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STRATEGIES OF ACCESS TO WATER IN THE BRAZILIAN SEMI-ARID: A CASE STUDY IN THE COASTAL WATERSHED - CE, BRAZIL

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Abstract
Access to water is a public right guaranteed by law n° 9433/1997; however, this right has become a problem when it comes to its concession, due to the water dynamics of the semi-arid environment. The space-time rainfall variation affects the condition of access to water, generating a process of scarcity and water crisis. The objective of this study is to analyze the strategies of access to water through the drilling of wells and the construction of dams in the semi-arid region of Ceará. Develop spatial analysis through the Geographic Information System-GIS, aiming to contribute with information on the understanding of the problem of water scarcity. The methodology used is a systemic approach associated with empirical understanding, following the operational development in bibliographic and literary review, analysis of the situation of water scarcity and the application of GIS in the construction of geospatial information. The results are represented in the spatial dynamics of the dams and wells as alternatives for public and social policies to face the condition of the drought phenomenon and the consequence of the water scarcity of the communities, the cartographic products are associated with a scale of 1:550,000 and represent the dimension of 8,619 km² of the coastal watershed. As considerations, it was observed that the supply of water is regulated by federal legislation, and the situation of water scarcity is strategically alleviated with the policy of drilling wells by the State, however, this condition needs to be understood as an intergovernmental aspect.
Keywords: Water scarcity, weirs and wells.

ESTRATÉGIAS DE ACESSO À ÁGUA NO SEMIÁRIDO BRASILEIRO: UM ESTUDO DE CASO NA BACIA HIDROGRÁFICA DO LITORAL – CE, BRASIL

Resumo
O acesso a água é um direito público garantido pela lei n° 9433/1997, entretanto, esse direito tornou-se um problema quando se trata de sua concessão, por conta da dinâmica hídrica do ambiente semiárido. A variação pluviométrica espaço-temporal afeta a condição de acesso a água gerando um processo de escassez e crise hídrica. O objetivo desse estudo visa analisar as estratégias de acesso a água por meio da perfuração de poços e pelas construções dos açudes no semiárido

cearense. Desenvolver a análise espacial através do Sistema de Informações Geográficas-SIG, visando, contribuir com informações sobre o entendimento do problema de escassez hídrica. A metodologia utilizada é abordagem sistêmica associada ao entendimento empírico, seguindo o desenvolvimento operacional em revisão bibliográfica e literária, análise da situação de escassez hídrica e a aplicação do SIG na construção de informações geoespaciais. Os resultados estão representados na dinâmica espacial dos açudes e dos poços como alternativas de políticas públicas e sociais ao enfrentamento da condição do fenômeno da seca e a consequência da escassez hídrica das comunidades, os produtos cartográficos estão associados a escala de 1:550.000 e representam a dimensão de 8.619 km² da bacia hidrográfica do litoral. Como considerações observou-se que a oferta da água é regulamentada pela legislação federal, e a situação de escassez hídrica é amenizada estrategicamente com a política de perfuração de poços pelo Estado, porém, essa condição precisa ser compreendido como aspecto intergovernamental.
Palavras-chaves: Escassez hídrica, açudes e poços.

INTRODUCTION

Democratization and access to water was established by the National Water Resources Policy law No. 9433/1997. Making water an element of the public domain, whose process of spatial and temporal distribution in the semiarid northeastern region of Brazil and Ceará, is directly affected due to several factors. Sand-time rainfall variation along the hydrographic basins, potential evapotranspiration and water storage along the water infrastructures.

In this perspective, the objective of this study is to analyze the strategies of access to water in the coastal watershed in the semiarid region of Ceará, through the existing water infrastructures, which are: the drilling of wells and the reservoirs. Currently there are several graphic tools that can help in the process of making social or environmental decisions, being them: ENVI, ARGIS, QGIS and SPRING.

The set of geospatial information available for consultation on a digital basis, assists computational technical procedures that, when processed, allow us to infer decision-making and subsidize social, political and economic information of a region. For Hayne & Wyse (2018) decisions are the needs related to problem solving and increased well-being.

Therefore, it was decided to identify the biggest problem related to the difficulties of access to water in the region and to predispose the demand prognosis in relation to the situation of water supply in the basin. With the use of geoinformation Maciel Pinheiro, Foggiatto Silveira & Bazzo (2009) mention technology as the main factor of progress and development. Thus, as a process to assist the production of social and scientific knowledge.

For Câmara & Monteiro (2001) geoinformation corresponds to the use of computer as an instrument for representing spatially georeferenced data. As a relevant instrument for the processing of cartographic information, since the basis to be represented is the earth's surface and spatial phenomena.

In the field of scientific research, the spatial analysis of the geographic environment results in spatialization, representation, interpolation of natural and social phenomena, after a set of technical and methodological procedures applied in the computational environment. The future perspective is that geoinformation becomes a fundamental support to various professionals who work directly with spatial phenomena.

Over time, a set of new spatial technologies emerged, being Web-SIG, UAvTS, GPS and Satellites, which enable, respectively, the crossing of technical operations in the computational environment and allow the performance of spatial analyses, through methodological procedures. According to Silva; Rocha & Aquino (2016, p.185).

> Map servers allow users to have extensive interaction with available spatial information. Thus, it is observed that the main characteristic of Geoinformation is to enable the user to analyze spatial data in a systemic way, especially from the products generated to represent reality.

Spatial analysis is itself a fundamental tool for the process of integration and data processing, of vector and matrix character, which from a GIS environment, provides a graphical visualization. Thus, to allow to represent reality and infer control and subsidy the taking of operational decisions at the level of public policies and referencing technical reports, from various sources.

According to Souza (2005, p.1292):

> Spatial analysis can be given in a simple way, only based on the visual analysis of the distribution pattern of an event on a map. What we usually call a thematic map and which in many cases can be replaced by a table. As an example, I can mention the spatial distribution of tuberculosis incidence by the municipalities of the State of Rio de Janeiro.

It is essential to mention that the data operationalized throughout the GIS environment need to be thought and contextualized to the spatial phenomenon to which it will be investigated. In the specific case, the problem of water scarcity in the semi-arid region of the coastal watershed. According to EMBRAPA (2014) the profile of users of geotechnologies and geoinformation has undergone profound changes due to technological and marketing aspects.

Postulated in emphasis the information to be represented in a GIS environment, requires its users to know technical criteria, as presupposes the thought of Rosa (2011) when the rules of cartography are not respected, the reading of the map is compromised, which can be crucial in the communication and transmission of spatial information.

The semi-arid region and the water issue

According to SUDENE (2017) the semi-arid is characterized and delimited according to the criteria established by the following legislations, law no. 107, of 07/27/2017 and Law No. 115, of 11/23/2017, which characterize it by an average annual precipitation equal to or less than 800 mm, Thornthwaite's aridity index equal to or less than 0.50, daily percentage of water deficit equal to or greater than 60%.

The Brazilian semi-arid, located in the interior of northeastern Brazil, is present from Ceará to the north of Minas Gerais, contemplating two important biomes of the territory, to a greater extent the Caatinga and part of the Cerrado. For a better spatial understanding of the dynamics of drought in the semi-arid, Ab'saber (2003, p. 85-86) describes:

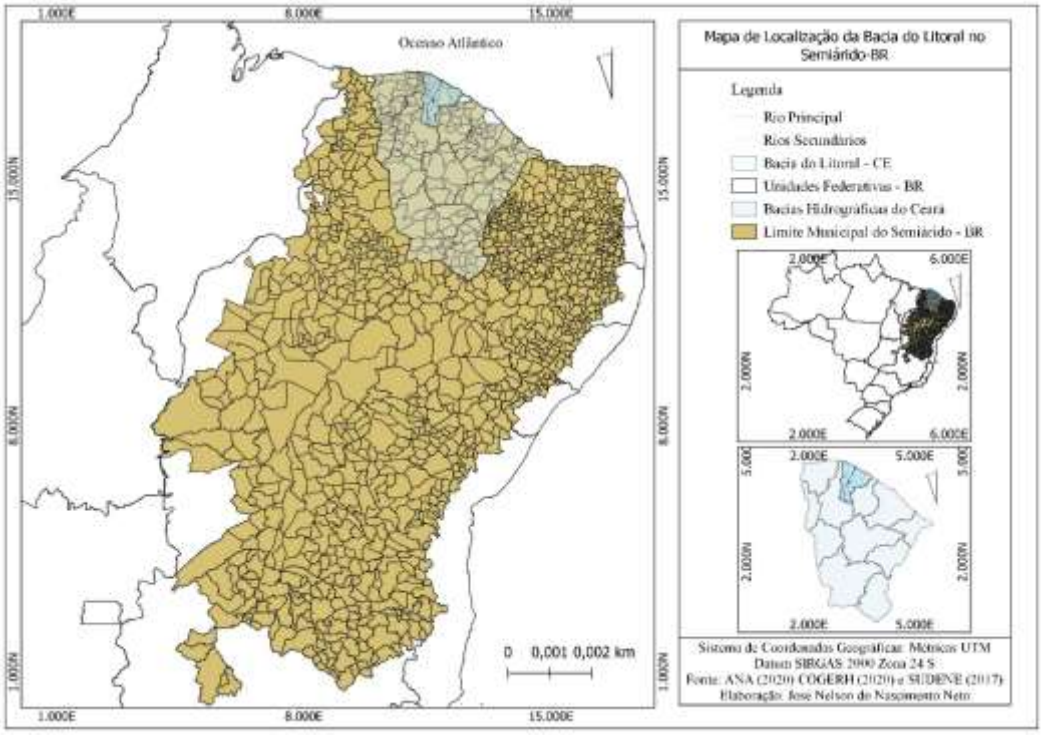
> There is no better thermometer to delimit the dry Northeast than the extremes of the caatinga's own vegetation. As far as the different facies of caatinga's go relatively continuously, we will be in the presence of semi-arid environments. The vegetation map is more useful for defining the confines of the regional climate domain than any other type of approach, however rational it may seem.

In this sense, with regard to the semi-arid region of Ceará, it is directly impacted by the natural characteristics presented by Ab´saber (2003), that is, it is located in a climatic region where heat and drought are predominant and the dry time can reach up to seven months, thus causing a situation of water scarcity and consequently impairing the quality of life of the population, as well as damage to agriculture.

As Nobre (2012) describes the surface waters of the northeast region, as opposed to those from deep aquifers, are mainly from rains that fall into watersheds totally contained in the region itself. Thus, the question about access, use and water management mainly reflects the rainfall measurement data captured along the water infrastructures distributed in the context of the basin.

Seeking to understand the spatialization and extent of the Brazilian semiarid region, we present figure 01 below, and superpose as object of investigation the spatial location of the coastal hydrographic basin in the semi-arid region of Ceará.

Figure 1: Map of the Brazilian semiarid and location of the study area



Organization: NASCIMENTO NETO, 2021.

According to the representation of Figure 01, there are several municipalities inserted in the semiarid region, which naturally present a sand-time variation in relation to rainfall distribution. In context, it is observed that there is an eminent need in relation to the water management of the region, according to Cortez; Lima & Sakamoto (2017, p. 86):

> In relation to water resources, it is necessary to consider the impact of low rainfall on the surface water reserve in Ceará, which are quite representative and the main source in the state. In 2016, the reservoirs monitored by the Water Resources Management Company of Ceará (Cogerh) totaled 153 reservoirs, representing more than 90% of the total surface accumulation capacity of the State, which is 18.64 billion m3. It is worth mentioning the considerable increase in the number of dams in Ceará since the 1980s, when the State began to build important reservoirs, which added to the historical reservoir implemented by the National Department of Works Against Droughts (Dnocs) over the last century.

From the perspective of surface water flow, the coastal basin has a delimitation of 8,619 km². Thus, the importance of water management in the Brazilian semi-arid region is ratified, because there are families served and others with absences of water service along the various specialized communities in the coastal basin.

For Villar (2016, p.92) Law No. 9,433/1997 relativizes legal duties for the case of drilling wells that are provided for meeting the needs of small rural population centers and for uses

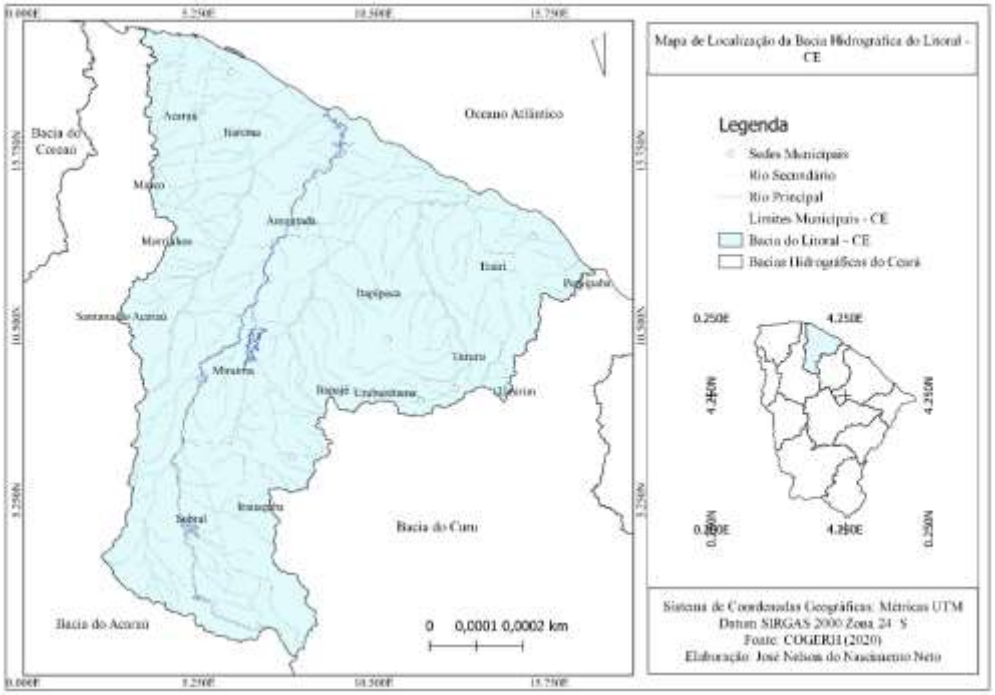
considered insignificant. Thus, it is observed that water structures need to be disseminated throughout small communities as a way of supplying and serving the semi-arid population of the northeast.

MATERIAL AND METHOD

Location of the study area

Located in the northwest region of the state of Ceará, the coastal basin represented in Figure 02 below drains an area of 8,619 km², encompasses areas such as Aracatiaçu (3,415 km²), Mundaú (2,227 km²), Aracati-Mirim (1,565 km²), Trairi (556 km²) and Zumbi (193 km²). The municipalities Acaraú, Amontada, Irauçuba, Itapipoca, Itarema, Miraíma, Marco, Morrinho, Santana do Acaraú, Trairi, Tururu, Uruburetama and Sobral are constituted, according to CEARÁ (2009).

Figure 2 - Ceará, Brazil: Location Map of the Coastal Hydrographic Basin. 2019



Organization: NASCIMENTO NETO, 2021.

According to Ceará (2009) the coastal watershed has crystalline rocks, of which 60.31% are composed of gneisses, migmatites, quartzites and metalimestones, associated with plutonic rocks, and sedimentary rocks and another 39.69% of sandstone of the barrier group. These lithostructural characteristics condition, respectively, the behavior of surface runoff along the coastal basin.

Technical and operational procedures

At the beginning, a literature review was carried out to highlight the importance of the theme, as well as to highlight the need for studies focused on water scarcity in dry regions, in this case, the Brazilian semi-arid region, to understand the actions of well drilling and construction of dams understood as water structures and carried out as strategic policies in the semi-arid environment.

Cartographic, theoretical and legislative information on the problem of water scarcity and its implications in the Brazilian semi-arid community was accessed in the following institutions: ANA, COGERH, SOHIDRA, IBGE and SUDENE, which are the agencies responsible for generating and producing technical information in the territory. After access to data collection in institutional agencies, geoprocessing techniques were applied to elaborate cartographic products.

The construction of cartographic products represented in the figure of the maps is graphic elements essential to the spatial understanding of the problem. Given the above and understanding the reality of water scarcity in the semi-arid is that the maps produced aim to contribute to the reading of a case study. The empirical analysis of the phenomenon of water scarcity arose in view of the need to understand the spatial distribution of water resources through the natural condition of the semi-arid environment.

In the process of empirical analysis of the spatial problem of water scarcity in the Coastal Hydrographic Basin, it was observed the understanding of the surface and subsurface structure of the hydrological system of the hydrographic basin, from the reservoirs and deep wells. The discussion about the natural condition and the types of policies implemented over time is essential to understanding the problem of water scarcity.

Application of the GIS, in the decision-making process of the production of cartographic information, the information available in: http://i3geo.cogerh.com.br/. The base of shape files were designed for the UTM systems, Datum Sirgas 2000, Zone 24s. The operational processes are based on data vectorization, aiming to expose the social importance of wetting information and deep wells distributed throughout the communities.

Having as operational support the Geographic Information Systems-GIS, which consists of a set of elements, including human resources (understanding of the problem and the search for solutions), the free Qgis 10.16 software, the hardware (notebook) and the metadata (shapefile and attribute table), associated with a delimitation of graphical scale of 1:550,000, to represent the spatial dimension of 8,619 km².

Thinking about the dynamics of the Coastal Hydrographic Basin, the following products were generated map of the Brazilian semi-arid to which aimed to identify the municipalities and the location of the coastal basin, the map of location of the basin aimed to know the

municipalities of the basin, the map of dams that aims to identify the spatialization of the same, the depth map of the wells aims to understand the difficulty of access to water and the flow map, aims to know the regions with greater water availability in l/h.

The procedure of spatialization of information in the GIS environment was performed, constructing the maps of centroids that represent the relationship between depth and flow, and a heat map representing the areas with the highest flow concentration of the wells in the study area.

RESULTS AND DISCUSSIONS

In the State of Ceará, the water resources management company - COGERH is the body responsible for the management of watersheds, technical monitoring of dams and water management, but the process of capturing raw water for the commercialization and distribution of drinking water is the responsibility of the municipalities, being it, the water and sewage company of Ceará - CAGECE and the autonomous water and sewage service-SAAE that act by granting the process crude water collection on site.

COGERH established the watershed committees (CBH) by state law No. 14,844 that provide for the State Water Resources Policy and instituted the Integrated Water Resources Management System-SIGERH, as "regional water resource management entities with consultative and deliberative functions, acting in basins, sub-basins or hydrographic regions" linked to the state council of water resources - CONERH.

Thus, in order to know the reality of quantitative demand for access to water, it is necessary to identify the spatial distribution of the population of the basin according to table 01 below according to the municipalities.

Table 01: Population distribution in the municipalities of the Coast basin- CE.

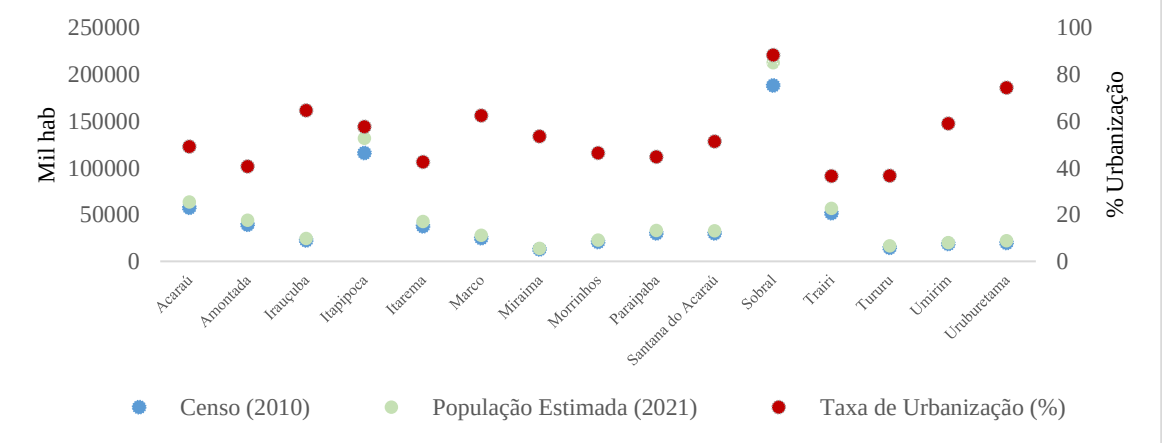
Municipalities	**Acaraú**	**Amontada**	**Irauçuba**	**Itapipoca**	**Itarema**	**Marco**
Censo 2010	57.551	39.232	22.324	116.065	37.471	24.703
P. Estimated	63.556	44.195	24.450	131.687	42.595	27.822
Urbanization	49,07	40,65	64,65	57,65	42,53	62,48
Municipalities	**Miraíma**	**Morrinhos**	**Paraipaba**	**S. Acaraú**	**Sobral**	**Trairi**
Censo 2010	12.800	20.700	30.041	29.946	188.233	51.422
P. Estimated	13.965	22.830	33.232	32.851	212,437	56,653
Urbanization	53,49	46.43	44,72	51,33	88,35	36,53
Municipalities	**Tururu**	**Umirim**	**Uruburetama**			
Censo 2010	14.408	18.802	19.765			
P. Estimated	16.588	19.976	22.223			
Urbanization	36,70	58,99	74,32			

Source: IBGE (2010)

Observing the distribution of the population according to the data presented in the table, the correlation between the quantitative data of the last IBGE census of 2010 was verified, comparing the estimated population projected for the year 2021 and correlated with the percentage of urbanization of the municipalities to size the urban population.

The following is shown in graph 01 on the spatial dimension of the basin population and its respective characteristics by municipality.

Graph 01: Population distribution along the Coastal Hydrographic Basin – CE



Source: IBGE (2010 and 2021*) *Estimated

The distribution of the population in the coastal basin corresponds to the crossing of data between the 2010 IBGE census and the estimated population of 2021, and a total population of 683,469,000/inhabitants was found in 2010 and according to the estimated 2021 IBGE data, an estimated population of 765,060,000/inhabitants is recorded, which corresponds to a population growth of 81,591,000/inhabitants over a decade.

Next, it shows graph 02 and table 02 that describes more specifically the relationship of the urban and rural population according to the 2010 IBGE census.

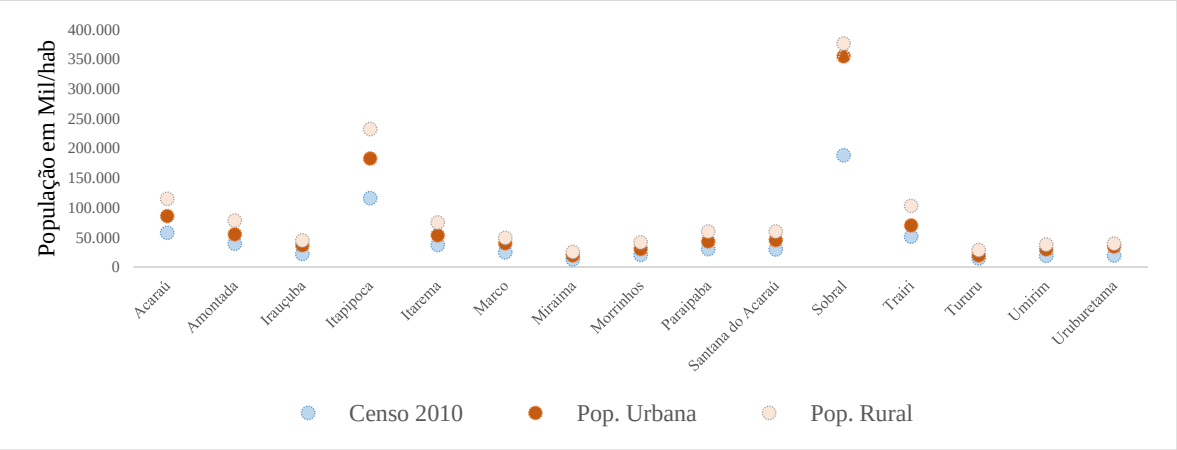
Table 02: Distribution between the urban and rural population of the coastal basin - CE

Municipalities	**Acaraú**	**Amontada**	**Irauçuba**	**Itapipoca**	**Itarema**	**Marco**
Censo 2010	57.551	39.232	22.324	116.065	37.471	24.703
P. Urban	28.242	15.974	14.343	66.909	15.938	15.432
P. Rural	29.302	23.285	7.981	49.156	21.533	9.268
Municipalities	**Miraíma**	**Morrinhos**	**Paraipaba**	**S. Acaraú**	**Sobral**	**Trairi**
Censo 2010	12.800	20.700	30.041	29.946	188.233	51.422
P. Urban	6.874	9.612	13.435	15.372	166.310	18.784
P. Rural	5.953	11.088	16.606	14.574	21.923	32.638
Municipalities	**Tururu**	**Umirim**	**Uruburetama**			
Censo 2010	14.408	18.802	19.765			
P. Urban	5.244	11.091	14.689			
P. Rural	9.120	7.711	5.075			

Source: IBGE (2010).

Table 02 mentions the importance of knowing the urban population in relation to the rural population, in order to identify where the largest population is concentrated among the spatial zones of the municipalities and to analyze them within the context of the basin. In graph 02 below is presenting this information in spatial character.

Graph 02: Rural and Urban Population along the Coastal Watershed – CE



Source: IPECE (2017).

It was observed that for the 2010 census data, the relationship between the rural and urban population is significant, since the municipalities of Acaraú with 29,309,000 inhabitants, Amontada with 23,285,000 inhabitants, Itarema with 21,533,000 inhabitants, Morinhos com11,088,000, Paraipaba with 16,606,000 inhabitants, Trairi with 32,638,000 inhabitants and Turu with 9,120,000 inhabitants, have a larger rural population than the urban population. Therefore, it is essential to cross-reference the data to understand about the process of water distribution between municipalities.

We have in graph 03 and table 03 below, the relationship between the population served by water supply in the urban area and the volume sold in the urban perimeter.

Table 03: Relationship between the urban population and the volume sold in the basin.

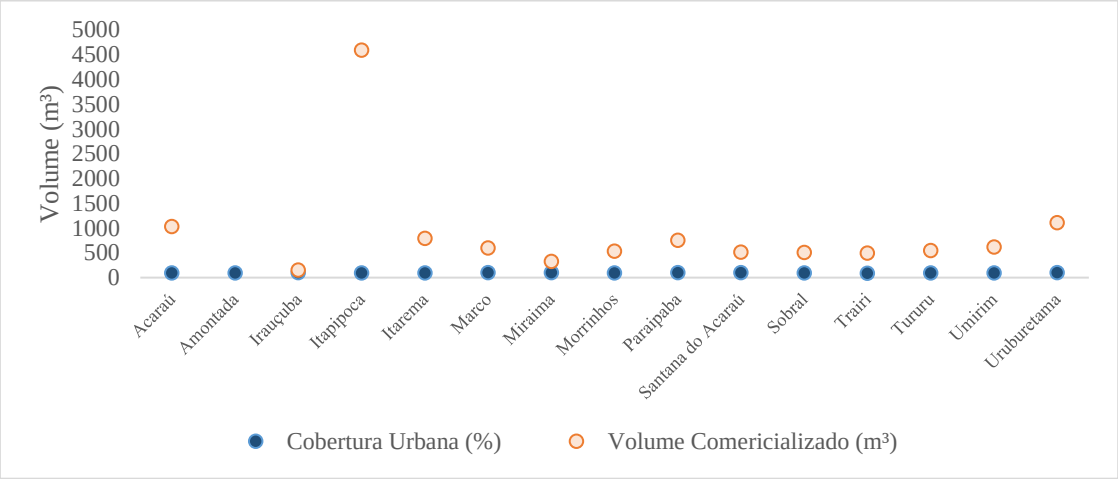
Municipalities	**Acaraú**	**Amontada**	**Irauçuba**	**Itapipoca**	**Itarema**	**Marco**
C. Urban	97,48	95,79	99,41	98,67	95,32	99,18
V.C	1.035,04		151,191	4.594,28	790,89	599,236
Municipalities	**Miraíma**	**Morrinhos**	**Paraipaba**	**S. Acaraú**	**Sobral**	**Trairi**
C. Urban	99,72	98,91	99,32	99,87	96,50	91,62
V.C	327,891	533,503	755,05	515,78	511,275	498,679
Municipalities	**Tururu**	**Umirim**	**Uruburetama**			
C. Urban	98,68	98,93	99,62			
V.C	550,808	620,371	1.109,86			

Source: CAGECE (2016) in IPECE (2017).

Table 03 expresses the relationship between the urbanization rates according to the last IBGE census of 2010, with the volume rate sold in m³ by the municipalities of the basin

along the urban space. And respectively, it has a minimum ratio of 91.62% of urban coverage. This means stating that the urban population has access to water as a function of the municipal water distribution system via the figure of (SAAE) or state by (CAGECE). In graph 03 it is possible to verify this spatialization in the basin.

Graph 03: Population with access to water in the Urban Zone of the Coastal Basin – CE



Source: CAGECE (2016) in IPECE (2017).

According to the data linked to the graph, it is verified that access to water is greater than 90% in interurban space throughout the municipalities, with a small variation between 95.32% and 99.87% of supply coverage. Although we know that the northeastern region faces great differences in access to water in general context, it is worth mentioning that the greatest need ends up concentrating along small diffuse rural communities.

According to Kelting (2009) the access to water is limited to the place and districts. In small localities or diffuse communities, access to water lacks water infrastructure investments that would make access to water possible through a well drilling strategy or water distribution system linked to dams through pipelines.

The following is table 01 that expresses the relationship between the constructed dams and the volume storage capacity in (m³) respectively. For this reality, it is important to know that this water infrastructure serves the urban centers of the municipalities, which guarantees a favorable urban service of access to water.

Table 01: Dams for human supply in the Coastal Watershed-CE

Coordinates SIRGAS/UTM	Municipalities	Reservoirs	Capacity m³	Sistema	River/barred Creek	Organ Executor	Conclusion
445481.657627 9627253.67065	Itapipoca	Gamileira	52642392 m³	Coast	Mundaú River	SRH	2012
430095.660167 9627253.67065	Itapipoca	Poço Verde	12430000 m³	Coast	Sororó Creek	DNOCS	1955
430444.972569 9605100.21989	Itapipoca	Quandú	3370000 m³	Coast	Quandú River	SRH	1990
391828.354775 9605129.32787	Miraíma	S. P Timbaúba	15768679 m³	Coast	Aracatiaçu River	DNOCS	1916
404811.475451 9616219.47723	Miraíma	Missi	65300000 m³	Coast	Quandú River	SRH	2011
442580.150286 9598421.83120	Uruburetama	Mundaú	21300000 m³	Coast	Mundaú River	DNOCS	1988
385335.260683 9584192.42659	Sobral	Patos	7550000 m³	Coast	Aracatiaçu River	DNOCS	1918
390504.545096 9553053.05033	Sobral	S.M do Aracatiaçu	8200000 m³	Coast	Bom Jesus Creek	DNOCS	1923
387553.375724 9570783.67637	Sobral	S. A do Aracatiaçu	24340000 m³	Coast	Aracatiaçu River	DNOCS	1924

Source: GOGERH (2021).

The importance of this water infrastructure for its storage capacity of 216,257,391 m³ of water resources in the context of the basin. For Neto (2017) the construction of water reservoirs in the Brazilian semi-arid region appears, therefore, as one of the first alternatives of policies to combat the effects produced by the drought phenomenon by the national department of works against droughts-DNOCS.

This strategy that began in the process of construction of large reservoirs in the northeastern region has a fundamental significance to the process of local and regional social development, by minimizing the effects arising from the irregular distribution of rainfall in the semi-arid region. Thus, it is contextualized about the importance of knowing water availability and its importance as water infrastructure equipment.

The basin has a water supply of 216,257,391 m³ available for use. However, to achieve this availability, there are three direct limitations, one is the dependence on water precipitation captured during the rains for recharge, the second is the availability of exclusive care from the urban population and the third is that not all municipalities in the basin have built dams. As there is an increase in the demand of new users, in population or social and economic development aspects, such as industry, agro industry and commerce, new challenges arise on the water management process.

According to Campos (2013) the main policy practiced at the beginning of the last century was the politics of dam. She was the one who consumed dnocs' most financial resources. For Oliveira, Silveira & Júnior (2020) many rural communities live with the problem of long periods of drought, as well as, with the absence of reservoirs. Therefore, it is interesting to understand the social dimension of wells to serve communities. For Sostenes (2019) in the search for solutions to water scarcity, the population of the semi-arid northeast began in 1980 through investments by government agencies, to build public dams, bars, cisterns and artesian wells.

Given the structural difficulties of access to water for the rural population, the phenomenon of water scarcity ended up concentrating on diffuse communities along the basin. The strategy launched was respectively the dissemination of the well drilling policy, as observed in table 02 and graph 04 below as an aspect of mitigating the effects produced by the drought phenomenon.

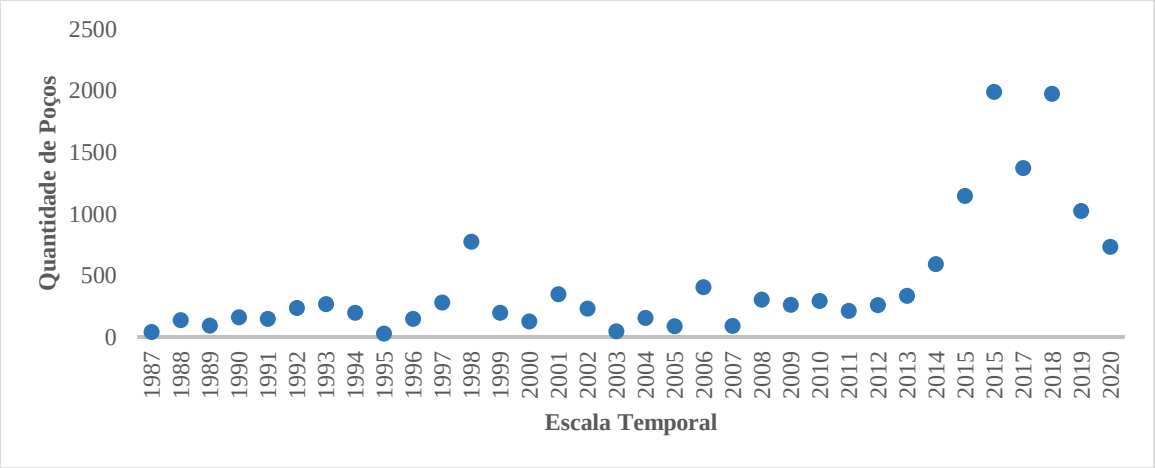
Table 02: Distribution of wells built over the years by SOHIDRA.

Year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Wells	41	137	93	161	147	238	267	197	28
Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Wells	149	282	774	197	127	349	232	47	157
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Wells	47	157	89	405	90	304	269	294	214
Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Wells	261	336	592	1147	1994	1374	1977	1024	733

Source: SOHIDRA (2020).

Below, graph 04 shows the spatial distribution of wells built in the State of Ceará, it is worth noting that there is a progressive growth in the tabulated data and, respectively, the dynamics of the coastal basin can be contextualized.

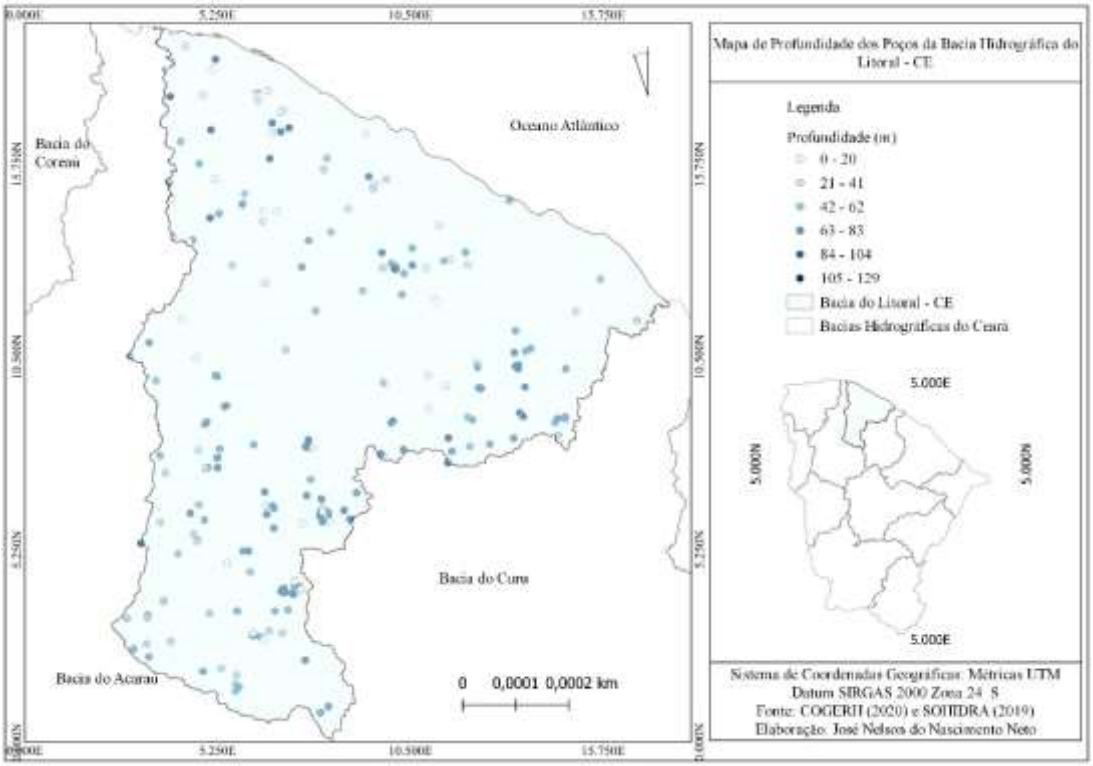
Graph 04: Wells drilled by SOHIDRA from 1987 to 2020.



Source: SOHIDRA (2020).

Approximately 14,720 wells were drilled over 33 years by SOHIDRA in the State of Ceará, of which 240 are distributed along the coastal basin. The concentration of these wells in specific regions expresses the importance of this strategy as a way of mitigating the condition of water scarcity in rural communities, as can be seen in Figure 03.

Figure 03: Well depth map in the Coast basin- CE

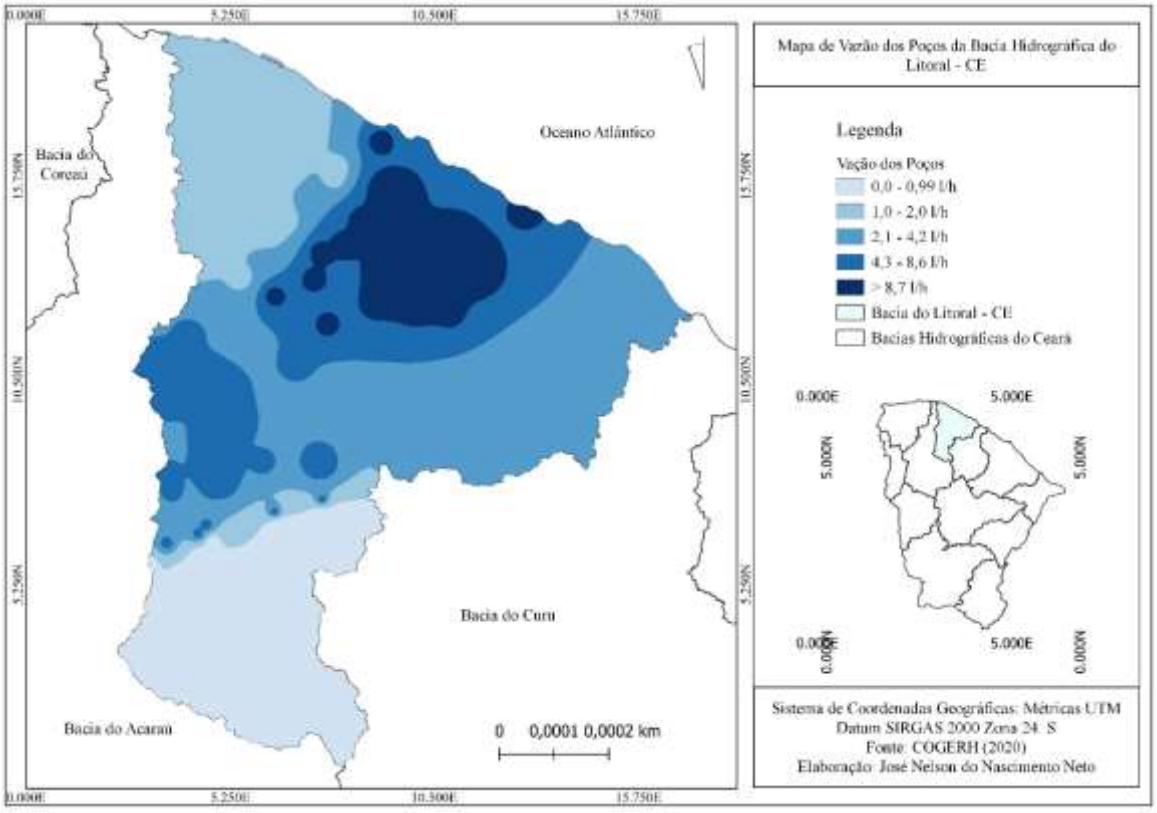


Source: The Authors (2021)

The concentration of wells in specific regions associated with diffuse communities along the basin represents an important strategy of access to water in situations of water scarcity and the decentralization of water structures. SOHIDRA has headed the execution of well drilling in Ceará, but it is essential that it is in accordance with Technical Resolution No. 03/2019, according to CPRM (1998) the drilling of tubular wells has been used as an alternative to supply the water supply of small communities and herds.

The demand for multiple use of water mentioned in law 9.433/1997 aims to determine the water availability to various sectors of society, using the strategy of drilling wells throughout the communities, since the reservoirs are limited to a wide range of service to the urban agglomerations of cities, restricting the access of water to communities. Figure 04 below is possible to check the ratio of the well flow.

Figure 04: Map of well flow in the Coast Basin – CE



Source: The Authors (2021)

Water availability ranges from 0 l/h in the condition of dry wells to 8,700 l/h with favorable water availability, thus, it was observed that this water availability is concentrated in the region of low course to the mouth, confirming in turn the condition of some regions presenting low water availability. It was observed that although these strategies have a

good representation in the coastal basin, it cannot equalize or guarantee access to water to small communities

The process of water scarcity and the insertion of wells as an alternative to mitigate the social problem, as Medeiros, Gomes and Albuquerque consider (2011 p.114). Thus, access to such information allows the improvement of water management of this space. For CEARÁ (2021) the state policy of Ceará, to face the drought problem, has the Drought Contingency group, from SOHIDRA, in which in the period from 2015 to 2020, it drilled 8,249 wells representing 56% of all wells performed. As you can identify in graph 04.

Wells represent an important state policy to face the effects of water scarcity in the State of Ceará; however, it is necessary to consider that even containing water they can dry, becoming a strategy that requires control and supervision of the exploitation of subsurface water. Thus, table 03 expresses the relationship between the flows of wells to meet the demand of the rural population of the basin.

In this analysis, of the 683,469 thousand/inhabitant scan of the census (2010), of these 61.19% of its population 418,000/inhabitants had favorable access to water supply in urban space according to CAGECE and IPECE, with a 4.55% change. Otherwise, the population of 256,220,000/inhabitants, which corresponds to 39% of the rural population, did not have access to supply. Thus, it was observed that the dams contribute significantly to this reality by providing a volume of 216,257,391 m³ for the population around them.

In the situation of the wells this value corresponds to the average values of 7659,833 m³ of flow, for a population of 256,220 thousand/inhabitant, which represents, respectively, an average of 643.12 m³ per person, a reality that is questionable, when perceiving the social dimension of the water scarcity of the basin once the wells have zero flow.

Table 03: Water availability of wells to the rural population of the Coastal Basin

Municipality	Wells	Dry	Average Flow	Rural Population (2010)	Non-supplied population	Average per Person
Acaraú	10	1	16594,78	29.309	50,93 %	566,20 m³
Amontada	15	1	8128,5	23.285	59,35 %	0,34 m³
Irauçuba	75	52	1803,25	7.981	35,35 %	0,22 m³
Itapipoca	30	28	3426,667	49.156	42,35 %	69,71 m³
Itarema	19	-	12970,53	21.533	57,47 %	0,60 m³
Marco	2	-	40650	9.268	37,52 %	4,38 m³
Miraima	14	5	2641,44	5.953	46,51 %	0,44 m³
Morinhos	3	-	3917	11.088	53,57 %	0,35 m³
Paraipaba	1	1		16.606	55,28 %	0 m³
Santa do Acaraú	6	2	3226	14.574	48,67 %	0,22 m³
Sobral	29	9	2660	21.923	11,65 %	0,12 m³
Trairi	5	5		32.638	63,47 %	0 m³
Tururu	11	8	610	9.120	63,30 %	0,06 m³
Umirim	4	3	1300	7.711	41,01 %	0,16 m³
Uruburetama	6	4	1650	5.075	25,68 %	0,32 m³
Total	230	119	7659,833	256,220	38,80 %	643,12 m³

.**Source**: SOHIDRA and IBGE (2021). Authors Organization (2022).

CONCLUSIONS

Geoinformation is highlighted as a significant aspect to express the spatial objects of the territory and environmental studies. In addition, to assist in the graphic representation of the coastal basin and the context of multiple water uses. The strategies for drilling deep wells and reservoirs as alternatives of territorial management in the coastal basin reflect the perspectives of uses and analysis of water throughout the productive systems.

It is worth mentioning that this study contemplated its objective and the problem listed, since it was possible to identify that the population living in the rural area suffers from water scarcity and it was observed that the problem is linked to the concentration of strategies in space. Therefore, it is considered that this research contributed qualitatively to the interpretation and analysis of the problem of scarcity and water crisis in the semi-arid region of Ceará. It was also observed that wells and dams are important strategies for access to water in the condition of serving the population and mitigating the effects of drought.

The need to supply water is regulated by legislation, however it was observed the difficulty of granting these rights to the population. Moreover, the phenomenon of water scarcity needs to be strategically thought of as an intergovernmental situation, since demand is increasing in relation to supply making the semi-arid environment of high social vulnerability.

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