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ECOSYSTEMS

Water springs: an immeasurable resource for ensuring sustainability

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Abstract: Water springs are manifestations of groundwater to the surface, forming and ensuring the supply and sustainability of streams, lakes, rivers, and dams. Therefore, its riparian forest is considered an area of permanent preservation, which aims to protect the water, as well as the spring, from consequences of disordered population growth, added to deficient basic sanitation systems, climate change, agricultural activities, inappropriate land uses, unplanned urbanization, and diffuse sources of pollution. In addition to compromising water quality, many of these factors affect the permanence of water upwelling at the source, compromising the formation and continuity of streams, lakes, and rivers. In this context, the objective of the present research was to carry out a bibliographic review on water springs, approaching adjacent themes to the main axis of the study that are fundamental for a deep understanding of their importance for the maintenance of water resources and ensuring biodiversity in the search for the sustainability of life for present and future generations. This research collaborates with the environmental view and shows that the function of a water sources is broader than its concepts can reveal.

Key words: development, environmental education, life, UN 2030 Agenda, water resources.

INTRODUCTION

Water springs are essential aquatic ecosystems for the sustainability of life, due to their functions in the formation and renewal of watercourses by allowing the passage of groundwater to the soil surface. These watercourses contribute to the formation of the contribution mesh of the hydrographic basin, a geographic unit constituted by an area of the earth's surface, which contributes to the formation and storage of a certain main watercourse. Machado & Soares (2018) emphasize that everything starts with water springs, which are responsible for the entire river/water network. In addition, its waters are often used for human consumption, watering animals, irrigation of crops, and various activities on rural properties that require water, reducing the growing pressure on underground reserves. In addition, their natural environments are important for animal and plant biodiversity, aquatic and terrestrial (Tundisi 2008, Calheiros 2009, Pinto 2019).

There is a great concern with these aquatic environments, which have great ecosystem importance that contrasts with the high vulnerability to anthropic interference. This fragility is the result of the intense relationship between aquatic and terrestrial environments that share their characteristics and vulnerabilities (Calheiros 2009, Pinto 2019). The disorderly population growth, added to deficient basic sanitation systems, climate changes, deforestation practices with suppression of riparian forests, agricultural activities, inadequate land uses, urbanization without planning, and other factors potentiate the process of deterioration of springs. It compromises the ecosystem functions of springs and affects water availability, in quantity and quality, generating several negative effects (Postel 1998, Jackson et al. 2001, Pinto et al. 2004, Hepp & Restello 2007, Balaji et al. 2012, IPCC 2014, Honda & Durigan 2017, Galvan et al. 2020, Daronco et al. 2020).

Tundisi (2003) emphasized that human actions that interfere with natural cycles and water availability, both quantity and quality, have compromised the sustainability of water resources. In this sense, the concept of water-environment sustainability, which refers to integrated management of water resources in a region, includes springs and involves various aspects of water, such as the hydrological cycle; the different uses of water; the interrelationship between natural and social systems; and the interdependence between the economic, social, and environmental scopes that characterize sustainable development (Vieira 1996, Bomfim et al. 2015).

In this context, the objective of the present research was to carry out a bibliographic review on water springs, approaching adjacent themes to the main axis of the study that are fundamental for a deep understanding of their importance for the maintenance of water resources and ensuring biodiversity in the search for the sustainability of life for present and future generations.

MATERIALS AND METHODS

This research is a narrative review of the qualitative literature, aiming to understand the importance of water springs for the sustainability of life. In this perspective, the following topics are presented: water spring: maintenance of water resources; water spring: maintenance of biodiversity; formation and classification of water springs; adverse environmental impacts on water springs; legislation pertaining to water springs; and water springs: a valuable resource for education and environmental awareness. The research was carried out through online access to the Google and Google Scholar databases, from October to November 2021. Scientific articles in any language, from national and international journals, and other documents that addressed themes about water springs were selected and analyzed. As it is a narrative-type review, there were no inclusion or exclusion criteria for the selection of materials used for the development of this research. Likewise, specific years were not defined for the selection and reading to compose the development of this research. This methodological configuration is described in the work developed by Rother (2007).

Water spring: maintenance of water resource

springs are outcrops from groundwater or artesian waters that create streams, rivers, and lakes. Springs are not the beginning of the hydrological cycle, but are important because it is from them that waters rise from the water table to the surface, forming and guaranteeing the supply and continuity of streams, streams, lakes, rivers, and dams. The flow of these water source varies depending on the layers responsible for its supply. In addition, it is interconnected with the hydrological cycle and, thus, has a direct relationship with precipitation, evapotranspiration, and infiltration, changing the position of outcrop points, according to the variation of the water table. In this way, water sources are susceptible to climate effects and may undergo changes in location and flow over the hydrological year (Valente & Gomes 2005, 2015, Brasil 2006, Romero 2017).

Springs have the function of maintaining the continuity of water courses, thus, in addition to a high amount of water, their flows should be distributed as uniformly as possible throughout the year. Therefore, the watershed's contribution area should not function as an impermeable container, draining off, in a short time, all the water received during rainfalls. It is essential that most of the rainwater is absorbed by the soil and stored in the water table, maintaining the springs perennial and, consequently, feeding rivers throughout dry periods. Thus, the management of hydrographic basins should preserve springs and promote different infiltration ways, avoiding disorderly use and occupation (Valente & Gomes 2015).

The rainwater that reaches the ground increases the groundwater availability and artesian water, intensifies water outcrops in springs, and benefits the entire hydrographic basin through its streams and forming rivers. These layers are natural underground reservoirs with great potential to store water in rainy periods, ensuring more regular water flows throughout the year (Roberti et al. 2008, Valente & Gomes 2015).

Each watercourse has its source, consequently, the number of watercourses in a watershed is equal to its number of sources, which are essential for the formation and sustainability of rivers. Thus, degradation of springs can harm water courses. Therefore, absence of protection of springs results in a lower water flow, then, water courses can dry up, harming the water quality and availability and affecting all living beings that depend on it to survive (Valente & Gomes 2015, Biggs et al. 2017, Stevens et al. 2021).

Water availability in water bodies and drinking water reserves are essential, not only for the development of agricultural activities, but for the supplying urban centers, industrial production, and generation of electricity (Zehnder et al. 2003, Baker & Miller 2013, Almeida et al. 2021). In Brazil, water resources support the economy, which is the ninth largest in the world. Agriculture depends on rainfall and surface irrigation, and hydroelectric power is the backbone of the Brazilian electricity grid, producing around 65% of the total electricity in 2020 (EPE 2021). This high contribution of hydropower to generate electricity has enabled Brazil to achieve SDG 7, which is related to the production of clean energy (Lima et al. 2020). Thus, Brazil largely depends on its water resources to provide energy for the population, ensuring socioeconomic development. However, the transition of Brazil to sustainability requires to combine the existing natural abundance with rational and potential use of water resources, and overcome obstacles related to conservation and management of water bodies, in addition to systematically consider existing anthropic impacts and threats to the balance of the hydrological cycle by climate changes (Farjalla et al. 2021).

Water spring: maintenance of biodiversity

Despite the generally small size of water springs compared to their surrounding area, they have great physical diversity and are true hotspots of biodiversity and biological productivity. They function as ecosystems, considerably influencing geographic areas around them and have a variable potential to serve as ecohydrological refuges, providing water, food, shaded areas, and shelter, an especially important role during periods of drought and water scarcity. These ecosystems are influenced by exposure to the terrestrial environment and the flow of groundwater, so that the location and characteristics of the surroundings define the heterogeneity of the habitat, contributing essentially to biological richness and diversity.

Thus, the habitat area influenced by the springs and the heterogeneity of existing microhabitats in these natural environments are variables that influence the biodiversity (Cantonati et al. 2020, Cartwright et al. 2020, Stevens et al. 2021).

The important role of springs for biodiversity stems from ecological phenomena, such as the occurrence of taxa physically confined to these aquatic environments, wetlands and riverside areas fed by springs, including plants, fish, and other vertebrates, crustaceans, mollusks, insects, and other invertebrates. In addition, springs provide important resources, which are often scarce in the surroundings, for larger terrestrial animals that circulate wider areas, such as birds and large mammals. According to the state of preservation, the springs can provide localized environmental stability, i.e., hydrological and thermal conditions (humidity and temperature) relatively stable and dissociated from climate changes that occur regionally. These conditions are requirements for habitats of multiple endemic species, providing the maintenance of aquatic and terrestrial biota (Cartwright et al. 2020).

As for biological integrity, they are in heterogeneous environments composed of soil, water, air, and surrounding vegetation, in which intense exchanges between aquatic and terrestrial systems occur. The water that runs from the outcrop through the newly formed small stream comes into contact with soil, oxygen, light, and nutrients and enables life to develop according to the quality of the water and the surrounding environment. Many organisms present in these environments are at the base of the food pyramid, benthic macroinvertebrates stand out among them (Zardo et al. 2013, Biggs et al. 2017).

Benthic macroinvertebrates are organisms that live at the bottom of water courses, during at least one of the phases or throughout their life cycle. This group is composed of helminths, crustaceans, mollusks, and insects. They are macroinvertebrate organisms, presenting sizes larger than 0.5 mm and are important by participating in several processes in aquatic ecosystems, including nutrient cycling, energy flow, food source for fish, and releasing of nutrients into the water (Rosenberg & Resh 1993, Hussain & Pandit 2012, Zardo et al. 2013).

These organisms that inhabit these aquatic ecosystems have taxa that are sensitive, tolerant, or resistant to pollution and environmental degradation. Thus, they are used as bioindicators of water quality and can provide valuable information on the degree of preservation or level of impact of water springs. Many scientific studies are developed to evaluate this intense relationship and have shown that the reduction or increase in diversity of these organisms is related to the health of the ecosystem or biological integrity of the aquatic environment and, consequently, with the use and occupation of the soil in its surroundings (Epa-Ohio 1987). However, research on these organisms in spring water is scarce when compared to streams, rivers, and lakes. Santos & Melo (2017) evaluated water springs and concluded that there is a decrease in the diversity of individuals directly proportional to the degree of land use and occupation, evidencing its impact on water quality.

Formation and classification of water springs

Regarding the origins, water springs can be formed by water tables, on impermeable layers, or artesian, between two impermeable layers. They can emerge from the contact between impermeable layers and the surface, from outcrops in depressions, geological faults, or karst channels. Contact springs or depression springs from groundwater are at the origin of most of streams (Valente & Gomes 2005, Brinkmann & Beynen 2008, Roberti et al. 2008, Romero 2017).

Springs from water tables are those on impermeable layers, and the reactions caused by rainfall are faster, as well as the impacts of land use in their surroundings. These springs can be called: contact springs, which usually emerge at the base of hills and are called slope springs; or depression springs, which emerge in well-defined outcrop points or as small surface leaks spread over a waterlogged area and water accumulated in puddles until continuous flows, also known as diffuse springs (Brinkmann & Beynen 2008, Roberti et al. 2008, Romero 2017).

Springs from artesian water are those whose waters are stored between two impermeable layers, which can be: contact; geological faults interconnecting confined water tables and the surface; and channels and galleries formed in caustic or carbonated rocks that can be fed by rainwater, through sinkholes. Dolina or sinkhole is a circular depression that occurs in karst relief and is formed from the depression of soil and rocks in the ceiling of a cave through an underground drainage (Brinkmann & Beynen 2008, Roberti et al. 2008).

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) has a Hydrological Glossary that presents definitions and classifications for water sources according to their origin (Table I).

Water springs can be classified according to their arrangement on the ground as: i) point source, when the water emerges in a single point; and ii) diffuse spring, when water emerges in several points. The continuity of water flow can be classified as: i) perennial, when the flow is continuous in dry and rainy periods throughout the year; ii) intermittent, when the water flows only during and shortly after the rainy season, but dries up in periods of low rainfall; and iii) temporary or ephemeral, when they only emerge when there is rainfall (Valente & Gomes 2005, Roberti et al. 2008, Marciano et al. 2016, Stevens et al. 2021).

The nature of the water outcrop can be distinguished by natural or anthropogenic origin. Water springs are anthropogenic when they emergence from the water table due to direct or indirect human actions, such as excavations and gullies caused by erosive processes. Considering the definitions presented, springs should be a natural occurrence and with enough flow to form and maintain watercourses or accumulations, different from water eyes (Valente & Gomes 2005, Marciano et al. 2016, Santos & Melo 2017).

Environmental impacts on water springs

Water spring have ongoing and interacting threats, due to aquifer depletion and pollution, surface water diversion, channeling of spring-streams, cattle trampling, and even recreation. Groundwater extraction is a global phenomenon with high potential to impact springs, especially when the groundwater recharge process simultaneously decreases due to effects of climate change (Cartwright et al. 2020). In this way, the quantity and quality of water from springs can be altered by several factors that interact simultaneously, such as climate, relief, soil type, vegetation cover, soil use and occupation, and inadequate disposal of waste (Oliveira et al. 2020, De Mello et al. 2020).

The reduction in the amount of water is directly related to the decrease in water infiltration into the soil, with an increase in direct surface runoff, impairing the recharge process of the surface water table that maintains the spring. Infiltration and recharge are influenced by the type of soil and its physical-hydric attributes that interfere with the water retention capacity (soil density, macro and micro-porosity and hydraulic conductivity); relief inclination, as the more it is inclined, the shorter the time available

Table I. Hydrological Glossary.

ITEM	DESCRIPTION
Source	(1) origin of a river; (2) in fluid dynamics, point (or line) from which streamlines diverge
Diffused source	Spring emanating from a permeable medium over a relatively large area
Spring	Place from which water naturally emerges, from a rock or soil, to the ground surface or to a surface water body
Artesian spring	Spring whose water comes from an artesian aquifer, usually through a fissure or other type of opening in the impermeable formation that delimits the aquifer
Contact spring	Spring where water flows from a permeable formation underlying a relatively impermeable formation
Depression or gravity spring	Spring that emerges to a surface, due only to the fact that this surface intersects the aquifer level
Intermittent or periodic spring	Spring whose flow occurs only in certain periods and ceases in others
Geological fault spring	Spring fed by deep groundwater emerging from a large fault
Fissure spring	Spring that arises from a fissure
Fracture spring	Spring flowing from the fracture of a rock
Mineral spring	Spring whose water contains significant amounts of mineral salts
Thermal or thermomineral spring	Spring whose water has a temperature higher than the average annual temperature of the place where it emerges
Vauclusian or karst spring	Upwelling in karst regions that is controlled by a natural siphon and with intermittent operation

for the infiltration of rainfall; type of vegetation cover, as soils with native or reforested forest generally intensify the processes of infiltration and recharge of the surface water table (Rizzardi et al. 2014, Oliveira et al. 2014, 2020).

Regarding water quality, it is compromised in rural and urban environments; despite spring water is seen as “pure” for consumption, it may have its quality compromised without causing perception by users (Lopes et al. 2019). Natural waters are characterized according to their physical, chemical, and biological characteristics obtained along the hydrological, geological, and biochemical cycles in nature. Furthermore, as water springs are not isolated systems and present constant exchange between the aquatic (underground and surface) and terrestrial environments, the quality of their water is the result of the processes that occur on the surface of the drainage area and influenced by natural elements (geology, vegetation, soil, and climate) and by anthropic activities carried out in its surroundings, which significantly alter biological, physical, and chemical water processes (Goulart & Callisto 2003, Galvan et al. 2020).

In general, the quality of water from water springs is affected by human activities that alter the profile of land use and occupation, modifying runoff and water infiltration and evapotranspiration in the drainage area, affecting flow rate and dynamics and nutrient, sediment, and contaminant loads. Furthermore, in spring recharge areas, local and global changes observed in the hydrological cycle transform the hydrological dynamics, directly affecting water quality through sudden fluctuations in the rainfall regime. In some periods there are severe droughts and in others, floods and destruction, production, and transport of sediments that allow the supply of nutrients, directly influencing the natural characteristics of the water (De Mello et al. 2020). In rural areas, the impairment of the water quality of springs by anthropic actions occurs due to the occupation of recharge areas by agricultural activities; inappropriate land use practices; soil erosion; elimination of native vegetation in permanent preservation areas; and improper disposal of waste (Galvan et al. 2020).

In terms of the urban environment, the degradation of spring waters is a consequence of the type of development of urban areas; disorderly occupations often occur, without monitoring its impact on water resources. In this process, changes in the urban soil due to earthworks to drainage and other factors cause several changes that directly affect water characteristics (Tucci 2005, Belizário 2015). According to Tucci (2008), urbanization causes negative impacts on water quality due to the lack of sewage treatment, increase in impermeable areas, occupation of riverine flood beds, and incorrect deposition of urban solid waste that permanently contaminate waters. In this context, urban areas present a contamination cycle generated by domestic and industrial effluents due to the lack of investments of the public sanitation system and treatment plants, with release of large concentrations of organic matter, affecting springs and watercourses. The eutrophication of the aquatic environment is one of the problems generated by increases in concentration of nutrients in the water. In addition, rainwater is responsible for carrying metals and organic substances that reach spring waters during rainfall, characterizing diffuse pollution sources (Tucci 2005, Hepp & Restello 2007).

Urban and rural development often results in removal of vegetation areas around springs for construction projects and implementation of economic activities. Riparian forests around springs are natural protective shields, serving as a filter, maintaining the water course in its bed, and absorbing agricultural pesticides, pollutants, chemical substances, and sediments that would be transported to the water (Boretti & Rosa 2019, De Mello et al. 2020). These areas are also regulators and rechargers of the water table, promoting thermal stability of the water and preservation of rare or endangered species of fauna and flora. Studies evaluating water quality of urban springs have shown that the most significant impacts occur due to nearby human intervention and in the absence of riparian forest (Garcia et al. 2018, De Mello et al. 2020).

Although springs are considered permanent preservation areas in Brazil, they are often disregarded, which compromises water quality through pollution, causing silting and burying of water outcrops and often extinction of these sources (Brasil 2012a, Silva et al. 2019).

LEGISLATION RELEVANT TO WATER SPRINGS

Water springs, or water eyes, are defined as places where underground water flows naturally, even if intermittently (Gomes et al. 2005). Since 1965, their protection has been determined by the Brazilian environmental legislation, as it is considered a Permanent Preservation Area (APP). The Brazilian Forest Code was instituted by Law No. 4.771/65 on September 15, 1965, in its article 2, describes APP as the natural vegetation located in springs, and even in so-called "water eyes", whatever their topographical situation. However, it did not define the protection range (Brasil 1965). In 1981, the National Environmental Policy Law (PNMA) transformed APPs into ecological reserves (Brasil 1981), which were regulated by the National Council for the Environmental (CONAMA) in 1985, which defined springs and water eyes as synonyms and conceptualized as the "place where the appearance of water due to the outcrop of the water table" (Brasil 1986). Furthermore, it established a minimum protection strip of 50 meters wide as an ecological reserve, counting from the edge of the outcrop (De Souza et al. 2019).

In 1989, Law No. 7,754 of April 14, 1989, known as the Spring Protection Law, established measures for the protection of existing forests at river sources (Brasil 1989a), defining only the possibility of creating a parallelogram of coverage forest to protect the headwaters. Subsequently, in 1989, Law No. 7,803 amended the 1965 Forestry Code, which defined the surroundings of springs and water eye within a minimum radius of 50 meters in width as APP (Brasil 1989b). In addition, when necessary, an additional area corresponding to the contributing drainage basin could be required, based on CONAMA Resolution No. 4 of 1985, approved by the so-called Spring Protection Law (Brasil 1989a). On July 19, 2000, the Law on the National System of Conservation Units (SNUC) was published, which extinguished ecological reserves (Brasil 2000) and revoked CONAMA Resolution No. 4 of 1985, restricting protection to a range of 50-meter-wide strip, failing to incorporate the contributing drainage basin into the protected surroundings of water springs (De Souza et al. 2019).

The CONAMA Resolution 303 of March 20, 2002, regulated the Forest Code (Brasil 1965) and the Spring Protection Law (Brasil 1989a). It provides for parameters, definitions, and limits of Permanent Preservation Areas and in its article 3, and defines APP as the area located around a springs and water eyes, even if intermittent, with a minimum radius of 50 m, to protect the contributing hydrographic basin. In addition, it maintained the concept of springs and water eyes as synonyms and defined them as the "place where groundwater naturally arises, even if intermittently" (Brasil 2002, De Souza et al. 2019).

After several years, the new Brazilian Forest Code was regulated by Law No. 12,651 of May 25, 2012, and in October of the same year, it was amended by Law No. 12,727 of October 17, 2012 (Brasil 2012a, b). The new Brazilian forest code defines an APP as "a protected area, covered or not by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability, and biodiversity, facilitating the gene flow of fauna and flora, protect the soil and ensure the well-being of human populations". In addition, this legislation establishes the necessary parameters for the protection and preservation of permanent preservation areas to restrict the use of this area and prevent the source from being subject to improper occupation, physically, biologically, and chemically contaminating the water. There was a differentiation between water spring and water eye in this legislation, which considers that water spring is the natural outcrop of the water table that is permanent and gives rise to a watercourse and a water eye can be intermittent and do not form watercourses (Brasil 1965, 2006, 2012a, De Souza et al. 2019).

Another attribution of Law No. 12,651 of 2012, amended by Law No. 12,727 of 2012, was to define as areas of permanent preservation in article 4 of the Brazilian Forestry Code, in rural or urban areas, the areas around perennial and intermittent springs and water eyes, whatever their topographical situation, which must have a minimum radius of 50 meters (Brasil 2012a). Regarding the protection of the surroundings, the Forestry Code of 2012 originally established APP for perennial springs and water eyes. However, Law No. 12,651 of 2012 was amended by Provisional Measure No. 571 of 2012, converted into Law No. 12,727 of 2012, extinguishing the APP around intermittent water eyes and on the banks of ephemeral water courses (Brasil 2012b, c). After this change, in 2018 the Supreme Court established an interpretation according to the Constitution and declared that "the surroundings of springs and intermittent water eyes constitute an area of environmental preservation". However, so far there have been no developments that would make this definition effective. Therefore, if there is a change in the water regime of the springs, which was previously perennial, it becomes intermittent, is no longer protected by law, thus, it can suffer human interventions without penalty by the legislation (De Souza et al. 2019).

Regarding the suppression of native vegetation protecting springs, the legislation defines that it may be authorized in case of public utility, social interest or low environmental impact provided for in this Law. And, if there is suppression of vegetation located in PPA, the owner or occupant is obliged to promote the reconstitution of vegetation, except for the authorized uses provided for in this Law (Brasil 2012a). Considering rural areas consolidated until July 22, 2008, i.e., rural properties with preexisting anthropogenic occupation on that date, the Law 12,651/2012 (included by Law no. 12,727/2012), Art. 61-A, § 5, allowed the continuity of agrosilvopastoral, ecotourism, or rural tourism activities in permanent preservation areas around springs and perennial water sources, but the restoration of a minimum radius of 15 meters is mandatory, regardless of the size of the property (Brasil 2012b, Marciano et al. 2016).

Therefore, permanent preservation areas are one of the main tools of the Brazilian Forest Code, whose environmental function is to protect soil and water resources, avoiding water pollution and silting, and maintaining the gene flow of fauna and flora and the population quality of life, including water springs (Reis et al. 2012, Galvan et al. 2020).

Water springs: valuable resource for education and environmental awareness

Concerns about the current problems regarding preservation and conservation of water resources, including water springs considered globally threatened aquatic ecosystems, and the view of humans about their relationship with nature, which is available to serve them, have raised debates and actions related to environmental education in academic research, campaigns, events, and schools. Environmental education is a process intended to promote, in the long term, changes in the relationship between humans and the environment, in which each citizen needs to assume their responsibility to care for and respect the environment in which he lives. In this regard, education is a fundamental tool for searching sustainable development, as community awareness can promote the necessary changes in the environment and society (Turke et al. 2019, Ardoin & Bowers 2020).

The environment theme as a fundamental factor to address in basic education, and the inclusion of environmental areas as a transversal theme in the National Curricular Parameters (PCN) were included in the Law of Directives and Bases of Brazilian Education (LDB 9394/96), which was a very important action for the education sector. The National Curricular Base for Elementary Education (BNCC) was approved in 2018 and became essential for the analysis of spaces and insertion of environmental education in schools. It is a document that presents rights and objectives of learning and development, which should guide the elaboration of curricula for the different stages of schooling (MEC CONSED & UNDIME 2016).

The BNCC was created for all subjects and stages, from early childhood education to high school. It is based on four training axes for elementary education that articulate information throughout this training stage, subdivided as follows: literacies and ability to learn; solidarity and sociability; critical thinking and life project; and intervention in the natural and social world. Thus, the interaction between environmental education and society occurs mainly in the school environment, and the school is primarily responsible for spreading environmental understanding (MEC CONSED & UNDIME 2016).

Based on the principle that environmental education can result in a differentiated performance in terms of commitment of humans to take care of the Earth, the school is fundamental in terms of raising students' sensitize of their role in society, their actions, and their commitment to the preservation of water springs, essential resource for the sustainability of life on the planet. Environmental education should be implemented primarily in schools, as they are environments in which children spend time and are in the process of learning new concepts. In addition, contact with topics related to conservation of water springs will be better assimilated by students during this phase, when they will be more apt to receive information and form critical thinking (Layrargues 2006, Pineli et al. 2013, Oliveira et al. 2013, Turke et al. 2019).

The first paragraph and item VI of article 225 of the 1988 Constitution determine that the public power has the task of promoting environmental education at all levels of education and public awareness, with a view to preserving the environment (Brasil 1988). Environmental education with development of activities that promote mutual learning is important for students to understand and raise awareness on water resources in their community and enable them to experience a context in which knowledge is built based on life experiences, making these members of society disseminators of the knowledge obtained from the community around them. In this way, awareness, mobilization, and capacity building have the potential to promote greater involvement, as well as willingness to participate and cooperate in solving problems related to water springs and their preservation (Beckauser et al. 2019, Turke et al. 2019, Ardoin & Bowers 2020).

In this context, the development of environmental education activities in natural environments is a fundamental tool to promote changes in attitudes and behavior of children and adolescents in relation to environmental issues, as well as to promote their connection with nature and raise awareness regarding the need to reduce the human impact on aquatic ecosystems, including water springs (Pirchio et al. 2021). According to Carvalho (2006), environmental education enables those involved to appreciate life from a different perspective of love, awareness, and liberty, and act ethically on the environment, allowing the population in general to be actual citizens in a more intense way (Oliveira et al. 2013).

Using playful and interactive activities in the learning process during activities related to environmental education awakens and intensifies the interest of students on environmental issues, making them more sensitive and able to develop a critical and dynamic character, stimulating them to express their views to colleagues (Beckauser et al. 2019, Turke et al. 2019). Several tools have been used in this regard, including ecological trekking with walks surrounding aquatic environments under theoretical and practical study workshops involving the collection, sorting, and identification of benthic macroinvertebrates, to raise awareness on the importance of conserving water springs for maintenance of biodiversity; development of booklets as a support to link the theoretical learning obtained in the classroom and the experiences and information obtained in practical workshops in water springs (Goulart & Callisto 2003, Pirchio et al. 2021).

Taking walks in natural environments, such as water springs, stands out among these tools for contributing to the perception of the connection between human beings and nature, the main predictor of pro-environmental attitudes and behaviors. Next to springs, it is possible to observe and feel the relationships between the surrounding air, water, soil, fauna, vegetation and human being. In these workshops, awareness, interactivity, the senses, and the ludic are used to transmit technical and ecological information and curiosities in a language that is appropriate to the age of the participants (Cerqueira et al. 2020, Ardoin & Bowers 2020, Pirchio et al. 2021). In this regard, the learning process requires to adapt the language to children, with adoption of environmental booklets for understanding technical information, as well as development of practices to establish the topics covered. According to Bacelar et al. (2009), booklets become a viable option, as the use of illustrations assists in the reproduction of actual aspects and in the perception of details, allowing the adaptation of the real size of the objects studied, bringing events and distant places in space and time together, and allowing an immediate view of many processes that occur in water springs.

Water springs are excellent environments for pedagogical practices searching for developing environmental education actions in schools to sensitize children to the importance of water springs for the sustainability of life for present and future generations. These aquatic environments enable the transmission of comprehensive information about the importance of water, water cycle and water springs for the maintenance of water resources and biodiversity in them. In addition, the elements that make up the water spring and its surroundings allow children to interact with the surrounding vegetation, water, and water outcrops on the soil surface.

CONCLUSIONS

The ecosystem function of water springs along with water resources goes beyond the environmental sphere, but to the social and economic sphere. Water availability and continuity in the rivers is due to a strengthened and preserved contribution mesh, which ensures water for human consumption and various economic activities, with emphasis on agriculture, livestock, energy generation, industry, and commerce. Understanding processes that promote the recharge of groundwater, which form and maintain springs, and factors that interfere with this dynamic are essential for the sustainable management of these resources.

In addition to water availability, water springs are responsible for boosting the aquatic life that begins soon after its emergence on the surface of the earth, whose organisms, including benthic macroinvertebrates, form the basis of the food chain in streams and rivers.

This primordial function, of maintaining the aquatic biodiversity present from the smallest watercourse to the largest river, is practically imperceptible when observing a spring and its surroundings.

Developing education and environmental awareness are key aspects in citizenship training and understanding the importance of water springs, promotes knowledge that goes beyond aquatic and terrestrial environments. The interaction of these environments with different species, including human, shows the need for care in the recovery and preservation of springs for the safety of life on the planet for present and future generations.

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