Chapter 251

Reuse of rainwater through the construction of cisterns

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ABSTRACT
Water is an essential natural resource for life on the planet, either as a biochemical component or as a living thing, as a means of life for various plant and animal species, as a representative element of social and cultural values, and even as a factor of production of various final and intermediate consumer goods. However, the increasing population has increased the demand for this good. On the other hand, the supply of drinking water becomes increasingly scarce to meet the diverse needs of the population. Given this scenario, it is essential to implement methodologies that enhance the rational use of water. Water resources come from various natural origins, such as aquifers, groundwater, and rivers essentially for the existence of all living beings, which is the essential reason why society is increasingly concerned with the availability of drinking water on our planet. Therefore, it is necessary to study the ways of reusing rainwater as a way of saving and preserving drinking water. In the present work, d e research was carried out a study on the feasibility of the use of rainwater throughout the country, taking into account the differences in precipitation. Thus, for this purpose, it was necessary to identify the rainfall regime of the different Brazilian capitals through the database of the National Institute of Meteorology (INMET), determine the volumes of rainwater reservoirs for each situation, and evaluate the influence of the rainfall regime on the potential for rainwater use.

Keywords: Drinking water, Use of Rainwater, Cisterns.

1 INTRODUCTION

Water resources come from various natural origins, such as aquifers, groundwater, and rivers essentially for the existence of all living beings, which is the essential reason why society is increasingly concerned with the availability of drinking water on our planet. Therefore, it is necessary to study the ways of reusing water from rain as a way of saving and preserving drinking water.

It is noticeable that the natural sequence of such a resource has been changing, fostered by the action of human beings, and this can be easily seen while there have been more pronounced droughts in many parts of the globe and floods in many others. Another major problem linked to the water resource on earth is pollution, which makes such resources not suitable for direct consumption. The water found today in sources of easy access for consumption is, in a large majority, contaminated by pathogens, algae in abundance, urban and industrial sewage, solid waste, and various chemicals (Barboza *et a*l., 2022; Martins et al., 2021; May 2004).

However, the natural sources of water intended for consumption and public supply are increasingly scarce, since the purification capacity through the method of natural recycling of pollutants and the natural filtration process carried out by the action of the sun or also by porous rocks is slower than contamination, Thus, water resources currently gain a volume of pollutants at a speed and quantity faster than their ability to self-regenerate. Because of this, for them to go to the whole society with quality needs to be consumed, it needs increasingly aggressive treatment, with new and modern technologies, growing in this way, raising the costs for p treatment that the sanitation concessionaires pass on to consumers, which requires more attention regarding the priorities of water use for the most diverse objectives.

It is important to highlight the water preservation measures. These are being used around the globe to reduce the impact of degradation of the sources that supply water to the biosphere in general. We have as an example, of such measures, which have been widely adopted in all parts of the world, is the use of water from rain, mostly for non-potable purposes, which uses the natural resource differently from those that are already used and helps in reducing the consumption of drinking water (Lage, 2012).

To emphasize the relevance of the use of rainwater Tomaz (2011) Amorim and Pereira (2008) state that such a process, in addition to providing savings in drinking water, corroborates the prevention of floods fomented by rains in large urban centers, where the impermeable surface is vast, and thus prevents rainwater from penetrating n the soil, and go through the natural process of purification of the same, being understood as a non-structural measure in the organization of drainage of the cities. As well as providing savings in drinking water, the use of rainwater in homes can reduce the cost of drinking water and help reduce peak flooding, while it is used on a large scale, in a well-thought-out and structured way in a watershed (Lima *et al.*, 2011).

In certain more problematic cases, where the rainfall situation is immensely reduced and consequently the availability of drinking water as well, it is also possible to verify the use of rainwater also for potable purposes. Thus we can see that the adoption of such rainwater harvesting systems is fundamental for the conservation of the same, as well as of human existence (Bezerra *et al*., 2010).

In Brazilian lands with its abundant availability of water, seen here, as a good of general use of the people and having low economic vocalization fosters in this way, the culture of waste. Another aggravating factor is that in Brazil the water concessionaires, and also the Brazilian government in all its spheres are having incentive projects for society to adopt actions to approver an in water (Lima *et al.*, 2011).

Thus, it was becoming aware of the relevance of studying the potential of saving drinking water throughout Brazil, while the exchange drinking water for rainwater, being taken into account each of its characteristics.

Based on these considerations, the present study will consist of research under a qualitative approach of the data, of the bibliographic type, and exploratory, carried out through the collection of information about the has in scientific and informative sources, identifying data compatible with the theme, among studies already carried out, in books, magazines, articles, scientific works, and Internet sites, through downloads, or acquisition of books, examining them from reading and filing and then analyzing them according to the compatibility with the project in question, the reliability of the data and the usefulness of the information for the present study and future research (Gil, 2007).

The present research work addresses the feasibility of using rainwater throughout the country, taking into account the differences in rainfall. Thus, for this purpose, it was necessary to identify the rainfall regime of the different Brazilian capitals through the database of the National Institute of Meteorology (INMET), determine the volumes of rainwater reservoirs for each situation, and evaluate the influence of the rainfall regime on the potential for rainwater use.

2 METHODOLOGY

The research work carries out a theoretical approach to the potentialities of the reuse of rainwater. This is bibliographic research followed by a qualitative analysis based on relevant works on the proposed theme. According to Sousa *et al* (2021), bibliographical research is the survey or review of published works on the theory that will direct the scientific work which requires dedication, study, and analysis by the researcher who will perform the scientific work.

For the bibliographic survey, the following keywords were used as descriptors, in Portuguese and iglés: Potable water economy, Harvesting of rainwater, water consumption in Brazil, and water collection systems. The research work covered 20 years (2002 – 2022).

The results presented in the research work were obtained from books, theses, dissertations, articles, and specialized websites that deal with the subject, such as the National Water Agency. The articles selected for the development of the research were obtained in Portuguese and English from databases: Portal Capes, *Science Direct*, and PubMed.

3 RESULTS AND DISCUSSION

3.1 WATER RESOURCES AT THE GLOBAL LEVEL

The availability of water resources slows down the totality of water resources, surface, and groundwater, in a given locality or watershed, for any destination. Of the total amount of water found on planet Earth, it is stipulated that only 2.5% is considered potable or fresh water, and most of this amount is not easily accessible. Within the proper context, only 0.266% then in lakes, rivers, and reservoir rivers, all the rest is divided by all biomass and in the atmosphere in the form of steam. In this way, it is estimated that only 0.007% of the total freshwater of planet Earth is found in places of simple access for man.

About 68.9% of the sweet water is in the glaciers of the Arctic, Antarctica, and in the regions of extremely high mountains. In turn, groundwater covers about 29.9% of the amount of fresh water on the globe (Tomaz, 2003).

One of the largest freshwater aquifers on the planet is found underground, is called the Guarani Aquifer, which comprises an area of about 1.2 million km2 and is found in the Paraná Sedimentary Geological Basin, encompassing Brazil, Paraguay, Uruguay, and Argentina. Sente is understood as the main reserve of fresh groundwater in South America, with about 46 thousand km2, of which about 71% is under Brazilian soil.

The planet's water is divided non-uniformly, with Asia and South America having the largest quantities of fresh water. In Asia this large world part of the resource, reaching about 31.6%, and reaching rainfall of about 458,000 km3 per year. The lowest potentials are seen in Oceania, Australia, and Tasmania (Tomaz, 2003). For Tomaz (2001), it was agreed that the nations with water scarcity would be those with percentages of global partition of the amount of freshwater per year available, referring to the number of people, less than $500m^3$, inhabitants per year. Among these countries, we can relate to Saudi Arabia, Israel, and Libya among others. On the other hand, we can relate to the nations considered rich in water Brazil, Canada, Russia, and Colombia, among others. The United Nations Environment Programme (UNEP) uses the classification of the distribution of the amount of fresh water on the globe.

3.2 WATER RESOURCES IN BRAZIL

Brazilian lands to a high supply of water comprised in $35.732m^3$ per inhabitant per year, being understood as a nation rich in the water supply. Still with this, we have the relationship to its world water potential, the Brazilian nation has about 12% of the total world freshwater (Tomaz, 2001). Among the nations of South America, Brazil stands out for having an annual flow of about 177,900 km3 of water, which accounts for about 53% of all flow in the South American region.

The supply of water in Brazil is largely through the watersheds. The most important hydrographic basins in Brazilian lands are the Amazon River, the Tocantins-Araguaia River, the São Francisco basin, the North Atlantic Northeast, Uruguay, the East Atlantic, the South, and Southeast Atlantic, the Paraná and Paraguay Rivers.

The showiest hydrographic network in the world is the Amazon, which comprises a drainage area of about 6,112,000 km2, comprising by volt [42]% of the entire surface of Brazil, and entering both Venezuela and Bolivia. Even though Brazil shows a lot of freshwater supply, it is not evenly distributed throughout the national territory, having a lot of imbalance between supply and demand in certain Brazilian regions. In Brazil, we can perceive the regions with higher population density are those that have less water availability, however where it is a noticeably large supply of water, we have a reduced population density. An example of this is the Southeast Region of Brazil, which has only about 6% of Brazil's water capacity, but its population density is around 43% of the total Brazilian population, while the North Region, which has 69% of the national water capacity, has only 8% of the entire national population (Ghisi, 2006).

3.3 WASTE OF DRINKING WATER

Among the natural resources, fresh drinking water, is essential for all life on planet earth, contemporaneously and what is most threatened by its scarcity as in the same way, quality, and other types of degradation. The impact of increasing attacks on the environment is constantly compromising both the quality of water and its water volume offered.

Meanwhile, the supply of drinking water has been misused in various ways around the globe, especially in the world's major cities. This scenario has been developing and drawing the attention of everyone in the world, taking into account that drinking water is a finite resource, day by day more expensive and more scarce. The lack of knowledge and also of education and awareness of society regarding the volume of water wasted by its misuse, including hydraulic appliances and equipment and leaks in poorly constructed or worn out installations, are major reasons why water waste, essentially refers to waste inside homes. As well, the issues of leaks in the system of the concessionaires are also part of the reasons for the waste of water.

Within water supply systems, both physical and non-physical losses can occur. The first was how water does not reach the consumer's home because of leaks in the pipes of the supply network and/or in the connections with the houses or extensions of the buildings. The second is understood as errors in the measurement of water meters, fraud, clandestine calls, or registration failures.

The percentage of losses disclosed by Companhia de Saneamento Básico de São Paulo, a company that operates in 366 municipalities throughout the State of São Paulo, is around 33%, being physical 15% and non-physical 18%. These percentages are translated into about nine thousand liters of unprepared drinking water in just one second. However, these rates are close to the measurements made in nations considered first worlds such as Canada, which loses 14%, and England which loses 17.3% of all drinking water. In Japan, more precisely in the capital Tokyo, the percentage is only 8.4%, since the pipes are stainless steel because of issues with earthquakes.

The leaks can be understood between the perceptible and the imperceptible, the first being those that are possible to see with the naked eye, without the help of devices, and the others those that need devices and sharper investigation to be detected. Noticeable leaks happen most often in faucets, water tanks, and showers. However, the imperceptible happens in hidden pipes or hidden reservoirs (Gonçalves, 2009).

The verification and restoration of water leaks in homes is the responsibility of the consumer. In building installations, leaks have to be studied from the entry of agua in the meter to the water points, since small leaks can result in large losses.

Several theses are easy to carry out: checking for leaks or not at home. Leaks in valves or discharge boxes can be verified through the following tests (Gonçalves, 2009):

(i) Cigarette ash test: Cigarette ash in the toilet. Usually, the ash will stay at the bottom of the toilet. When otherwise, it is a possible indication of leakage in the valve or yet in the discharge box;

ii) Test for water meters: To be able to verify whether or not there is a leak between the water meter and the water tank, it is opened from the meter register by closing the box buoy until the water flow stops completely. The counter has to be inert being proof that there is no leakage;

iii) Test for water tanks: To notice leaks here, the entire buoy is closed by checking the water level in the tail. As well as if all water points are properly closed and not used for an hour. After that, the level inside the reservoir has to be inert. If this does not occur, there may be leakage;

iv) Test for pipes: When closing the register of the house counter, a tap is opened by it fed directly, and it is expected that until the complete emptying of the water from the glass by the tap, it is indicative of leakage in a pipe.

3.4 RATIONAL USE OF WATER

Nowadays, the conscious use of water is more and more present in the media, seeking to foster the awareness of as many people as possible of the relevance of not wasting, but conserving this resource of fundamental relevance. It is understood as rational use of water a set of actions, as well as incentives that have a fundamental purpose (Tomaz, 2011): Reduce water consumption; improve water use, aiming to reduce losses and waste; establish actions and technologies that enable water saving; raise awareness and inform consumers.

Several activities are necessary to reduce water consumption, such as verification and restoration of leaks, educational programs, technological innovations, and studies aimed at the use of rainwater and the reuse of gray water (Sousa *et al.*, 2022; Junho *et al.*, 2020).

Such actions concerning the rational use of water are developed through the establishment of new technological processes that have as a consequence a transformation of the conduct of the population, fostering sustainable use of water. In turn, incentives are carried out through programs, data, public education, as well as rules that encourage the population to take more conscious actions (Montibeller & Schmidt, 2004).

To Tomaz (2001), the actions for the preservation of the water of urban use can be defined as common and unusual actions. Common activities for water preservation include the correction of leaks in water distribution systems and homes, changes in tariffs, reduction of pressure in pipes, recycling, and reuse of water, standards regarding hydraulic and sanitary equipment, as well as mass awareness.

Among the conventional actions, we can see that the repair of leakage in water distribution systems is the most relevant action so that one can see water savings. The unusual, or unconventional, actions for the preservation of water resources are the use of gray water, rain, and toilets for composting, desalination of seawater, and reuse of rainwater, both for commercial and residential buildings (Tomaz, 2001).

In nations of North America, Europe, and Japan, the conscious use of water is being established, since the fundamental actions adopted in such countries and continents are the use of toilets of reduced consumption; faucets and showers more effective in the face of water-saving; use of equipment that provides water saving, reduction of waste in the public distribution system and so that the loss rate is less than 10%; recycling and public awareness. In addition, some other unconventional actions are used, such as the reuse of water and the use of water from rain.

The conscious use of water and leaving the use of water for other diverse uses, such as the establishment of new industrial parks, housing expansion, and improvement of the environment. The awareness and awareness of consumers to preserve water, together with the adoption of new technologies that allow saving, can form activities of great impact in the face of the conscious use of water and the consequent economy. Along with this, the problem of the conscious use of water opens up in the same way improvement in architectural designs, and the hydraulic and sanitary projects of buildings.

The advantages obtained with the rational use of water are not the most comprehensive possible, both economic and environmental scopes, such as Savings in water bills; preservation of water resources and the environment.

3.5 RATIONAL WATER USE PROGRAM

The effective use of water in all construction models is directly linked to the attitude of the building users and their attitude toward this important but finite resource. Because of this, several projects aimed at the conscious use of water have been created around the world and in Brazil. In Brazilian lands, nowadays the National Program to Combat Water Waste – PNCDA has been established, with the coordination of the federal government, which aims to promote the conscious use of water from the public supply in national urban centers, to benefit public health, environmental sanitation and the effectiveness of the services of the systems.

In turn, the Rational Use of Water Program – PURA, was created only for the state of São Paulo, in 1995 through a partnership between the Polytechnic School of the University of São Paulo –EPUSP, Building Systems Laboratory of the Department of Civil Construction – LSP/PCC, Basic Sanitation Company of the State of São Paulo – SABESP and Technological Research Institute – IPT, to combat water waste, ensure the supply of drinking water and the quality of life of society as a whole.

The Rational Use of Water Program – PURA, is systematized into six levels of macro-programs that are unified, to cover a series of technical documentation, laboratories, modern technologies, research in residential and professional buildings, quality control programs, and case studies in various models of buildings, such as commercial, schools, hospitals, industries, among many others.

3.6 WATER IN THE STATE OF CEARÁ

Water is a determining factor in the quality of life of the population, because in a direct relationship if there is more water, there is more development and quality of life. According to the world health Organization (WHO), in the year 1990, some 700 million people did not have access to drinking water or at least a covered well. Currently, this value remains much the same. The lack of water has deprived countless people of access to education and work, as they are forced to spend several hours searching for it and transporting it for basic consumption.

In the Northeast Region, the average freshwater potential represents only 3% of the national total, being considered the lowest index in the country. Considering also the water availability of the rivers, per inhabitant per year, which is 4,384 m3, and in the subsoil of the Brazilian Northeast, there are approximately 20,000 km3 of fresh water. According to the National Council of the Environment (CONAMA), Ceará is inserted in this context of low availability and the great demand for this natural resource so indispensable to life.

Ceará has 184 municipalities with a population of 8,448 million inhabitants. The territory of the state is almost entirely inserted in the Hydrographic Region of the Eastern Northeast Atlantic, with a small portion located in the Parnaíba Region. Characterized by a semi-arid climate in practically all its extensions, with intermittent watercourses, the surface water resources are available in a high number of regularization reservoirs, 118 of them with storage capacity equal to or greater than 10 hm^3, according to data from the Brazilian Association of Rainwater Capture and Management (ABCMAC) in 2013.

The management of the supply of raw water and the demand for water resources throughout the state is carried out by COGERH - Companhia de Gestão dos Recursos Hídricos do Ceará, while CAGECE - Companhia de Água e Esgoto do Ceará is responsible for providing water supply services in 83% of the municipalities.

Ceará, unlike what occurs in other states, practically does not register excess water in geographic regions or regularity of rainfall during the year. Thus, droughts and droughts are still one of the major problems faced by the inhabitants of Ceará. According to data from the National Water Agency – ANA, in 2012, 95% of its municipalities, that is, 175 cities in Ceará declared a situation of emergency or state of public calamity. These data allow us to realize that Ceará faces a critical situation regarding the amount of water available for consumption.

Parallel to the climatic characteristics and their influences on the quantity and distribution of water, the state faces a problem regarding the precariousness of water supply services, especially in the rural area, with only 18.8% of the households in the state having a water supply network, according to data from the Institute of Research and Economic Strategy of Ceará (IPECE) for the year 2011.

The IPECE data corroborate stating that Ceará has a shortage in the supply system, which still cannot serve the entire population of the state, especially in municipalities in the interior. This fact is a result of the lack of basic supply and sanitation infrastructure that serve rural or even metropolitan regions, despite government actions to solve this problem (Cirilo *et. al.*, 2008).

Due to the process of urbanization and industrialization, the age has come to be used in an increasing number of functions, and its consumption per inhabitant is progressively increased. The surface and underground water resources of the main urban centers and rural areas of Ceará are mostly polluted, which leads to the search for alternative and sustainable practices. (Benedict, 2011).

3.7 RAINWATER HARVESTING TECHNOLOGIES

The advancement of new technologies has allowed the development of rainwater harvesting system techniques. With the use of new materials and equipment, the emergence of new use practices that seek to improve the quality and efficiency of rainwater harvesting systems was facilitated.

There are several techniques of rainwater use used in the various states of Brazil that have positive results. The most used are the rural cisterns, Total flow system, Sist. of derivation, Sist. retention and Sist. of infiltration. However, in Ceará, as in the entire Northeast, the use of the traditional cistern system predominates, especially in rural areas (Cirilo, 2008).

These rainwater harvesting techniques will be discussed in the following topics. Initially, the system of rural cisterns will be described, due to its traditional use and then the other systems currently used, trying to explain them objectively for a better understanding.

Rural Cisterns

In Brazil, a widely used form for the use of rainwater is the construction of cisterciansin the Northeast for storage of water for consumption, among others.

The cisterns with accumulation capacity normally between 7 and 15^{m3} represent the supply of 50 liters of water daily for 140 to 300 days, assuming that it is ischemia at the end of the rainy season and no recharge has occurred in the period. Taking proper care with the cleaning of the roof, cistern, gutter, and pipe, is a fundamental solution for meeting the most essential needs of the diffuse rural population. Although they exist in large numbers, scattered throughout the state, the number of cisterns is still tiny when compared to the need of the diffuse rural population (Cirilo, 2008).

However, it should be borne in mind that in the climate of the semi-arid, the cisterna cannot, without other sources, give sustainability to the population. It should be used as part of the solution for diffuse populations. The rural cisterns being used traditionally have advantages in terms of cost and the construction system is simple and cheap compared to the other technologies that will be explained, however, this system has limitations regarding the quality of use due to its storage does not go through basic cleaning processes of impurities brought by rain. The current systems of exploitation are characterized by the capitation surface used, such as roofs or slabs; by the filtration system to remove impurities; by the types of pipes and storage reservoirs concerning the type of material and layout scheme in the system.

Teston (2022) points out that current water harvesting systems feature four main techniques in which the main components of the system are: the catchment area, screens or filters for coarse materials such as leaves and branches, pipes for water conduction, and the storage reservoir. In these types of techniques, buildings must be equipped with gutters and vertical conductors for the direction of rainwater from the roof to the reservoir. It also emphasizes that it is important that special attention be paid to the design and installation of gutters and vertical conductors, because the under-sizing of these components can significantly reduce the efficiency of collection, compromising the operation of the entire rainwater harvesting system.

NBR 10.844/89, ABNT's Rainwater Building Installations, should be used as a reference for the design of these components. The feasibility of implementing a rainwater harvesting system is usually related to regularity and high annual precipitation, problems in the supply, and the cost of drinking water. On average, in a project of a house with 250 m2, the installation of a rainwater reuse system adds 6% to 8% to the hydraulic cost of the work (Ciocchi, 2003).

The use of the techniques described represents a technological advance in the rainwater harvesting system, however, they no longer meet the requirements that currently demand in buildings such as distribution for non-potable uses in toilets, washing areas in general, gardens, and the destination of the surplus volume. Thus, an alternative to this system should be used, such as the mixed System (repression with more severity).

The use of the rainwater harvesting system through the mixed system technique (repression and gravity) represents the main technology currently in use and its practice may contribute to the reduction of drinking water consumption in Ceará.

The mixed system (repression and gravity) becomes efficient by meeting the needs of rational distribution of the waters collected for non-potable use, as it has improved the resources of the techniques previously used with the addition of new devices becoming a very efficient system in terms of current quality and sustainability standards.

Below we will make a description of the Mixed System (repression more gravity) highlighting the operation and the main aspects of this technology. In this technology to capture rainwater is used a system of roofs and gutters directed to a self-cleaning filter, which removes debris that is then taken to a cistern (underground water reservoir). The água in the cistern is channeled to the bottom preventing it from mixing with the sedimentation. A repression pump (pressurised) feeds the non-potable water tank or external taps of restricted use.

The process of using the rainwater of this system consists of the use of a trough that collects rainwater that enters the filter, and soon after it is filtered to the cistern where it is stored. A repression pump captures the water from the cistern for later use. When the volume of rainwater stored in the cistern exceeds its capacity, it is drained to the public rainfall collection network avoiding overflow. In the case of elevated reservoirs, there is a need for a support structure. The maximum height (top, reservoir, and filter) must be below the lowest catchment level. Remembering that the capture in single-story buildings of 3 meters high, for example, equipped with gutters and aerial pipes, can obtain a pressure of up to 1.5 MPa. no use of bombs. The types of materials of the reservoir are concrete, waterproofed masonry, and stainless steel, among others.

The use of equipment is indispensable for the good performance of the reservoir because through them you have control of water quality. Examples: filters, extravasations, flow valves, drains, sieves, and self-cleaning devices. In the case of filters, the most used are self-cleaning (volumetric), easy to maintain, and have little water loss. These may vary according to area, diameter, and ability to retain parts.

We must also highlight the first *flush* filter, responsible for an initial runoff with the first water that drips from the roof. It is usually dirty water and takes between 10 to 20 minutes to get clean, as it brings with it particles between 10 and 240 µm. The use of the first flush is not mandatory, it depends on the discretion of the designer and the contact of the water with humans. (Ciocchi, 2003).

Because of the above, it was found that the use of rainwater represents a tool of great importance to complete the current supply system in regions with an abundance of water resources, as it contributes to the economy and rational use of this resource; and extreme importance in regions with a lack of it.

To make this use we have the technologies described above as a process of evolution that has resulted in the most efficient technology that has been proposed, which is the Mixed System (repression more gravity) until improvements are made and new solutions for rainwater harvesting systems emerge.

4 FINAL CONSIDERATIONS

We conclude that it is of great importance to use a rainwater system even if the return on investment of a rainwater system occurs slowly, especially in systems with small catchment areas, therefore the decision to build a rainwater harvesting system in residential buildings with small catchment areas, The objectives will be to reduce the costs of water supply services with the lowest consumption of drinking water, ensuring the future of water sustainability, promoting water conservation and continuous supply in periods of drought.

In the case of the state of Ceará, the use of new technologies for the use of water from the grape will represent an advance in the reuse of this potentially available resource, contributing to the reduction of the consumption of drinking water offered by the supply system and ensuring its capacity to meet the great demand of the population in periods of ECA, a fact of common occurrence in the region. In addition to contributing to the balance and use of water resources with gains for sustainable and socioeconomic development.

Therefore, the benefits derived from the collection and use of rainwater are of great importance for the supply of drinking water, and it is necessary to establish standards that lead to the safe use of this water source, as well as the creation of public policies that encourage the implementation of these systems in homes. What should be done through projects with this technology is an economically efficient and reduced cost to promote access to the population, especially in the interior of the state.

Considering the importance of the theme for the sustainability of the plan and the maintenance of the supply of drinking water for the population. The work presents fundamentals and relevant information for students, researchers, and the population about the need to adopt methodologies aimed at the reuse of water, providing subsidies for future research on this theme.

REFERENCES

Amorim, S. V. & PEREIRA, D. J. A. (2008) Estudo comparativo dos métodos de dimensionamento para reservatórios utilizados em aproveitamento de água pluvial. *Ambiente Construído*, 8(2), 53-66.

Barboza, E. N., Silva, V. F., Marques, A. T., Santos, S. A., Maia, A. G., Vieira, F. I. D. M., Costa, R. O., & Maracajá, P. B. (2022). Water management for housing located in rural areas: case study. Research, Society and Development, 11(2), e34811225442. https://doi.org/10.33448/rsd-v11i2.25442

Bento, V. R. S. (2011). Centro e periferia em Fortaleza sob a ótica das disparidade de infraestrutura de Saneamento básico. Dissertação (Mestrado Acadêmico em Geografia), Universidade Estadual do Ceará, Centro de Tecnologia.

Bezerra, S. M. C., Christan, P., Teixeira, C. A. & Farahbackhsh, K. (2010). Dimensionamento de reservatório para aproveitamento de água de chuva: comparação entre métodos da ABNT NBR 15527:2007 e Decreto Municipal 293/2006 de Curitiba, PR. *Ambiente Construído*, 10(4), 219-231.

Ciocchi, L. (2003). Para utilizar água de chuva em edificações. *Téchne, Ed. Pini*, 72, 58-60.

Cirilo, J. A., Montenegro, S. M. G. L. & Campos, J. N. B. (2008). A questão da água no semi-árido brasileiro, *Empraba.*

Ghisi, E. (2006). Potential for Potable Water Savings by Using Rainwater in the Residential Sector of Brazil. *Building and Environment*, 41(11), 1544-1550.

Gil, A. C. (2007). Métodos e técnicas de pesquisa social. São Paulo: Atlas.

Gonçalves, O. M. (2009). Estratégias para redução do impacto da demanda de água nas cidades e edifícios. II simpósio brasileiro de construção sustentável, São Paulo.

Junho, A. L., Santos, I. F. S., Silva, A. M. L. & Barros, R. M. (2020). Avaliação da eficiência do tratamento de águas cinzas utilizando sementes de Moringa oleífera sob diferentes metodologias de ensaio. Research, Society and Development, 9, e8879118136.

Lage, E. S. (2012). Aproveitamento de água pluvial em concessionárias de veículos na cidade de Belo Horizonte: Potencial de economia de água potável e estudo da viabilidade econômica. Dissertação (mestrado) - Universidade Federal de Santa Catarina, Centro Tecnológico, Programa de Pós-Graduação em Engenharia Civil, Florianópolis.

Lima, J. A., Dambros, M. V. R., Antonio, M. A. P. M., Jazen, J. G. & Marchetto, M. (2011). Potencial da economia de água potável pelo uso de água pluvial: análise de 40 cidades da Amazônia. *Revista Engenharia Sanitária e Ambiental*, 16(3), 291-298.

Martins, B. E. S., Menezes, L. K. M., Farto, C. D. & Athayde Junior R, G. B. (2021). Analysis of the economic feasibility of using rainwater for vertical residential type buildings in the City of João Pessoa State of Paraíba. Research, Society and Development, 10(8), e49010817655. https://doi.org/10.33448/rsd-v10i8.17655

May, S. (2004). Estudo da viabilidade do aproveitamento de água de chuva para consumo não potável em edificações. Dissertação (Mestrado) - Departamento de Engenharia de Construção Civil, Escola Politécnica de São Paulo. São Paulo.

Montibeller A. & Schmidt R. W. (2004). Análise do Potencial de Economia de Água Tratada Através da Utilização de Água Pluvial em Santa Catarina. Trabalho de Conclusão de Curso. Curso de Graduação em Engenharia Civil, Universidade Federal de Santa Catarina – UFSC. Florianópolis.

Sousa, A. S., Oliveira, G. S. O. & Alves, L. H. (2021). A pesquisa bibliográfica: princípios e fundamentos. Cadernos da Fucamp, 20(43), 64-83.

Sousa, L. P., Pereira, M. S. & Lima, M. E. A. (2022) Análise de custos para implantação de telhados verdes em região semiárida com reutilização de águas cinzas. *Research, Society and Development*, 11(7), e15511729770. http://dx.doi.org/10.33448/rsd-v11i7.29770

Teston, A., Scolaro, T. P., Maykot, J. K. & Ghisi, E. (2022). Comprehensive Environmental Assessment of Rainwater Harvesting Systems: A Literature Review. Water 2022, 14, 2716. https://doi.org/10.3390/w14172716

Tomaz, P. (2011). Aproveitamento de água de chuva para áreas urbanas e fins não potáveis. São Paulo: Navegar.

Tomaz, P. (2001). Economia de água. São Paulo: Navegar.