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Determination of water retention by the native field of the Pampa Biome with simulated rain

Determinação da retenção de água pelo campo nativo do Bioma Pampa com chuva simulada

Cabrieli Aline Jaeger*, Renato Beppler Spohr, Edner Baumhardt***, Fagner Augusto Rontani******

* Discente do Programa de Pós Graduação em Ciência e Tecnologia Ambiental, Universidade Federal de Santa Maria – *Campus* Frederico Westphalen, cabrieli@hotmail.com
** Programa de Pós Graduação em Ciência e Tecnologia Ambiental, Universidade Federal de Santa Maria – *Campus* Frederico Westphalen, renato.spohr@ufsm.br
*** Departamento de Engenharia Florestal, Universidade Federal de Santa Maria – *Campus* Frederico Westphalen, ednerb@gmail.com
**** Discente de doutorado na Universidade Estadual da Dakota do Norte - Campus Fargo, Estados Unidos, fagner_rontani@outlook.com

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Abstract

Pampa was one of the most neglected biomes in Brazil, mainly due to its floristic composition distinct from the others. The expansion of agriculture and forestry are often linked to the advancement of negative impacts on the hydrology of this biome. However, there isn't enough information about the hydrological functioning of small basins with native vegetation in Pampa. The objective of this study is to evaluate the applicability of two different methodologies to determine water retention by native vegetation of the Pampa Biome, using a rainfall simulator. The methodology 1 used structured samples of native field vegetation and soil, and methodology 2 used only vegetation samples without the presence of soil; all of which were submitted to the application of simulated rain. With the obtained data, the amount of water that this vegetation retains during rainy events was estimated. Using method 1, we found estimated retention values of 5.4% and 10.9%, 18.6% and 27.8%. However, through method 2 we found estimated retention values of 8.5% and 12.7%. In any case, both methods showed significant values of water retention by this vegetation, being the variations found associated with the methodology itself, or the natural characteristics of each study area.

Keywords:
Vegetation, Hydrological, Methodology.

Resumo

O Bioma Pampa foi um dos mais negligenciados do Brasil, principalmente por sua composição florística distinta dos demais. A expansão da agricultura e da silvicultura são frequentemente atreladas ao avanço dos impactos negativos sobre a hidrologia do Pampa. No entanto, pouco se conhece sobre o funcionamento hidrológico de pequenas bacias com vegetação nativa neste Bioma. O objetivo deste trabalho é avaliar a aplicabilidade de duas metodologias distintas para determinar

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a retenção de água pela vegetação nativa do Bioma Pampa, utilizando um simulador de chuvas. A metodologia 1 utilizou-se de amostras estruturadas de vegetação de campo nativo e de solo, e a metodologia 2 utilizou-se apenas de amostras de vegetação sem a presença de solo; todas quais foram submetidas à aplicação de chuva simulada. Com os dados obtidos, estimou-se a quantidade de água que esta vegetação retém em eventos chuvosos. Por meio do método 1 encontrou-se valores estimados de retenção de 5,4% e 10,9%, 18,6% e 27,8%. Já, pelo método 2 encontrou-se valores estimados de retenção de 8,5% e 12,7%. De todo modo, ambos os métodos apresentaram valores significativos de retenção de água por esta vegetação, sendo as variações encontradas associadas à própria metodologia, ou às características naturais de cada área de estudo.
Palavras-chave:
Vegetação, Hidrológicos, Metodologia.

I. INTRODUCTION

Despite its importance, water is a natural element that is becoming increasingly scarce in quality and quantity, due to the growing demand for natural resources (TUNDISI; MATSUMURA-TUNDISI, 2020). For it is a limited and essential life resource, it is necessary to monitor and conduct integrated studies of hydrology, pedology, geology and land use (SILVA; SILVA, 2023; PEIXOTO; OLIVEIRA-COSTA, 2023), to clarify interactions between the components of a given water system.

Studies that analyze the relationship between water production in a micro-basin under the effect of eucalyptus forestry are, at times, divergent on the real effect of the forest on the water balance in micro-basins. In this context, a debate about the historical controversy over the role played by eucalyptus arises, for example, concerning its use and hydrological function in the drainage basins on which it is cultivated. An issue frequently addressed by the media, society, and laypeople is that eucalyptus causes rapid drying of the soil, causing damage to the original ecosystem (BAUMHARDT, 2014).

On the other hand, agricultural monoculture also continues to advance in areas where, previously, there was only extensive livestock farming, such as in the Pampa biome. However, there is limited research and controversy about its real impacts on the landscape, ecology, water resources, etc. According to the MapBiomas project, between 1985 and 2020 Pampa lost 21.04% of its natural vegetation, of which 76% was converted to agriculture (SOUZA et al., 2020).

When considering these socio-environmental difficulties of planted forests and agriculture and also due to the complexity of the context in which they are inserted, Mosca (2003) argues that the water cycle should not be reduced to a phenomenon that develops outside society. The goal should be to bring arguments to the

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debate on the agricultural-agrarian model in search of guidance to implement best practices in planted forests and agriculture.

The interception is a hydrological process in which is directly related to vegetation; which consists of rainwater being temporarily retained by plants, and returns to the atmosphere through evaporation (RIBEIRO FILHO et al., 2019).

Although much of the relationship between vegetation and hydrological processes is known, in what concerns the native vegetation of the Pampa biome, little is known about its interaction between the water balance, mainly regarded to the precipitation retention process (GIGLIO; KOBIYAMA, 2013); unable to realize a comparison parameter, which makes it possible to evaluate the effects that changes in natural cover can cause on hydrological variables in this biome.

Thus, already carried out studies to determine the interception of water by herbaceous vegetation, cite only the intervention of the aerial part of the plants (TSIKO et al., 2012; ZOU et al., 2015; REICHERT et al., 2017; BRITTO; BAPTISTA; LIMA, 2019; GORDON et al., 2020; EBLING et al., 2021), it is important to obtain water retention data from both the aerial part and from the underground part of herbaceous species; considering that the root system also influences the amount of precipitated water which is available to the groundwater, due to the feedback relationship that the roots have with the soil water (LU et al., 2020).

Thus, the present study aimed to evaluate the applicability of two distinct methodologies to determine water retention by native vegetation of the Pampa Biome, using a rainfall simulator.

The tests of rain simulations were carried out in November 2014 and November 2022 in the county of Rosário do Sul - RS, and in November 2021 in the county of Caçapava do Sul - RS. In one of the methodologies used to determine water retention by herbaceous vegetation of native field, samples of vegetation and soil were used, and for the other, only vegetation samples.

II. Material and Methods

Location of the study areas

The study was conducted in two distinct areas of natural fields within the Pampa Biome of the state of Rio Grande do Sul, in Brazil, one is located in the county of Rosário do Sul (RO), in which data collection tool place in November 2014 and November 2022, and the other in the county of Caçapava do Sul (CA), in which the data collection happened in November 2021.

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The municipality RO has a humid subtropical Cfa climate, according to the Köppen classification, with hot summer and average annual temperature of 18.6 °C, whose annual precipitation varies between 1500 to 1600 mm, with rainfall well distributed throughout the year (ALVARES et al., 2013). The soils are moderately deep (STRECK et al., 2018) with high sand content in the surface layer (DIAS; TRENTIN; ROBAINA, 2019).

The municipality of CA, according to the Köppen classification, has a Cfb climate for the higher parts and Cfa in the lower parts. Summer is warm and humid, and winter is cool; average annual temperature is 18 °C and the average annual precipitation is 1727 mm, with rainfall well distributed in the year (PEREIRRA FILHO et al., 2023); and the soils are shallow, stony and sandy (SOUZA; BORBA, 2021).

Both study areas have a predominance of wavy relief (DIAS; TRENTIN, 2018; SOUZA; BORBA, 2021) with natural grassland vegetation, native to the Pampa Biome, composed mainly of grasses (ROLIM; OVERBECK, 2023), which are kept under continuous grazing at a height of approximately 0.50 m.

EXTRACTION OF NATIVE FIELD READERS

A total of 96 samples were collected, of which 56 were obtained in the test area located in the city of Rosario do Sul and 40 in Caçapava do Sul. The sampling points were selected at random with each test area, and at each of these points a sample set was composed of four samples, of which three samples of vegetation (vegetation + soil), and a control sample (soil only). Each sample set was extracted from the same sampling point.

For the sample's extraction, metal trays with removable bottom measuring 0.50 m x 0.40 m were used. And, to demarcate the dimensions of the samples, the metal trays were placed on the ground, delimiting the area of each one, so that the samples could have their sides cut.

Regarding depth, each sample had its bottom sawn to a height of approximately 0.05 m thickness, so that the bottom plate of the tray could be inserted, obtaining native field readouts with their preserved structures (Figura 1).

The witness samples were extracted in a layer immediately below the place where the vegetation samples was collected, using the same methodology, however, collecting only soil.

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Figura 1 - Extraction sequence of samples containing vegetation (A to E) and of the control sample (F). (Source: Authors, 2014).
(A) Allocation of the tray on the area to be sampled; (B) Cutting and insertion of the tray at 5 cm depth; C) Cutting in depth of the sample; (D) Insertion of the removable bottom of the tray; (E) Removal of the sample with its structure preserved; (F) Taken from the witness sample with its structure preserved.

TESTS WITH SIMULATED RAINFALL (METHOD 1)

After collecting and weighing the samples, they were placed on a wooden bench arranged in the area covered by the simulator, which reproduces the slope of the field in which these samples were naturally arranged (slope of 13%).

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After collecting the samples as described in the previous item, and weighing them to obtain the sample mass before applying rain, they were placed on a wooden bench placed in the area covered by the simulator, which reproduces the slope of the field where these samples were naturally arranged (slope of 13%).

The rainfall simulator used for the tests was calibrated and validated by Spohr et al. (2015), presenting a relationship that exceeds 84% between the rain produced and the natural rain. The coverage area of the simulated rain was 1.0m x 1.2m, approximately, which was applied at an intensity of 100 $mm.h^{-1}$, during 10 minutes for each of the tests performed, simulating a high intensity rain.

To avoid the soil surface sealing caused by the direct impact of the raindrop, the witness samples (without vegetation) were covered with a 50% shading screen, before the being of simulation submission.

After realization each test with simulated rain, we waited 5 minutes until the excess water drained from the tray stopped, before weighing the samples again, and obtaining the mass of the samples after applying the rain.

The mass of water retained in each of the control samples was determined by calculating the gravimetric content (Equation 1), and the average results were then found.

$$Ug = \frac{Mu - Ms}{Ms} * 100 \quad (1)$$

Where Ug is the gravimetric water content contained in the control sample (%); Ms is the mass of the control sample obtained before applying the simulated rain (g); and Mu is the mass of the control sample obtained after the application of simulated rain (g).

Obtained the gravimetric content of the control samples (Ug), it was estimated by the water mass which was retained only by the soil samples present with in the vegetation. For this, the turgid biomass of the vegetation was discounted from the total mass of each sample with vegetation, obtained before rainfall application; then, the result obtained was multiplied by the average percentage of the gravimetric content of the control samples, as described in Equation 2. Therefore, the difference between the total mass of water retained by the sample and the amount of water retained by the soil, resulted in the content volume retained by vegetation, which was converted into water layer.

$$Ma = (Mua - Msa) - (Msa - Bt) * MUg \quad (2)$$

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Where Ma is the mass of water retained by vegetation (g) in each simulated rain event; Msa is the mass of the sample with vegetation (g) obtained before the application of simulated rain; Mua is the mass of the sample with vegetation (g) obtained after the simulated rain; Bt is the turgid biomass of the vegetation (g), obtained by weighing only the vegetal part of the samples; and MUg is the average percentage of gravimetric soil moisture (%), obtained by Equation 1.

As for the amount of rain that fell in each of the tests, this was determined using 8 water collecting cups, rain gauge-type, with a catchment area of 0.005026 m², installed under the simulator's coverage area. The water layer that fell on the samples during the simulated rain was used to determine the percentage of water that was retained in the samples in each test.

SIMULATED RAINFALL TESTS (METHOD 2)

After the tests described in method 1, the samples collected in the municipality of RO in 2022 were submitted to another method to determine water retention by the native vegetation of the Pampa Biome. As this method only used samples that contained native vegetation, the control samples were discarded, and those with vegetation were washed to remove all soil from them, as shown in Figure 2.

Figure 2 - Demonstration of the washing process of the samples for the soil removal in them. (Source: Authors, 2022).

Subsequently, the samples were dried out in the shade for approximately 4 hours, until all the water on the vegetation evaporated, and then, they were weighed to obtain their “dry” mass (before the application of simulated rain) and were again subjected to the simulation of rain, under the same conditions as those described in method 1, however, with application of rain for only 5 minutes for each of the tests.

After each simulation, wait 2 minutes for the excess water to drain, and then the samples were weighed again to obtain their wet mass. The determination of the volumetric content of water retained by vegetation is done using Equation 3.

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$$Ma = \frac{\frac{(Muv - Bu) - (Msv - Bs)}{Al} \ast 10}{Bt} \quad (3)$$

Where Ma is the mass of water retained by vegetation (mm. Kg^{-1}); Muv is the mass of the plant sample obtained after the application of simulated rain (g); Bu is the mass of the wet tray, obtained after the application of simulated rain (g); Msv is the mass of the plant sample obtained before the application of simulated rain (g); Bs is the mass of the dry tray, obtained before the application of simulated rain (g); Al is the area of the law (cm^2); and Bt is the turgid biomass of the vegetation (Kg).

RAINFALL DATA

From the determination of the water layer retained by the vegetation of the Pampa biome, historical precipitation data from this region was used to estimate the amount of water retained over a period of 24 months. The historical rainfall data were acquired through the HidroWeb Portal (stations 03054007 in Rosário do Sul and 03053022 in Caçapava do Sul), from where daily precipitation data occurred in 2019 and 2020 were obtained.

When processing the rainfall data obtained, it was considered that for events that had a sequence of two days or more of rain occurrence, water retention was effected in just one day, as a greater amount of water precipitated in longer periods causes vegetation saturation.

Thus, having determined the number of rainy days in which there was effected retention, these were multiplied by the water layer retained in the vegetation, obtained through rain simulation tests; and then, the percentage of water retained by the vegetation of the Pampa Biome was estimated, considering the total precipitation for the respective years.

PLANT BIOMASS

The turgid biomass of the vegetation of the native field (shoot and root) used in Equations 2 and 3, was determined using 5 samples ($1m^2$) of each test area, from which the soil was removed and its mass was obtained by weighing.

Subsequently, the same plant material was dried in an oven at 65 °C until a constant weight was obtained, to obtain its dry biomass, which was used in the analysis of the influence that the biomass of the native field can exert on the amount of water retained by this vegetation.

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III. Results and discussion

Water retention by vegetation obtained by Method 1

In this method the simulated rain applied on the samples varied little between the tests, presenting an average of 16.9 mm form the performed tests in the municipality of Rosário do Sul (RO), and 17.7 mm form those performed in Caçapava do Sul (CA). The small variations observed may be related to the method limitations.

Table 1 - Soil gravimetric content (Ug) and water depth retained by vegetation, obtained from the tests performed with simulated rain, by method 1.

County	Rosário do Sul		Caçapava do Sul	
Test	Ug on soil (%)	Layer retained in the vegetation (mm)*	Ug on soil (%)	Layer retained in the vegetation (mm)*
1	8.4	1.5	20.0	2.4
2	9.4	2.3	18.4	0.0
3	8.6	1.4	18.6	1.7
4	10.2	3.5	18.8	3.3
5	10.3	4.2	24.7	3.5
6	19.7	6.9	10.6	0.7
7	8.7	6.1	22.0	1.2
8	12.0	4.6	16.5	3.2
9	6.8	4.6	23.2	0.4
10	8.3	3.9	23.5	0.3
11	18.5	2.2	-	-
12	22.8	2.0	-	-
13	17.0	3.1	-	-
14	26.8	3.3	-	-
Mean	13.4	3.5	19.6	1.7
SD	6.1	1.6	3.9	1.3
CV	45.7%	44.9%	20.0%	76.5%

*Mean of the three repetitions; SD = standard deviation; CV = coefficient of variation. (Source: Authors, 2022).

The gravimetric soil moisture in the control samples (Table 1) was higher for CA soil (19.6%) than that obtained for RO soil (13.4%). This difference is possibly related to the soil characteristics, since the RO was visibly more sandy, while the CA soil appeared to have higher levels of silt/ clay, which may explain its greater water retention capacity (KLEIN; KLEIN, 2015).

As for the amount of dry biomass (shoot and root), the value found for the native field of CA was 2.16 kg.m^{-2}; while for RO, the value found was 1.48 kg.m^{-2} and in 2022, was 3.64 kg.m^{-2}. This difference observed

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between the two years in the RO area may be related to the fact that, in the year 2022, litter was considered in the biomass accounting, while in 2014 it was not.

In any case, the vegetation samples obtained showed development characteristics very similar to those found in the literature: sparse aerial biomass due to grazing in the area (GÓES et al., 2021) and a high root density in the superficial layers of the soil, which influenced the proportion of existing plant material (ATAIDE, 2015; WOLSCHICK et al., 2016).

The average water depth retained by vegetation in RO was 3.5 mm, while in CA was 1.7 mm, presenting high variability of retention data in relation to the average for both areas, 45.7 and 76.5%, respectively. This variation may be related to the amount, type of biomass and floristic composition, as well as the variation, although subtle, in the thickness of the samples, because the amount of root biomass varies according to its depth (ATAIDE, 2015).

The retained water percentage by the vegetation during the simulation tests was 20.9% and 9.4%, for the tests performed in RO and CA, respectively. Considering the provisions of Giglio and Kobiyama (2013), these values may have been minimized due to rainfall intensity and application time, since these were obtained through a simulated rain of 100 mm.h^{-1} applied for 10 minutes.

Considering that the average interception for precipitation event by herbaceous vegetation of the native field in the literature is 7.5% (BAUMHARDT, 2010), the values found in this study were higher. However, the present methodology was idealized considering the aerial part and root part of the plants, and not only the aerial part, as presented by Reichert et al. (2017), which may have influenced this due to the increased water retention that the root part of the plants provides; according to Dunnett et al. (2008), water retention is higher in plants with high root biomass.

WATER RETENTION BY VEGETATION BY METHOD 2

The simulated rain applied on the vegetation samples also varied little in this second method, presenting an average of 9.6 mm and coefficient of variation of 9.2%, as shown in Table 2.

Table 2 - Water retention by native field vegetation obtained by tests performed with simulated rain in Rosário do Sul, by method 2.

Test	Rain (mm)	Turgid Biomass (Kg)*	Depth retained in the vegetation (mm)*	Water retained in the vegetation (mm.kg^{-1}) *
1	8.5	1.39	1.76	1.29
2	9.2	1.38	1.34	1.10
3	9.5	1.43	1.45	1.00
4	11.3	1.23	1.88	1.23

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5	9.1	1.38	1.85	1.66
6	9.8	1.36	1.63	1.32
Mean	9.6	1.4	1.6	1.3
SD	0.9	0.1	0.2	0.2
CV	9.2%	4.7%	12.1%	16.4%

*Mean of the four repetitions; SD = standard deviation; CV = coefficient of variation. (Source: Authors, 2022).

The water depth retained by the vegetation presented an average of 1.6 mm, which corresponds to 17.2% of the rainfall incident on the samples (applied at 100 mm.h^{-1} for 5 minutes). This percentage was lower than that found by other authors who evaluated the interception by herbaceous species: Simpson and Francis (2021) obtained retention values ranging from 26.4% to 100%; while Zou et al. (2015) observed an interception between 25 and 60%; and Gordon et al. (2020) found an average retention of 21% of the total incident precipitation for this type of vegetation.

The difference to the literature may lie in the rain intensity, higher in this study; for, according to Giglio and Kobiyama (2013), the lower the intensity of rain, the greater the amount of water retained by the vegetation, interception in these cases can reach 100% of the total precipitate.

Plant biomass also influences the amount of water that is retained by native field vegetation, as reported in studies conducted by Liu et al. (2018) and Sisi, Jia e Han (2020) plants showed a relationship between the interception capacity of rain and biomass.

In this way, the RO vegetation presented a mean density biomass of 1.4 kg per sample, with low standard deviation (0.1 kg) and low coefficient of variation (4.7%) of the data. The relation between biomass and the amount of water retained is approximately 1.3 mm for kilogram of native herbaceous vegetation.

It´s important to note that the retention of values mentioned in this study are only applicable to the native vegetation of the field that is grazed by extensive livestock farming, representing the smallest vegetable portion found in this biome, with an aerial part height and root depth of approximately 0.05 m. In other words, for the natural variation of the biome, across the seasons, there is a large variation in the amount of biomass and the water retention value will probably be greater.

Rovedder (2013) highlights that the presence of cattle grazing does not allow the colonization of open areas by the forest component, even though the climate is favorable. The author also mentions that there is an understanding that livestock farming itself can be a great ally in the conservation of native vegetation, as long as the practice respects the ecosystem's support capacity, thus maintaining the grazed vegetation with access to light and at a lower height, which will then enable a greater number of species to develop.

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The observed difference between the results of the two methods possibly occurred, because method 1 uses vegetation samples with soil, and considering that there is an interaction between soil and root which favors water retention, this method showed higher values, compared with method 2, which used samples containing only plant material.

However, it is emphasized that method 1 may have presented a low sensitivity to the amount of water retained by the plant samples, since it was obtained null results of water retention by the vegetation for the tests performed in CA, methodology, a greater amount of water was retained by the soil compared to the vegetation. Thus, the results suggest that for small portions of water retained by plants, method 1 did not present sufficient sensitivity to record such quantities.

As for method 2, as it was considered only the existing vegetation in the samples, it was more sensitive to small amounts of water. Thus, the water retention value found for the aerial and root part of these samples is the amount that effectively becomes unavailable for infiltration, as it returns to the atmosphere through evaporation.

ESTIMATION OF WATER RETAINED BY NATIVE FIELD IN PRECIPITATION EVENTS

Pampa is the smallest biome in Brazil and does not have forests as its predominant vegetation, therefore it requires studies that explore the use and consumption of water by planted forests that are expanding in this ecosystem, thus enabling the measurement of the potential impact of introducing exotic agricultural and forestry crops into a field.

Through the 2019 and 2020 rainfall data obtained for both study areas, it was possible to estimate the amount of water that native field vegetation retains in a drier year (2020), with total precipitation below the historical average; and in a wetter year (2021) where the total precipitate was higher than the historical average.

For the municipality of CA in which the total incident precipitation was 1963.3 mm in 2019 and 1285.5 mm in 2020, the average annual retention estimate was, respectively, 5.4% and 10.9%, obtained from 38 and 44 precipitation events that effectively had retention in these years. For the municipality of RO, the total incident precipitation was 1960.1 mm in 2019 and 991.8 mm in 2020, and the number of rainfall events that were retained was 44 and 55 for the respective years. Thus, using method 1, the average annual retention by herbaceous vegetation was 18.6% and 27.8% for 2019 and 2020, respectively (Table 3).

Baumhardt (2010) highlights that in the literature, there were no scientific references that provided average interception data about Pampa. Baumhardt (2014) also observes that the interception of eucalyptus

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planted in the same areas presented values close to 15% of rainwater retention in the biomass. The author mentions that the number of rain events directly influences interception, in addition to aspects inherent to the vegetation. The greater the number of events, the greater the intercepted value.

Table 3 - Estimated values of water retention by the herbaceous vegetation of the Pampa biome, for the 24 months evaluated, according to data obtained by method 1.

	Rosário do Sul						Caçapava do Sul					
	2019			2020			2019			2020		
Mth	EV	Total PP (mm)	RV (%)	EV	Total PP (mm)	RV (%)	EV	Total PP (mm)	RV (%)	EV	Total PP (mm)	RV (%)
jan	2	431.6	1.6	5	78.2	22.4	4	302.1	2.3	3	275.3	1.9
feb	5	87.3	20.0	1	23.2	15.1	6	68.5	14.9	3	19.9	25.6
mar	3	101.5	10.3	4	54.4	25.7	5	95	8.9	2	50.4	6.7
apr	4	145.1	9.6	4	14.4	97.2	1	194.7	0.9	6	25.8	39.5
may	6	174.3	12.0	5	206.1	8.5	3	263.1	1.9	2	204.6	1.7
jun	3	33.2	31.6	7	163.7	15.0	3	65.6	7.8	4	153.2	4.4
jul	3	259	4.1	4	66.3	21.1	3	241	2.1	7	114.7	10.4
aug	5	57.1	30.6	4	32.1	43.6	4	109.3	6.2	2	68.7	4.9
sep	3	63.9	16.4	7	108.5	22.6	1	96.8	1.8	2	146.7	2.3
oct	2	496.5	1.4	3	72.3	14.5	1	395.4	0.4	4	64	10.6
nov	4	90.4	15.5	5	61.4	28.5	3	58.6	8.7	4	43.4	15.7
dec	4	20.2	69.3	6	111.2	18.9	4	73.2	9.3	5	118.8	7.2
Tot.	44	1960.1	18.6*	55	991.8	27.8*	38	1963.3	5.4*	44	1285.5	10.9*

*Annual average; EV = event of rain that there was retention; PP = precipitation; RV = water retention by vegetation. (Source: Authors, 2022).

There are higher retention values for RO vegetation, however, the number of rainfall events lasting less than two days was also higher in this municipality, which probably explains this retention difference between the areas, because, according to Rodrigues et al. (2015) a greater number of rainy events with prolonged durations lead to lower water retention, due to the saturation of the aerial part of vegetation and soil.

Other factors that may have influenced the results found is that the two areas are in distinct geographic spaces, and although they are inserted in the same biome, there is a variation in floristic composition and plant characteristics between the areas, and also, there is variation in climatological characteristics. Such factors can directly influence the capacity of water retention by vegetation (FERRETO et al., 2021).

As for method 2, water retention values for vegetation were estimated at 8.5% and 12.7% for 2019 and 2020, respectively (Table 4).

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Table 4 - Estimated values of water retention by the herbaceous vegetation of the Pampa biome, for the 24 months evaluated, according to data obtained by method 2.

	Rosário do Sul					
	2019			2020		
Month	EV	PP total	RV	EV	PP total	RV
January	2	431.6	0.7%	5	78.2	10.2%
February	5	87.3	9.2%	1	23.2	6.9%
March	3	101.5	4.7%	4	54.4	11.8%
April	4	145.1	4.4%	4	14.4	44.4%
May	6	174.3	5.5%	5	206.1	3.9%
June	3	33.2	14.5%	7	163.7	6.8%
July	3	259	1.9%	4	66.3	9.7%
August	5	57.1	14.0%	4	32.1	19.9%
September	3	63.9	7.5%	7	108.5	10.3%
October	2	496.5	0.6%	3	72.3	6.6%
November	4	90.4	7.1%	5	61.4	13.0%
December	4	20.2	31.7%	6	111.2	8.6%
Total	44	1960.1	8.5%*	55	991.8	12.7%*

*Annual average; EV = event of rain that there was retention; PP = precipitation; RV = water retention by vegetation. (Source: Authors, 2022).

Thus, the average retention estimated for these two years was 10.6%, a value close to that found by Reichert et al. (2017), whose rain interception by the native vegetation of the Pampa Biome showed an average of 8.95% of the total incident precipitation. However, it is emphasized that the values found by the authors were obtained by different methodology, which considered only the interception of the aerial part of the vegetation, acquired 0.10 m above the soil surface; while this considers the entire plant structure (aerial and root part).

This study aims to understand a specific hydrological parameter of Pampa, the interception. This biome naturally has a lower biomass production, lower evapotranspiration, and paradoxically, a possible reduction in infiltration, due to the historical type of land use that took place in the Pampa over hundreds of years, when compared to recent more intensive uses of the soil. All these original aspects of the biome coordinate the current processes of the, even in those areas occupied by extensive livestock farming. (BAUMHARDT, 2014).

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IV. CONCLUSION

The studies that cover the relationships between the native field vegetation of the Pampa biome and the hydrological variables are still little carried out, due to the lack of methodologies that allow the obtaining of such data.

The use of the rainfall simulator as a methodology for data acquisition of water retention by native herbaceous vegetation was efficient to obtain the variable for both used methods. However, in method 1 it was possible to perceive some limitations, such as the lack of sensitivity to capture small amounts of water present in the samples, and the influence that the interaction between soil and root causes on the amount of water retention.

Thus, method 1 showed very significant retention values for both areas studied, and the municipality of Rosario do Sul had a higher percentage of water retention by native vegetation, compared to Caçapava do Sul, both for the tests with simulated rain, as for the estimates made with the precipitation occurred in the region.

On method 2, as there is no interaction between soil and root, retention is being evaluated only by plant parts; therefore, the results refer to the amount of water that is effectively retained by vegetation, variability related to plant biomass present in the samples.

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