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Scientific Article
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Stem water storage potential in plants of the Caatinga biome[1]

Potencial de armazenamento de água no caule em plantas do bioma Caatinga

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ABSTRACT - Hydrological processes in forests are greatly influenced by existing plant species and their specific physiological characteristics. Water consumption by these plant communities is considered important in studies of water availability and water balance, especially in semi-arid regions. The aim of this study was to analyse water storage potential in the stems of representative plants of the Caatinga biome. The study was carried out in a preserved area of Caatinga in the Aiuaba Experimental Basin, Ceará, Brazil, where a phytosociological survey of the spatial distribution of wood density and stem water storage capacity was conducted. Allometric models were developed to estimate the active xylem area. Thirteen species and eight botanical families were registered during the floristic survey. The species with the highest density per hectare are the marmeleiro (*Croton sonderianus* Mull.) and the catingueira (*Poicianella pyramidalis* Tul.), reaching 85% of the total number of inventoried species. The water content in the stem of the catingueira is around five times that of the marmeleiro; however, due to their greater occurrence in the area, the amount of water retained in the stem of marmeleiro plants (per hectare) is around twice that of the catingueira plants. After 40 years of conservation, the area is at a stage of secondary succession. The water potential of the species included in the survey is equal to about one fifth of the maximum storage capacity of the reservoir that receives all the water drained from the basin.

Key words: Caatinga. Water availability. Allometric models. Biological water. Ecohydrology.

RESUMO - Os processos hidrológicos ocorridos em florestas sofrem grande influência das espécies vegetais existentes e suas específicas características fisiológicas. O consumo de água por essas comunidades vegetais tem sido considerado importante nos estudos de disponibilidade hídrica e balanço hídrico, principalmente em regiões semiáridas. Este trabalho teve como objetivo analisar o potencial de armazenamento de água no caule em plantas representativas do bioma Caatinga. O estudo foi realizado em zona de Caatinga preservada na Bacia Experimental de Aiuaba, Ceará, Brasil. Foram feitos levantamentos fitossociológico, de distribuição espacial da densidade da madeira e de capacidade de armazenamento de água pelo caule. Modelos alométricos foram desenvolvidos para estimativa da área do xilema ativo. No levantamento florístico registraram-se treze espécies e oito famílias botânicas. O marmeleiro (*Croton sonderianus* Mull.) e a catingueira (*Poicianella pyramidalis* Tul.) são as espécies que detém a maior densidade de plantas por hectare, chegando à 85% do número total das espécies inventariadas. O conteúdo de água no caule de uma planta de catingueira é cerca de cinco vezes maior que em uma planta de marmeleiro. Entretanto, devido à maior ocorrência na área, a lâmina de água retida no caule das plantas de marmeleiro (por hectare) é cerca de duas vezes maior que em plantas de catingueira. Após 40 anos de conservação a área se encontra em estágio de sucessão secundário. O potencial de água nas espécies levantadas equivale a cerca de um quinto da capacidade máxima de armazenamento do açude que recebe toda a água drenada da bacia.

Palavras-chave: Caatinga. Disponibilidade hídrica. Modelos alométricos. Água biológica. Ecohidrologia.

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INTRODUCTION

Most of the territory of the northeast of Brazil is covered by a Seasonally Dry Tropical Forest, a xerophilous vegetation of varied physiognomy and flora that covers an area of around 800,000 km², and which, since the colonial period, has kept the ancient indigenous name of 'Caatinga' (RODAL; SAMPAIO; FIGUEIREDO, 2013). Most of the vegetation is characterised as completely deciduous, with water deficit being a common feature for most of the year.

Nowadays, remnants of preserved Caatinga are rare. The interrelationships of plant species within the plant community over space and time, with reference to a quantitative study of the composition, structure, dynamics, history, distribution and environmental relations of the plant community, are included in phytosociological studies (CISZ; FALKOWSKI; ORR, 2013; SHAHID; JOSHI, 2016).

For the water balance on the scale of hydrographic basins, changes in the volume of water stored in the plant stem forms a biological water reservoir, which is not usually included in the water balance, and plays an important role in maintaining water in the leaf. In addition, it minimises the temporal imbalance between the water supplied by the soil and the atmospheric demand (JIN; WANG; SANG, 2011), ignored for being considered insignificant in relation to compartments of greater volume, such as reservoirs (ARAÚJO; PIEDRA, 2009), aquifers (MENDONÇA *et al*., 2008, 2009) or the soil in the root zone (COSTA *et al*., 2013).

The active xylem area can be modelled by relating specific variables for each individual, which can then help in estimating transpiration in a single tree or an entire forest (APARECIDO *et al*., 2015; ČERMAK; KUČERA; NADEZHDINA, 2004; ENQUIST, 2002). In addition to size, anatomical differences in the wood, species ecology, microclimate and individual age are factors that directly affect patterns of water use (BAKER *et al*., 2003; GEBAUER; HORNA; LEUSCHNER, 2008; HORNA *et al*., 2011; MENCUCCINI *et al*., 2007) and storage. Therefore, estimating transpiration without significant errors requires in-depth studies on a variety of ecological, physiological and anatomical behaviours at species level within a forest (HOFFMAN, 2012).

This study is divided into two main approaches: a survey of the phytosociology of a soil-vegetation association, and an evaluation of water storage potential in representative species of the Caatinga biome. The main scientific question to motivate this study is: what is the water storage potential in the stems of plants of the Caatinga biome, and whether this can be characterised as an important reservoir of biological water? This question raises two main hypotheses, each tested in this research: i) in preserved caatinga, the plants have the same specific area for conducting crude sap (hydroactive xylem), both in the plant strata and between the various species; ii) water storage capacity in plants of preserved caatinga does not vary according to species.

The aim of this work, therefore, was to study the water storage potential in representative plants of a Seasonally Dry Tropical Forest of the Caatinga biome under the conditions of preserved vegetation in an experimental basin.

MATERIAL AND METHODS

Study area

The study was carried out at the Aiuaba Experimental Basin (AEB) (Figure 1), which has a total area of 12 km² at the outlet of the Boqueirão reservoir (60 thousand m³) (ARAÚJO; PIEDRA, 2009; FARIAS *et al*., 2019). The basin is in the district of Aiuaba, in the state of Ceará, Brazil, and is completely within the Aiuaba Ecological Station (ESEC), the largest federal conservation unit in the Caatinga biome, administered by the Chico Mendes Institute for Biodiversity Conservation (ICMBio).

According to the Köppen classification, the climate in the region is type BSh (tropical semi-arid), with an annual potential evaporation of 2500 mm, mean annual precipitation of 549 mm and mean annual temperature of 26 ºC (PINHEIRO *et al*., 2016).

The AEB is divided into three soil-vegetation associations (SVA). The first (SVA1) occupies 20% of the area, the soil is a Chromic Luvisol and the depth of the plant root zone is 80 cm. The Second System (SVA2) occupies 34% of the area, has a soil classified as a Red Yellow Argisol, with an average root zone depth of 60 cm. SVA3, which represents 46% of the area of the basin, has a Litholic Neosol soil, and a root depth of 40 cm (COSTA *et al*., 2016; FIGUEIREDO *et al*., 2016; PINHEIRO *et al*., 2016).

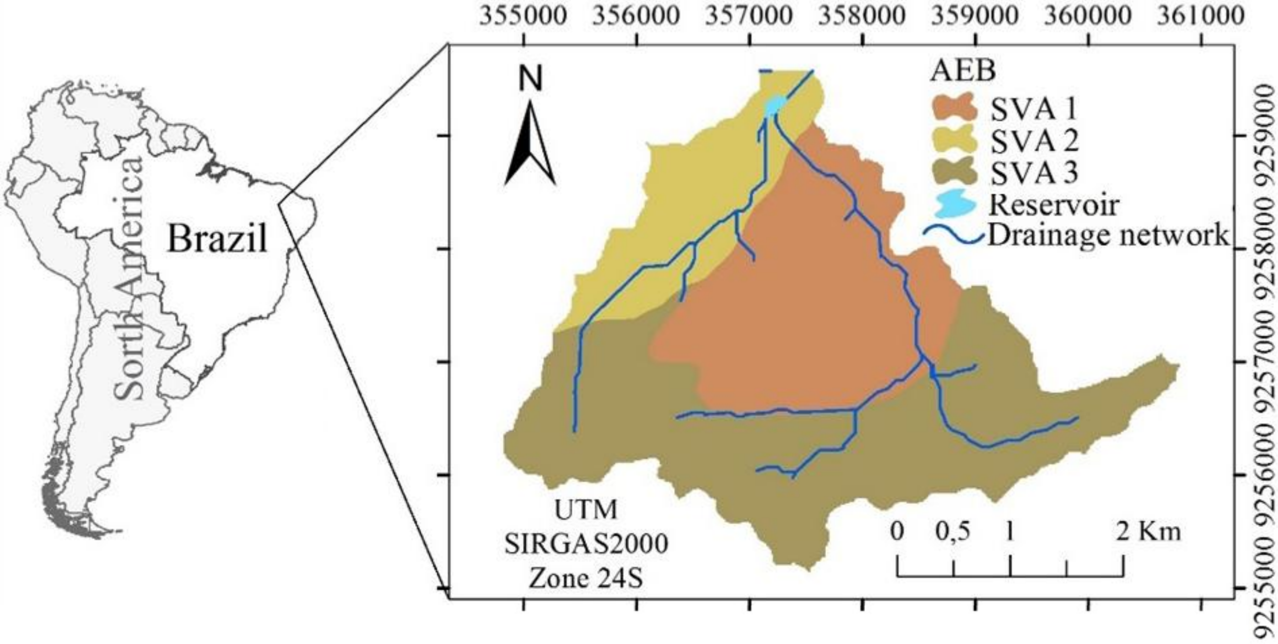
Phytosociological survey

Type and dimensions of the sample unit

The multiple-plot method was adopted for the phytosociological survey, where each plot was 20 x 10 m (200 m²) in size. The sample units were semi-permanently installed and systematically distributed 50 m apart, being allocated with the aid of a compass and a fiberglass tape measure. Each plot was delimited using four stakes and string, as per Rodal, Sampaio and Figueiredo (2013). Seven plots near RS1 (Rainfall Station 1) were analysed, giving a total sampling area of 1400 m².

Inside each plot, the stems were measured of all living or dead woody individuals, including vines, that

Figure 1 - Soil map with the location of the hydrological monitoring equipment and sampling units of the Aiuaba Experimental Basin (AEB)



were still standing, were distinct at ground level, and met the following criteria: diameter at breast height (DBH) greater than or equal to 2 cm and total height (TH) greater than or equal to 1.0 m.

The parameters collected in the field (species, diameter at breast height - DBH, diameter at the base – DAB, and height - H) for each individual were processed using the INFL software, a specific forest inventory program for the Caatinga developed by the UNDP/FAO/IBAMA/BRA/087/077 project. The following phytosociological parameters were estimated: absolute and relative density, absolute and relative frequency, absolute and relative dominance, importance value and vegetation cover value.

For the purpose of the inventory, and the mathematical model of the volume equation used, trees whose stems bifurcated up to 0.3 m from the surface of the soil were considered a single individual.

The diameter at the base and at chest height were measured with a Finnish parabolic calliper which consists of a parabolic arc whose graduation depends on the opening. This opening is supported on the trunk at the point where the diameter is to be measured. The reading is taking by viewing parallel to the normal arm, also known as the normal white arm. The grading or reading bands are on the parabolic arm and correspond to the tangencies of the shaft. The total height of the plants was estimated using a hypsometer (Blume-Leiss) that works on trigonometric principles, i.e. it automatically transforms angles (degrees) into distances (metres). The equipment consists of a viewer with a pendulum that shows the height in four scales depending on the distance from which the sighting is taken (15.0 m, 20.0 m, 30.0 m and 40.0 m).

To evaluate the Shannon-Weaver diversity index (H’) and the Pielou evenness index (J), data from the phytosociological survey were used in Equations 1, 2 and 3. The H’ index ranges from zero to five; the higher the value for H’, the greater the floristic diversity of the population under study. This index can express richness and uniformity (MORENTE; CAMPOS; RUANO, 2018). The J index ranges from zero to one, where a value of 1.0 represents maximum diversity, i.e. each species is equally abundant.

$$H' = \frac{\left[D_{abs} \times \ln(D_{abs}) - \sum_{i=1}^{S} D_{abs}^{i} \times \ln(D_{abs}^{i})\right]}{D_{abs}} \quad (1)$$

$$J = \frac{H'}{H_{max}} \quad (2)$$

$$H_{max} = \ln S \quad (3)$$

where: H’ is the Shannon-Weaver diversity index; D_{abs} is the absolute density; D_{absi} is the absolute density of the i-th species; J is the Pielou evenness index; S is the total number of sampled species.

Allometric relationship of the species to obtain the hydroactive xylem

From measurements of the hydroactive xylem area (sapwood) and stem diameter, an empirical mathematical equation for the correlation between the two variables was obtained. The model used was of the type $Y=aXb+\varepsilon$, potential, where Y equals the active xylem area, a is equal to a normalising constant, X to the diameter at breast height (DBH), and b is an allometric scaling exponent as per the methodology used by Aparecido *et al*. (2015) and Enquist (2002).

To obtain the data, trunk slices from ten trees of the two most important species were sampled based on the indices under evaluation: catingueira (*Poicianella pyramidalis*) and marmeleiro (*Croton sonderianus* Mull.).

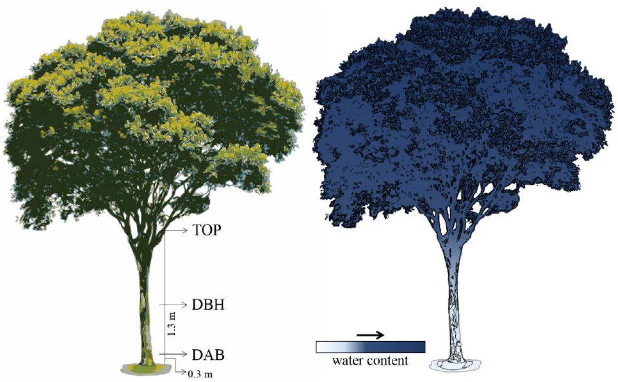
To identify the active xylem area, the methodology proposed by Aparecido *et al*. (2015) and Lubczynski, Chavarro-Rincon and Rossiter (2017) was adopted. However, the use of dye to increase the contrast between the xylem and heartwood was not necessary. In both the catingueira and marmeleiro, the hydroactive xylem could be determined by visual analysis due to the contrast in colour between the sapwood and the heartwood. The area was obtained via computational processing of digital photographs using CAD (Computer Aided Design) software.

Obtaining the water potential stored in the stem

Five plants of each species were used, to give a total of ten trees. The plants were sliced into discs, with three discs taken from each arboreal stratum of the plants: DAB; DBH; TOP. Figure 2 shows a schematic diagram of the division of the arboreal strata in plants of the catingueira and marmeleiro. The diameter at the base (DAB) is located 0.3 m relative to ground level, the diameter at breast height (DBH) is at 1.3 m from the ground, and the highest part of the plant (TOP) is formed by the thinner branches. These three strata were evaluated from disk sections. Monitoring and data collection took place in three campaigns: May, July and October 2016, covering the rainy and dry periods in the region.

The trunk slices were weighed fresh in the field and then immersed in water to obtain the turgid weight. The discs were dried in a rectangular oven at 65 °C, verifying the change in weight of the samples every six hours until the weight stabilised. After 30 hours oven drying, the weight change in the samples was negligible, stabilising and showing asymptotic behaviour along the time axis.

Figure 2 – Diagram of the divisions for evaluating water distribution in each arboreal stratum



A total of nine disks per plant, three per stratum, were sampled in the marmeleiro and catingueira. As five plants were used, a total of 45 samples were obtained to represent each of the two species in question.

To calculate the water potential in the stem, it was necessary to weigh fresh, turgid and dry samples, evaluating the data per stratum (Equation 4). The number of branches, the number of plants per hectare and the total length of each stratum were considered to determine the volume per stratum (Equation 5), per plant and per hectare, the water depth and the percentage of water contained in the plant.

$$\theta_i = \frac{\rho_{wood}}{\rho_{water}}\left[\frac{(Wsat)-(WD)}{WD}\right] \quad (4)$$

$$Wsat = WW + WD \quad (5)$$

where: θ_i = volumetric moisture of the xylem, m^3 m^{-3}; ρ_{wood} = specific weight of wood, kg m^{-3}; ρ_{water} = specific weight of water, kg m^{-3}; *Wsat* = weight of the wood after saturation, kg; weight of the wood after drying at 65 ºC (+/- 2), kg; and *WW* weight of the water, kg.

RESULTS AND DISCUSSION

Thirteen species from eight botanical families were registered in the floristic survey. The families Euphorbiaceae (77.5%) and Fabaceae (9%) had the highest number of plants, comprising 86.5% of the total inventory. Among the botanical families found (Table 1), those with the highest number of species were: Fabaceae (5), with the greatest floristic richness, followed by Euphorbiaceae (2). The other families each had only one representative.

Pereira Júnior, Andrade and Araújo (2012), analysing the floristic composition of the vegetation in the semi-arid region of Paraíba, also found greater abundance of families Fabaceae and Euphorbiaceae. These families are more frequently found in areas of Caatinga and can also be found in other studies of floristic composition (BARBOSA *et al*., 2012; LEMOS; MEGURO, 2015).

The sociological position of species in any given forest typology concerns the vertical distribution of these species in the different strata (lower: 1.0 to 2.5 m; intermediate: 2.6 to 5.0 m and upper: over 5.0 m), taking their height as reference. As it is an area of more than forty years conservation, the distribution of individuals by height was heterogeneous despite not presenting any species in the lower stratum. The number of plants in the intermediate and upper strata corresponded to 15% and 85% respectively.

Table 1 - Phytosociological parameters of the species sampled in SVA1, Aiuaba Experimental Basin

	Common name	Species	AD	RD (%)	BsA	RDo (%)	RD (%)	CVI (%)	IVI (%)
1	Marmeleiro	*Croton sonderianus* Muell. Arg. (Euphorbiaceae)	2680	77.3	14.1	68.5	16.7	72.9	54.1
2	Catingueira	*Poicianella pyramidalis Tul*. (Fabaceae)	256	7.4	2.8	13.5	14.3	10.5	11.7
3	-	Morta	179	5.2	1.2	5.7	16.7	5.5	9.2
4	Cipó	*Combretum laxum*. (Combretaceae)	107	3.1	0.1	0.7	14.3	1.9	6.0
5	Frei Jorge	*Cordia trichotoma* (Vell.) Arrab.ExSteud (Boraginaceae)	99	2.9	0.6	3.1	7.1	3.0	4.3
6	Rompe gibão	*Bumeliao btusifolia* Humb. Ex Roem. &Shult. (Saponaceae)	56	1.6	0.3	1.3	7.1	1.5	3.4
7	Pau mocó	*Luetzelburgia auriculata* (Allemão) Ducke (Fabaceae)	21	0.6	0.1	0.7	2.4	0.6	1.2
8	Feijão bravo	*Cynophalla flexuosa* (L.) J.Presl (Capparaceae)	14	0.4	0.2	1.0	4.8	0.7	2.1
9	Jurema branca	*Mimosa ophthalmocentra* Mart. exBenth. (Fabaceae)	14	0.4	0.1	0.4	4.8	0.4	1.8
10	Violeta	*Dalbergia Cearensis* Ducke (Fabaceae)	14	0.4	0.1	0.5	2.4	0.5	1.1
11	Guaxuma	*Helicteres guazumifolia* Kunth (Malvaceae)	7	0.2	0.1	0.1	2.4	0.1	0.9
12	Juazeiro	*Zizyphus joazeiro* Mart. (Rahmnaceae)	7	0.2	0.4	2.1	2.4	1.1	1.6
13	Jurema preta	*Mimosa tenuiflora* (Willd.) Poir. (Fabaceae)	7	0.2	0.5	2.4	2.4	1.3	1.7
14	Maniçoba	*Manihot glaziovii* Müll. Arg. (Euphorbiaceae)	7	0.2	0.1	0.1	2.4	0.1	0.9

AD= Absolute Density (ind.ha^{-1}), RD= Relative Density (%), BsA= Base Area (m².ha^{-1}), RDo= Relative Dominance (%), RF= Relative Frequency (%), CVI= Cover Value Index and IVI =Importance Value Index

A total of 487 individuals were sampled. Density was 3,468 individuals ha^{-1}. The most abundant species in the area were the marmeleiro (Croton sonderianus Mull.) and catingueira (Poicianella pyramidalis Tul.), (Table 1), with a total of 2,936 plants (85% of the individuals). These species stood out in relation to the total phytosociological parameters observed, and are considered primary colonisers in processes of secondary succession. The results corroborate those obtained for locations with a similar phytophysiognomy (CALIXTO JÚNIOR; DRUMOND, 2014; PEREIRA JÚNIOR; ANDRADE; ARAÚJO, 2012), confirming that these families are representative of the caatinga. The other families contributed with less than 4%.

In analysing the Shannon-Wiener diversity index (H’) and the Pielou evenness index (J), the values were 2.63 and 0.43 nats ind^{-1} respectively. Barbosa *et al*. (2012) found values for H’ of 2.05 and for J of 0.57 in areas of hypoxerophilic Caatinga vegetation with no cutting or burning for 51 years, having been used for raising cattle in a semi-extensive regime. Pegado *et al*. (2006) found an H’ of 2.81 and J of 0.79 nats ind^{-1} in a well-conserved remnant of arboreal caatinga located on the banks of the River Paraíba at an altitude of 621 m, where the predominant soils are Fluvic Neosols.

For the sampling sufficiency of the number of plots used, seven randomly distributed plots were initially marked out in the field within the area of vegetation to be explored. After collecting the data, the minimum number of plots was obtained for a probability of success greater than 90%, i.e. a sampling error of 20% was accepted. By analysing this sample using the INFL software (a Forestry Inventory Program specific to the caatinga and developed by the UNDP/FAO/IBAMA/BRA/087/077 Project), the ratio was obtained between the number of plots used in the field and the recommended minimum number of plots, in this case four. From this, it was found that the number of samples used in this research was almost twice that recommended. In addition, the sampling error in the inventory was 14.7%, lower than the pre-established error. As such, it was not necessary to include new sample units in the field in addition to the seven units used initially.

Figure 3 shows the values for the hydroactive xylem area in the strata (DAB, DBH and TOP) and in the marmeleiro and catingueira plants as a whole. The results relative to a sample of 15 data by the Kruskal-Wallis test at a level of 5% indicate mean values of 19.92 cm², 15.73 cm² and 7.24 cm² for the marmeleiro, and 65.93 cm², 40.28 cm² and 13.30 cm² for the catingueira.

Parameters followed by the same lowercase letter do not differ statistically between the plant strata by the Kruskal-Wallis test at 5% probability. Different uppercase letters indicate a significant difference between the xylems from different plants.

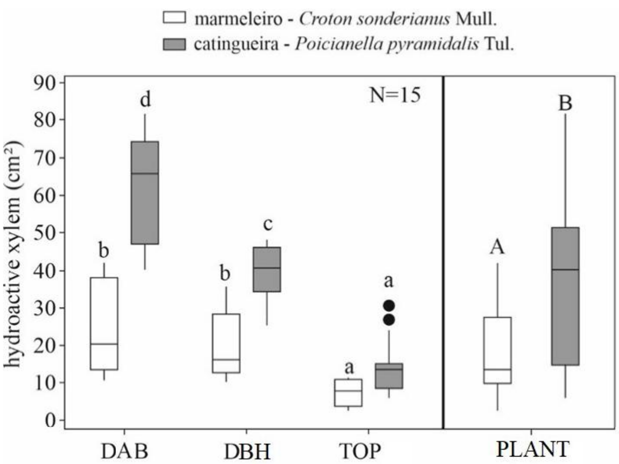
Based on the successional stage effect, the marmeleiro shows stagnant growth, and the catingueira plants need to absorb more water to grow, this causes the latter to increase its conductive area to meet this need (APARECIDO *et al*., 2015; GEBAUER; HORNA; LEUSCHNER, 2008). From the base to the top, the marmeleiro plants have a more homogeneous xylem area compared to the catingueira plants. However, this does not mean that the conductive area at the top is smaller, since the number of branches in this stratum must be considered.

The active xylem area measured in the two arboreal individuals ranged from 2.11 cm² to 81.75 cm², with the ratio between the active xylem area and the transversal area varying between 13.50% and 100% (Table 2).

Figure 4 shows the relationship between the stem area and the xylem area in representative plants of the Caatinga, allowing species-specific regression models to be generated, represented by allometric equations of the active xylem area predicted by the stem diameter of the species.

For the catingueira, the potential model is the model that best represents the relationship between the stem area and xylem area. Up to 60 cm², the stem area and the xylem area show the same, approximately linear, growth pattern. The xylem area has a maximum value of around 80 cm², regardless of the variation in stem area. The maximum area seen for the catingueira is around 150 cm². In the marmeleiro, the potential model is again the model that best represents the relationship between the stem area and the xylem area. The maximum value for the stem area of the marmeleiro is around 60 cm² under the conditions of preserved Caatinga.

Figure 3 – Hydroactive xylem area (cm²) of the strata (DNB, DAP e TOP), and the marmeleiro and catingueira plants as a whole



There is a significant difference between the potential water volume in TOP and the other two strata (DAB and DBH) in both the marmeleiro and the catingueira (Figure 5), but not between DAB and DBH; there was also a significant difference between the plants as a whole by the Kruskal-Wallis test at a level of 5%.

Parameters followed by the same lowercase letter do not differ statistically between the plant strata by the Kruskal-Wallis test at 5% probability. Lowercase letters refer to the comparison between strata of the same species, and uppercase letters between the strata of different species

An analysis of the water storage capacity of the stem in representative plants of the Caatinga can be seen in Table 3. The upper part of these plants (TOP), composed of thinner branches, corresponds to six to eight times the volume that can potentially be stored in the stems of the catingueira and marmeleiro plants respectively.

Various compartments, especially the soil, aquifer and dam, comprise water storage reservoirs on the scale of a hydrographic micro basin. In addition to these, in this study, the stems of the plants were considered water reservoirs as important to the hydrological dynamics of the basin as the others mentioned above. It can be seen in Table 3 that, considering only the Soil-Vegetation Association, the species under analysis have the potential to store the equivalent of 21% of the maximum capacity of the catchment reservoir of the basin. It is worth considering that there are no scientific reports on the physiological mechanisms of plants for reaching this potential moisture. However, it is expected that during the rainy season, the time of year with the most moisture in the soil, the stems of the plants will be closer to their maximum storage capacity. This retention by the plants, together with the characteristics of the soil, restrict the capacity for surface runoff in the basin.

This study raises the need for evaluating water storage in plants when calculating the water balance of a basin. This portion is generally considered to be included in the term evapotranspiration; however, although it is known that on larger time scales the water stored in plants will be lost to the atmosphere, on a smaller scale, not considering the difference between water in the plants and transpiration can result in errors in the water balance.

Table 2 - Summary of the biometric and anatomical characteristics of the sampled trees (n=10)

Species	Total Mean Height (m)	DBH (cm)	Acyive Xylem Area (cm²)	Transversal Area (cm²)	Condutive Area/ Transversal Area (%)	Volume (DBH;Ht) (m³)
Catingueira (*Poicianella pyramidalis* Tul.)	7.50	8.02	38.49	58.48	65.82	0.04
Marmeleiro (*Croton sonderianus Muell.* Arg.)	6.00	6.09	17.18	31.95	53.77	0.02

DBH: diameter at breast height; Ht: total height

Figure 4 - Relationship between stem area and hydroactive xylem area in plants of the catingueira and marmeleiro

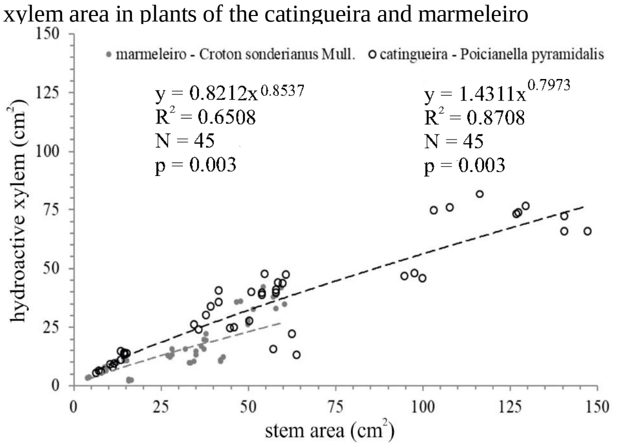


Figure 5 - Potential water volume in the strata of the marmeleiro and catingueira plants

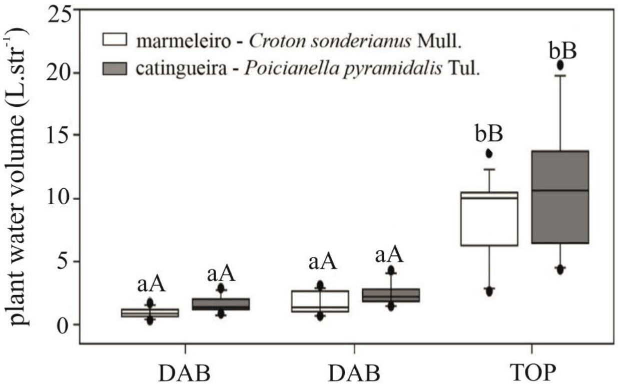


Table 3 - Results for water volume per stratum, water volume per plant, stem water storage potential, potential plant water storage depth, ratio between the potential water storage depth in the stems of the plants in this study and the maximum capacity of the Boqueirão reservoir

		Marmeleiro (Croton sonderianus Mull.)		Catingueira (Poicianella pyramidalis Tul.)
Water volume (L str^{-1})	diameter at the base (DAB)	1.59		3.32
	diameter at breast height (DBH)	3.07		5.07
	highest part of the plant (TOP)	25.40		31.80
Water volume per plant (L.pl^{-1})		30.04		40.19
Density (pl.ha^{-1})		2.680		256
Potential stem water storage depth (mm)		8.05		1.03
Potential stem water storage depth in Soil-Vegetation Association 1 (SVA1) (mm)			9.08	
Potential plant water storage volume (m³) by species in Soil-Vegetation Association 1 (SVA1)		10.627		1.358
Potential water storage volume in Soil-Vegetation Association 1 (SVA1) (m³)			11.985	
Maximum capacity of the Boqueirão reservoir (m³) (Araújo and Piedra, 2009)			56.700	
Ratio between the potential water storage volume in the stems of representative Caatinga plants in Soil-Vegetation Association 1 (SVA1) and the maximum capacity of the Boqueirão reservoir		19%		2%
Relationship between the potential stem water storage volume in Soil-Vegetation Association 1 (SVA1) and the maximum capacity of the Boqueirão reservoir			21%	

CONCLUSIONS

1. Despite the 40 years of conservation of the Aiuaba ESEC, the area is in the second stage of secondary succession (shrub), evidenced by the greater occurrence of species of genus *Croton*, which is found in soils that have good physical and chemical characteristics and is an indicator of secondary succession recovery. Characteristics of the third stage of secondary succession (tree-like shrubs) are also found, showing that the vegetation in the study area is undergoing a change in successional stage.
2. The water contained in the set of Caatinga plants surveyed in the Soil-Vegetation Association of this study proved not to be negligible in studies of water availability. The water storage potential of the stems of plants of the Caatinga is around one fifth of the capacity of an optimally sized, shallow reservoir.

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