12																		
p16																		
p9						0.32			0.48									
p10						0.43			0.41	0.34								
p23											1.00							
p22												1.00						
p17												−0.38	1.00					
p11											−0.33	−0.36	0.67	1.00				
p12												−0.32	0.57	0.93	1.00			
p16													0.51	0.33		1.00		
p9														−0.45	−0.46		1.00	
p10														−0.34	−0.33		0.71	1.00

Source(s): Authors' elaboration using Stata (18)

Table 5. Correlation of latent variables

	Inform ~ n	Minimi ~ n	Practi ~ s	Percep ~ n	Action	Respon ~ e
Information	1					
Minimization		1				
Practices	0.325		1			
Perception	0.307			1		
Action			0.371	−0.475	1	
Responsible		0.378	0.416	0.412		1

Source(s): Authors' elaboration using Stata (18)

inaction by believing that others should lead environmental efforts (Table 5). This may reflect a disconnection between environmental concern and agency, where participants intellectually recognize the seriousness of the crisis but do not translate that concern into personal commitment. As a result, their perceived responsibility becomes rhetorical rather than actionable, weakening their engagement in direct participation.

Conversely, the moderate positive correlation (0.412) between "Perception of Responsibility" and "Domestic Water Management" indicates that individuals who view the environmental crisis as a serious and shared problem tend to take concrete actions at home to reduce water consumption and prevent pollution. This implies that even if some individuals are not actively involved in high-impact environmental initiatives, they may still implement changes in their daily routines that contribute to sustainability (Table 5).

The factorial structure obtained highlights the multidimensional nature of water-related environmental awareness among university students. The six retained dimensions reflect not only knowledge and perception but also behavioral engagement and personal responsibility. These findings suggest that the adapted instrument captures a comprehensive range of competencies that are critical for designing educational and awareness-raising interventions tailored to the Latin American context.

Discussion and conclusions

The objective of this study was to validate an adaptation of the Andalucia Ecobarometer, focused on measuring individuals' perceptions, knowledge, practices, and attitudes toward water management and water pollution in a Latin American context.

Regarding the adaptation of the instrument, it is important to note that several items from the original questionnaire were excluded. This decision was based on two main criteria. On one hand, statistical criteria were applied, eliminating items that showed low factor loadings (below 0.40) or cross-loadings that negatively affected the internal consistency and validity of the proposed dimensions. On the other hand, items whose content did not directly align with the central objective of this study, specifically focused on practices, perceptions, and environmental responsibilities related to water, were also discarded. Thus, priority was given to including questions that clearly and relevantly addressed water-related issues, while more general environmental items, such as recycling practices, energy use, or transportation, were eliminated to ensure the relevance and specificity of the instrument within the context of this research.

Overall, the results confirm the instrument's validity and reliability. Through exploratory and confirmatory factor analyses, six key dimensions were identified—information on environmental problems, minimization of personal responsibility, daily environmental practices, perception of responsibility, participation and responsible consumption, and domestic water management, each demonstrating a well-defined structure and acceptable levels of internal consistency. These findings support the instrument's applicability for more

precise analysis of the factors influencing water awareness and environmental behavior in the region. Similar approaches to instrument adaptation and validation in Latin America have demonstrated that even when working with small samples, clear factorial structures and internal consistency indicators can provide robust initial evidence (Sierra-Barón *et al.*, 2025). This is consistent with methodological literature emphasizing that conceptual coherence and item selection are critical for scale validity, particularly in exploratory contexts (Knekta *et al.*, 2019).

The results indicate a positive association between environmental knowledge and both the perception of environmental responsibility and the adoption of sustainable practices, although this relationship is not necessarily decisive. Individuals with environmentally conscious habits in their daily lives were more likely to engage in broader environmental actions, consistent with previous studies that have underscored a link between environmental awareness and pro-environmental behavior (Gifford & Nilsson, 2014). However, one notable finding is the negative relationship between perceived responsibility and active environmental participation. This suggests that individuals who attribute responsibility primarily to external actors, such as governments or corporations, are less likely to engage personally in environmental mitigation efforts. This reinforces earlier claims about the knowledge–action gap, a phenomenon repeatedly documented in research on environmental perception and behavior (Báez Gómez, 2016).

Other studies have shown that this gap is particularly evident among younger populations, where pro-environmental attitudes do not always translate into behavioral engagement due to social, economic, or motivational barriers (Babutsidze & Chai, 2018; Corral-Verdugo *et al.*, 2003). These findings align with the moderate associations found in our study between awareness, perception, and concrete action.

Another significant finding is the moderate relationship between the minimization of personal responsibility and domestic water management. This indicates that even among participants who downplay their own role in the environmental crisis, there is a tendency to implement practical water-saving and anti-pollution measures at home. This behavior suggests that some environmental practices may be perceived more as matters of pragmatism or necessity than as reflections of a deeper ecological commitment.

Finally, the discriminant validity analysis confirms that the instrument captures distinct and structurally coherent constructs. Each dimension functions as an independent variable, with no significant conceptual or statistical overlap. This finding is particularly relevant for researchers and practitioners seeking to diagnose and intervene in specific aspects of water awareness, as it ensures that the instrument allows for targeted analysis and nuanced interpretation of environmental behavior patterns.

From a theoretical perspective, the findings of this study reinforce the principles of Ajzen's Theory of Planned Behavior (1991), particularly the role of perceived behavioral control and subjective norms in shaping pro-environmental action. The observed knowledge–action gap also supports the Value-Belief-Norm Theory (Stern *et al.*, 2016), which suggests that ecological behavior is more likely when individuals internalize environmental values and moral obligations. The correlation patterns identified in this study offer empirical support for both frameworks, while also highlighting the need to address motivational and perceptual barriers in environmental education.

Finally, as noted in the results, the relatively low internal consistency of the Perception of Responsibility dimension may reflect the coexistence of distinct subcomponents. Further studies could explore disaggregating this construct to improve both statistical performance and conceptual clarity.

Beyond the structural validation of the instrument, the responses gathered provide preliminary insights into water awareness levels among university students. Overall, participants demonstrated moderate concern for water pollution and a relatively high commitment to sustainable practices, particularly in domestic water management. However, lower scores in the Responsibility dimension suggest a tendency to externalize accountability,

which may hinder active participation in environmental solutions. These findings illustrate the instrument's potential not only as a psychometric tool but also as a diagnostic resource for educational and policy planning.

Theoretical and practical implications

From a theoretical perspective, this study contributes to the field of environmental perception and water awareness by validating an instrument that assesses how individuals internalize the water crisis and assume responsibility for its management. The adaptation of the Ecobarometer of Andalucia to the Latin American context broadens the scope of this type of assessment, enabling comparisons with other studies on environmental perception and ecological behavior (Pozo-Muñoz *et al.*, 2023). Furthermore, the findings may inform the development of theoretical models that delve deeper into the psychosocial factors influencing the adoption of sustainable practices.

From a practical standpoint, the validated instrument offers a robust tool for environmental education programs and public policy initiatives. Its application can support the design of more targeted strategies to promote water conservation and encourage responsible consumption habits across diverse population groups. For example, it may be implemented in secondary or university curricula to assess baseline awareness and monitor the effectiveness of sustainability content. Similarly, local governments or water authorities could deploy the tool to gauge public perceptions before and after awareness campaigns. A hypothetical municipal pilot program could, for instance, use the instrument to evaluate behavioral change following a campaign promoting household water-saving practices. Additionally, its potential use in longitudinal studies offers a means to track changes in hydric awareness over time and evaluate the long-term impact of environmental policies.

Limitations and future research directions

Despite the positive results in terms of validity and reliability, the study has some limitations. One limitation is that data collection was based on self-reported surveys, which may introduce social desirability bias. Some participants may have overstated their environmental knowledge or sustainable practices in an attempt to align with socially accepted norms (Dlangalala & Mudhara, 2020). To mitigate this effect, future studies could complement these findings with indirect evaluation methods or observational studies that provide more objective data on environmental behavior.

Also, although traditional recommendations suggest a minimum of 150 participants for factor analysis, recent studies indicate that smaller samples can yield valid and reliable results when the data meets specific criteria, such as high communalities, well-defined factor structures, and strong internal consistency (de Winter, Dodou, & Wieringa, 2009; Costello & Osborne, 2005). In this study, the adequacy of the sample was supported by robust KMO and Bartlett's test values, as well as high factor loadings and reliability indices across all dimensions. Nevertheless, the limited sample size remains a constraint and future research should aim to replicate these results with larger and more diverse populations.

Another limitation concerns the lack of a formal cross-cultural adaptation process. Although the instrument was adapted thematically for the Latin American context, no structured procedures, such as expert linguistic review or cognitive interviews, were applied prior to data collection. Future studies should include these steps to enhance the cultural and linguistic validity of the tool across diverse populations.

In addition, although a negative relationship was identified between the perception of responsibility and engagement in environmental actions, causality cannot be established. It is likely that mediating or moderating variables—such as sociocultural or economic factors—play a role in shaping this association. In this regard, longitudinal or experimental studies could offer a more nuanced understanding of these dynamics and their influence on the adoption of sustainable behaviors (Hussain *et al.*, 2023).

A relevant limitation of the study concerns the Perception of Responsibility dimension, which reported a relatively low Cronbach's alpha (0.633), potentially indicating some heterogeneity among its items. While its composite reliability (DG Rho = 0.797) suggests acceptable internal consistency overall, this finding invites reconsideration of its current unidimensional structure. Future research could explore whether a conceptual subdivision, for instance, differentiating between institutional responsibility and individual responsibility, would enhance internal consistency and clarify the interpretation of the underlying constructs.

The use of non-probabilistic convenience sampling may introduce selection bias, limiting the generalizability of the findings beyond the specific characteristics of the current sample. Although the instrument showed adequate factorial validity and internal reliability, its applicability across different cultural and demographic contexts remains to be evaluated. Therefore, future studies are encouraged to replicate the validation process with larger and more diverse populations, spanning various socioeconomic, educational, and geographic backgrounds, to confirm its robustness and strengthen its external validity, particularly for transnational and cross-cultural applications.

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References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. doi: 10.1016/0749-5978(91)90020-T.

Babutsidze, Z., & Chai, A. (2018). Look at me saving the planet! The imitation of visible green behavior and its impact on the climate value-action gap. *Ecological Economics*, *149*, 290–303. doi: 10.1016/j.ecolecon.2017.10.017.

Báez Gómez, J. (2016). La conciencia ambiental en España a principios del siglo XXI y el impacto de la crisis económica sobre la misma. *Papers*, *101*(3), 363–388. doi: 10.5565/rev/papers.2145.

Bassiouny, G., Awad, S., & Metry, M. (2024). Studying the role of social awareness in rationalizing water use in Beheira Governorate. doi: 10.21608/ijsrsd.2024.348824.

Bertiz, H. (2022a). The water awareness via drama: an experimental study on pre-service science teachers and their views. doi: 10.31219/osf.io/ntq2v.

Bertiz, H. (2022b). The water awareness via drama: an experimental study on pre-service science teachers and their views. *Education Quarterly Reviews*, *5*(1). doi: 10.31014/aior.1993.05.01.455.

Borja, Á., & Garmendia, J. M. (2004). Propuesta de regionalización ecológica para Andalucía. *Boletín de Medio Ambiente de la Junta de Andalucía*, *8*(2), 67–85.

Brouwer, S., van Aalderen, N., & Koop, S. H. A. (2021). Assessing tap water awareness: The development of an empirically-based framework. *PLoS One*, *16*(10), e0259233. doi: 10.1371/JOURNAL.PONE.0259233.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed). Toronto: L. Erlbaum Associates.

Consejería de Sostenibilidad y Medio Ambiente de la Junta de Anadalucía (2022). *Ecobarómetro de Andalucía 2021*. Sevilla: Red de Información Ambiental de Andalucía.

Corral-Verdugo, V., Frías-Armenta, M., & González-Lomelí, D. (2003). On the relationship between antisocial and anti-environmental behaviors: An empirical study. *Population and Environment*, *24*(3), 273–286. doi: 10.1023/A:1021251128081.

Corral-Verdugo, V., Aguilar-Luzón, M. C., & Hernández, B. (2019). Bases teóricas que guían a la psicología de la conservación ambiental. *Acción Psicológica*, *16*(1), 39–52.

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research and Evaluation*, *10*(7), 1–9.

de Winter, J. C. F., Dodou, D., & Wieringa, P. A. (2009). Exploratory factor analysis with small sample sizes. *Multivariate Behavioral Research*, *44*(2), 147–181. doi: 10.1080/00273170902794206.

Dlangalala, S., & Mudhara, M. (2020). Determinants of farmer awareness of water governance across gender dimensions in smallholder irrigation schemes in KwaZulu-Natal Province, South Africa. *WaterSA*, *46*(2), 234–241. doi: 10.17159/WSA/2020.V46.I2.8238.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues*, *56*(3), 425–442. doi: 10.1111/0022-4537.00176.

Figueiredo, M., Teixeira Fernandes, A. C., Neves, J., & Vicente, H. (2024). Sustainable water use and public awareness in Portugal. *Sustainability*, *16*(13), 5444. doi: 10.3390/su16135444.

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology*, *49*(3), 141–157. doi: 10.1002/ijop.12034.

Gleick, P. H. (2018). *The world's water: The biennial report on freshwater resources*. Washington: Island Press.

Gomera, A., Villamandos, F., & Vaquero, M. (2013). Construcción de indicadores de creencias ambientales a partir de la Escala. *Acción Psicológica*, *10*(1), 149–160. doi: 10.5944/ap.10.1.2351.

Grønhøj, A., & Thøgersen, J. (2017). Why young people do things for the environment: The role of parenting for adolescents' motivation to engage in pro-environmental behaviour. *Journal of Environmental Psychology*, *54*, 11–19. doi: 10.1016/j.jenvp.2017.09.005.

Hein, C., D'Agostino, M., Donkor, C., Lin, Q., & Sennema, H. (2023). Editorial issue 1/2023: Water and heritage in action: Commitments for a sustainable future. *Blue Papers*, *2*(1), 6–9. doi: 10.58981/bluepapers.2023.1.

Hubbard, B., Gelting, R., Portillo, M. D. C., Williams, T., & Torres, R. (2013). Awareness, adoption and implementation of the water safety plan methodology: Insights from five Latin American and Caribbean experiences. *Journal of Water, Sanitation and Hygiene for Development*, *3*(4), 541–548. doi: 10.2166/washdev.2013.001.

Hussain, I., Hayat, W., Gong, S., Yang, X. D., & Lai, W.-F. (2023). A Comparative analysis of public awareness level about drinking water quality in Guangzhou (China) and Karachi (Pakistan). *Sustainability*, *15*(10), 8408. doi: 10.3390/su15108408.

Junta de Andalucía. (2022). Ecobarómetro de Andalucía 2021. *Sevilla: Red de Información Ambiental de Andalucía*, *1*(1).

Knekta, E., Runyon, C., & Eddy, S. (2019). One size doesn't fit all: Using factor analysis to gather validity evidence when using surveys in your research. *CBE-Life Sciences Education*, *18*(1), rm1. doi: 10.1187/cbe.18-04-0064.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior?. *Environmental Education Research*, *8*(3), 239–260. doi: 10.1080/13504620220145401.

Lal, M., Sood, A., Thakur, P. K., & Kumar, A. (2023). Creating awareness on water conservation among students: A Hamirpur study. *International Journal of Advanced Community Medicine*, *6*(2), 43–46. doi: 10.33545/comed.2023.v6.i2a.263.

Mogambi, H. (2025). Knowledge and awareness of corporate social responsibility in water projects in Narok, Kenya. *Deleted Journal*, *5*(1), 91–102. doi: 10.33093/jclc.2025.5.1.6.

Ortega, M. (2021). *Green Nudges. La economía del comportamiento aplicada a la toma de decisiones ecológicas y ambientalmente responsables*. Ciudad de México: Universidad Nacional Autónoma de México (UNAM). doi: 10.22201/fe.2021.192.

Pozo-Muñoz, M.-P., Martin-Gamez, C., Velasco-Martínez, L.-C., & Tójar-Hurtado, J.-C. (2023). Research and development of environmental awareness about water in primary education students through their drawings. *Education Sciences*, *13*(2), 119. doi: 10.3390/educsci13020119.

Red2Red. (2021). *Informe técnico del Ecobarómetro de Andalucía 2021: Metodología y análisis de datos*. Sevilla: Junta de Andalucía.

Sasa, T., Ahmad, W., Khuzaie, R., Bahtiti, N. H., & Miri, O. (2024). *Sustainable water use practices: Behavior and knowledge awareness of applied science private university-students*. Athens: WSEAS Transactions on Environment and Development. doi: 10.37394/232015.2024.20.38.

Sierra-Barón, W., Gómez-Acosta, A., & Saza-Quintero, A. F. (2025). Validity and reliability evidence of a water-saving instrument in the Colombian population. *Ánfora*, *32*(59), 344–373. doi: 10.30854/anf.v32.n59.2025.1153.

StataCorp (2025). *Stata statistical software: Release 18*. College Station, TX: StataCorp LLC.

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (2016). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human Ecology Review*, *6*(2), 81–97. doi: 10.2307/4603098.

Trumbo, C. W., & O'Keefe, G. J. (2001). Intention to conserve water: Environmental values, reasoned action, and information effects across time. *Society and Natural Resources*, *14*(6), 471–486. doi: 10.1080/089419201753242797.

UN (United Nation) (2020). *World water development report 2020: Water and climate change*. París: UNESCO.

Westland, C. J. (2010). Lower bounds on sample size in structural equation modeling. *Electronic Commerce Research and Applications*, *9*(6), 476–487. doi: 10.1016/j.elerap.2010.07.003.

Further reading

Rojas, A., Fernández, N., & Ibáñez, C. (2020). Impacts of climate change on water availability in Latin America: Challenges and adaptation strategies. *Climatic Change*, *163*(2), 245–262. doi: 10.1007/s10584-020-02833-1.

Secretaría General de Medio Ambiente, Agua y Cambio Climático. (2018). *Tendencias en la percepción ambiental en Andalucía (2010-2018)*. Sevilla: Junta de Andalucía.

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