Australian Journal of Environmental Education (2025), 1–16
doi:10.1017/aee.2025.10084

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Water Sustainability among Secondary Education Teachers: Perspectives from Two Hispanic Cities

Alejandra Ramírez-Segado[1], Freddy Enrique Castro-Velásquez[2] and Alicia Benarroch Benarroch[1]

[1]Department of Didactics of Experimental Science, University of Granada, Melilla, Spain and [2]Faculty of Education, University Culture Research Group, Antonio Nariño University, Bogotá, Colombia
Corresponding author: Alejandra Ramírez Segado; Email: alermzsgd@ugr.es

(Received 18 February 2025; revised 22 August 2025; accepted 06 September 2025)

Abstract
This article explores how water conditions in geographical contexts could influence the construction of teachers' professional identities and, consequently, their knowledge and beliefs about water sustainability. Water sustainability is defined as the responsible management of water from a perspective that integrates environmental, social and economic sustainability principles. This quantitative study employed an ad hoc questionnaire, inspired by the New Water Culture principles as a conceptual sustainability framework. The instrument, designed with Google Forms, was administered to 221 secondary school teachers from two cities with contrasting water and cultural conditions: Bogotá (Colombia) and Melilla (Spain). Results indicate that teachers' knowledge and beliefs in both cities are not aligned with water sustainability principles, with no significant differences between the two groups due to their different water conditions. However, there are partial differences related to the respective personal experiences: in Bogotá, teachers show greater concern for water quality, whereas in Melilla the focus is more on the quantity available. These findings underline the importance of promoting teachers' professional development in water sustainability aligned with professional identities, as a key strategy for nurturing aware and engaged citizens. This approach is fundamental to tackle water stress challenges and foster a paradigm shift towards more responsible, sustainable lifestyles globally.

Keywords: New Water Culture; secondary education; sustainable education; sustainability; teachers

Introduction

One of the main challenges facing humanity in the 21st century is advancing towards sustainable development, based on a dynamic balance between environmental, social and economic dimensions (Purvis et al., 2019). The response from the educational sector to this global challenge is Education for Sustainable Development (ESD). Its objective is to achieve personal and social transformation for sustainable development. The member states of the United Nations committed to the incorporation of ESD in their formal and informal educational systems and recognised the fundamental role played by educators in ESD promotion (UNESCO, 2021).

However, each context integrates ESD into its education system in a distinct way. In the case of Spain, one of the countries where the study was carried out, the Spanish education act LOMLOE (Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica de Educación, 2/2006, de 3 de mayo, 122868-122953, 2020) includes sustainable development as one of its five key pillars for addressing the modern demands of society along with gender equality, children's

rights, personalisation of learning and digital competence. Prior to this law, the presence of ESD in the Spanish educational sphere was limited (Benayas et al., 2017; Rodrigo-Cano, 2019; Ramírez-Segado et al., 2023).

In Colombia, the other country involved in this study, the concept of sustainable development has been broadly integrated into the curriculum since the 1990s (Galeano-Martínez et al., 2016; MEN 1998b, Colombia, 1998a). While the environmental dimension has historically received notable attention in educational frameworks, recent studies indicate that its implementation is often uneven, and there is a growing recognition of the need to integrate social and economic dimensions more effectively (Cavalcanti-Bandos et al., 2021).

Water sustainability is the version of sustainability related to the management and conservation of this vital resource. Given the omnipresent nature of water in all of the processes involved in human development, the knowledge and beliefs of teachers in relation to water sustainability are crucial for all of their sustainable development-related teaching.

This study offers an inquiry into the knowledge and beliefs of secondary school teachers on water sustainability. It employs samples from the two cities where the authors reside, Melilla (Spain) and Bogotá (Colombia), with very different water realities and a comparable perspective between them. Whilst Melilla is characterised by a scarcity of water resources, Bogotá enjoys a robust water supply system. On the other hand, due to its maturity in water management, Melilla could present more stable technical conditions of water sustainability than Bogotá. We ask whether these differences affect teachers' knowledge and beliefs on water management and culture.

Theoretical framework

Water sustainability

The term water sustainability refers to the need to address challenges related to the long- term management and conservation of water resources. Its relevance derives from the recognition of water as a catalyst for sustainable development, as it acts as a link to all of the Sustainable Development Goals (UN, 2023).

The last two decades have seen an increase in studies related to water sustainability (Adetoro et al., 2021; Bai et al., 2022; Olawumi & Chan, 2018) focused on areas such as economic growth, water resource management, water security, water consumption, climate change and the circular economy. However, interest in the area of education is much lower (Olosutean & Cerciu, 2022).

The current state of the Earth and its aquatic ecosystems manifest the urgent need to foster the transition of citizens towards water sustainability. This scenario confirms the importance of promoting water sustainability-related ESD.

Water stress

According to the world report on water stress levels by the Food and Agriculture Organization of the United Nations (FAO) and UN-Water (FAO & UN-Water, 2021), water stress is defined as a decrease in freshwater resources due to a demand that exceeds the amount of water available in a given period or a quality unfit for satisfying needs. Based on data from 180 countries, this report indicated that in 2018, 18.4% of the total renewable freshwater resources available on the planet were withdrawn. In this same year, the south of Spain showed levels of water stress classified as low (25%–50%) and medium (50%–75%), while the North Africa region, where Melilla is located, suffered high water stress (75%–100%). In contrast, Colombia remained in the "no stress" category (0–25%).

Freshwater resources in Colombia are eight times above the world average and around twenty times those of Spain (World Bank, 2022). In the world water stress ranking created by World

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

Resources Institute (2023), Colombia occupies 126th place in contrast to the 29th position of Spain. In the case of Bogotá, the city has a robust water supply system comprising rivers, lagoons, reservoirs and an extensive network of pipes that capture, process and distribute water for the population (EAAB, 2021).

Melilla, a Spanish city in North Africa, faces a severe shortage of water resources, especially in the supply of drinking water. Its climatic conditions, characterised by low rainfall and high average temperatures, result in a negative water balance, with a clear inequality between precipitation and evapotranspiration (CAM, 2021). Given that its water resources, both surface water and groundwater, are threatened by drought and marine intrusion (MITECO, 2023), its main water supply source is a seawater desalination plant.

The concept of water stress is key to identifying regions where pressure on water resources is highest. This indicator is closely related to the water sustainability indicator, as the latter seeks to mitigate and prevent water stress through appropriate and responsible water management. In this regard, the relationships between water stress and water sustainability are fundamentally opposed: a territory free of water stress is, a priori, better positioned to achieve water sustainability. From the perspective of water stress, it could be concluded that Bogotá presents significantly better water sustainability conditions than Melilla.

Other divergent approaches influencing water sustainability: the New Water Culture

A territory without water stress may have favourable conditions, but it does not guarantee, by itself, sustainable water management. Water sustainability requires a more comprehensive, ethical and long-term approach that incorporates ecological, social, political and cultural elements.

From a socio-political perspective, Spain has a long institutional tradition of hydrological planning at the basin level, through public structures such as the hydrographic confederations. In contrast, Colombia presents a more fragmented framework, where in many rural areas water management falls to community organisations or to a low-capacity state apparatus.

On the other hand, both countries face different pressures. In Spain, the pressure comes mainly from intensive agriculture, tourism and the effects of drought. In Colombia, water resources are threatened by activities such as mining, agribusiness and the aftermath of the armed conflict.

In Spain, as a response to the traditional vision of water, focused on large hydraulic works (dams, water transfers, desalination plants . . .) and economic growth, in the 1990s the New Water Culture (NWC) was suggested. This movement, of an academic, social and political nature, driven by the New Water Culture Foundation (FNCA), promotes an ethical, democratic and ecological management of the resource. Although its influence has been uneven, it has contributed to fostering a more sustainable water culture and, since the beginning of this century, to consolidating the European Declaration for a NWC (2005).

The key principles of the NWC, in contrast to the traditional or Old Water Culture (OWC) were developed by Benarroch et al., (2021) within the six contexts shown in Table 1. The NWC aligns with the principles of ESD by promoting a holistic, ethical and responsible approach to water. Integrating these perspectives into education strengthens water sustainability and serves as a powerful foundation for developing key sustainability competences such as critical thinking, active citizenship and environmental awareness.

In contrast to this transforming trend already consolidated in Spain, in Colombia there is still an active debate on water as a human right, an issue that in the Spanish context has been widely recognised and integrated into public policies (Echeverría & Anaya, 2018; Lara & del Moral, 2020).

Based on this approach, it could be suggested, as a starting hypothesis, that Melilla, being part of a country with more mature water management, could present more stable water sustainability conditions than Bogotá, at least in terms of coverage and institutional control.

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

Table 1. Contexts that distinguish the New Water Culture from the Old Water Culture

Context 1. Water scarcity: anthropogenic activity or natural imbalance? Faced with the widespread conception that nature presents a water imbalance that can be corrected by humans, it is necessary to vindicate the idea that nature is the way it is and that we must adapt to it rather than correct it.
Context 2. Value of water: multidimensional or economic value? Water is an essential component of the economic activity of all countries. However, in contrast to this exclusively economic conception, the NWC claims its social, environmental and even sentimental and patrimonial value.
Context 3. Responsibility for water: shared by all or by governments? In contrast to the concept that water should be managed by governments, we must raise awareness of the importance of water governance, where we are all part of the problem and its solution.
Context 4. Saving water: reducing demand or increasing supply? In contrast to the widespread idea that the quantity of water available must be increased to meet human needs, the NWC advocates demand management through responsible water use.
Context 5. Tariff system: costs that penalise waste versus costs that do not encourage savings? With regard to water tariffs, an adjustment is proposed that, in addition to economic costs, takes into account environmental impacts.
Context 6. Responsible consumption and food: responsible consumption versus consumerism? In the face of the exaggerated consumerism (including goods such as technology, food and clothing) that has become established in our society, the NWC advocates environmentally responsible consumption and food.

Context and participants factors that influence water sustainability teaching

The teacher is positioned as a key actor in fostering responses to the growing global environmental challenges. Over time, the concepts used to prepare citizens for environmental and sustainability issues have evolved: from Environmental Education (EE), through ESD and Education for Sustainability (EfS), to the more recent Environmental Education for Sustainability (EEfS). This shift reflects a transformation from a nature-centred environmentalist approach to a more critical perspective, oriented towards social justice and recognition of the diversity of contexts. In this sense, the term EEfS seeks to articulate ecological knowledge with a transformative gaze committed to equity (Almeida, Moore & Barnes 2018). However, recent scholarship warns that conventional ESD frameworks often prioritise economic and social objectives over ecological considerations, which can obscure the ecological roots of unsustainability (Kopnina & Bedford, 2024). For the purposes of this work, given that it is developed in contexts that are very different from each other, the term ESD will be used, in accordance with UNESCO's proposal (2021). This choice promotes ESD as a widely accepted and transformative educational process that facilitates dialogue across diverse contexts and fosters a sustainable future without imposing a single cultural or pedagogical perspective.

A number of factors have an influence on the reach and quality of this teaching, including the official curriculum, textbooks, educators' personal experiences with water, their knowledge and beliefs (Kwee & Dos Santos, 2023; Tuncer et al., 2014).

The official curriculum reflects the knowledge considered essential for integrating learners into society (Sammel, 2016). Despite this, curriculum research has brought to light significant shortcomings that have a negative effect on water sustainability teaching. Among the most notable omissions are crucial issues such as water conservation (Pozo-Muñoz et al., 2023; Xiong et al., 2016), extreme events (floods and droughts)(Sammel et al., 2018), the concept of virtual water (McCarroll & Hamann, 2020), the aesthetic value of water, water legislation, water accessibility and water-related professions (Khiri et al. 2023). In addition to the points mentioned above, the official curriculum in Colombia shows notable heterogeneity and significant discrepancies across the three official documents currently in force, issued by the Ministry of National Education (Castro-Velásquez et al., 2024): *Lineamientos Curriculares* (MEN 1998b, Colombia, 1998a),

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

Estándares Básicos de Competencias (MEN Colombia, 2004), *Derechos Básicos de Aprendizaje* (MEN 2016b, Colombia, 2016a). This heterogeneity, reflected in the Colombian curriculum, highlights a lack of coherence, as some of the content presented in Table 1 —such as that associated with Context 3— align more closely with the principles of the NWC, whereas others —such as those in Context 6— are further from this perspective. Furthermore, the discrepancies reflect that the three official documents diverge in their treatment of content related to water culture.

In reference to textbooks, they continue to be one of the educational resources most used by teachers in schools. However, with respect to water, textbooks tend to offer a utilitarian (Gugssa et al., 2020), traditional and economic view of this resource (Cuello & García, 2019), relegating its heritage and emotional value, as well as minimising the influence of humans on water scarcity (Benarroch et al., 2022; Khiri et al., 2023). In response to water scarcity, they often promote supply augmentation through additional water infrastructure (Hussein, 2018). Furthermore, textbooks often present conceptual errors and promote unfounded beliefs and fragmented views about water, such as a simplified representation of the water cycle that omits the urban cycle, human management, indirect consumption, or industrial and domestic pollution. As shown in the study by Pozo-Muñoz et al., (2023), this partial view, present in a primary school textbook, is reproduced in students' conceptions and is particularly noticeable in the figures, models and graphical representations of phenomena related to this resource (Castelltort & Sanmartí, 2016; McCarroll & Hamann, 2020). As a result, teaching on water sustainability via textbooks requires a critical review that ensures a more comprehensive and contextualised understanding of water and its multiple dimensions.

Benarroch et al., (2022) studied and compared textbooks from Spain and Colombia. In addition to the previously noted trends, they highlighted that both contexts show a continued lack of a clear stance on water, even within a single textbook. This ambiguity was attributed to the absence of a clear ideological orientation in official curricula, which may lead textbook authors to adopt vague and eclectic approaches that do not conflict with dominant opinions.

Despite the importance of curriculum and textbooks as transmitters of public policies to educational contexts, recent studies have shown that teachers are primarily responsible for the actual implementation of these policies in the classroom (Snyder & Bristol, 2020). Teachers' professional teaching identities, built on teachers' personal and professional experiences throughout their lives, plays an important role in choosing which, among the many policies competing for their attention, will actually be addressed in classrooms (Almeida et al., 2018). If this is true in any teaching practice, in the field of environmental and sustainability education, it is even more so, because, as Hart (2003) argues, environmental issues are ethical issues, in a similar way as politics and religion are. In this context, teachers' personal experiences with water, such as exposure to scarcity or poor water quality, gain particular significance, as they provide a contextual and emotional dimension that can deepen their commitment to sustainability. These lived experiences, alongside their scientific, local, or regulatory knowledge about water, guide pedagogical decisions and shape their professional identities at the intersection of what they have lived, learned and taught. Although research on the influence of teachers' personal experiences related to water is still limited, existing studies reveal that those who have encountered water-related challenges are more likely to integrate content on water resources into their teaching (Kwee & Dos Santos, 2023; Tuncer et al., 2014), thus illustrating the powerful impact of identity on educational practice within ESD frameworks.

Finally, it should be noted that several studies indicate that teachers' knowledge of water has a significant influence on the way they teach about the resource (Beiswenger et al., 1991; Byker & Ezelle-Thomas, 2021; Fortner & Meyer, 2010; Johnston et al., 2008; McCarroll & Hamann, 2020). As teachers are confronted with new understandings of water, for example, by recognising it as a human right, as a contested common good, or as a resource affected by dynamics of power and inequality, they may begin to question their own educational practices, values and roles as agents

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

of change. This cognitive and reflective process can lead to an identity transformation, in which the teacher is no longer seen only as a transmitter of content, but as someone who educates for environmental citizenship, water justice or sustainability. In other words, critical knowledge about water can act as a trigger for teachers to reinterpret their educational purpose, their ethical commitments and their way of positioning themselves in the face of socio-environmental problems. Added to this is the ambiguity of these topics in the curriculum and textbooks. Recent educational literature lacks studies that specifically analyse knowledge and beliefs about water among practicing teachers, and even fewer that compare these perspectives among cities with contrasting water and cultural characteristics. This article aims to fill this research gap, providing new perspectives in this field of study. We propose to answer the following questions: What are the knowledge and beliefs about water sustainability of working teachers in Melilla and Bogotá? Are there significant differences between them? If so, could these differences be related to the professional teaching identities of the participants?

Methodology

Context and participants

The study was carried out with a sample of 221 in-service teachers of 15 to 16 years old students, distributed between Bogotá (Colombia, $n = 129$) and Melilla (Spain, $n = 92$). These cities were selected not only for being the authors' places of residence, but also due to the marked contrasts in their hydric conditions. On the one hand, their natural water availability contrasts, as Bogotá (Colombia) has a robust water supply system, while Melilla, a Spanish city located in North Africa, is characterised by a scarcity of water resources. On the other hand, Bogotá faces strong challenges in its water management due to urbanisation and pollution, which especially affects water quality.

The participation of teachers was completely voluntary, and the only criterion for inclusion was to be an active teacher in areas related to natural sciences (physics, chemistry, biology and geology) or social sciences (such as geography and history). The participants were recruited either face-to-face or via institutional contact with the management of the educational centres. The Bogotá sample covered teachers from 35 different schools, whereas in Melilla teachers from the city's nine existing centres participated.

Table 2 shows the sociodemographic characteristics corresponding to each locality separately, as well as the total consolidated sample.

The Bogotá sample was predominantly female, whereas the Melilla sample showed gender parity. Both age range and years of teaching experience are broad in both samples with an average age that varied from 45 to 46 and average teaching experience of 14–19 years. With regard to area, the respondent teachers belong to the specialisations of Natural Sciences and Social Sciences, with a greater frequency of the former, particularly among those from Melilla.

Instrument

To enquire into teachers' knowledge and beliefs on water sustainability, the questionnaire created by Benarroch et al. (2021) (https://doi.org/10.5281/zenodo.15561445). This instrument was designed based on the conceptual framework of the NWC. This Likert-type questionnaire consists of 27 questions, which include multiple-choice items, totalling 69 items. Responses are structured on a four-point scale (from 1 to 4) that indicates the degree of agreement with each statement. The questionnaire items were organised into four thematic blocks, which incorporate the six contexts of the NWC proposed by Benarroch et al. (2021) and described in Table 1.

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

Table 2. Sociodemographic characteristics of in-service teachers in Bogotá, Melilla and the combined sample

Variables		Bogotá teachers (n = 129)	Melilla teachers (n = 92)	Combined sample (n = 221)
Gender	Female	77 (59.7%)	46 (50%)	123 (55.7%)
	Male	52 (40.3%)	46 (50%)	98 (44.3%)
Age	Minimum–Maximum	28–68	25–66	25–68
	Mean (SD)	46.4 (10.2)	45.1 (10.4)	45.9 (10.3)
Area	Natural Sciences	68 (52.7%)	58 (63%)	126 (57%)
	Social Sciences	61 (47.3%)	34 (37%)	95 (43%)
Teaching experience	Minimum–Maximum	2–46	0–42	0–46
	Mean (SD)	19.7 (10.1)	14.4 (10.7)	17.4 (10.7)

Table 3. Relationship of the questionnaire items, questions, blocks, contents and contexts

Contexts	Contents	Blocks	Questions	N° items
C1	Influence of human activity on water scarcity	B1 Scarcity	1–9	17
C2	Valuing water	B2 Valuation	10–14	11
C3	Water responsibility			
C4	Water saving	B3 Saving	15–21	22
C5	Tariff system			
C6	Responsible consumption and diet	B4 Actions	22–27	19

Table 3 sets out the relationships between the items, content blocks and contexts of the questionnaire.

Block 1: Water scarcity. The NWC interprets scarcity as a problem resulting from irresponsible human activity and proposes a profound paradigm shift in water management. In contrast, the OWC tends to minimise these impacts and focuses on technical solutions that often exacerbate the crisis rather than resolve it.

Block 2: Valuing water. In contrast to the exclusively economic view of water upheld by the OWC, a sustainable perspective recognises the multidimensional value of water: social, environmental, emotional and heritage-related. Moreover, this perspective emphasises the importance of inclusive water governance, in which everyone assumes responsibility as part of both the problem and its solution.

Block 3: Water saving. While the traditional view focuses on increasing the amount of water available to meet human needs, the sustainable perspective advocates for demand-based management, promoting the responsible use of the resource. One of the key tools for reducing demand is water pricing, which must be carefully calculated based on environmental impacts.

Block 4: Water actions. In contrast to the excessive consumerism that prevails in today's society, a sustainable vision promotes the responsible consumption of goods (such as technology and clothing) and diet in harmony with the environment.

For the Bogotá context, although the same language is shared there are variations in terms of linguistics, idiomatic expressions and cultural references that may affect the comprehension of the respondents. Therefore, with the support of a group of 10 experts, the instrument was adapted in the following aspects:

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

a. The items related to water scarcity, given that it is a less relevant issue in Bogotá, were contextualised in the Alta Guajira region, an area of Colombia that experiences water stress conditions similar to those in Melilla
b. Some terms used in the Spanish context, such as "trasvases" (water transfers) and "desalinizadoras" (desalination plants) were unknown to the teachers from Bogotá. To improve comprehension, it was decided to redefine "trasvases" as "water transfers from river to river, sometimes via human-built channels," and "desalinizadoras" was replaced with "facilities that remove salt from seawater to convert it into drinking water."

Finally, the instrument for Bogotá retained the structure of the Spanish instrument, consisting of 69 items representative of the four blocks (https://doi.org/10.5281/zenodo.15561567).

Procedure

The questionnaire was administered in both cities from May to July 2023 in paper and digital format, via the Google Forms tool.

Cronbach's alpha was employed to evaluate the reliability of the questionnaire, both for the combined sample and for each individual sample. The results showed an alpha coefficient of 0.883 for the combined sample, 0.885 for the Bogotá sample and 0.904 for the Melilla sample, indicating fairly good to excellent internal reliability (George & Mallery, 2019).

The scores for the items whose formulation reflects a traditional view of water culture and, therefore, non-sustainable, were inverted to facilitate the interpretation of the results. These items have been identified with an "i" next to the item number.

To analyse the differences between the Bogotá and Melilla teachers, a new variable called *agreement index* with water sustainability was created. This index is the result of the difference between the desired response percentages and the non-desired response percentages. Once the scores of the negative items were transformed, the desired scores are found among options 3 (agree) and 4 (completely agree), whereas the undesired ones are 1 (completely disagree) and 2 (disagree). The *agreement index* has a range of values from −100 to 100, to the extent that a higher *agreement index* indicates greater agreement with water sustainability approaches related to the framework of the NWC. By consensus among the authors, only those results that reach a minimum value of 50% are considered to be aligned with the principles of water sustainability.

Furthermore, to study the possible significant differences between the responses provided by the Bogotá and Melilla teachers, the Mann–Whitney *U* test was employed, as the variables involved did not respond to a normal distribution according to the Kolmogorov–Smirnov test.

The results are grouped according to the blocks: "Block 1-Scarcity," "Block 2-Valuing," "Block 3-Saving" and "Block 4-Actions," which summarise the results of the items in each block of the questionnaire, respectively. Additionally, a variable entitled "Global" is included, obtained via the arithmetic sum of all of the items in the questionnaire.

All of the analyses were carried out with the statistical analysis software program IBM SPSS version 28.

Results

Table 4 summarises the results of the *agreement index* for the complete questionnaire and for each of the blocks from both samples, as well as the combined sample. The final column shows the two-tailed asymptotic significance of the Mann–Whitney *U* test, when comparing the Bogotá and Melilla results.

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

Table 4. Agreement index of each questionnaire block and comparative analysis between both samples

	Agreement index (%)			Comparative analysis	
Variables	Bogotá teachers	Melilla teachers	Combined sample	Mann–Whitney *U* (Z)	*p-value*
Global	45.1	42.5	44	−1.521	0.128
Block 1-Scarcity	35.0	15.5	26.9	−3.794	0.001*
Block 2-Valuing	49.6	57.9	53.1	−2.306	0.021*
Block 3-Saving	38.2	48.4	42.5	−4.583	0.001*
Block 4-Actions	59.6	50.9	56	−0.175	0.861

*Significant *p*-values ($p < 0.05$).

Table 4 indicates that:

a. The value of the *agreement index* with water sustainability for the "Global" variable stood at 44% for the combined sample, 45.1% for the Bogotá sample and 42.5% for the Melilla sample. These values indicate that the results obtained by the in-service teachers are far from the ideal benchmark (100%) for water sustainability.
b. An analysis of the results across blocks reveals a common trend for the samples. Specifically, Block 1-Scarcity consistently records the lowest agreement levels, followed by Block 3-Saving. In contrast, the Block 2-Valuing and the Block 4-Actions alternately occupy the top positions. In both the combined sample and the Bogotá sample, Block 4 reaches the highest values, while in Melilla, it is Block 2 that obtains the best results.
c. There are significant differences ($p < 0.05$) between Bogotá and Melilla teachers in blocks 1, 2 and 3. When comparing the *agreement index* in these blocks, it can be stated that the Bogotá teachers obtained a higher value than the Melilla teachers in Block 1-Scarcity, while the reverse is observed in Block 2-Valuing and in Block 3-Saving.

Dependence of results on sociodemographic factors

The differences in the responses provided by the teachers show a relationship with variables such as age and subject area.

Regarding age, it was observed that the teachers from Melilla in the 25 to 35 age range, the youngest in the sample, obtained the most favourable results in the study. This might be explained by the fact that this generation has grown up in a context of greater environmental awareness and wider access to information on the importance of conserving water resources.

In relation to subject area, it was found that teachers trained in Natural Sciences obtained higher scores compared with those from Social Sciences. This difference, consistently observed in both the individual and overall samples, may be attributable to their stronger understanding of scientific and environmental principles related to water sustainability.

Discussions and conclusions

The aim of this work is, above all, to extract educational implications for guiding and fostering teaching on water towards water sustainability.

The most noteworthy conclusion is that the conceptions and beliefs of the in-service secondary school teachers in Bogotá and Melilla, generally speaking, are not completely aligned with the principles of water sustainability defined by the NWC. This situation reflected in the low levels of alignment with water sustainability (overall agreement rate of 44%) has had, and will surely have,

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

negative repercussions both on the educational sphere and society in general. As noted by Byker & Ezelle-Thomas (2021), teachers' knowledge about water directly influences their teaching and, consequently, the formation of an informed and engaged citizenry. If teachers do not explicitly promote the importance of water sustainability, it is less likely that their students, future responsible citizens, acquire the awareness and competences necessary for making decisions orientated towards the conservation and protection of water resources.

Another general conclusion is that the contextual variables (water stress and political maturity) of the studied cities do not appear to be sufficiently significant to create a radical difference between the in-service teacher groups. This study examined several hypotheses:

a. From the perspective of water stress, it is hypothesised that teachers in Bogotá possessed more advanced conceptions than those in Melilla;
b. From the perspective of political maturity, the opposite was proposed.

The findings do not provide clear support for either hypothesis. Instead, they indicate only partial differences, which appear to be more closely associated with the personal experiences of teachers in each context.

The discrepancies in knowledge and beliefs between the teachers from Bogotá and Melilla could be related to specific factors that influence specific aspects and which may be compensating each other, resulting in the lack of significant differences in the overall results. This phenomenon can be understood through teachers' professional identities, which are shaped by personal experiences, sociocultural contexts and institutional frameworks (Almeida et al., 2018). In our results, teachers in Melilla, accustomed to chronic water scarcity, may perceive it as a natural or inevitable phenomenon, rather than as a consequence of human activity. At the same time, the frequent water supply interruptions in the region could enhance their appreciation of sustainable water management, relative to their counterparts in Bogotá. Furthermore, Melilla teachers may have developed more practical expertise in water conservation strategies. Competences in ESD depends not only on the curriculum or resources, but also on ethical stance and commitment to sustainability (Lozano & Barreiro-Gen, 2022), which may explain divergent approaches in different contexts.

In relation to the results of Block 1: Water scarcity, it is evident that water scarcity is a shared concern in regions with high levels of water stress. This finding is consistent with the results of Tuncer et al. (2014) who identified similar concerns among prospective teachers in Turkey, a territory also facing significant water stress. Nevertheless, as also noted by Dimenäs & Alexandersson (2012), the predominant perception mainly attributes this problem to the unequal distribution of water in nature, leaving the impact of human activity in the background. As a result, factors such as population growth or land degradation are often dissociated from water scarcity. An activity that proves especially striking for illustrating the influence of human activity in the context of Melilla involves observing both sides of the road that marks the border between the Spanish city and the Moroccan state. At a specific point along this route, on the right-hand side, there is a military shooting range that is completely deforested, while on the left-hand side lies an Islamic cemetery, where restricted access has allowed the Mediterranean vegetation to be preserved in all its splendour. The contrast between the landscapes shows how human activity affects water availability: deforestation promotes scarcity, while preserved vegetation helps retain moisture and protect water resources.

Although the result is common in both samples, the Bogotá group shows greater maturity or proximity towards the principles of water sustainability, reflecting a slight tendency in favour of recognising the influence of human activity on water scarcity. A plausible explanation for this phenomenon is associated with the normalisation of the problem in contexts of chronic scarcity. That is, in settings where water scarcity is a historical and prolonged condition (such as in Melilla), the situation may be perceived as "natural" or inevitable, and not necessarily attributable to

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

human action. In contrast, in Bogotá, where water scarcity is more episodic and linked to recent phenomena (such as uncontrolled urbanisation or the pollution of water sources), it may be easier to establish a direct connection with human activity.

The results of Block 2: Valuing water reveal that the perception of the different water dimensions is strongly influenced by local context and direct experience with availability of the resource. In the case of the Melilla teachers, their constant exposure to scenarios of water stress, such as water shutoffs and reliance on water supply technologies such as desalination plants, seems to foster a more holistic understanding that encompasses the ethical, environmental and social dimensions of water. Lummis et al. (2016) report similar results for Australian trainee teachers, who also live with limited water resources. In contrast, the Bogotá teachers, who work in a context of relative water abundance, tend to adopt a more traditional perception, focused mainly on the economic use of the resource. These findings reinforce the thesis of Tuncer et al. (2014) and Kwee & Dos Santos (2003), who draw attention to the fact that personal experience plays a crucial role in shaping knowledge and beliefs related to water sustainability.

With regard to Block 3: Water saving, a clear difference is observed in the approaches adopted by the Bogotá and Melilla teachers in relation to the management of the resource. The Bogotá teachers tend to favour increasing the water supply, especially in territories that are less developed and face serious water challenges. In contrast, the Melilla teachers opt for measures related to saving and efficient management of water, such as the reduction of supply network losses and the reuse of treated water. These differences may be linked to the influence of the local context in perceptions and priorities related to water management.

In Bogotá, a context of relative water abundance encourages management focused on optimising the resource, under the perception that there is enough water. On the other hand, in Melilla, a region with limited water resources, greater awareness may have developed regarding the need to adopt sustainable practices and efficient management policies to guarantee the supply.

In this regard, the work by Erbasan & Erkol (2019) underscores how teacher attitudes and behaviours, especially in relation to water management, are deeply influenced by the context in which they operate. In particular, communities that have historically depended on water for their subsistence may have a deeper connection to the resource and be more willing to conserve it. This reinforces the importance of local settings in the shaping of responses and approaches towards environmental problems.

Furthermore, both groups considered water transfers as key strategies for mitigating water shortages in regions of deficit. This result coincides with the findings of Benarroch et al., (2022) and McCarroll & Hamann (2020). However, this initiative strays from the principles of sustainable water management. The FNCA warns that this vision is one of the main misconceptions related to water. According to the FNCA (2023) "more transfers are not going to guarantee a greater amount of available water" because "transfers don't work for sharing resources between territories, due to the ever-increasing extension of drought, even to wetter areas." This approach underlines the need to move towards more sustainable and adaptive management models, instead of depending on solutions that, although they appear effective, fail to address the structural causes of water scarcity.

Lastly, in Block 4: Water actions, the results show marginally different approaches in the perception and attitudes towards water saving and resource management. The Bogotá teachers favour efficient water management in the home and opt for a diet with a reduced water footprint. For instance, to produce one kilogram of beef requires 15,000 litres of water, whereas a mere 1,800 litres are needed to produce a kilogram of wheat flour (Mekonnen & Hoekstra, 2011). This approach coincides with the findings of Ferguson (2022) in her study on postgraduate teachers in the Caribbean. In contrast, the Melilla teachers focus more on management of the urban environment and adapting to local conditions. This includes adopting more efficient measures in water use in local farming and urban infrastructure planning. The measures proposed by both teacher groups, taken as a whole, could promote new forms of responsible consumer behaviour and more sustainable eating habits.

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

In short, the findings of this study reveal that teachers from Melilla compared to those from Bogotá:

- Tend to normalise the water scarcity characteristic of their environment, attributing it mainly to natural factors and the unequal distribution of water in nature, without establishing a clear link to human activity.
- Show greater awareness of the multidimensional value of water and the urgent need to save it.

These results can be interpreted in light of teachers' professional identity, which is closely shaped by the personal and contextual experiences of each group. In the case of Bogotá, teachers express greater concern about water quality and its deterioration due to human practices. In contrast, in Melilla, the focus is on the quantity of water available, which explains their sensitivity towards saving water and valuing the resource in contexts of structural scarcity.

It is concluded that teachers' professional development programmes should involve educators and their professional identities from the early stages of planning. Teachers should be given the opportunity to articulate their thoughts in order to increase the likelihood of success of the programmes.

From the perspective of the NWC, the teachers' professional development programmes should take into account the following aspects:

- Managing water as a resource subject to human action (Context 1)
- Valuing water in its entirety (Context 2)
- Promoting a culture of participation and imagination. Defending the notion of water as a public resource, to be managed in the public interest (Context 3)
- Managing water through demand-based management policies rather than by increasing supply (Context 4)
- Saving and preserving water quality while altering natural systems as little as possible (Context 5)
- Managing water resources sustainably, addressing waste not only of water but also of objects and food (Context 6)

The results of this study indicate that teachers in Melilla face specific challenges with Context 1, whereas those in Bogotá show difficulties mainly with contexts 2, 3, 4 and 5. In Context 6, there are no differences between the two locations.

In this context, ESD has the responsibility of fostering the transition of society towards more sustainable ways of living and, for this to occur, there is a need to educate society as a whole in water stress prevention. Among the key aspects for ESD to address in relation to water sustainability is, on the one hand, the transformation of lifestyles in developed countries and, on the other hand, the slowing of population growth in the least developed countries. In the case of the former, a raising of awareness that our lifestyle, consumer and eating habits are closely related to water consumption, pollution and climate change is essential. With regard to the latter, it should be highlighted that demographic growth puts unparalleled pressure on water resources, underscoring the need to control birth rates as part of the struggle to curb increasing water stress.

In this scenario, the professional development of teachers in ESD is consolidated as one of the main socio-educational strategies to promote the transition towards a way of life in harmony with global water sustainability.

Limitations and future research

This study has limitations that should be acknowledged. It was conducted in two Hispanic cities, Bogotá and Melilla, which limits the generalisability of the findings. The cross-sectional design

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

captured teachers' knowledge and beliefs at a single point in time, without considering changes over their careers or in response to specific events. Data were collected only through a self-administered questionnaire, which is subject to social desirability bias and differences in item interpretation. Although the instrument was adapted for the Colombian context, linguistic and cultural nuances across settings may affect comparability. The study examined perceptions rather than classroom practice, leaving unaddressed how beliefs translate into instructional strategies. Sociodemographic variables (e.g., age, gender, subject area) were described only, and their influence was not deeply analysed. Moreover, the study also did not assess the impact of teachers' perceptions on students' learning outcomes, a crucial dimension of water sustainability education.

Future research should broaden the scope, employ longitudinal mixed-methods designs and analyse how beliefs shape students' learning and behaviour towards water sustainability.

Acknowledgements. The authors wish to express their gratitude to all the individuals and institutions that have contributed to the development of this work.

Funding statement. This work was supported by project TED2021.129474B.100, with funding from MCIN/AEI/10.13039/501100011033 and the European Union NextGenerationEU/PRTR.

Ethical standards. The study was conducted in accordance with the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the Department of Cooperation and Social Responsibility of the University of Granada (ML_09_09_23).

References

Adetoro, A.A., Ngidi, M., Nyam, Y.S., & Orimoloye, I.R. (2021). Temporal evaluation of global trends in water footprint, water sustainability and water productivity research. *Scientific African*, e00732. https://doi.org/10.1016/J.SCIAF.2021.E00732.

Almeida, S.C., Moore, D., & Barnes, M. (2018). Teacher identities as key to Environmental education for sustainability implementation: A study from Australia. *Australian Journal of Environmental Education*, 228–243. https://doi.org/10.1017/aee.2018.40.

Bai, W., Yan, L., Liang, J., & Zhang, L. (2022). Mapping knowledge domain on Economic Growth and water sustainability: A scientometric analysis. *Water Resources Management*, 4137–4159. https://doi.org/10.1007/S11269-022-03245-7/FIGURES/3.

Beiswenger, R., Sturges, E.L., & Jones, R. (1991). Water education in Wyoming: Assessing educators' knowledge of water topics and their use in the elementary curriculum. *Journal of Environmental Education*, 24–29. https://doi.org/10.1080/00958964.1991.9943066.

Benarroch, A., Castro-Velásquez, F.E., Clavijo-Cuervo, V.J., & Ramírez-Segado, A. (2022). La cultura del agua en los libros de texto. *Revista Eureka Sobre Enseñanza y Divulgación De Las Ciencias*, 1501. https://doi.org/10.25267/Rev_Eureka_ensen_divulg_cienc.2022.v19.i1.1501.

Benarroch, A., Rodríguez-Serrano, M., & Ramírez-Segado, A. (2021). New water culture versus the traditional. Design and validation of a questionnaire to discriminate between both. *Sustainability*, 2174. https://doi.org/10.3390/su13042174.

Benarroch, A., Rodríguez-Serrano, M., & Ramírez-Segado, A. (2022). Conocimientos del profesorado en formación inicial sobre la Nueva cultura del Agua. *Enseñanza De Las Ciencias*, 1–20. https://doi.org/10.5565/rev/ensciencias.3554.

Benayas, J., Marcén-Albero, C., Alba-Hidalgo, D., & Gutiérrez-Bastida, J.M. (2017). *Educación para la Sostenibilidad en España: Reflexiones y propuestas*, *Fundación Alternativas y Red Española para el Desarrollo Sostenible*. https://www.unirioja.es/servicios/os/pdf/Informe_Educacion_Sostenibilidad_Espana.pdf.

Byker, E.J., & Ezelle-Thomas, V. (2021). Preparing teacher candidates with global competencies: Taking action on the global water crisis with service learning. *Journal of Research in Childhood Education*, 268–280. https://doi.org/10.1080/02568543.2021.1880996.

CAM. (2021). *Plan estratégico Melilla 2020–2029*. https://pemelilla29.es/wp-content/uploads/2021/03/PEMELILLA-CAPITAL-TERRITORIAL.pdf.

Castelltort, A., & Sanmartí, N. (2016). Nuevos retos para educar a favor de una nueva cultura ambiental del agua. *Revista educ@rnos*, 75–96. https://revistaeducarnos.com/wp-content/uploads/2017/06/articulo-alba.pdf.

Castro-Velásquez, F., Ramírez-Segado, A., & Benarroch, A. (2024). Libros de texto y currículo oficial: Contribuciones a la Nueva Cultura del Agua en Colombia. *En María Díez-Ojeda, etal, (coords.) Sobre la Educación Científica y el Cuidado de la Casa Común: Necesidades y Perspectivas* (pp. 532–557).

Cavalcanti-Bandos, M.F., Quispe-Prieto, S., Paucar-Cáceres, A., Burrowes-Cromwel, T., & Rojas-Jiménez, H.H. (2021). Provision of education for sustainability development and sustainability literacy in business programs in three higher education institutions in Brazil, Colombia and Peru. *International Journal of Sustainability in Higher Education*, 1055–1086. https://doi.org/10.1108/IJSHE-07-2020-0247.

Cuello, A., & García, F. (2019). ¿Ayudan los libros de texto a comprender la realidad fluvial de la ciudad? *Revista De Humanidades*, 209–234. https://doi.org/10.5944/RDH.37.2019.22895.

Dimenäs, J., & Alexandersson, M. (2012). Crossing disciplinary borders: Perspectives on learning about sustainable development. *Journal of Teacher Education for Sustainability*, 5–19. https://doi.org/10.2478/v10099-012-0001-0.

EAAB. (2021). La infraestructura de acueducto. https://www.acueducto.com.co/wps/portal/EAB2/Home/acueducto-y-alcantarillado/la-infraestructuraAcueducto.

Echeverría, J., & Anaya, S. (2018). El derecho humano al agua potable en Colombia: Decisiones del Estado y de los particulares. *Vniversitas*, 1–14. https://doi.org/10.11144/Javeriana.vj136.dhap.

Erbasan, Ö., & Erkol, M. (2019). Análisis de los niveles de alfabetización ambiental de los docentes de primaria. *Revista Internacional De Investigación Educativa Contemporánea*, 311–324. https://doi.org/10.33200/ijcer.566198.

European Declaration for a New Water Culture. (2005). Declaración Europea por una Nueva cultura del Agua. https://sostenibilidadyprogreso.org/files/entradas/declaracion-europea-poruna-nueva-cultura-del-agua.pdf.

FAO & UN-Water. (2021). Progress on level of water stress. Global status and acceleration needs for SDG Indicator 6.4.2. https://doi.org/10.4060/cb6241en.

Ferguson, T. (2022). Envisioning low-carbon futures: Possibility and hope as part of climate change teacher education. *Environmental Education Research*, 1191–1208. https://doi.org/10.1080/13504622.2022.2099532.

FNCA. (2023). *Desmontando Falacias*. https://fnca.eu/desmontandofalacias/.

Fortner, R.W., & Meyer, R.L. (2010). Discrepancies among Teachers' priorities for and knowledge of freshwater topics. *The Journal of Environmental Education*, 51–53. https://doi.org/10.1080/00958960009598652.

Galeano-Martínez, J., Parra-Moreno, C., & Méndez-Sánchez, M.A. (2016). Environmental education and the Bogotá River: An intervention to be carried out in Cundinamarca (Colombia). *International Research in Geographical and Environmental Education*, 281–296. https://doi.org/10.1080/10382046.2016.1262510.

George, D., & Mallery, P. (2019). *IBM SPSS Statistics 25 step by step: A simple guide and reference*.15th edition, Routledge. https://doi.org/10.4324/9781351033909.

Gugssa, M.A., Aasetre, J., & Debele, M.L. (2020). Views of "nature", the "environment" and the "human-nature" relationships in Ethiopian primary school textbooks. *International Research in Geographical and Environmental Education*, 148–163. https://doi.org/10.1080/14616688.2020.1763564.

Hart, P. (2003). *Teachers' Thinking In Environmental Education: Consciousness and Responsibility*. Peter Lang Publishing.

Hussein, H. (2018). A critique of water scarcity discourses in educational policy and textbooks in Jordan. *The Journal of Environmental Education*, 260–271. https://doi.org/10.1080/00958964.2017.1373620.

Johnston, C., Gandy, J., Cunningham, C., & Glennon Slattery, C. (2008). An exploration of factors that influence the regular consumption of water by Irish primary school children. *Journal of Human Nutrition and Dietetics*, 512–515. https://doi.org/10.1111/j.1365-277X.2008.00880.x.

Khiri, F., Benbrahim, M., Kaid Rassou, K., Amahmid, O., Rakibi, Y., El Guamri, Y., Itouhar, M., Mrabet, N., Yazidi, M., Razoki, B., El Badri, A. (2023). Water education and water culture in curricula for primary, middle and upper secondary school levels. *Australian Journal of Environmental Education*, 37–54. https://doi.org/10.1017/AEE.2022.9.

Kopnina, H., & Bedford, T. (2024). From pseudo to genuine sustainability education: Ecopedagogy and degrowth in business studies courses. *Australian Journal of Environmental Education*, 574–587. https://doi.org/10.1017/aee.2023.39.

Kwee, C.T.T., & Dos Santos, L.M. (2023). An international study of high school teachers' experience of incorporating water resources in their teaching. *Frontiers in Education*, 1048. https://doi.org/10.3389/FEDUC.2022.1065228/BIBTEX.

Lara, A., & del Moral, L. (2020). El derecho humano al agua en España en el contexto europeo, implicaciones para las políticas y los modelos de gestión del ciclo urbano. *Relaciones Internacionales*, 305–326. https://doi.org/10.15366/relacionesinternacionales2020.45.014.

Lozano, R., & Barreiro-Gen, M. (2022). Connections between sustainable development competences and pedagogical approaches. In P. Vare & e. talt (Eds.), *Competences in Education for Sustainable Development: Critical Perspectives*. (pp. 139–144).Springer International Publisihin. https://doi.org/10.1007/978-3-030-91055-6_17.

Lummis, G.W., Morris, J.E., Lock, G., & Odgaard, J. (2016). The influence of ecological citizenship and political solidarity on Western Australian student teachers' perceptions of sustainability issues. *International Research in Geographical and Environmental Education*, 135–149. https://doi.org/10.1080/10382046.2016.1235359.

Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica de Educación, 2/2006, de 3 de mayo, 122868-122953. (2020). Boletín Oficial del Estado § I 340. https://www.boe.es/buscar/doc.php?id=BOE-A-2020-17264.

MEN Colombia. (1998a). *Lineamientos Curriculares Ciencias Naturales*. https://www.mineducacion.gov.co/1759/articles-89869_archivo_pdf5.pdf.

MEN Colombia. (1998b). Lineamientos curriculares ciencias sociales. https://www.mineducacion.gov.co/1759/articles-89869_archivo_pdf.pdf.

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

MEN Colombia. (2004). Estándares básicos de competencias en Ciencias Naturales y Ciencias Sociales. *La formación en ciencias: ¡el desafío! Estándares Nacionales de Educacion*(pp. 96–147). https://www.mineducacion.gov.co/1621/articles-116042_archivo_pdf3.pdf.

MEN Colombia. (2016a). Derechos Básicos de aprendizaje ciencias naturales. https://aprende.colombiaaprende.edu.co/sites/default/files/naspublic/DBA_C.Naturales.pdf.

MEN Colombia. (2016b). Derechos Básicos de aprendizaje ciencias sociales. https://aprende.colombiaaprende.edu.co/sites/default/files/naspublic/DBA_C.Sociales.pdf.

McCarroll, M., & Hamann, H. (2020). What we know about water: A water Literacy Review. *Water*, 2803. https://doi.org/10.3390/W12102803.

Mekonnen, M., & Hoekstra, A. (2011). National water footprint accounts: The green, blue and grey water footprint of production and consumption, Volume 1, Main Report. Daugherty water for Food Global Institute: Faculty publications. https://digitalcommons.unl.edu/wffdocs/85.

MITECO. (2023). Plan Hidrológico de la Demarcación Hidrográfica de Melilla (2022–2029). Anejo no2. Inventario de Recursos Hídricos. https://www.chguadalquivir.es/documents/10182/2565404/PHMelilla_ANEJO2.pdf/005e0d81-06ce-5a70-7d74-8858a77202d2.

Olawumi, T.O., & Chan, D.W.M. (2018). A scientometric review of global research on sustainability and sustainable development. *Journal of Cleaner Production*, 231–250. https://doi.org/10.1016/j.jclepro.2018.02.162.

Olosutean, H., & Cerciu, M. (2022). Water sustainability in the context of Global Warming: A bibliometric analysis. *Sustainability*, 8349. https://doi.org/10.3390/SU14148349.

Pozo-Muñoz, M.P., Martín-Gámez, 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*, 119. https://doi.org/10.3390/EDUCSCI13020119.

Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: In search of conceptual origins. *Sustainability Science*, 681–695. https://doi.org/10.1007/S11625-018-0627-5/FIGURES/1.

Ramírez-Segado, A., Rodríguez-Serrano, M., Castro-Velásquez, F.E., & Benarroch, A. (2023). Knowledge of trainee teachers about the new water culture: A comparative study between two Spanish Cities. *Sustainability*, 13672. https://doi.org/10.3390/SU151813672.

Rodrigo-Cano, D. (2019). La educación situación de la educación ambiental en tiempos de cambio climático. In E. R. Fernández-Reyes & D. Rodrigo-Cano (Eds.), *La comunicación de la mitigación ante la emergencia climática* (pp. 149–167). Egregius. https://idus.us.es/handle/11441/91491.

Sammel, A. (2016). Her beauty and her terror: A case study exploring the framing of water and extreme water events within formal education in Queensland, Australia and Saskatchewan, Canada. *Geoforum*, 164–175. https://doi.org/10.1016/J.GEOFORUM.2016.09.015.

Sammel, A., McMartin, D., & Arbuthnott, K. (2018). Education agendas and resistance with the teaching and learning of freshwater and extreme freshwater events. *Australian Journal of Environmental Education*, 18–32. https://doi.org/10.1017/AEE.2018.10.

Snyder, J., & Bristol, T.J. (2020). Expanding the role of teacher leaders: Professional learning for policy advocacy. *Education Policy Analysis Archives*, 1–36. https://doi.org/10.14507/epaa.28.4850.

Tuncer, G., Boone, J.W., Tuzun, O.Y., & Oztekin, C. (2014). An evaluation of the environmental literacy of preservice teachers in Turkey through Rasch analysis. *Environmental Education Research*, 202–227. https://doi.org/10.1080/13504622.2013.768604.

UN. (2023). *The United Nations World Water Development Report 2023: Partnerships and Cooperation for Water*. https://unesdoc.unesco.org/ark:/48223/pf0000384655.

UNESCO. (2021). *Berlin Declaration on Education for Sustainable Development*. https://en.unesco.org/sites/default/files/esdfor2030-berlin-declaration-en.pdf.

World Bank. (2022). Renewable internal freshwater resources per capita (cubic meters). https://data.worldbank.org/indicator/ER.H2O.INTR.PC?end=2019&start=1961&view=chart

World Resources Institute. (2023). 25 Countries Face Extremely High Water Stress World Resources Institute. https://www.wri.org/insights/highest-water-stressed-countries.

Xiong, Y.J., Hao, X.R., Liao, C., & Zeng, Z.N. (2016). Relationship between water-conservation behavior and water education in Guangzhou, China. *Environmental Earth Sciences*, 1–9. https://doi.org/10.1007/s12665-015-4873-x.

https://doi.org/10.1017/aee.2025.10084 Published online by Cambridge University Press

Author Biographies

Alejandra Ramírez-Segado is an Assistant Professor in the Department of Experimental Science Didactics at the University of Granada. Her research focuses on science education and education for sustainability, with particular emphasis on the New Water Culture.

Freddy Enrique Castro-Velásquez is a professor in the Faculty of Education at Antonio Nariño University in Bogotá, Colombia, and a member of the University Culture Research Group. His research interests focus on sustainability education, science education and teacher training in the experimental sciences.

Alicia Benarroch Benarroch is a Full Professor at the University of Granada, in the Department of Didactics of Experimental Science, with an extensive research background in science education and education for sustainability.

Cite this article: Ramírez-Segado, A., Castro-Velásquez, F.E., & Benarroch Benarroch, A. (2025). Water Sustainability among Secondary Education Teachers: Perspectives from Two Hispanic Cities. *Australian Journal of Environmental Education*, 1–16. https://doi.org/10.1017/aee.2025.10084