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STUDY OF THE CEDRO DAM IN THE CENTRAL HINTERLAND OF CEARÁ STATE

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ABSTRACT – The importance of water and the difficulty of finding it in Ceará led the federal and state governments over the years to build several dams in northeastern Brazil to alleviate the problem of drought periods in the region. This manuscript analyzes the Cedro Dam, the first Brazilian dam, in Quixadá/Ceará. It was possible to conclude from the visual inspections that even 115 years after its construction, the equipment that makes up the Cedro Dam, especially the structure, remains in good condition.
Keywords: Water. Cedro Dam. Dam.

ESTUDO DO AÇUDE CEDRO NO SERTÃO CENTRAL DO ESTADO DO CEARÁ

RESUMO– A importância da água e a dificuldade de se encontrar água no Ceará fez com que o governo federal e os governos estaduais ao longo dos anos venham construindo vários açudes no nordeste brasileiro para amenizar o problema dos períodos de seca na região. O presente trabalho faz uma análise (estudo) do Açude Cedro localizado no município de Quixadá no Estado do Ceará, sendo o primeiro açude a ser construído no Brasil. Foi possível concluir que a partir das inspeções visuais, que mesmo depois de 115 anos de sua construção, os equipamentos que compõem o Açude Cedro, dentre eles a estrutura da barragem permanece em boas condições.
Palavras-Chave– água, Açude Cedro, barragem.

INTRODUCTION

Water is an essential, limited, and precious commodity for life. Only 3% of the land surface occupied by water is freshwater. Moreover, water is unevenly distributed in various regions of the planet, leading to water scarcity in several countries or regions due to different climatic and use characteristics (RIBEIRO, 2019).

The State of Ceará, inserted in the semiarid region of northeastern Brazil, had the evolution of the water resources policy directly influenced by the drought cycles, whose generated impacts and triggered reactive governmental actions initiated by the federal government, going from the hydraulic phase with the construction of large dams, such as the Cedro Dam (1890 - 1906) and idealized after the 1877 – 1879 drought, to the creation of permanent institutions, such as the Inspetoria de Obras Contra as Secas (Inspectorate of Works Against Drought, IOCS) (1909), today known as Departamento Nacional de Obras Contra as Secas (National Department of Works Against Drought, DNOCS) (1945), and the Superintendência de Desenvolvimento do Nordeste (Superitendency for the Development of the Northeast, SUDENE) (1959), created after the drought of 1958, reaching the 80s, when, due to the growing demand resulting from urban, industrial, and agricultural growth, the available water became scarce, imposing the need to elaborate planning and management mechanisms for the use of water resources (SRH, 2021).

The Cedro Dam results from one of the major droughts that Brazil and the Northeast have ever faced. In 1877, the drought that would last three years led, only in Ceará, to the withdrawal of 100,000 people from the countryside to Fortaleza. Therefore, Emperor Dom Pedro II requested a study of the areas suitable for constructing dams. Starting in 1890, the construction of the Cedro Dam in Quixadá (160 km from Fortaleza) would last 16 years, already during the republican period, with five dams damming the Sitiá River. It was the first main construction in Brazil involving irrigation canals (FERREIRA, 2017).

With a capacity of 125 million m³ of water (or 50,000 Olympic-sized pools), the dam has integrated with the local landscape, in which the Pedra da Galinha Choca (Broody Hen Rock) stands out, a tourist site listed as a national heritage Site and currently used mainly for leisure. One hundred and forty years (and a drought of five consecutive years) later, the Cedro Dam dried up in September 2016 – which had only occurred four times (1930, 1932, 1950, and 1999). In 2017, the oldest Brazilian dam turned into a cemetery for terrapins, where the death of animals is just one of the effects of the severe drought in the region (FERREIRA, 2017).

The Cedro Dam, which forms the reservoir of the same name, is in the municipality of Quixadá/Ceará, 164 km from Fortaleza. Its construction started with Dom Pedro II in 1890, who appointed the engineer Ernesto Antônio Lassance Cunha as the project manager, and finished in 1906. It is arch-shaped with a radius of 254 meters, discharging the efforts acting on the lateral buttresses of syenite, also known as Monolitos de Quixadá, in a place called Boqueirão do Cedro, with the Pedra da Galinha Choca in the background (EBANATAW, 2020).

The Cedro Dam has a stone barrier set in a valley surrounded by rocky mountains, having them as support, such as the Pedra da Galinha Choca on the left of the dam upstream and other stone hills on the right.

Built by the British, the Cedro Dam has overflowed four times since its construction, which finished in 1906. The first time was in 1924, a year of high levels of rainfall. The second time was in 1925, due to the winter of 1924, and needed little rain to overflow again. The third time the Cedro Dam overflowed was in 1974, due to a heavy rainy season where people prayed asking God to stop raining in Ceará. The last time was in 1985 due to another good winter.

This work analyzed the situation of the Cedro Dam concerning the constructive aspects and its usefulness throughout its years of existence.

METHOD

The production of this manuscript opted for on-site visits to the Cedro Dam with visual inspections and photographs.

ANALYSIS OF THE CEDRO DAM

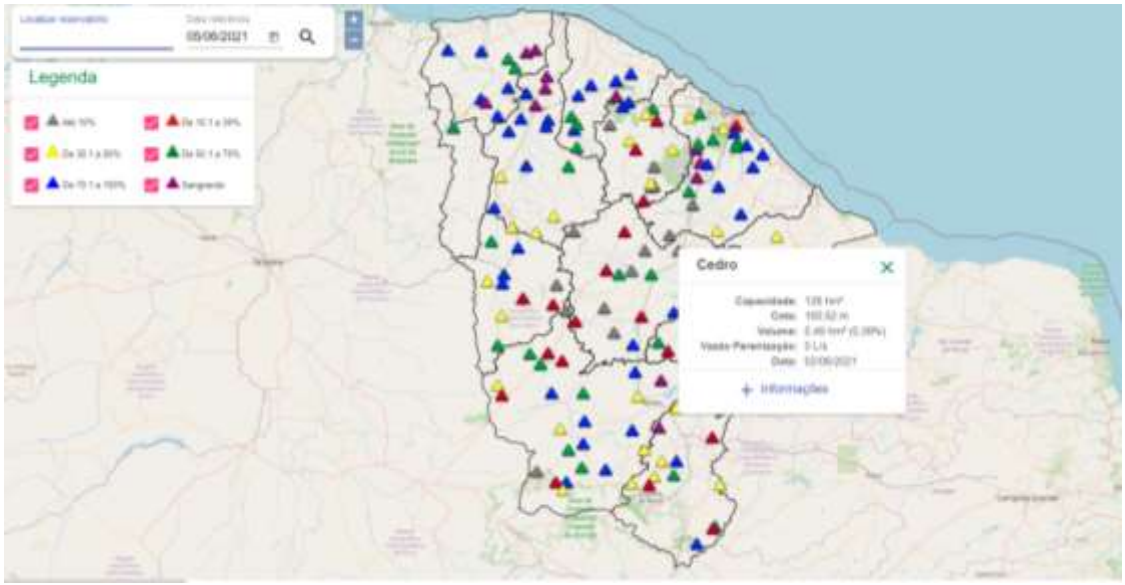
The Cedro Dam is in the municipality of Quixadá, belonging to the Banabuiú System and holding the Sitiá River. Concerning hydrology, the drainage basin covers 211.05 km^2, where its reservoir has a capacity of 126000000m³, whose regularized flow is 0.35 m³/s (COGERH, 2021).

The crest dam is 415 m long, 4 m wide, and 20 m high. The spillway is 91 m wide. The water intake is of the gallery type and is 15 m long (COGERH, 2021).

Figure 1 shows the location of Cedro Dam in Ceará and its conditions on June 2, 2021, when the volume was 0.49 hm^3, 0.39% of the total, the flow was 0.00l/s, and the quota was 100.52 m. Such data show the evolution of the stored volume. The gray triangle in the legend of Figure 1 is the dams that have less than 10% of their storage capacity, as is the case of Cedro Dam, located almost in the center of Ceará, in the central hinterland (PORTAL HIDOLÓGICO DO CEARÁ, 2021).

When analyzing the evolution of the stored volume, it was possible to verify that soon the Cedro Dam will completely dry because of the lack of rainfall and high evaporation.

Figure 1 – Cedro Dam location in the State of Ceará.



Source: PORTAL HIDOLÓGICO DO CEARÁ, 2021.

Currently, there is a town in the hinterland of Ceará called Piquet Carneiro in honor of the engineer who built the Cedro Dam, whose dimensions are more than necessary so it can overflow frequently. The reason is that, at the time, there was little knowledge of the morphometric characteristics of the Cedro Dam's Drainage Basin. Figure 2 shows the dam with its main barrier made of stones in the form of a vertical wall.

Due to the drought from 1877 to 1879, Dom Pedro II ordered the construction of the Cedro Dam. Concerning the material placed on the dam's floor, the ceramic is from Portugal, and the steel is from England. The dam holds the Sitiá River and belongs to the Banabuiú River Drainage Basin. Figure 3 shows the principal reservoir with monoliths at the end of the right shoulder. It also shows the monolith that forms the Pedra da Galinha Choca close to the Cedro Dam Bank.

Figure 2 – Cedro Dam.

Source: Own.

Figure 3 – End of the right shoulder where the monoliths are. The main dam is next to the monoliths.

Source: Own.

Figure 4 shows the dam's floor covered with English ceramic, an old building at the end of the right shoulder, and dense caatinga vegetation upstream of the principal reservoir.

Over the crest, there is a steel protection fence downstream and chains with several steel pillars upstream. Such material all came from England.

Figure 4 – The ceramic floor of the dam crest.

Source: Own.

Cedro Dam has two reservoirs – the first is the principal, and the second is the auxiliary. Figure 5 shows the second one, with lampposts over the crest, made of stone with a shoulder ending in a stone saw (monolith). It is possible to see water in the reservoir downstream of the dam. The auxiliary reservoir is trapezium-shaped. Among the equipment (reservoir, spillway, intake, dams, and others) that make up the Cedro Dam, a few anomalies are present, existing small vegetation on the upstream slope of the auxiliary reservoir.

Figure 5 – Auxiliary reservoir with lampposts over the crest.

Source: Own.

Dams have several purposes, such as water storage for animal and human consumption and irrigation, energy generation, and leisure. Figure 6 shows the leisure area with small restaurants near the right shoulder of the principal reservoir. The buildings are in good structural condition.

Figure 6 - Leisure area with small restaurants near the right shoulder of the dam.

Source: Own.

Figure 7 shows the device based on a mechanical system made of steel, where the transmission system consists of a spindle that, when driven, opens or closes the valve of the water intake. The system has two plates with gear teeth fixed to two spindles through a key. It was also possible to verify the existence of the two towers (made by the manufacturing process called casting) that support the spindles. All the water intake equipment came from England to build the Cedro Dam.

Figure 7 – Device that opens or closes the water intake valve.

Source: Own.

Ceará is the state in Brazil that lies almost entirely within the semiarid region of the Northeast. The water shortage often leads the inhabitants to move to other states. The

population usually turns to God asking for rain based on a passage in the Bible written by the prophet Isaiah.

The burning sand will become a pool, the thirsty ground bubbling springs (Isaiah 35:7) (Holy Bible, 1971). Over the years and assisted by engineering, several dams, pipelines, and canals have been born to irrigate regions distant from water resources, such as the northeastern semiarid region.

Currently, in Ceará, there is no need to build dams, except in Inhamus/Crateús, where the Fronteiras Dam is in construction, which will have a capacity of more than 450 million cubic meters. However, it is necessary to monitor and maintain the existing reservoirs.

Water is essential and hard to find in Ceará because it is in a semiarid region.

The construction of dams in the Brazilian semiarid region has been crucial to mitigate the local effects of droughts, along with damming policies implemented worldwide in semiarid areas.

CONCLUSION

The Cedro Dam in Quixadá was the first of its kind built by the Brazilian government in the central hinterland of Ceará.

After 115 years since its construction, the structure of the Cedro Dam remains in good condition because of the planning done before the building, the use of good-quality material (stones, steel, ceramic floor), the well-done execution, and the maintenance by DNOCS over the years.

The importance and difficulty of water in Ceará, as in the entire Brazilian semi-arid region, makes dam a mean of alleviating the drought problem.

The Cedro Dam has become a tourist attraction in Quixadá/Ceará.

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