CULTURE, EDUCATION AND WATER RESOURCES MANAGEMENT: A LITERATURE REVIEW HIGHLIGHTING NEW RESEARCH OPPORTUNITIES

Sofia Deodoro dos Santos Camata

Pontifical Catholic University of Campinas

Orandi Mina Falsarella

Pontifical Catholic University of Campinas

Duarcides Ferreira Mariosa

Pontifical Catholic University of Campinas

Rubén Danilo Bourdon G.

Agrarian University of Colombia

Diego de Melo Conti

Pontifical Catholic University of Campinas

Abstract

Given that water is a conditioning and irreplaceable element to the existence of life on Earth, equally present and future populations also depend on water to ensure their continuity and economic activities, biological and sociocultural factors that develop. Based on a review of the scientific literature available in EBSCO and Web of Science databases, this study aimed to investigate and discuss the existing relationships between culture and education in the context of water resources management. We conducted a systematic literature review technique in conjunction with a bibliometric analysis with the support of Rayyan, Microsoft Excel, and VOSviewer software. For the data collection, we evaluated the sample regarding the number of annual publications, the mapping of publications, and the relations network between the keywords created to identify new trends and a research agenda. The results highlighted the complexity of the relationship between culture, education, and water resources, revealing the need to deepen and advance research on the subject. In the analysis, we identified the need to consider man as the leading actor in a new structure in which education will be the leading mobilizer for constructing a new cultural perspective on water resource management.

Keywords: water crises; environmental education; sustainability

1. INTRODUCTION

Water is a strategic resource for humanity since it is responsible for life on the planet, sustains biodiversity, food production in agriculture, industrial activities, energy generation, and supports all-natural cycles (TUNDISI; MATSUMURA- TUNDISI, 2020, p.15; CONTI, 2021). For human use, however, water must be made available clean, drinkable, and ready for consumption, this represents less than 1% of all water found on the planet. Continuous use and the search for perennial sources of supply over the years have led to water shortages through pollution and degradation in many regions of the world, heralding a global water crisis (MENDONÇA; SANTOS, 2006).

Water crises are originated mainly from intensive human actions, such as deforestation, urbanization, and soil sealing. Among all these actions, urbanization seems to be one of the main problems and challenges for water supply and sustainable development (CONTI et al., 2019; BRAZ; LONGO, 2021). Currently, there are 37 megacities on the planet, each with more than 10 million inhabitants. Certainly, ensuring the water supply in adequate quantities and qualities has become one of the biggest challenges in these environments; there is also the issue of all waste produced by the urban population, whose lack of treatment can lead to tons of debris dumped in waters, rivers, springs, groundwater, and lakes (TUNDISI; MATSUMURA-TUNDISI, 2015).

Current evaluations of the conditions under which water distribution occurs suggest radical changes in terms of its management. For adequate water resources management, it is essential to have information about treatment mechanisms and distribution systems, in all their varieties, integrating with the economic and social aspects that influence water resources (TUNDISI; MATSUMURA-TUNDISI, 2020, p. 15).

Water is part of a social-ecological system and requires attention to the risks and damages, often irreversible, that can affect both its availability and its quality. Therefore, water sustainability depends on the ecosystem´s biocapacity to ensure quality and enough quantities for present and future generations (JANNUZZI et al., 2020). Tundisi, Matsumura - Tundisi (2020, p. 91) proposes a new ethical model for water, where collective security is focused on the conservation of stocks and the water balance.

The dissemination of environmental education is important to achieve water security and sustainability and should address issues such as social mobilization, the need for well-designed technical solutions, as well as the importance of appropriate technologies. The goal is to promote a culture of responsibility and demand, added to the sense of technical and economic feasibility, as opposed to a culture of demagogic simplicity (OECD, 2015, p. 91). The awareness of the population for the preservation of water and the reduction of pollution sources has increased on behalf of efforts in environmental education but is still insufficient. There is also an effort in the academic area to promote deeper studies about water (TUNDISI; MATSUMURA-TUNDISI, 2020, p. 95).

The capacity to monitor water use and enforce water policies is a great challenge since the lack of a culture of compliance and environmental education on the part of users and consumers further hinders compliance with restrictive regulations and, consequently, the management of water resources. A collective engagement is necessary, where all participants are involved in the process (CONT et al., 2019). In this sense, education is an indispensable tool in the promotion and development of an environmental water

compliance culture. Thus, shortly, the capacity for inspection and also for actions control by the managers of water systems will be strengthened, resulting in the preservation of a common natural asset.

The preservation of water sources is undoubtedly essential due to their systemic importance for life (CONTI, 2021). But it is also necessary that the studies and research carried out can be applied to the development of awareness regarding water consumption patterns with the adoption of sustainable values.

Despite the intellectual efforts that have been made to face the problem of comprehensive water management, they have not been enough to guarantee access in quantity and quality to all inhabitants of our planet. Study and management approaches, such as society-nature (LATORRE; MALO-LARREA, 2019), ecosystem-culture (BOURDON-GARCÍA; BURGOS-SALCEDO, 2016), water-energy-food security nexus (NARANJO; WILLAARTS, 2020) or syndromes (PETSCHEL-HELD et al., 1999), seek to address the integral water problem. These approaches consider all dimensions associated with water resources, give them equal importance, and seek to understand the interrelationships within and between dimensions to address water issues and the needs of communities to recognize and implement sustainable solutions.

To assess the state of the art in which this theme is, the present study reviewed publications with approaches on the relationship between culture, education, and management of water resources, to investigate and discuss this relationship, as well as identify trends and research opportunities. Due to the difficulty in identifying publications that directly address the relationship between these three dimensions, the focus of the review was defined in understanding the intersection and interrelationships between the subjects (Figure 1).

Figure 1. Intersection and interrelationships on dimensions.
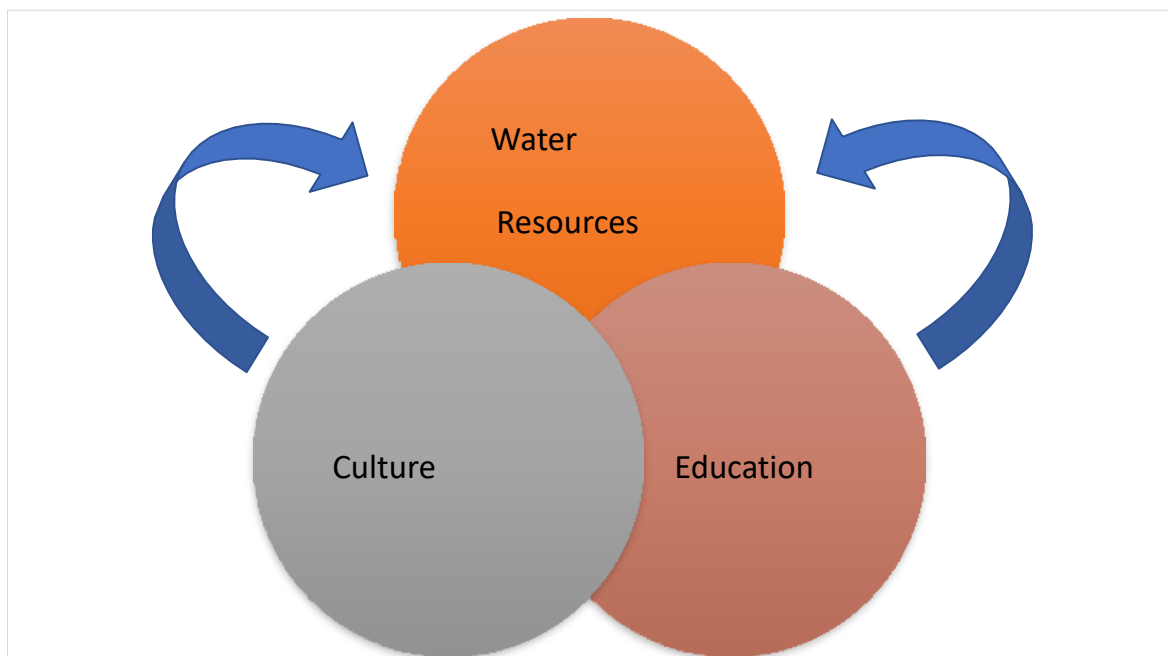
Source: Elaborated by authors, 2021.

It is expected that the proposals and suggestions presented in this paper will contribute to leveraging future studies, providing comprehensive guidelines on the relationship between culture, education, and water resources management.

2. THE WATER

Catastrophic phenomena caused by water variability, until recently, seemed to occur in regions far from the industrialized world. However, this has changed. Recurrent droughts in regions with high rainfall, such as England, and disastrous floods in desert areas of the Mediterranean basin, have highlighted how vulnerable we are when it comes to understanding and anticipating the behaviour of water.

In areas of intense urbanization, access to water human activities consumption has become a major challenge in terms of supply, distribution, and management (CONTI, 2021). Sulas e Pikirayi (2018) also explain that tradition and history provide different examples of how water scarcity, in some cases, and excess water, in others, was a trigger for the decline of different civilizations or motivated the development of social complexity.

Therefore, as precisely as water determined which civilizations would survive in the past, its importance for maintaining the sustainability of human life and all biodiversity on the planet is evident. Jannuzzi et al. (2020), from this perspective, highlights the importance of raising awareness throughout society about the conditions under which water resources are found today in all its dimensions, whether in the use of water in daily routine or decision- making about its exploitation and conservation by organizations in different sectors of the economy.

2.1. Water resources management and its relationship with education and culture

The waters that constitute rivers and lakes, together with the groundwater that forms aquifers and groundwater, are the primary source of food production, maintaining biodiversity and practically all human activity. This water is either relatively scarce or in the process of depletion. In the last hundred years these sources have been suffering the effects of a set of human activities: accelerated urbanization and intensive use of water, especially in agriculture and industry (TUNDISI; MATSUMURA-TUNDISI, 2020). According to Al-Weshah, Saidan e Al-Omari (2016), to the World Bank, water scarcity is among the main problems facing humanity and indicates that it may remain so in the future due to increased exploitation and side effects such as pollution and environmental degradation, which has been the cause of social and political instability in many countries.

It is known that the water crisis is mainly related to management problems and, nowadays, water governance is one of the major challenges and discussion issues. The public and private sectors that make up this governance need to take responsibility for managing water resources through public policies that meet the needs of the population in a sustainable way (TUNDISI; MATSUMURA-TUNDISI, 2020, p. 106).

Water governance, in turn, is often shaped to reflect a country's culture, legal regime, political system, and territorial organization. The water management system is made up of complex issues because it involves interests from all social representations (OECD, 2015, p. 41). These interests generally function

as mobilizers of different behaviours and attitudes according to each context-geographical, socioeconomic, cultural, political-which can generate positive or negative results for water resource management.

Fernández-García *et al.* (2021) consider the issue to be very broad, since water is a "polyhedral" resource, with different facets that change according to the multiple roles it plays in the environment, economic activities, public health, the liturgies of different cultures and religions, and even current issues such as gender difference.

Campos e Campos (2015) tells that in 1970 the problems of water resources were considered engineering problems and could be solved with works in which hydrology generated knowledge for application, mainly in hydraulic engineering. Kaspersma et al. (2012) suggest, however, that to face the challenges arising from hydric resources, professionals with specialization in specific disciplines are needed, but who also talk to other relevant disciplines. In this case, for an engineer, it is not enough to master an operational and theoretical knowledge of mathematical and physical principles, but also the understanding of processes, systems analysis, and computer modelling, laws and regulations, history, sociology, and ethics.

At present, productive activities require greater consumption of water, mainly because of human population growth and cities development (CONTI, 2021). Water pressure has also increased due to climate change, as this change has resulted in greater demand for water for irrigation and crop care in rural areas and human consumption and use in cities. Thus, conflicts arise over the use of water, as it is often necessary to face disputes regarding its use, whether for human consumption, irrigation, industrial use, among others.

Consequently, the water problem has even acquired a global, multidimensional, and multisectoral character and involves multiple interests and agendas. The direct consequence is complex management that highlights the limits of centralized and sectorized water resources management. Therefore, the great global challenge is the coordination of multiple stakeholders for decision-making and the involvement of all actors, that is, the integrated water management (MUNIZ-MIRANDA; REYNARD, 2020).

Environmental education dissemination is important and should address not only the social mobilization component but also the need for well-designed technical solutions, as well as the importance of skills and appropriate technologies. In a scenario of scarcity and continuously increasing water demand, it is increasingly recognized that improvements in water management cannot be achieved by technical or regulatory measures alone but must be combined with changes in behaviour and attitudes towards water use (WWAP, 2012, p. 436). Amahmid et al. (2019) argue that education, through a motivating and inspiring approach, can play a crucial role in transforming values and habits, aiming at the wise and sustainable use of water resources, and with permanent effects, by developing appropriate aspects of character, and thus establishing a new cultural attitude.

## 3. MATERIALS AND METHODS USED

As a widespread practice in academia, the literature review is an essential feature of research and lays the foundation for the investigations of any study (XIAO; WATSON, 2019). However, for a more efficient delimitation of the frontiers of knowledge on a given subject, which meets a series of pre-established criteria (MENGIST; SOROMESSA; LEGESE, 2020), research with more rigorous criteria is

necessary. The systematic review is a specific methodology that locates existing studies, selects, and evaluates contributions, analyses, and synthesizes data, and reports the evidence in a way that allows reasonably clear conclusions about the limits of what is known or not. (DENYER; TRANFIELD, 2009). According to Denyer e Tranfield (2009), most areas that use systematic review prescribe those studies should conform to a set of principles.

In this study, the authors followed the systematic literature review (SLR) methodology to identify and evaluate relevant publications addressing the existing relationships between culture, education, and water resources management dimensions. The main objective of this literature review was to detect and discuss research gaps and trends comprising the relationships between these three dimensions. It is worth remembering, however, that each research stream has its dynamics and becomes even more complex when three subjects or themes are addressed simultaneously.

To establish reliability, accuracy, and transparency in the literature search, a systematic literature review (SLR) approach consisting of five phases was used in this study. This approach was modified and adapted from similar methods previously introduced by other researchers: (1) formulation of the research question; (2) creation of prior database; (3) screening of prior database; (4) data analyses; and (5) data synthesis (BRIZOLA; FANTIN, 2016). Figure. 2 shows the flow of research used.

Figure 2: Research Flow.
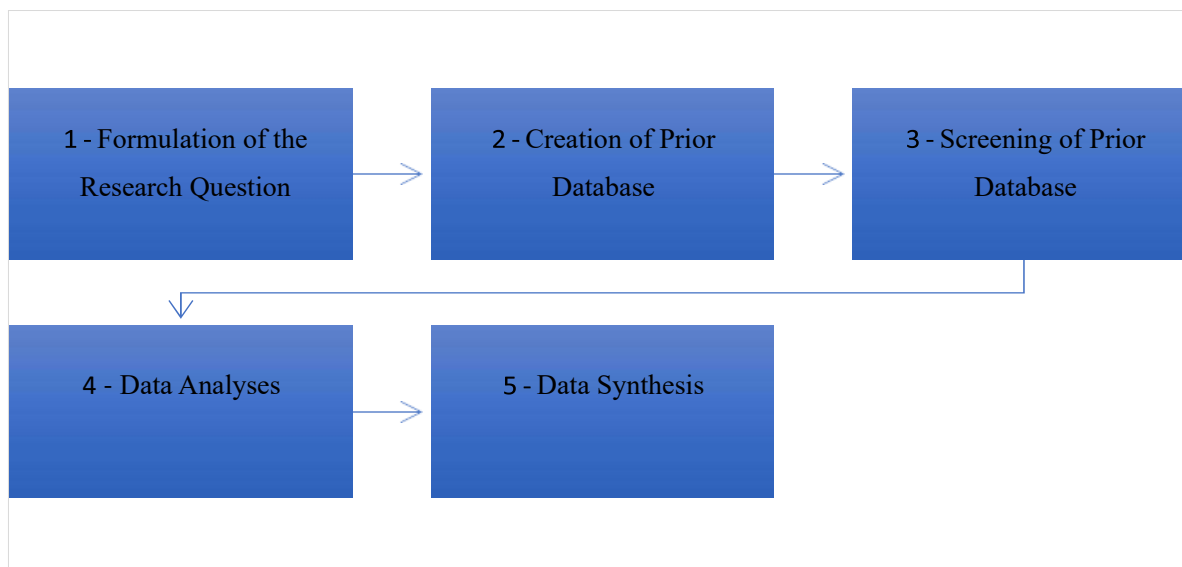
Source: Elaborated by authors, 2021.

In the first stage, as a starting point, the research problem that guided the entire process of the systematic literature review was formulated: "What is the relationship between culture, education and water resources management? ".

In the second phase, the objective was to establish a research protocol. In this sense, two major research bases were determined: EBSCO and Web of Science, to ensure the reliability and quality of the content. Following the exclusion/inclusion criteria, only peer-reviewed articles were considered in the period between the years 2011 and 2021, published in English, Portuguese, and Spanish languages,

containing the keywords of the question. Review articles, reviews, book chapters, and conference papers were excluded.

The set of keywords used to collect the documents as defined by the Boolean expression: < < < ("water resources management") AND (culture OR cultural OR ethnicity OR identity) AND (education)>>.

The collection was performed on 05/10/2021. The articles that contained the keywords in the title or abstract were used to create the previous database. This collection initially generated 64 articles, 58 in EBSCO and 6 in Web of Science. This collection contained duplicate documents, which were excluded, leaving the database with a total of 61 articles.

In the third step, with the Rayyan's help application (https://rayyan.ai/reviews/327654), the screening of the 61 articles that made up the previous database was performed, and the documents that contained the keywords in the title, abstract or keywords of the articles, but that the context did not refer to the subject of the study were excluded from the previous database. This left a total of 41 articles.

In the fourth stage, using Mendeley software for reference management, and Microsoft Excel software for spreadsheets, the data were coded and tabulated for subsequent descriptive analysis of the articles. As a complementary tool, we used the free-access software VOSviewer, which allows us to draw bibliometric maps, showing the network formed between the most cited keywords (Chàfer et al., 2021). The documents were classified according to the topic addressed, keywords, year of publication, and country of origin of the study. In this phase, graphs and tables were also prepared for the visual representation of the data analysed.

The fifth phase of the SLR was dedicated to the discussion of the results, identification of gaps, and possible future research in the field. During the interpretation phase, there was the contribution of articles and books on the subject.

4. RESULTS AND DISCUSSIONS

4.1. Keyword network analysis

The keywords in a scientific article represent the main issues addressed by the authors. In this research, a frequency analysis of all keywords in the 41 articles was carried out with the objective of identifying which are the main topics discussed when relating culture, education, and management of hydric resources in the established period. From this analysis, one can even establish not only the most explored knowledge areas in the subject but also the research "gaps". For a more precise interpretation of the terms, the synonymous words were grouped, being defined the minimum of 2 occurrences of the same word to compose the network of keywords (Figure 3).

For this analysis, the VOSviewer software was used. The application allowed the construction of relationship networks of keywords from the bases, which enabled the interpretation of the relationship between them. Through this mapping, it was possible to perform the analysis of the clusters created, and identify, for example, which areas interact among themselves to relate culture, education, and management of hydric resources.

When interpreting Figure 3, the keywords are represented by spheres, and their frequency by size. In this analysis for example, of the total of 299 keywords, 44 met the protocol of a minimum of 2

occurrences. The keyword "water supply" appeared in 9 articles and had 36 interactions with other keywords. The keywords "sustainable development" and "water management" were present in 6 articles, with 15 and 21 interactions respectively.

In this illustration (Figure 3), it is still possible to identify the mapping of five dominant areas grouped, represented by different colors. The red cluster includes terms related to water, irrigation, sanitation, sustainable development, and community programs; the green cluster has terms such as environment, management, policy, and health resources; the blue cluster water supply, water resources, water quality, wetlands, and sustainability; while the yellow cluster includes terms culture, water conservation and climate. And in the purple cluster appear the terms light computing, water management, human-water resources integration.

Figure 3. Network between the keywords.
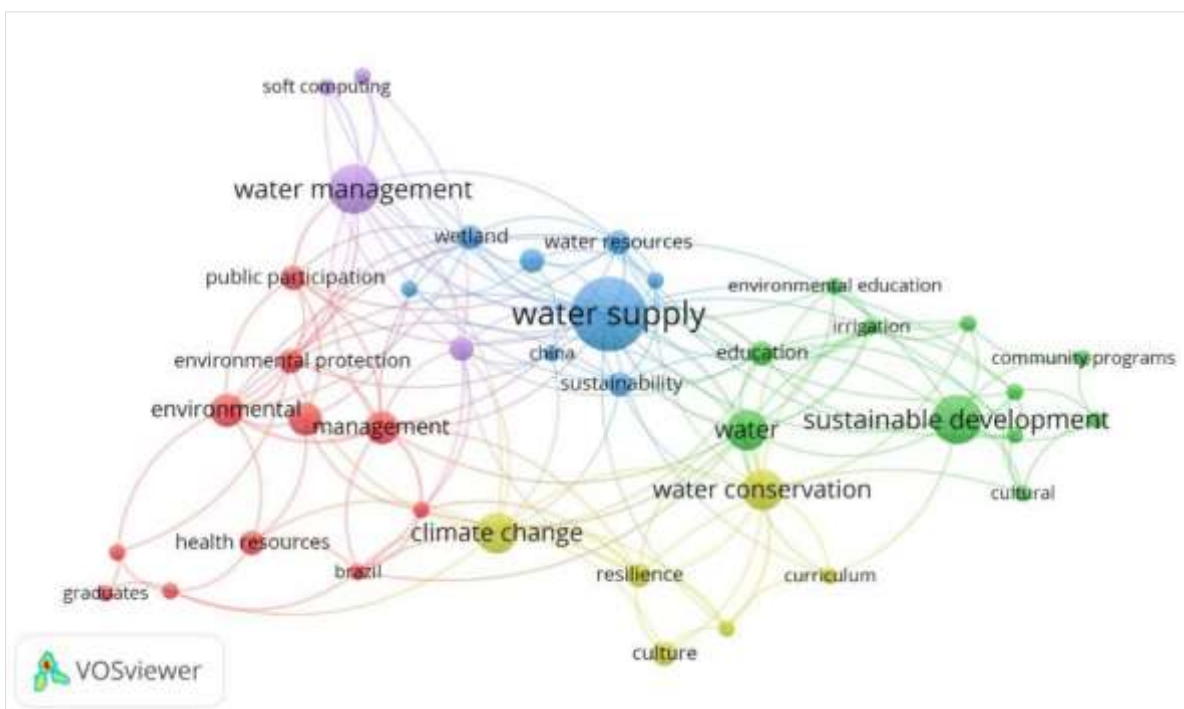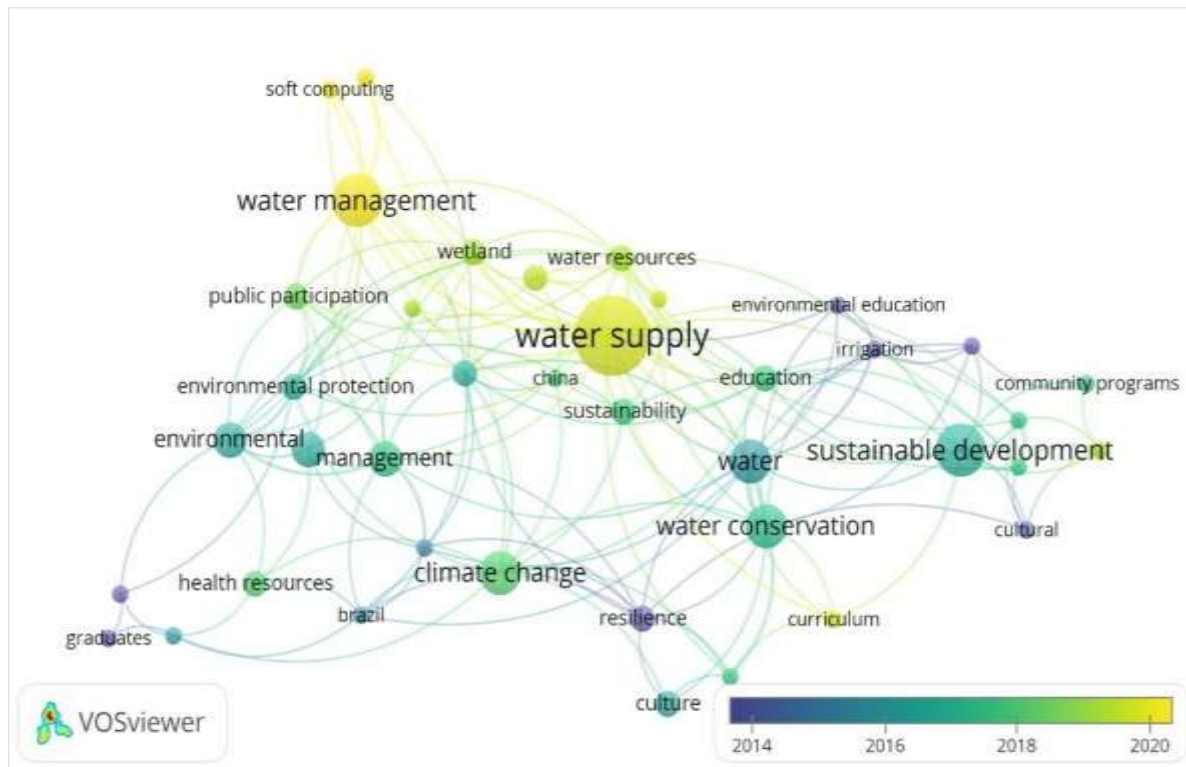

Source: Elaborated by authors, 2021.

In this network, it was possible to verify that the sphere of "sanitation" and "water resources" are in distinct clusters, meaning that they are rarely treated intimately in the same research. In this study, for example, there was only one connection. OECD (2015) study also recognizes as a challenge the fact that the national water resources management system does not establish satisfactory links with sanitation, which directly affects water quality, considering that contaminated water cannot be used without incurring high treatment costs.

In a second version of the network between the keywords (Figure 4), it was possible to note the periodicity in which these terms were most used in the papers. In this illustration, the closer to the blue tone, the older are the research, as the keywords "education" (environmental education) and "irrigation" (irrigation), for example, appear more frequently in studies near 2014. In contrast, yellow represents the

most recent studies, which can be understood as trends or research opportunities, such as water supply and lightweight computing.

Figure 4. Network between keywords in the period 2011-2021.

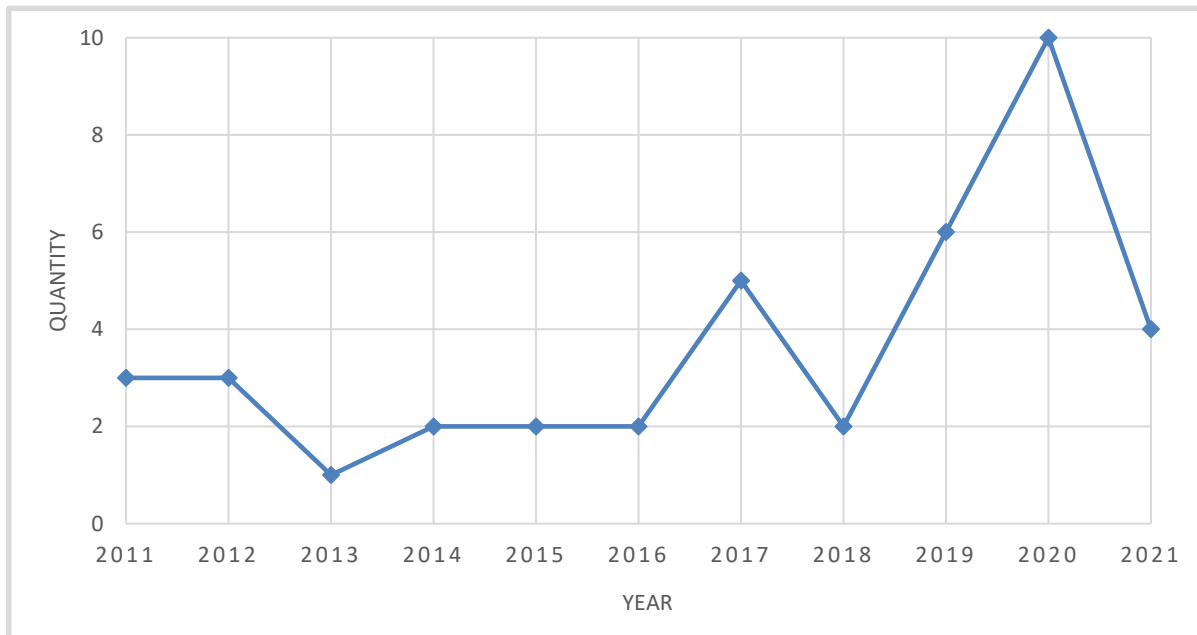**Source**: Elaborated by authors, 2021.

The keyword "water supply" had 9 occurrences indicating a strong interest in the area, while "soft computing" appeared in 2 recent studies, suggesting a new study, which can be interpreted as a research opportunity. The article by Zeinali et al. (2021) e Bozorg-Haddad, Baghban, Loáiciga (2021), suggest soft computing as a research method on the hydro-social cycle, focusing on the feedback systems between human and water interactions. Both studies recognize the human impact on the hydrological cycle as part of the dialectical development of water systems and social systems.

Another 2 studies identified in this review as a research opportunity, also present in the yellow zone, are those that adopt games as decision support tools. The article by Cheng et al. (2019) narrates the development of a board game based on problematic situations aiming to promote education on water resources management. The objective of the study from Onencan, Enserink, Van De Walle (2019) was to develop a negotiation game that could evaluate whether the diversity of personal attributes (gender, age, and education) influence decision making in water resources management negotiations.

4.2. Distribution of articles over the period defined in the research (2011-2021)

The first part of the study verified the flow of publications over the defined period between 2011 and 2021, as presented in Figure 5.

Figure 5. List of publications by year.

Source: Elaborated by authors, 2021.

Throughout the analysed period, the volume of publications on the subject increased. The first 5 years, 2011 to 2015, presented an average of 2 publications per year. In the following 5 years, 2016 to 2020, the annual average presented was 5 publications. Hydric resources are a theme studied worldwide, in the most diverse areas. These data represent growth in scientific interest on the topic of culture and education within the scope of hydric resources management.

4.3. Water resources management, culture, and education

Throughout document collection, it was observed that of the 41 articles, the term "education" was present in the abstract of 38 documents, while the term "culture" appeared in 19 abstracts.

In this sense, considering the studies with the term "culture" in the abstract signalled a gap in the scientific literature within the scope of water resources management. It is to be considered that any study that aims to implement improvements in the management of water resources and does not consider the need to combat the culture of water waste through misuse and environmental degradation will not have positive advances.

Education must play a central role in the process of change through the formation of individuals aware that water should be treated as a finite resource and that, therefore, there is a need to develop new technologies for its use, reuse, monitoring and control systems, involving all economic and social sectors.

It is through the improvement of the quality of education that it will be possible to identify the competencies necessary for the development of skills for behaviour change that can contribute to the construction of new models of water resource management, replacing the current culture.

5. CONCLUSIONS

The present study sought to investigate, analyse, and discuss the existing relationships between culture and education in the context of water resources management. To this end, it was carried out systematic literature review techniques in conjunction with bibliometric analysis and support from the Rayyan, Microsoft Excel, and VOSviewer software.

The research showed that although the scientific study on the topic of water resources is broad, when relating education, culture, and management of water resources, despite showing growth in the last 5 years, publications are still more restricted, revealing the need to produce new research that addresses education as a strategic means for changing the existing culture on the use of water as an inexhaustible resource.

We realize that the creation of new models of technological systems for the management of water resources is not enough if they are dissociated from an educational project aimed at raising people's awareness of the responsible use of water.

The analysis of the relationships identified the need to consider people as a fundamental key in a new framework in which education is the main mobilizer for the construction of a new cultural perspective on the management of water resources. Involving all stakeholders and capitalizing on the cultural values of the social system offers a chance to promote a debate necessary for the emergence of a new culture of intelligent and sustainable use of water as an essential element for life on earth.

As an underlying result, the systematic literature review evidenced the complexity of the relationship between culture, education, and water resources, revealing the need for further and advanced research on the subject.

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