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PERIODICITY AND INPUT DATA GROUPING PROCEDURES IN A WATER BALANCE

Periodicidade e procedimentos de agrupamentos de dados de entrada em balanço hídrico

Jorge Luiz Moretti de Souza[1], Bruno Cesar Gurski[2*], Jessé Adamuchio[3], Daniela Jerszurki[4]

[1] Doutor em Irrigação e Drenagem; Professor em Universidade Federal do Paraná: jlmoretti@ufpr.br
[2] Doutor em Ciência dos Solos, Universidade Federal do Paraná: brunogurski@ufpr.br
[3] Mestre em Ciência dos Solos; Universidade Federal do Paraná: adamuchio@ufpr.br
[4] Doutora em Ciência dos Solos; Ben Guiron University: jerszurki@ufpr.br
*Autor para correspondência

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Abstract – We aimed to evaluate the influence of periodicity of input data on values of output components of a water balance (WB) in Goiânia and Ponta Grossa, Brazil, considering different shifts in total available water in soil and two input data grouping procedures. It was considered a two years-data series of climate variables provided by a near automatic meteorological station and readily available water (RAW) ranging from 10 to 160 mm, with an interval of 15 mm. WB output components were evaluated considering different entry data procedures for precipitation (P) and reference evapotranspiration (ETo): WBgd – WB with daily P and ETo, with output components grouped into periods; and WBP – P and ETo grouped into periods, and later used in WB estimations. The periodicity and input data grouping method may show a great effect in WB estimations. For activities that require greater detail and accuracy, it is recommended to perform as WBgd instead WBP. Estimated errors tend to increase from short to long periodicities and for lower soil water availability. The soil water storage had the highest daily average deviations, showing great increase for short periodicities and higher readily available water values.

Keywords – agriculture water balance, procedure of calculation, readily available water, water accounting, water components.

Resumo – Teve-se como objetivo no presente trabalho avaliar a influência da periodicidade dos dados de entrada sobre as componentes de saída de um balanço hídrico (BH) climatológico em Goiânia e Ponta Grossa, Brasil, considerando diferentes disponibilidade total de água no solo e dois procedimentos de agrupamento de dados de entrada. Considerou-se séries de dados de dois anos de variáveis climáticas fornecidas por estação meteorológica automática e água facilmente disponível (AFD), variando de 10 a 160 mm, com intervalo de 15 mm. As componentes de saída do BH foram avaliadas considerando diferentes procedimentos de entrada de dados para precipitação (P) e evapotranspiração de referência (ETo): WBgd – BH com P e ETo diários, com componentes de saída agrupados em períodos, e; WBP – P e ETo agrupados em períodos, e posteriormente utilizados na estimativa do BH. Periodicidade e método de agrupamento de dados de entrada podem mostrar grande efeito no BH. Para atividades que exigem maior detalhe e precisão é recomendável utilizar WBgd em vez do WBP. Os erros estimados tendem a aumentar de curtas para longas periodicidades e menores disponibilidade de água no solo. O armazenamento de água apresentou os maiores desvios médios diários, mostrando grande aumento para curtas periodicidades e maiores valores de AFD.

Palavras-chave – balanço hídrico agrícola, procedimento de cálculo, água facilmente disponível, contabilidade hídrica, componentes hídricas.

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INTRODUCTION

The water balance (WB) has a key role to access the real water conditions in the soil-plant-atmosphere continuum. Water balance components can be directly measured in the field, or estimated, from climatological data using specific models. In addition, the WB is useful to estimate and compare soil water conditions for different locations and times (KHAZAEI & HOSSEINI 2015).

However, Silva et al. (2006) and Yan et al. (2012) already emphasized the difficult to perform WB measurements in the field, which in the most of cases are expensive and difficult. The variability of its components and especially the uncertainty in the calculation of internal drainage and capillary rise in the soil, are major problems to access reliable results. The choice for a specific WB model depends on the purpose of water accounting (SOUZA & GOMES 2007; SOUZA & GOMES 2008).

In addition, the best WB model is mainly determined by the degree of knowledge about water dynamic in the soil-plant-atmosphere continuum. The more complex models have a great demand for data, which can to compromise their use (KHAZAEI & HOSSEINI 2015). The original model of Thornthwaite and Mather (1955) is well known and used to determine the climatological water balance without the need for direct measurements of soil conditions. Its diffusion and frequent use are due to the few need of inputs and consistent estimations in comparison to the field water balance (DOURADO NETO et al. 2010). However, due to the currently computer facilities, adaptations of the original method of Thornthwaite and Mather (1955) are useful in order to estimate water balance for different crop groups (SOUZA & FRIZZONE 2007). There are methodologies that consider different periodicities (1, 5, 7, 10, 15-days and monthly) and continuity (sequential and cyclic) in the calculations (MAAYAR et al. 2009). Despite the mathematical dissimilarities, the calculation processes are quite similar between all WB methodologies (PRAVEENA et al. 2012).

Several studies considering periodicities of 1, 5, 7, 10, 15 days or a month, are found in the literature, but they often overlook the real effect of data periodicity to the final results of WB. Interestingly, the lack of information about the influence of periodicity on WB estimations can lead to errors and inconsistencies in the analysis of the results. Generally, when the intention is to obtain more accurate estimations of water conditions, the literature recommends only the use of short periodicities, without giving any cause or clear enough to let the desired maximum errors in its estimations (SOUZA & FRIZZONE 2007; SILVA et al. 2008; MAAYAR et al. 2009; DOURADO NETO et al. 2010).

It is important to note that there are occasions when the particularities of a methodology are sufficient to provide significant variations in the results of the analysis (YAN et al. 2012). In this context, Maayar et al. (2009) found the need to perform daily, monthly and annual simulations of WB in a land surface model, in order to study its components and highlight the urgent need of appropriate methodologies for field measurements to correct energy disparities.

In this study we aimed to evaluate the influence of periodicity of the input data on the output components of a water balance in Central-Western and Southern Brazil, considering the variation of total available water in the soil and two distinct input data grouping procedures.

MATERIAL AND METHODS

Analyses were carry out for the cities of Ponta Grossa, Parana State, and Goiânia, Goiás State, South and Center of Brazil, respectively. The two locations were chosen because the different climatic characteristics (CAVIGLIONE et al. 2000; CARDOSO et al. 2014), being located near to regions where the study of water relations and rural planning are important in decision-making for agricultural, livestock and forestry activities.

According to Alvares et al. (2013), the climate type of Ponta Grossa is classified as Cfb, mesothermal humid subtropical, with annual average temperature around 17.5 ºC, annual average rainfall between 1,600 mm and 1,700 mm well-distributed over year (CAVIGLIONE et al. 2000). The climate of Goiânia is classified as Aw, semi-humid tropical, with annual average temperature around 23 °C, with annual precipitation ranging between 1,500 mm and 1,800 mm, concentrated in the summer months (CARDOSO et al. 2014).

Simulations of WB were taken containing a series adaptations to the original method of Thornthwaite and Mather (1955) (SOUZA & FRIZZONE 2007; SOUZA & GOMES 2008). The program required data series of precipitation (P), reference evapotranspiration (ETo), initial soil water storage (S), crop coefficient (Kc), total available water (TAW) and fraction of available water (p fraction); the latter variable is required to calculate the readily available water (RAW) in the soil.

Climatic data of Ponta Grossa were obtained from an automatic meteorological station of SIMEPAR Technological Institute, coordinates 25°12'59"S, 50°00'59"W and altitude of 885.59 m. Climatic data of Goiânia were from evapotranspiration station, coordinates 16°41'00"S, 49°16'00" W and altitude of 741.48 m. Climatic data were collected from 2007 to 2009. The daily data needed for the study were precipitation, maximum, minimum and average air temperature, average relative humidity, solar radiation and wind speed. The 2007 data series was used to estimate the soil water storage for WB estimations with start in January 2008.

The estimation of ETo (mm day^{-1}) was performed using the method of Penman-Monteith FAO (Allen et al., 1998). The values of Kc was considered equal to one (Kc = 1). As in the model Kc values are used to transform ETo in crop evapotranspiration (ETc), the i-th values ETc_i were equal to the respective i-th values of ETo_i:

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$$\mathrm{ETc} = \mathrm{Kc} \cdot \mathrm{ETo} \quad (1)$$

Where: ETc is crop evapotranspiration (mm day^{-1}); ETo is reference evapotranspiration (mm day^{-1}); and, Kc is crop coefficient.

In order to perform sensitivity analysis to verify the trend and deviation of soil water storage (S), actual evapotranspiration (ETa), water deficit (WD*)* and water surplus (WS*)*, the simulations were carry out considering different values of total available water (TAW): 20, 50, 80, 110, 140, 170, 200, 230, 260, 290 and 320 mm. The estimation of readily available water in the soil was carried out using the p fraction for a given crop:

$$\mathrm{RAW} = \mathrm{p} \cdot \mathrm{TAW} \quad (2)$$

Where: RAW – readily available water (mm); TAW – total available water (mm); p – soil water depletion fraction (dimensionless).

To achievement of the analysis it was considered a single average value of soil water depletion fraction (p = 0.5), which includes large group of crops, such as vegetables, fruits, grass and grains (ALLEN et al. 1998). Thereby, in the WB simulations, RAW values were 10, 25, 40, 55, 70, 85, 100, 115, 130, 145 and 165 mm.

The estimation of S was performed using Cosine equation (DOURADO NETO & JONG VAN LIER 1993) that considers the soil water storage as a result about the relation between RAW and p. The initial value of S in the WBs performed for 2008 was taken as the S in 12/31/2007, after the calculation of the WBs for the period from 01/01/2007 to 12/31/2007. The initial value of S in 2009 was equal to the S of 12/31/2008.

Simulations of WBs for both locations (Ponta Grossa and Goiânia) were performed considering two procedures as the entry of P and ETo data:

– Procedure 1 (WBgd – water balance grouped daily): water balances were performed for daily, with values of P and ETo daily as input. After the simulation, the values of water balance components (ETa, WD and WS) were grouped into periods of 5, 7, 10, 15 days and monthly. The values of the i-th S_i were considered equal to the S existing on the last day of each i-th period (five days, week, ten days, fifteen days or monthly).

– Procedure 2 (WBP – water balance in periodicities): the values of P and ETo were grouped into periods of 5, 7, 10, 15 days and monthly. After grouping, the P and ETo values served as input to simulate water balances and, respectively, determine the values of its components (ETa, WD and WS*)*, according to the periodicity.

The results of WB were organized and appointed following the pattern: **Procedure 1 – WBgd** (Water balance grouped daily), together with the periodicity (5, 7, 10, 15 days and one month), being represented as WBgd5, WBgd7, WBgd10, WBgd15 WBgdmonth, respectively; **Procedure 2 – WBP** (water balance in periodicities) accompanied by the periodicity (5, 7, 10, 15 days and one month), represented as WBP5, WBP7, WBP10, WBP15 and WBPmonth, respectively.

The results of WB components performed according to Procedure 1 (WBgd) and 2 (WBP), to Ponta Grossa and Goiânia were compared statistically using the linear regression equation fit to the data and its corresponding correlation coefficient (R), index "d" of agreement of Willmott et al. (1985), and index "c" of Camargo and Sentelhas (1997), which considers: "c" > 0.85 – "great"; 0.75 < "c" ≤ 0.85 – "very good"; 0.65 < "c" ≤ 0.75 – "good"; 0.60 < "c" ≤ 0.65 – "median"; 0.50 < "c" ≤ 0.60 – "tolerable"; 0.40 < "c" ≤ 0.50 – "bad"; and "c" ≤ 0.40 – "very bad". Therefore, independently, both for the location of Goiânia-GO as Ponta Grossa-PR, the following contrasts were performed: WBgd5 vs WBP5, WBgd7 vs WBP7, WBgd10 vs WBP10, WBgd15 vs WBP15 and WBgdmonth vs WBPmonth for AWs 10, 25, 40, 55, 70, 85, 100, 215, 130, 145 and 160 mm. Finally, 880 analyzes was obtained, as a result of two locations, five periodicities, 11 AWs; four components (S, ETa, WD and WS) and two years.

Deviations from the WB components (S, ETa, WD and WS), calculated according to Procedure 1 (WBgd) and 2 (WBP) were determined by absolute mean deviation:

$$\mathrm{AMD} = \sum_{i=1}^{n} \left| \frac{C_{\mathrm{WBgd.i}} - C_{\mathrm{WBP.i}}}{n} \right| \quad (3)$$

$$\mathrm{DMA}_{\mathrm{day}} = \frac{\mathrm{DMA}}{N_{\mathrm{dp}}} \quad (4)$$

Where: AMD – absolute mean deviation; $\mathrm{DMA}_{\mathrm{day}}$ – daily absolute mean deviation; CWBgd.i – water balance component value (S, ETa, WD and WS) determined according to Procedure 1 (WBgd); CWBP.i – water balance component value (S, ETa, WD and WS) obtained according to Procedure 2 (WBP); n – total number of considered values; and Ndp – number of days of the periodicity (5, 7, 10, 15 days or monthly).

RESULTS AND DISCUSSION

The values of P and ETo of 2008 and 2009 used in the analysis of WBs for the two locations were within the specifying for climatic classification of each region. It is important to note that the presentation of data was performed for the monthly period, by allowing to verify the trend of the components P and ETo over years (2008 and 2009) (Figure 1).

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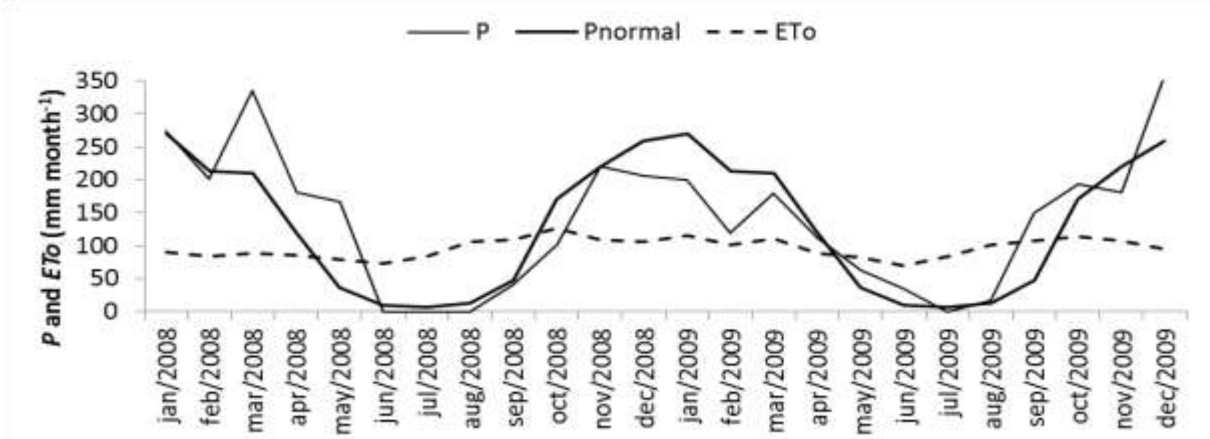
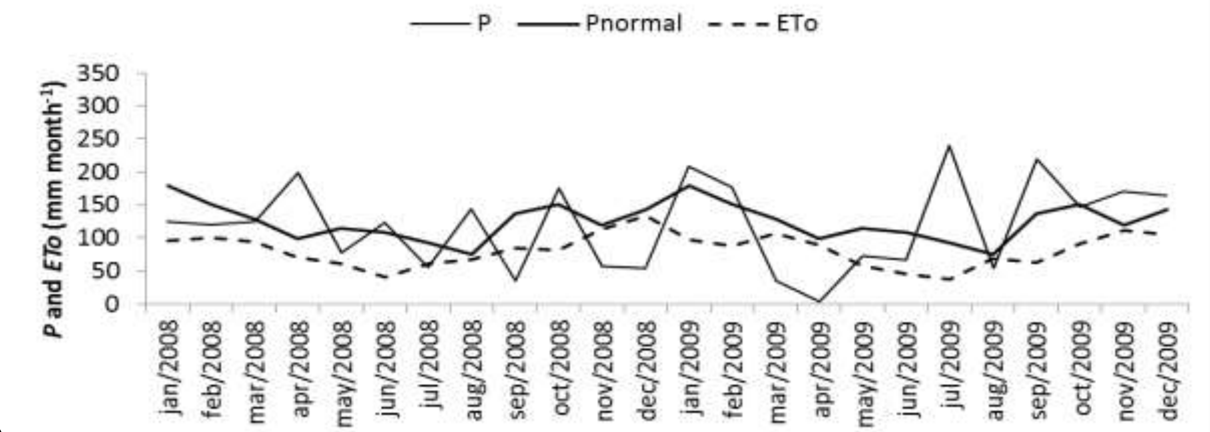


(a)



(b)

Figure 1. Monthly trend of precipitation (P), normal precipitation (Pnormal) and reference evapotranspiration (ETo) in 2008-2009, to: a) Goiânia-GO; and b) Ponta Grossa-PR.

The cumulative annual precipitation of Goiânia-GO was 1,727.1 mm year^{-1} in 2008 and 1,607.8 mm year^{-1} in 2009, values similar to normal precipitation in the region (1,575.9 mm year^{-1}) (BRASIL 2012). The greatest precipitation occurred in December 2009 (359.1 mm month^{-1}) and the lowest occurred in the months from June to August 2008, when there was no precipitation in the period. Between 2008 and 2009 were found two very distinctive periods, in which the ETo was higher than P: June to October 2008 (356.1 mm period^{-1}); and, from May to August 2009 (224.2 mm period^{-1}).

The cumulative annual precipitation of Ponta Grossa-PR was 1,289.2 mm year^{-1} in 2008 and 1,557.2 mm year^{-1} in 2009, approaching the normal precipitation in the region (1573.4 mm year^{-1}) (BRASIL 2012). The greatest precipitation occurred in July 2009 (240.6 mm month^{-1}) and the lowest occurred at the end of April (3 mm month^{-1}) 2009. Even under well P-distribution between 2008 and 2009, there were five periods in the region in which ETo is greater than P: July 2008 (5.1 mm month^{-1}); September 2008 (49 mm month^{-1}); November 2008 to early January 2009 (135.1 mm period^{-1}); March until the end of April 2009 (157.2 mm period^{-1}); and August 2009 (16.1 mm month^{-1}).

The values of accumulated annual ETo in Goiânia were 1,143.0 mm year^{-1} in 2008 and 1,179.5 mm year^{-1} in 2009 and for Ponta Grossa were 1,004.8 mm year^{-1} in 2008 and 959.1 mm year^{-1} in 2009. Accounting for the amounts of P entered and ETo that occur throughout the year ("P - ETo"), it was found that: Goiânia had a positive balance (input) of 584.1 mm year^{-1} in 2008 and 428.3 mm year^{-1} in 2009; Ponta Grossa also showed a positive balance (input) of 284.4 mm year^{-1} in 2008, and 598.1 mm year^{-1} in 2009. Thus, Goiânia and Ponta Grossa have annual P and ETo values closely, differing enough in the distribution of P over the months and seasons.

The periodicities of 5, 7 and 10 days showed, on average, the best performance results (Table 1). The correlation coefficients (*R*), index "d" of Willmott et al. (1985) and "c" of Camargo and Sentelhas (1997), in general, showed gradual reduction in their values when there was increasing periodicity (5 days for a month) and decreased in RAW values (160 mm to 10 mm). Thus, it can say that the periodicity influences the performance of estimates of components of WBs.

Ponta Grossa presented performance (index "c") lower than Goiânia, in the contrast between the Procedures 1 (WBgd) and 2 (WBP) in 2008. Most shifting between wet and dry periods during 2008 at Ponta Grossa can be an explanation for the lower performance obtained, especially for S and WD components. In 2009, the alternation of wet and dry periods was lower in Ponta Grossa and the performance indexes were higher than in Goiânia (Table 1).

Aside from WD to Ponta Grossa, the other components of WB (S, ETa and WS) presented performance “very good” to “great” up than 72.7% of the analyzes of the WBs to Goiânia and Ponta Grossa, in 2008 and 2009 (Table 1). The percentage of performances “very good” to "great" was 52.7% for WD in Ponta Grossa in 2008 and 2009.

Table 1. Percentage of index "c" of achieved performance, the contrasts between the respective values of the water balance components (WBgd vs WBP) to Goiânia-GO and Ponta Grossa-PR, in 2008 and 2009.

Performance	Index “c” of performance (%)							
	Goiânia-GO				Ponta Grossa-PR			
	S	ETa	WD	WS	S	ETa	WD	WS
2008								
“Great”	81.82	67.27	87.27	100.0	76.36	83.64	30.91	63.64
“Very Good”	10.91	25.45	12.73	0.0	10.91	10.91	21.82	36.36
“Good”	3.64	5.45	0.0	0.0	3.64	1.82	14.55	0.0
“Median”	0.0	1.82	0.0	0.0	3.64	0.0	0.0	0.0
“Tolerable”	1.82	0.0	0.0	0.0	1.82	3.64	9.09	0.0
“Bad”	1.82	0.0	0.0	0.0	0.0	0.0	9.09	0.0
“Very Bad”	0.0	0.0	0.0	0.0	3.64	0.0	10.91	0.0
2009								
“Great”	80.0	81.82	58.18	90.91	85.45	92.73	36.36	100.0
“Very Good”	10.91	14.55	14.55	9.09	5.45	7.27	16.36	0.0
“Good”	5.45	0.0	10.91	0.0	3.64	0.0	7.27	0.0
“Median”	0.0	0.0	3.64	0.0	1.82	0.0	5.45	0.0
“Tolerable”	0.0	1.82	3.64	0.0	1.82	0.0	7.27	0.0
“Bad”	0.0	1.82	1.82	0.0	1.82	0.0	1.82	0.0
“Very Bad”	3.64	0.0	7.27	0.0	0.0	0.0	25.45	0.0

In a superficial analysis, it can be considered that the percentage of performance (index “c”) obtained for Goiânia and Ponta Grossa were promising for Procedure 2 (WBP), because the results of the WBs components (S, ETa and WS) performed according to this methodology approached quite the results obtained according to the Procedure 1 (WBgd). However, as the Procedure 2 (WBP) is widely used in scientific work analysis, due to the simplicity or unavailability of daily series of climate data in a given region, it is important to note that there was underperformance to “good”, ranging from 0 to 43.7% in the analyzes for the two locations studied. Thus, the analyzes shown that it is always important to verify the purpose of water accounting in order to choose procedures to provide greater reliability (KHAZAEI & HOSSEINI 2015).

For the purpose of water accounting, some activities does not require very accurate results, for example, to agricultural practices, soil preparation and harvesting. It would be acceptable the achievement of WB as Procedure 2 (WBP). The methodology details will not significantly influence the analysis results. For activities that require greater detail and accuracy in results, as scientific studies, it is recommended to choose the Procedure 1 (WBgd). Therefore, if possible, it is more advisable to perform daily WB and subsequently carry out the grouping of the results of daily water components as the desired output periodicity.

Dourado Neto et al. (2010) also consider the use of daily WB becomes necessary to obtain more accurate estimates of outputs, which confirms the fact that the most accurate results with the use of daily WBs. Souza and Gomes (2007) evaluating the performance of water storage in the soil estimating equations in Ponta Grossa-PR, with an water balance with 10 days of periodicity, failed to obtain satisfactory and conclusive results for a sandy soil due to the used periodicity. Silva et al. (2008) reported that monthly estimates for WD component, obtained with daily WB, are better than those obtained with monthly WB, especially in spring and summer, with reverse trend in winter.

The results obtained to Goiânia and Ponta Grossa agreed with the considerations of Carvalho et al. (2011). Accordingly, the real soil-water conditions can vary considerably in a single day, with different concentrations of precipitation and daily water demand by plant, which is often higher than the crop actual transpiration, generating water deficit. In this sense, the use of WBs using short periodicities can assist in achieving better results. Sometimes the use of higher periodicities, such as monthly, may reflect inaccurate results for scientific purposes (SOUZA & GOMES 2007; SOUZA & GOMES 2008).

The 880 analyzes allowed, in addition to statistical analysis, excellent views of graphical trend of the WB components, revealing how the ways of grouping data as Procedures 1 (WBgd) or 2 (WBP), modify the results of the

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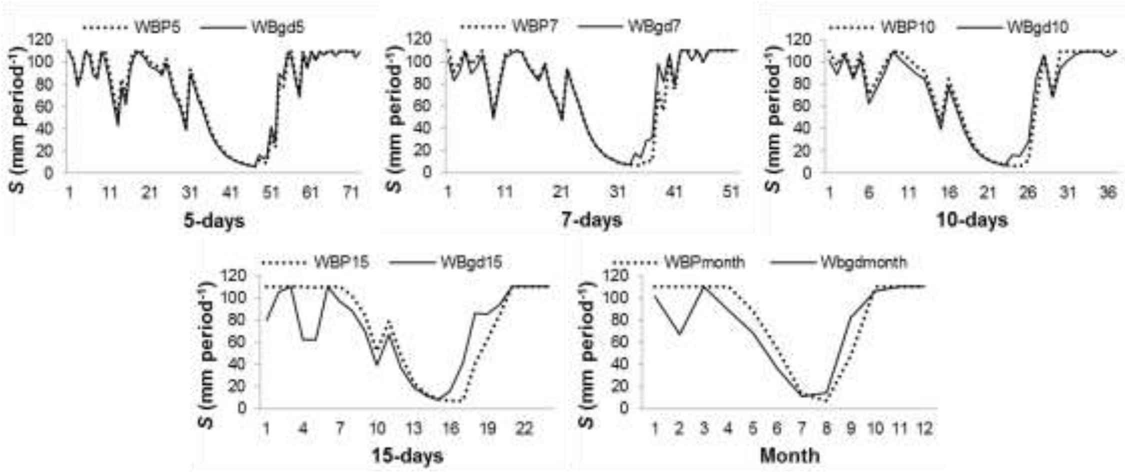
output components. As an illustration, Figure 2 shows the variation of S in Goiânia and Ponta Grossa, for different periodicities, when considered RAW was 55 mm.

Goiânia-GO



Ponta Grossa-PR

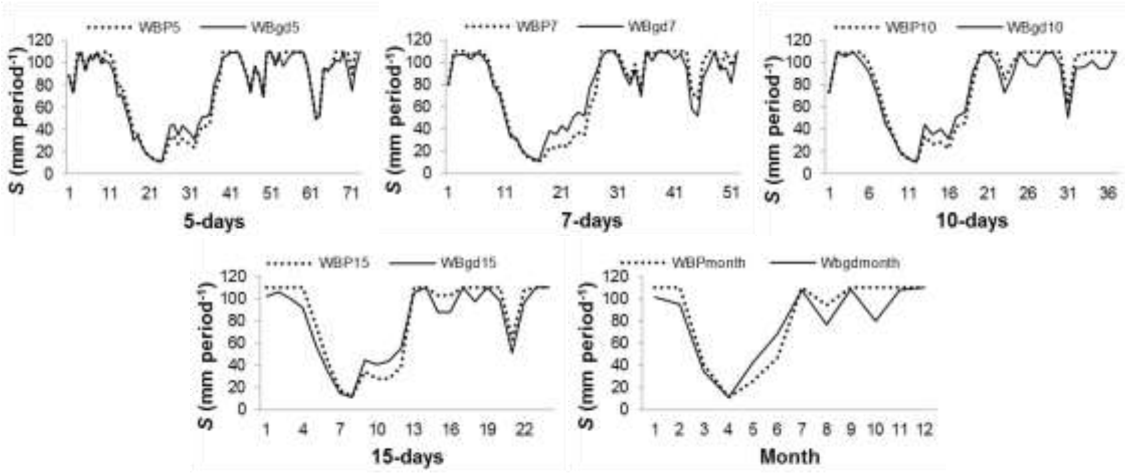


Figure 2. Water storage in soil (S) estimated by the water balance in 2009 in Goiânia-GO and Ponta Grossa-PR, considering Procedure 1 (WBgd5, WBgd7, WBgd10, WBgd15 and WBgdmonth) and Procedure 2 (WBP5, WBP7, WBP10, WBP15 and WBPmonth) to readily available water (RAW) of 55 mm, for 5, 7, 10, 15 days and monthly.

Although the present study do not compare the estimated WBs to Goiânia and Ponta Grossa with real data field, it is believed that the analyzes considering the groups of input data, as Procedures 1 (WBgd) or 2 (WBP), can generate good estimations of water conditions in the system. Bruno et al. (2007) found that the use of WB models based on the estimated evapotranspiration, as Thornthwaite and Penman Monteith models, can replace the field measurements by having good estimations. However, it is important to note that Dourado Neto et al. (2010) found that these models underestimate the values of ETa and S components.

Except for S, in which the absolute mean deviation increased for greater values of RAW, for ETa, WD and WS, in general, the deviations were higher for RAW = 10 mm, and tended to decrease and stabilize when reach RAW = 160 mm. With regard to different periodicities, the deviations increased gradually from short (daily) to the long periodicity (monthly) for all components (Table 2).

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Table 2. Absolute Mean Deviation (AMD) between Procedures 1 (WBgd) and 2 (WBP), to water balance components obtained to Goiânia-GO and Ponta Grossa-PR, in 2008 and 2009, considering readily available water (*RAW*) values (10 mm to 160 mm) and periodicities of 5, 7, 10, 15 days and monthly.

Periodicity	Absolute Mean Deviation (mm)							
	Goiânia-GO				Ponta Grossa-PR			
	S	ETa	WD	WS	S	ETa	WD	WS
2008								
5 days	4.49	0.71	0.71	1.10	2.96	0.39	0.39	0.83
7 days	5.97	1.08	1.08	1.71	3.39	0.54	0.54	0.83
10 days	9.32	2.14	2.14	2.03	4.57	0.82	0.82	2.39
15 days	14.71	3.24	3.24	5.20	9.79	1.75	1.75	6.38
Monthly	19.80	9.20	9.20	8.60	13.91	3.62	3.62	12.54
2009								
5 days	3.54	0.41	0.41	0.98	5.39	0.38	0.38	1.43
7 days	5.32	0.83	0.83	1.40	5.33	0.61	0.61	2.23
10 days	6.79	1.29	1.29	2.52	6.50	0.86	0.87	3.08
15 days	14.63	3.38	3.38	9.31	8.39	1.50	1.50	4.92
Monthly	13.19	6.67	6.67	12.28	9.12	3.27	3.27	9.85

The AMD (Table 2) and AMD_{daily} (Table 3) obtained for S, tended to increase the deviation with decreasing periodicity (monthly for 5-days) for both locations, and this component that presented the biggest errors (in mm), compared to the deviations presented by the other components of WB. The results agreed with the findings of Silva et al (2006), when describing that S is the one that most contributes to the spread of WB errors.

The AMD_{daily} values are interesting because they provided information about the daily error that can occur when using the WBP (Procedure 2) instead WBgd (Procedure 1). Furthermore, AMD_{daily} values allow the comparison of estimates between tested periodicities (Table 3). For ETa, WD and WS, it was found that the increase in periodicity (5 days for a month) provided greater deviations in Goiânia and Ponta Grossa. For S, the opposite was found, because the possibility of obtaining average S, calculated as periodicity and Procedure 2 (WBP), match the value of S calculated according to Procedure 1 (WBgd) and is arguably more difficult. It is important to emphasize that in Procedure 1 (WBgd) the i-th S were obtained on the last day of the i-th periods (5, 7, 10, 15-days or monthly).

In general, the AMD_{daily} of the components of WBs of Ponta Grossa (Table 3) were lower than those found in Goiânia. The trend was verified both with increasing available water in the soil (AW 10 mm to 160 mm) as the increase in periodicity (5-days for monthly). The results evidence that the performance of WBs as Procedure 2 (WBP) to regions with similar climate type as Goiânia, is subject to greater errors. The existence of well-defined seasons, where the dry season has a poorly precipitation distribution and the wet season has very intense precipitation (Figure 1a), may affect the calculation procedures and the probability of errors in WBs performed with grouped data entry (WBP - Procedure 2). On the other hand, in a long dry period it is important to note that due to the lower occurrence of precipitation, performances (index "c") obtained in the period are "good", as can be seen in Table 1.

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Table 3. Daily Absolute Mean Deviation (AMD_{daily}) between Procedures 1 (WBgd) and 2 (WBP), to water balance components obtained to Goiânia-GO and Ponta Grossa-PR, in 2008 and 2009, considering readily available water (RAW) values (10 mm to 160 mm) and periodicities of 5, 7, 10, 15 days and monthly.

Periodicity	Absolute Mean Deviation (mm)							
	Goiânia-GO				Ponta Grossa-PR			
	S	ETa	WD	WS	S	ETa	WD	WS
2008								
5 days	0.90	0.15	0.15	0.22	0.59	0.08	0.08	0.17
7 days	0.85	0.16	0.16	0.25	0.49	0.07	0.07	0.12
10 days	0.93	0.21	0.21	0.42	0.46	0.08	0.08	0.24
15 days	0.98	0.21	0.21	0.35	0.65	0.12	0.12	0.43
Monthly	0.66	0.31	0.31	0.29	0.46	0.12	0.12	0.42
2009								
5 days	0.71	0.08	0.08	0.20	0.78	0.08	0.08	0.28
7 days	0.76	0.12	0.12	0.20	0.76	0.09	0.09	0.32
10 days	0.68	0.13	0.13	0.25	0.65	0.09	0.09	0.31
15 days	0.97	0.23	0.23	0.62	0.56	0.10	0.10	0.33
Monthly	0.44	0.22	0.22	0.41	0.30	0.11	0.11	0.33

Dourado Neto et al. (2010) also found that the use of monthly scale in WB models, likely in Procedure 2 (WBp) in the present study, may underestimate S, increasing the error of the other WB components.

CONCLUSIONS

According to the analyzes, it was concluded that:
− Depending on the purpose, readily available water (RAW) and water balance component of interest, the periodicity and how to group the input data (WBgd and WBP) affect the estimations of water balance components. For activities that require greater detail and accuracy, it is recommended to perform the analysis according to Procedure 1 (WBgd) instead Procedure 2 (WBP);
− Deviations found in the water balance components tend to increase for longer periodicities (5 days for monthly) and lower values of water available in the soil (160 mm to 10 mm); and
− The soil water storage showed the highest daily average deviations with an opposite trend, increasing to short periodicities (a month to 5-days) and greater RAW values (10 mm to 160 mm).

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