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Estimation of water loss by evapotranspiration in an oceanic island reservoir colonized by water lettuce (*Pistia stratiotes L.*)

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Highlights:

·Predictive study of evapotranspiration of *Pistia stratiotes* present in Pernambuco reservoir based on literature data.

·The water loss forecast considers the scenario without *Pistia stratiotes*, applying the percentage of evapotranspiration predicted in the literature.

·The importance of macrophyte management aquatic in water bodies.

Keywords: Macrophyte; water availability; accumulation.

INTRODUCTION

Evapotranspiration is the way in which water from the Earth's surface (free water surfaces, soil, humid vegetation and plant transpiration) passes into the atmosphere in the vapor state and it is estimated 40% water accumulated in reservoirs is lost through evapotranspiration in the Brazilian semi-arid region. The increase in water losses through evapotranspiration is one of the most important negative interferences caused by extensive and dense colonization of water bodies by macrophytes (Pitelli, 1998, Tripathi et al., 2010).

Aquatic macrophytes are important for the aquatic environment, as they are sources of oxygen and can retain nutrients and pollutants. However, their high population growth rates favor the colonization of large areas, affecting the multiple use of water, in addition to the gradual decrease in the quality and quantity of water available for public supply (Scheffer et al., 1993; Hegel & Melo, 2016; Thomaz, 2002; Mohr, 2009).

Studies of evapotranspiration of plant communities are carried out by comparing between water losses through from surfaces colonized by plants. Therefore, the objective of this work was carry out a bibliographic review on the effects of evapotranspiration by macrophytes and apply the results observed to predict evaporation losses in a real scenario in the Xareu reservoir, largest reservoir and main supplier of fresh water in the archipelago Fernando de Noronha, Pernambuco, Brazil.

METHODOLOGY

A literature review was carried out, with different types of documents (articles, theses, dissertations, online texts). We used works obtained from the search with the descriptors "evapotranspiration", "macrophytes", "transpiration", "aquatic systems", "pistia stratiotes" and "water losses" on the websites Google Scholar and Scielo. 26 studies were identified and we opted for an integrative review with the synthesis of results from different types of studies (experimental, theoretical, empirical) about the object of study.

The predictive study was carried out in Xaréu dam, in the Fernando de Noronha Archipelago, Pernambuco, Brazil. Located at coordinates 3°51'56.85"S and 32°25'45.27"W (Figure 1). Fernando de Noronha has population of approximately 3,167 habitants and average floating population of 11,000/month. The main surface source used for supply is Xaréu dam. The island has no springs nor are there perennial watercourses, depend exclusively of relevant rainfall events. The prevailing climate is semi-humid tropical with a tendency to semi-arid, with low average annual rainfall (1,286 mm/m^2) and average annual temperature is 26°C. Xaréu dam has a maximum storage capacity of 411,000 m^3, occupies area 90,000 m² (9 ha) when at 100% capacity.

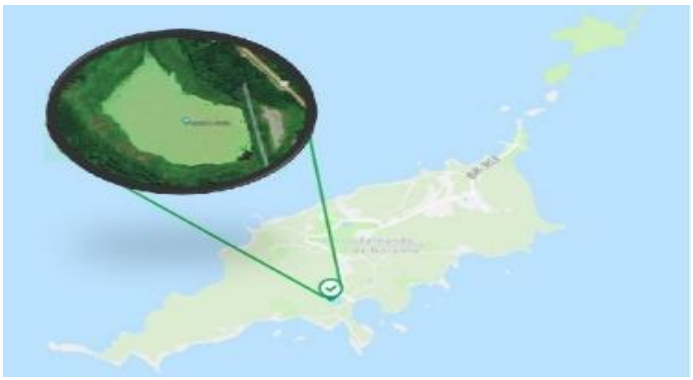

Figure 1 Location of the Xaréu Reservoir. Source: Sousa et al. (2023).

Pistia stratiotes (Figure 2), an exotic species, is the only species established in the Xareu dam.

Figure 2 *P. stratiotes L.* or Water lettuce. Source: Motta et al. (2008).

RESULTS AND CONCLUSIONS

One of the most common comparative approaches in the studies observed is the relationship between water losses through evapotranspiration from surfaces colonized by plants. The values observed in the literature vary greatly depending on various climatic factors, hence, solar radiation, air temperatura, air

huidity and wind speed are the climatologicla parameters that have to be considered, and among the articles evaluated we have:

Table 1: Evapotranspiration study with *Pistia Stratiotes*.

Test Condition	Evapotranspiration	References
50 L water, temperature 28.0 ± 2.0°C and humidity 68 ± 10% (Sri Lanka)	9.55 m d $^{-1}$ Pistia stratiotes 2.5 mm d $^{-1}$ free water surface	Bandara and Nahim (2012)
1 L water, temperature min 26 °C max 31°C, humidity 63.50%, 30 days (Brazil)	12,464.7 mL Pistia stratiotes 12,147.7 mL free water surface	Cerqueira Jr et al. (2014)
100 L water, temperature min 18 °C max 31°C (Argentina)	8.4 mm d $^{-1}$ Pistia stratiotes 7.4 mm d $^{-1}$ free water surface	Lallana et al. (1987)
150 L reservoir water, temperature 30 ± 2.0°C (Brazil)	11 mm d $^{-1}$ Pistia stratiotes 7.61 mm d $^{-1}$ free water surface	Aguiar (2014)

Studies in table 1, under different conditions, demonstrated the loss of water on surfaces colonized by Pistia Stratiotes, reinforcing the relationship between water losses through evapotranspiration and the presence of macrophytes in bodies of water (Pitelli, 1998; Pott & Pott, 2000). According Bandara and Nahim (2012) evapotranspiration from Pistia stratiotes showed positive relationships with temperatures and vapor pressure déficit while showing negative relationship with relative humidity. The low precipitation in the Fernando de Noronha Archipelago can contributes to a high rate of evaporation and growth of macrophytes, increasing water loss through evapotranspiration (Motta, 2008). Accumulated volumes of the Xaréu reservoir were plotted, in Figure 3, from 2022 to 2023, in the real scenario with Pistia and the prediction without Pistia, assuming the maximum losses of 30% observed by Aguiar (2014) in the scenario of 100% coverage with Pistia Stratiotes,obtaining loss equivalent 1,500,000 m³. This estimated volume may represent a water guarantee and reinforcement of supply.

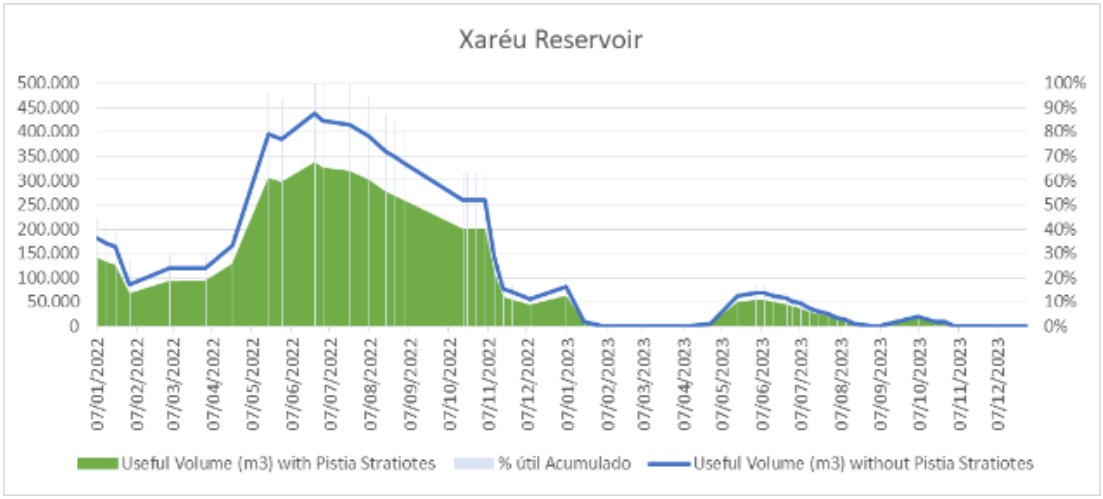

Figure 3 Volume Xareu Reservoir (2022-2023).

A sustainable project Floating Solar Plant to generate renewable energy will be installed in the water mirror in the Xaréu dam, occupying 4,400 m² (Casarin, 2022). Aguiar (2014) carried out study of evaporation losses with the reducing system (styrofoam), get losses reduction 32% comparable to the free surface and reduced the water temperature. Myres and Frasier (1970), obtained 21% reduction in evaporation using white granular floating materials, in addition to cooling water by reflecting shortwave radiation. With this it is estimated the installation of the floating solar will can positively impact to loss reduce evaporation in Xareu dam balancing evapotranspiration losses from macrophytes.

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