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Monitoring of matric potential in degraded area and its relationship with erosive processes, Uberlândia – MG

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ABSTRACT

The objective of this work is relate the soil water behavior with erosive processes based on tensiometry data obtained through the monitoring of erosion plots. The evaluation period comprised two well defined climatic seasons characteristic of the Tropical climate, being from October to January (2014) and from February to April (2015) characterizing the two stages of the research. For analysis of the matric potential, the INFIELD 5 tensiometer was used to read the capsule tensiometers, on depths of 80 cm, 40 cm, 100 cm, 20 cm and 60 cm, respectively in the plots, where were also collected data from runoff and production of sediment. The plots are located in the watershed of Córrego do Glória, near to Uberlândia (MG). The results of the plots in the first stage of study show that the lack of vegetation associated with the large volume of precipitation caused the sealing of soil superficial layer contributing to soil saturation and consequently with the increase of the surface flow. On the second stage the results show a considerable change in relation to the vegetation cover, which contributed to the efficiency of infiltration and reduction of runoff, but also favored the splash effect due to its inefficient distribution through plots and, consequently, contributed to the increase of sediment production.

Key-words: Pore pressure; Erosive Processes; Runoff; Sediment production; Experimental plots.

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RESUMO

O objetivo deste trabalho é relacionar o comportamento da água no solo com processos erosivos a partir de dados de tensiometria obtidos através do monitoramento das parcelas de erosão. O período de avaliação compreendeu duas estações climáticas bem definidas características do clima Tropical, sendo de Outubro a Janeiro de 2014 e de Fevereiro a Abril de 2015 caracterizando as duas etapas da pesquisa. Para a avaliação do potencial matricial foi utilizado o tensímetro INFIELD 5 para leitura dos tensiômetros, nas profundidades de 80 cm, 40 cm, 100 cm, 20 cm e 60 cm respectivamente inseridos nas parcelas, onde também foram coletados dados de escoamento superficial e produção de sedimento. As parcelas estão localizadas na bacia hidrográfica do Córrego do Glória, próximo ao município de Uberlândia (MG). Os resultados das parcelas na primeira etapa de estudo mostram que a falta de vegetação associada ao grande volume de precipitação ocasionou o selamento das camadas mais superficiais favorecendo a saturação do solo e consequentemente no aumento do escoamento superficial. Na segunda etapa os resultados mostram uma mudança considerável em relação à cobertura vegetal, que contribuiu na eficiência da infiltração da água da chuva e na redução do escoamento superficial, mas também favoreceu o efeito *splash* devido a sua ineficaz distribuição no interior das parcelas e, por conseguinte colaborou para o aumento da produção de sedimento.

Palavras-chave: Poro pressão; Processos Erosivos; Escoamento Superficial; Produção de Sedimento; Parcelas Experimentais.

Introduction

Erosion is a natural process of alteration and degradation of soils, being one of the main holders

of landscape and relief and intensifying itself more and more through the anthropic activities. There are some types of erosion, such as water erosion and most common in Brazil, which consists of the

detachment of soil fragments through the action of precipitation and runoff, where its particles are deposited downstream of the slope and subsequently being detached again from this soil, in addition to the water erosion we have a laminar erosion caused by the progressive concentration of surface runoff, besides these there are many others and not less important, but associated with other factors.

These interference can be perceived in both urban and rural areas of a municipality. The effect of one or the other type of erosion in a particular region will depend much more on the particular conditions of each place as climate, the action of living beings, the weather, which presents conditions and characteristics or predisposed properties to be degraded.

A factor that contributes to the understanding of the water dynamics in the soil is called the matric potential, which allows to define the degree of water saturation in the soil. This degree indicates the point of saturation, in which the more saturated this soil is the less its water infiltration propensity and consequently the greater the superficial runoff and sediment production. For this to be possible, are necessary to use some equipment, such as tension meters, capsule tensiometers and or electronics, among others.

Therefore, a study was carried out of the matric potential at the depths of 80 cm, 40 cm, 100 cm, 20 cm and 60 cm with inserted capsule tensiometers inserted in erosion monitoring plots, located in the watershed of Córrego do Glória, in the municipality of Uberlândia, in a degraded area of Cerrado, where exposed soil and regeneration of grasses were used. Thus, the objective of this work is to analyze the matric potential in the two stages of the research, for understand the dynamics of the internal flows of water in the exposed soil, correlating them with the erosive processes, in this way seeking to contribute to new methods that help the revitalization, erosion control and greater soil conservation.

Erosive processes

In Brazil, rainfall is one of the climatic elements that have the greatest influence on soil erosion, and water erosion is the most significant form of this phenomenon in our territory. Among the primary variables that influence soil water erosion, surface cover and surface roughness are the most important, being responsible for practically all the retention and storage of water and sediments of erosion on the soil surface (Cogo, 1981; Onstad, 1984; Kamphorst et al., 2000; apud Bertol, I. et al., 2006; Dechen, 2004).

Water erosion consists of the loss of the surface layer of the soil, thus characterizing the surface runoff of the water. The exposed soil is the main receptor of rainwater, being exposed to the intensification of erosive processes, this soil when receiving the raindrops suffers the direct impact of them and in this way their particles are disaggregated becoming more and more susceptible to the mechanical drag of the surface runoff of the water (Mafra, A. L. 1999; Embrapa, 2003; Guerra, A. T. 2012).

It is understood as erosion process the removal of particulate matter, its transportation and deposition of sediments occurring by splash action, generating soil compaction, crust formation and sealing of the soil. The formation of erosive features, such as micro ravines, occurs through surface runoff in linear streams, intensified by the formation of crusts that make difficult the infiltration process and, as a consequence, soil degradation (Guerra, A. T. 2012).

Second Guerra & Guerra (1997), when the soil becomes saturated the surface runoff occurs because of the lack of infiltration capacity on the surface of the soil that can no longer absorb water. In situations where the soil is devoid of vegetal cover, this superficial flow favors the production of sediments, giving rise to erosive processes.

Matric Potential

According Passioura (1980), the matric potential was originally introduced by TJ Marshall in 1959, According to Passioura (1980), the matrix potential was originally introduced by TJ Marshall in 1959 and makes reference to two instruments, being the tensiometer apparatus and the pressure plate, the two apparatuses function to measure or generate a matric potential which consists of the operational definition: "Matric potential is the difference in water potential between a system and its *"equilibrium dialysate"*, when both are at the same height, temperature and are subjected to the same external pressure".

To measure the matric potential, it is necessary to use some devices, such as tensiometric stations, capsule tensiometers, among others. "The tensiometer filled with water is synonymous with measuring the matrix potential. Tensiometers tend to be preferred sensors, because when they work correctly, they give a direct measure of matric potential" (Whalley; Ober; Jenkins, 2013, p. 3951).

According to Reichardt (1985: 122) "the mathematical description of matric potential is quite difficult and its determination is usually experimental". The matric potential is expressed according to the soil moisture, and thus, the more

saturated the soil is, the greater the value of the matric potential. And to obtain the data referring to the matric potential one of the equipment most used are the tensiometers (Bezerra, 2012).

Erosive processes and matric potential

Interpret the infiltration being the entry of water into the soil through its surface, ie the introduction of water into the soil through the soil-atmosphere interface. In this way, during a rainy event, part of the rain can infiltrate and move downward and the other part may run down the surface of the ground, depending on the slope of the terrain. Thus, infiltration is a process that divides how much of the precipitation flows over the soil surface and how much it flows below the soil surface. The infiltration requires many factors, being these, the texture and the structure of the soils, the vegetal cover and the initial humidity. It is stated that the soil infiltration process together with precipitation are important because they determine the amount of water that is accessible to the plants, in the runoff and in the supply of the groundwater (Libardi, 2012; Silva & Kato, 1998).

Water penetrability in the soil may be a way of anticipating the speed of the erosive process or of flooding since when the infiltration rate reduces, in most circumstances, the runoff is increased. On the surface, erosion depends on the action of precipitation and diffuse surface runoff.

The runoff is a function of slope and climatic conditions. The erosive power of the water depends on the density and velocity of the flow, the thickness of the water slide, the slope and length of the slope, and the presence of vegetation (Barcelos; Cassol & Denardin, 1999; Magalhães, 1995).

The definition of matric potential is completely linked to the definition of infiltration, since both are governed by common factors such as permeability, capillarity, grain size, compaction and porosity. The degree of saturation of the water in the soil can be determined with the matric potential, and the higher the soil saturation, the lower the water infiltration capacity and the more agile is the production of the surface runoff (Bezerra, 2006).

Matric Potential and Soil Conservation

The reversal of this situation involves soil conservation strategies, aiming to protect against rainfall impact in the case of rainfall erosion, increasing its infiltration capacity, improving the stability of aggregates and increasing surface roughness. These strategies reduce the impact of rain drops (splash), runoff velocity and wind action

(Harbor, 2000; Fullen & Catt, 2004; Bhattacharyya et al., 2009 apud Bezerra, 2006).

According to Bezerra (2012) the understanding of surface and subsurface dynamics of water in the soil are recognized as one of the most important tools for identification, analysis and recovery of areas that suffer from erosive processes. This dynamics of water, when internal, assume a connection of different factors that regulate the water component, being these, the physical properties of the soil, the climate, tension, vegetation root system, land use among others. And for this to become possible, it is necessary to use some apparatus, especially the tensiometers, which work with the measurement of the tension between the porous spaces in which the water is retained in the soil, in different diameters, being characterized in macro and micro pores and due to capillarity a negative pressure is generated at the interface water and soil denominated of matric potential.

Materials and methods

Characterization of the study area

The choice of the study area took into account the location and the experimental plots already existing in the area for the research, it was developed by the Laboratory of Geomorphology and Erosion of soils of the Federal University of Uberlândia. The study area is located at the Experimental Farm of Glória, at the geographical coordinates of 18°56'56 "south latitude and 48°12'21" west longitude of Greenwich, at an altitude of 850m above sea level, present in the watershed area of Córrego do Glória, a tributary of the right bank of the Uberabinha River and sub-affluent of the Araguari River. The area is located in the Planation Surface over the Sedimentary Basin of Paraná. The predominant geological formation is the Marília Formation, and the soils present are acid and little fertile of the Red Latosol type with clay-sandy texture (Bezerra, 2006).

According to Silva (2010), the climate of the region is characterized by tropical climate, being Aw according to the classification of Köppen. It presents dry winters and rainy winters, with an average annual temperature of 22°C, varying between averages of 24°C in the months of October to March (warmer months) and 18°C in the months of June and July (colder months). In relation to the precipitation, the variation is between 1300 mm to 1700 mm / year. The seasons, rainy and dry, last about six months each, and "this characteristic process occurs due to the displacement of the area of influence of the air masses that act on the region, which are:

Continental Equatorial Mass, Tropical Atlantic and Polar Air Mass” (Alves, 2007).

Experimental plots

The research is based on the monitoring and data collection from two experimental plots, located in the city of Uberlândia - MG (Figure 1).

The experimental plots where the activities of the present work were applied have 10 m² of extension, surrounded by masonry barriers, connected to collecting gutters and gallons with capacity of 250 liters, slope of 12°, and located in the left slope of the Gloria Stream.

The plots are located close to the gully present in the region, but due to the distance between them, such erosive action does not affect the plots in order to alter the results. These plots already existed at the site, since they were already used for research related to the quantification of the presence of organic matter and erosion monitoring that took into consideration other parameters of analysis, which in some way contributed to a better knowledge of the dynamics of the place in question, thus having a history already known. But for the accomplishment of the work, the parcels were adapted, undergoing changes like: insertion of tensiometer lines (Yellow lines - Figure 2) in different depths, being these, 80 cm, 40 cm, 100 cm, 20 cm and 60 cm (Figure 4), according to this sequence for the monitoring of the matric potential. In this way, the structure of the plots was reused, but with modifications in its use.

For the development of the research, some parameters were defined to contribute to the monitoring of the plots, being these, precipitation, surface runoff, sediment production and matric potential. The data acquired in the weekly collections were taken to the laboratory to be quantified and later analyzed.

Analysis of erosive processes and matric potential

The quantification of surface runoff parameters, sediment production, total weekly precipitation and matric potential were established in order to understand the evolution of soil physical changes in relation to erosion processes. In order to obtain the data concerning the surface runoff, it was necessary to collect the water resulting from the precipitation contained in the gallons, where it was initially homogenized, measured its total amount retained in the week and collected 2 liters of water for filtering and calculation of soil loss in the laboratory (Figures 6, 7 and 8).

In filtering of the samples, steps were followed, weighing the papers on a precision scale at 25° C ambient temperature, to avoid changes in

the weighing results before and after the filtering, were done at close times due to the difference in atmospheric pressure at different times of the day. At the end of weighing the initial filter with the filtering of the sample a new weighing was done to obtain the final result, where the final weight was subtracted with the initial weight of each filter paper, to obtain the amount of sediment found in each sample.

Subsequently the filtering of the samples was added in this quantification the sediments deposited through the surface runoff in the collecting gutter (Figure 6), being possible to obtain the weekly soil loss and for the collection of rainfall data the rainfall station installed near the plots was used, containing an electronic rain gauge equipped with a data logger, of the WATCHDOG brand, obtaining records every 5 minutes and being feasible to acquire precipitation values with precision to aid in the analysis of correlated parameters.

In order to obtain the results of matric potential, it was used in the soil moisture readings the INFIELD 5 digital tensiometer (Figure 5), the tensiometers were installed in a straight line in the direction of the slope of the plots, where the readings were performed once a week and their respective data recorded in a field card, due to the non-storage of the tensiometer, these data were transferred and handled with the aid of the Excel 2010 software.

Photo Comparison

For the quantification of the percentage of vegetation and exposed soil in the experimental plots throughout the monitoring, the software used was ENVI® 4.2 (*Environment for Visualizing Images – Research Systems, Inc.*), with the objective of performing the photo-comparison of the collected images. Monitoring of vegetation cover variation was performed in both plots using the technique of photo comparison, using a high resolution digital camera, ENVI 4.2 software and the methodology proposed by Pinese Júnior, Cruz and Rodrigues (2008).

Six photos were selected for treatment, being three photos of the first stage and three photos of the second stage of the research, in order to obtain the quantification of the protected area and exposed soil and or unprotected area as a factor determined by the vegetation.

The photos were executed according to the tensiometer lines, with the purpose of later comparing the vegetation development and its contribution to the values of matric potential.

According to Pinese Júnior, Cruz and Rodrigues (2008), the treatment of the images made in the software ENVI® 4.2 allows to separate the regions of interest in vegetation and unprotected soil with distinct colors, making photo-comparison possible. With the purpose of obtaining the percentage of the vegetal cover and

of the soil exposed only in the tensiometer lines, was made a clipping of the parcel in three parts, following line A, line B and line C respectively, with the purpose of contributing to the visualization of the result of the photo-comparison.

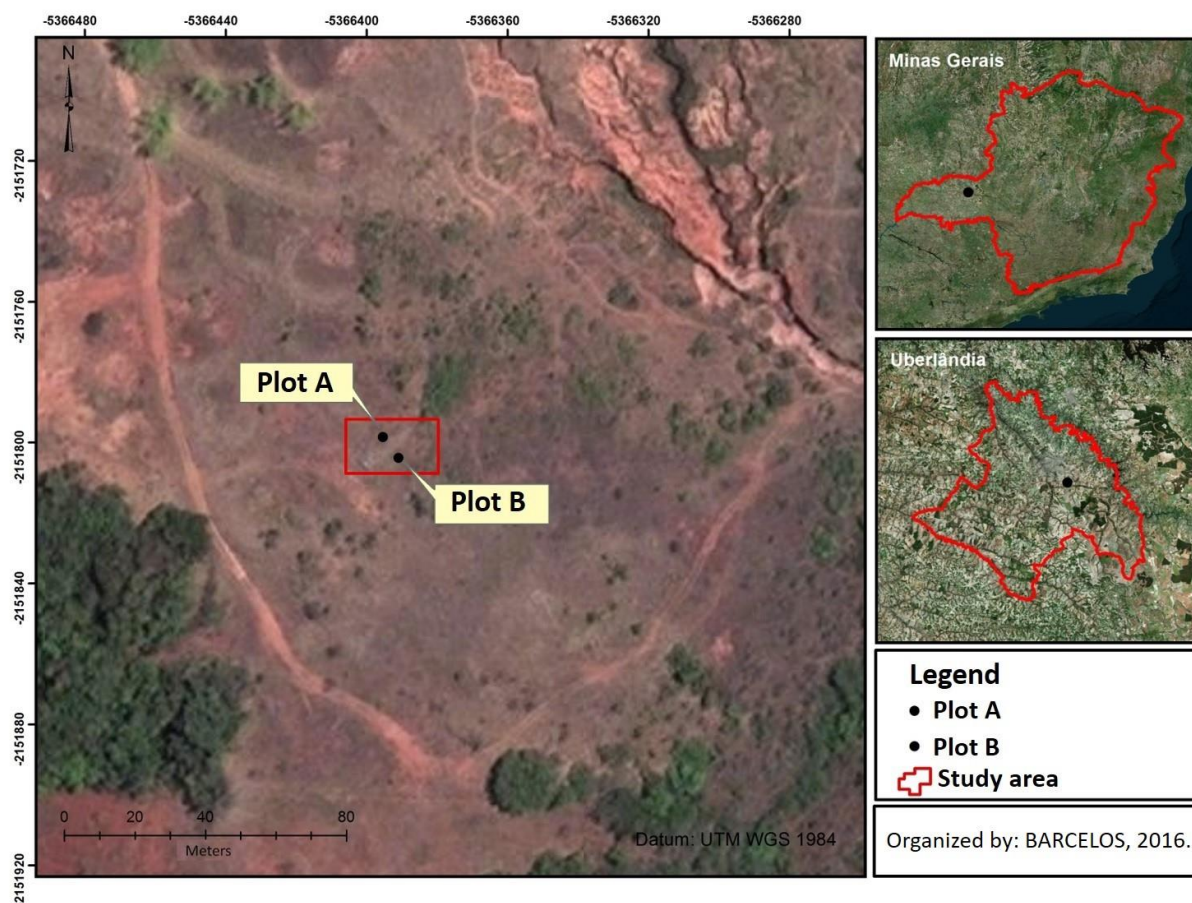


Figure 1. Location map of the area in which the experimental plots are inserted. Prepared by: Authors, 2016.

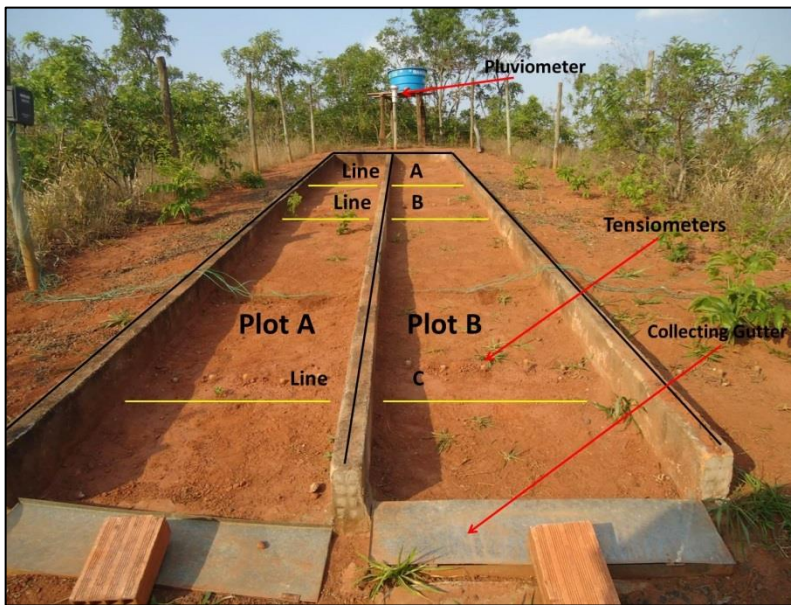


Figure 3. Structure of the experimental plots, first stage of the research.
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Figure 3. Structure of the experimental plots, second stage of the research.
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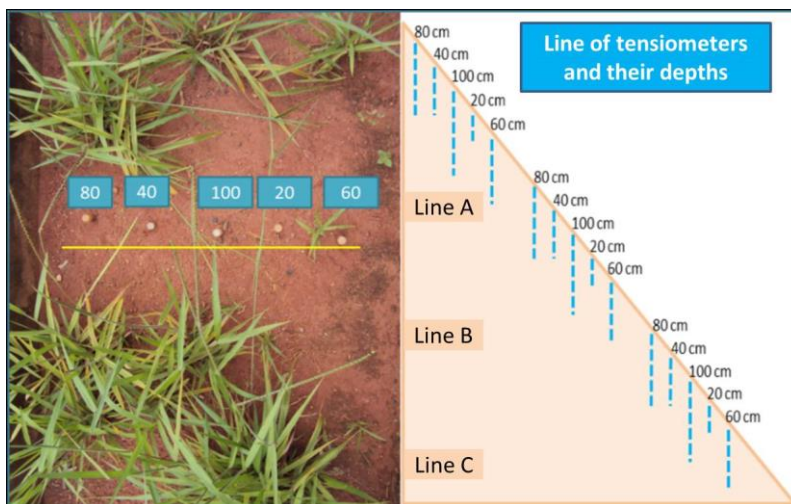


Figure 4. Lines and depths of the tensiometers in the experimental plots.
Prepared by: Authors, 2017.



Figure 5: INFIELD 5 tensiometer, used to measure the matric potential.
Source: Authors, 2017.



Figure 6: Collection of sediments deposited in the collecting gutter.
Source: Authors, 2017.



Figure 8: Weighing the samples in the laboratory.
Source: Authors, 2017.



Figure 7: Collection of sediment deposited in gallons.
Source: Authors, 2017.

Results and discussion

The information of matric potentials acquired through capsule tensiometers at depths of 20, 40, 60, 80 and 100 cm, during the monitoring between October 2, 2014 and April 29, 2015 express a wide difference between the plots at the beginning of monitoring (exposed soil, first stage) and at the end of monitoring (vegetation development, second stage) (Figures 2 and 3). According to the work of Bezerra (2006, p.77) carried out in the same study area, we have the granulometric characterization of the material according to the different depths ranging from 15 to 120 cm. At depths of 15 to 40 cm, there is 48.7% of fine sand, 22.4% of clay, 19.7% of coarse sand and 9.1% of silt. Between 60 and 120 cm of depth, are found with coarser granulometry, with 45% of coarse sand, 31% of fine sand, 14.3% of clay and 9.6% of silt.

According to Azevedo & Silva (1999) and Reichardt (1985), for the tensiometer to function it depends on the formation of an internal vacuum. Due to this reason, its operating limit is linked to the point where the water, under vacuum, goes into the process of cavitation, that is, there begins the intense formation of bubbles of water vapor inside the system. In addition, when the tension reaches high values, air can enter the tensiometer through the pores of the capsule, from which the internal pressure equates atmospheric pressure, reducing the sensitivity of the tensiometer measures or even ceasing to function. The measures that a tensiometer presents are related to the altitude of the place and with the temperature of the water, in general, the upper limit of measurement is considered the value of 80 kPa.

According to Bártková, K., Matula, S., Miháliková, M. (2013), the interpretations of the tensiometers readings are divided into:

- 0 KPa, indicates that the soil is completely saturated with water, it is equivalent to any type of soil;
- 0 - 10 KPa indicates excess water. The water contained by the soil at this pressure is drained in a few days;
- 10 - 20 KPa, indicates presence of water and air in the system. This pressure is related to the "field capacity" for soils, where the soil has already reached its capacity and can not contain more water for a possible vegetation growth;
- 20 - 40 KPa, indicates availability of moisture and aeration;
- 40 - 60 KPa, indicates low available humidity;

- 60 - 80 KPa, indicates low humidity. And in soils of medium texture, it indicates very dry soil, when in situations of high temperatures can quickly force the suction of the soil to extremely high reading values.

The granulometry of the soil between 15 and 40 cm approximately indicates a superficial soil, of a finer texture that can interfere in the process of infiltration, and for the granulometries of 60 to 120 cm are of coarser materials, facilitating the passage of water. In plot A with exposed soil, the data obtained on November 13, 2014 line A, with 50 mm of precipitation indicate the saturation of the water in the soil, marking the value of 0.4 kPa. However, on 01/22/2015 after a week of drought, marking 0.3 mm of precipitation, the recorded potential was -21.7 kPa, period where the vegetation inside the plots are under development.

Similar oscillations were also found in lines B and C of the same plot, with 0.3 kPa (50 mm, on 11/13/2014) and -19.6 kPa (drought, 01/22/2015), and in the line C with 176 mm was marked 0.5 kPa on November 27, 2014 and -35.4 kPa on January 22, 2015 (drought) (Graphs 1, 2 and 3). These oscillations were obtained at a depth of 20 cm, reflecting the possible compaction of the more superficial layers of this soil, which favored the prevention of a higher water infiltration, also contributing to higher evaporation rates, these factors are related to the exposed soil.

The water infiltration capacity in the soil can be defined by compacting the most superficial layer of this soil, this compaction can compromise both the infiltration capacity and also affect the matric potential data. According to Reichardt (1985: 276) "it is called infiltration of the process by which water enters the soil. [...] its rate or velocity often determines the superficial defluvium "run-off", responsible for the phenomenon of erosion during rainfall".

For the depths of 40, 60 and 80 cm the values found were relatively constant during almost the entire monitoring period, at the depth of 40 cm line A, the matrix potential ranged from -66.7 kPa (drought, 23/10/2014) at 0.2 kPa (87 mm, day 03/19/2015 with presence of vegetation in the plot), already at depth 60 cm line A pore pressure varied from -61.5 kPa (drought, 23/10/2014) at 0.6 kPa (176 mm, 11/27/2014), and in the pore pressure of 80 cm line A, were recorded variations of -31.6 kPa (drought, 10/23/2015) were recorded at 0, 3 kPa (54 mm, 12/18/2014). In lines B and C, there were also relatively constant values, line B 40 cm -60.4 kPa (dry season, 09/10/2014) at 0.5 kPa (87 mm, on 03/19/2015 with presence of vegetation in the plot), line B 60 cm ranged from -46.5 kPa (dry season, 09/10/2014) to 1.9 kPa (16.3 mm,

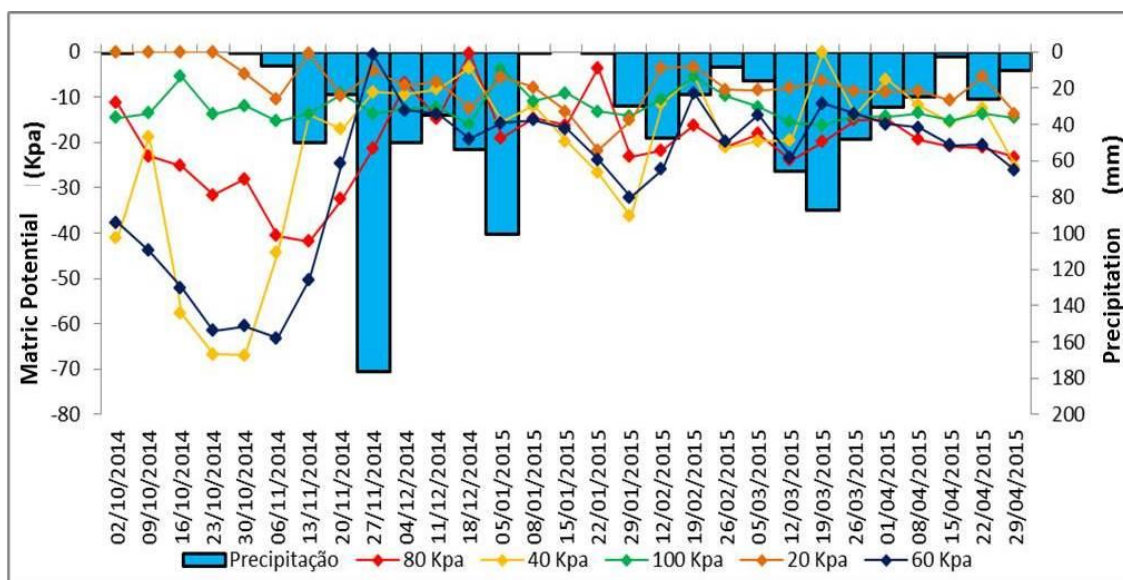
05/03/2015 with presence of vegetation on the plot) and line B 80 cm, -49.7 kPa (dry season, 09/10/2014) at 0.1 kPa (10.5 mm, 04/29/2015 with presence of vegetation on the plot).

In line C, the collected data of matrix potential in depth of 40 cm ranged from -43.8 kPa (drought, 09/10/2014) to 0.9 kPa (48 mm, 12/02/2015 with presence of vegetation in the plot), 60 cm from -45.9 kPa (dry season, 09/10/2014) at 0.9 kPa (176 mm, 11/27/2014) and 80 cm from -35.7 kPa (dry 10/10/2014) at 0.8 (54 mm, 12/18/2014). In relation to the values of the depth of 100 cm we find a later response related to pore pressure due to the characteristics of this soil, presenting fast saturation and consequently a rapid formation of surface flow, when compared to the depths of the surface tensiometers, since they suffer greater rainfall interference, infiltration, evaporation and plant roots.

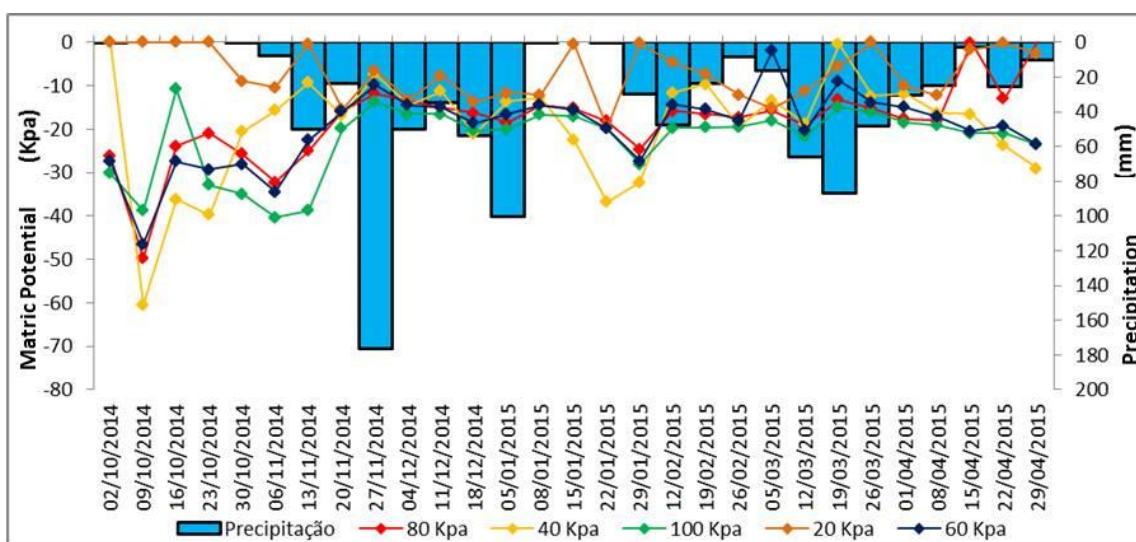
The matric potential at 100 cm depth line A marked negative pressures between -5.4 kPa (drought, 16/10/2014) to -13.6 (50 mm, 11/13/2014), line B between -10.8 kPa (drought, 10/16/2014) at -38.7 (50 mm, 11/13/2014) and line C between -17 kPa (dry 15/01/2015) to -31 kPa (50mm, 11/13/2014). In plot B (Graphs 4, 5 and 6) with presence of vegetation we obtained values in the depth of 20 cm line A that indicated surplus water at 0.9 kPa (48 mm, on 12/02/2015) and on day 30 / 10/2014 (without vegetation and drought period) the matric potential reached -51.3 kPa indicating low humidity. In lines B and C, line B, 0.6 kPa (87 mm, on 03/19/2015 with presence of vegetation) and -16.2 kPa (2.6 mm 15/04/2015 with presence of vegetation). And on line C, 0.5 kPa (176 mm and without vegetation) and on 10/10/2014 -59.7 (drought and without vegetation) were registered on 11/27/2014.

The values of pore pressure when associated with the presence of vegetation, demonstrate a relatively significant increase in water circulation conditions in the soil at all depths except in some cases at depth of 100 cm, this increase is mainly due to the natural growth of the vegetation inside the plots. (between January and April 2015). According to Coelho Netto (2001, p. 122) the surface hydrological dynamics “varies from one area to another according to local geographic characteristics, such as topography, soil profile discontinuities and / or moisture antecedent to rainfall precipitating on the basin of drainage”. In this way, vegetation plays a fundamental role in soil protection against the direct impact of precipitation and its root system favoring infiltration, prevailing subsurface flow in the wetter areas.

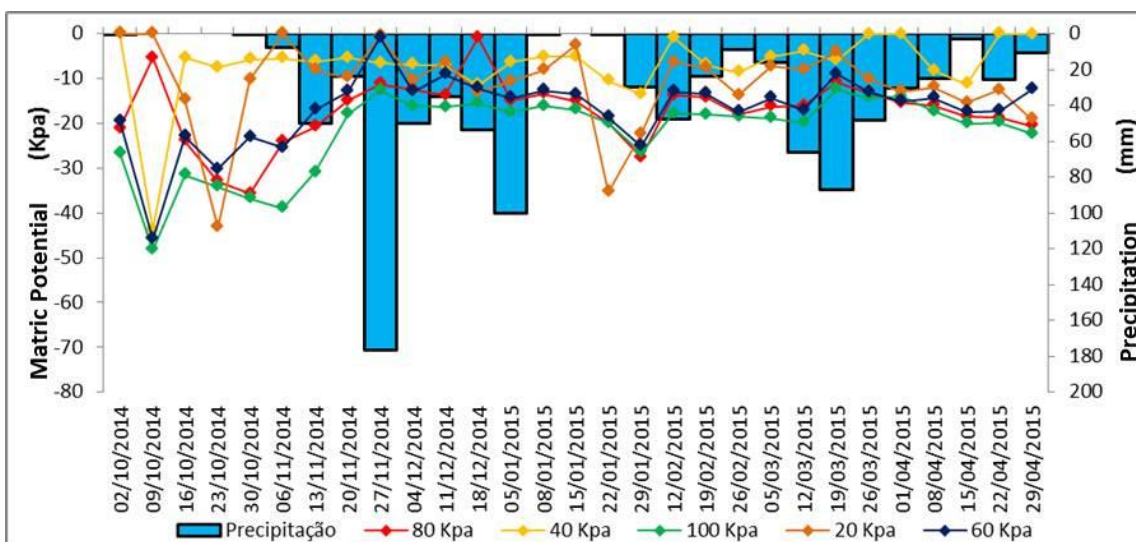
For depths of 40, 60 and 80 cm plot B, with vegetation influence were recorded in line A 40 cm, amplitudes in the matric potential ranging from -59 kPa (drought, 22/01/2015) to -0.5 kPa (23.5 mm, 19/02/2015), the low matric potential mentioned (-59 kPa), was due to the still incipient situation of the vegetation cover that provided better conditions for the circulation of water in the soil, directly influencing the permeability, suction and the behavior of the water flow in the profile of this soil, through the grass root systems. Line B and C maintained the amplitudes in the variations, line B between -62 kPa (dry season, 01/22/2015) to -6.8 kPa (47.4 mm, 12/02/2015) and line C between the variation was -36.4 kPa (dry season, 01/22/2015) to -0.8 kPa (30.2 mm, 01/04/2015). The same occurred with depths of 60 and 80 cm, ranging from -70 kPa (dry season, 01/22/2015) to -8 kPa (87 mm, 03/17/2015) line A, and from -32, 8 kPa (dry, 22/01/2015) at 0 kPa (30.2 mm, 01/04/2015) line B and -29.6 kPa (dry season, 01/22/2015) at -1, 3 kPa (30.2mm, 01/04/2015) line C. At 80 cm the values had a variation between -60.8 kPa (drought, 01/22/2015) to -14 kPa (87 mm, 03/19/2015) line A, and the tensiometer of line B presented errors in its reading, where we disregarded its values and in the line C of -26.1 kPa (dry season, 01/22/2015) at 0 kPa (16.3 mm, 03/05/2015). The pore values in the depth of 100 cm had no representative values when compared to the values of the other depths, ranging from -16.5 kPa (dry season, 15/01/2015) to -39.5 (87 mm, day 19 / 03/2015).



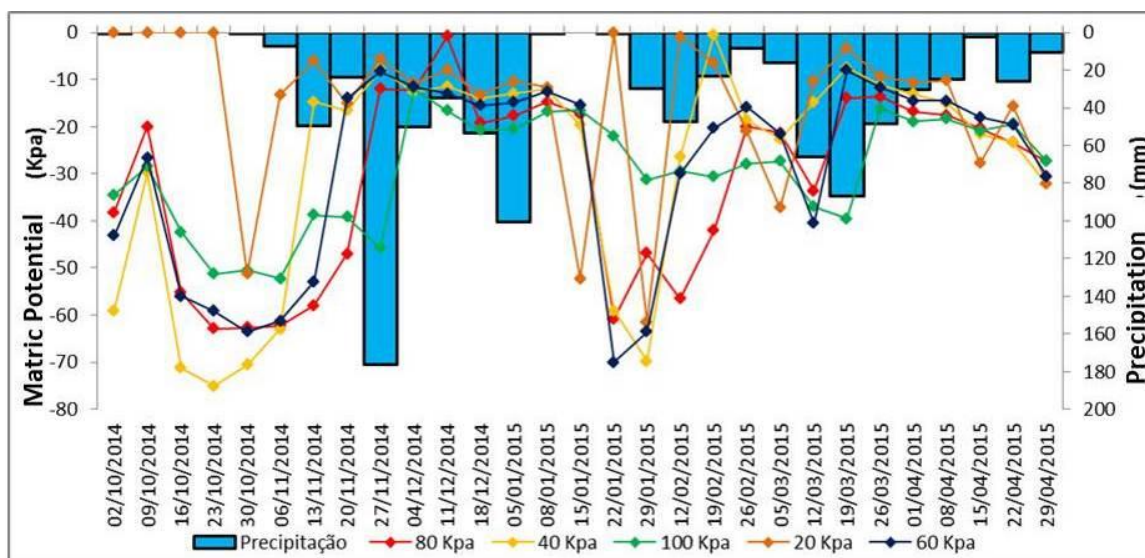
Graph 1. Matric potential in the depths 20 cm, 40 cm, 60 cm, 80 cm and 100 cm, plot A (line A).



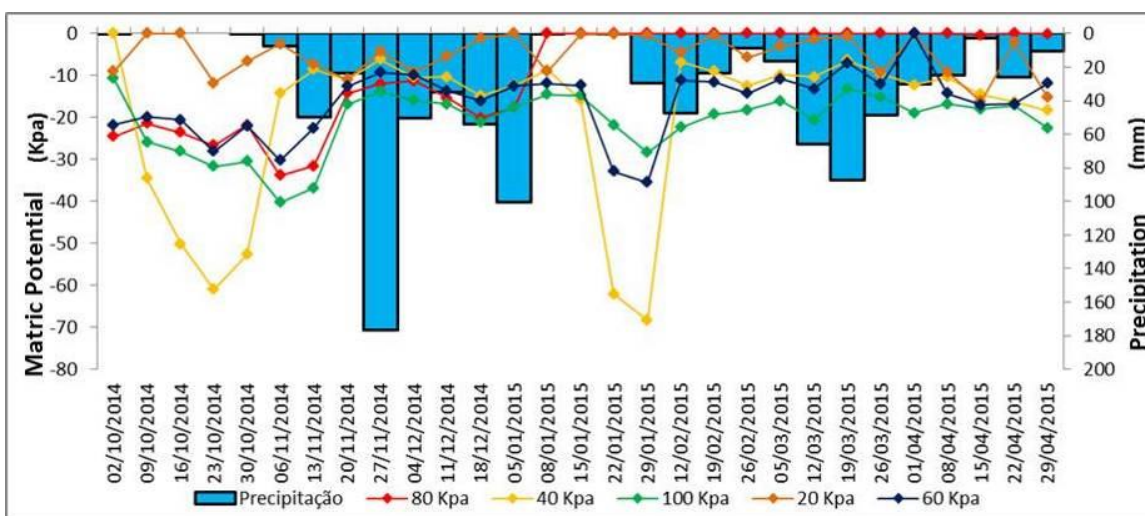
Graph 2 - Matric potential in the depths 20 cm, 40 cm, 60 cm, 80 cm and 100 cm, plot A (line B).



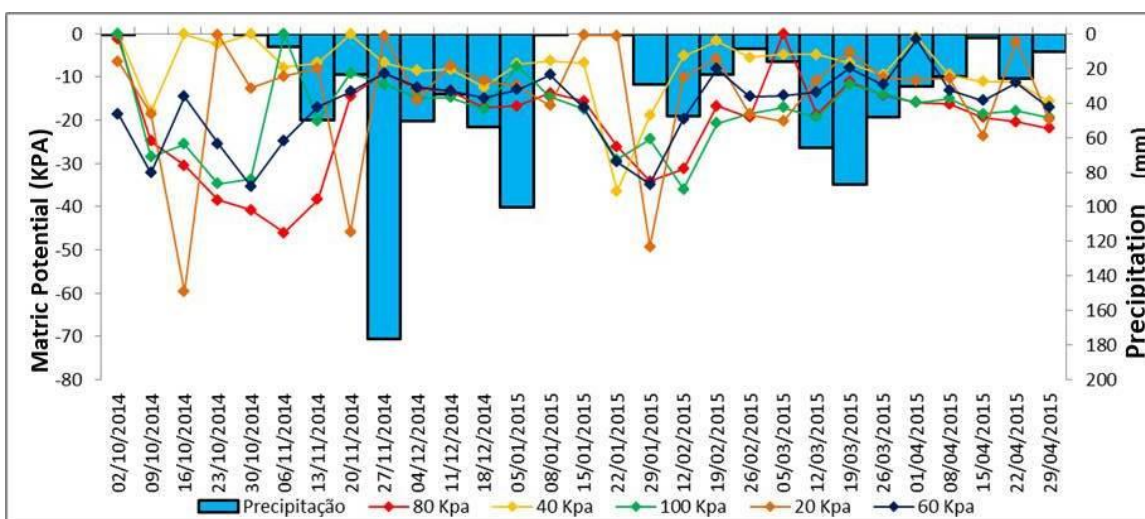
Graph 3 - Matric potential in the depths 20 cm, 40 cm, 60 cm, 80 cm and 100 cm, plot A (line C).
Prepared by: Authors, 2017.



Graph 4 - Matric potential in the depths 20 cm, 40 cm, 60 cm, 80 cm and 100 cm, plot B (line A).



Graph 5 - Matric potential at depths 20 cm, 40 cm, 60 cm, 80 cm and 100 cm, plot B (line B).



Graph 6 - Matric potential in the depths 20 cm, 40 cm, 60 cm, 80 cm and 100 cm, plot B (line C).

Prepared by: Authors, 2017.

The matric potential data helped to understand the data obtained during the runoff and sediment production research, these are directly associated due to the differences of water pressures inside the soil, being through the characterization of the saturation points of the water in the soil and the water circulation in each plot. Regarding plant cover and matrix potential, we have in the study by Costa et al (2005) in the more superficial depths are recorded drainage processes, evidencing that the water flow behavior occurs through the influence of the root systems at lower depths.

During the monitoring, 970 mm of precipitation was recorded, generating 3,465 l of surface runoff in plot A at the same time that plot B presented 2,895 l of runoff. With respect to sediment production, 52.35 kg of eroded material was obtained in plot A while in plot B, 75.82 kg of eroded material was obtained, presenting a significant difference between the two plots (Chart 1).

In the first stage of the research that includes the months of October 2014 to January 2015, there were high rates of precipitation and progressive development of the vegetation cover, already in the second stage of the research that includes the months of February to April of 2015 presented precipitation well distributed and establishment of the vegetation cover in most of the plots. Characterizing in the first step, plot A and B exposed soil (vegetative cover under development) and in the second stage (plot A) establishment of the vegetation cover in some portions of the plots. To determine the percentage of plant cover in the line of tensiometers was used the method of photo comparison and developed in the software ENVI 4.2, the values obtained were, plot A (1st stage, line of tensiometers A) 99.927% of exposed soil and 0.073% of vegetal cover, in plot A (1st stage, line of tensiometers B) the values were 99.029% of exposed soil and 0.971% of vegetation cover and plot A (1st stage, tensiometer line C) 99.342% of exposed soil and 0.658% of vegetal cover (Figure 9).

The values of plot B (1st stage, tensiometer line A) were 97.163% of exposed soil and 2.837% of vegetal cover, in plot B (1st stage, line of tensiometers B) 95.837% of exposed soil and 4.163% of vegetal cover and plot B (1st stage, line of tensiometer C) the results reached 95.755% of exposed soil and 4.245% of vegetal cover (Figure 11). In the second step of the research, the values obtained were plot A (second stage, tensiometer line A) 95.630% exposed soil and 4.370% of vegetation cover, in plot A (2nd stage, tensiometer line B) 92.350% of exposed soil and 7.650% of vegetal cover and plot A (2nd stage, line of

tensiometers C) 82.976% of exposed soil and 17.024% of vegetal cover, indicating little development of the vegetal cover compared to the values obtained in the first step (Figure 10), in relation to plot B (2nd stage, tensiometer line A) showed 64.544% of exposed soil and 35.456% of vegetal cover, already in plot B (2nd stage, line of tensiometer B) were quantified 62.467% of exposed soil and 37.533% of plant cover and plot B (2nd stage, line of tensiometer C) was obtained 49.024% of exposed soil and 50.976% of vegetation cover showing significant development in the values of vegetal cover (Figure 12).

This development of the upper vegetation cover in plot B in relation to plot A was probably due to the historical background of this experimental plot, where research was already carried out that used plot B for the implementation of geotextiles, requiring fertilization and control of soil quality in the preterit, which possibly contributed to this scenario in the second stage of the research.

Regarding the average values of matric potential, we have that the plot A that presented minimal development of vegetal cover throughout the research kept its results close to saturation, reaching values of -8.5 kPa (20 cm), -15.9 kPa (40 cm), -19.3 kPa (60 cm); (18 cm) and 18.8 kPa (100 cm), while the average values of plot B, as evidenced in most of the research, showed good values for plant cover, reaching -11.6 kPa (20 cm), -18.8 kPa (40 cm), -20.6 kPa (60 cm), -20.5 kPa (80 cm) and -22.7 kPa (100 cm).

Months	Precipitation (mm)	Runoff P.A (L)	Runoff P.B (L)	Total Sediment P.A (g)	Total Sediment P.B (g)
October	0,5	35,25	10,5	220,80	947,11
November	257,5	649,8	621,5	38.682,24	53.271,67
December	193,2	593,8	474,75	3.589,26	8.125,46
January	131	602,8	519,75	7.918,73	7.397,72
February	76,3	349,7	272,33	90,50	1.923,61
March	217,9	691,8	513,3	1.510,19	2.971,07
April	94,1	542,5	483	341,96	1.191,90
Totals	970,5	3465,65	2895,13	52.353,69	75.828,53

Chart 1. Variability of surface runoff and sediment yield in plots A and B.

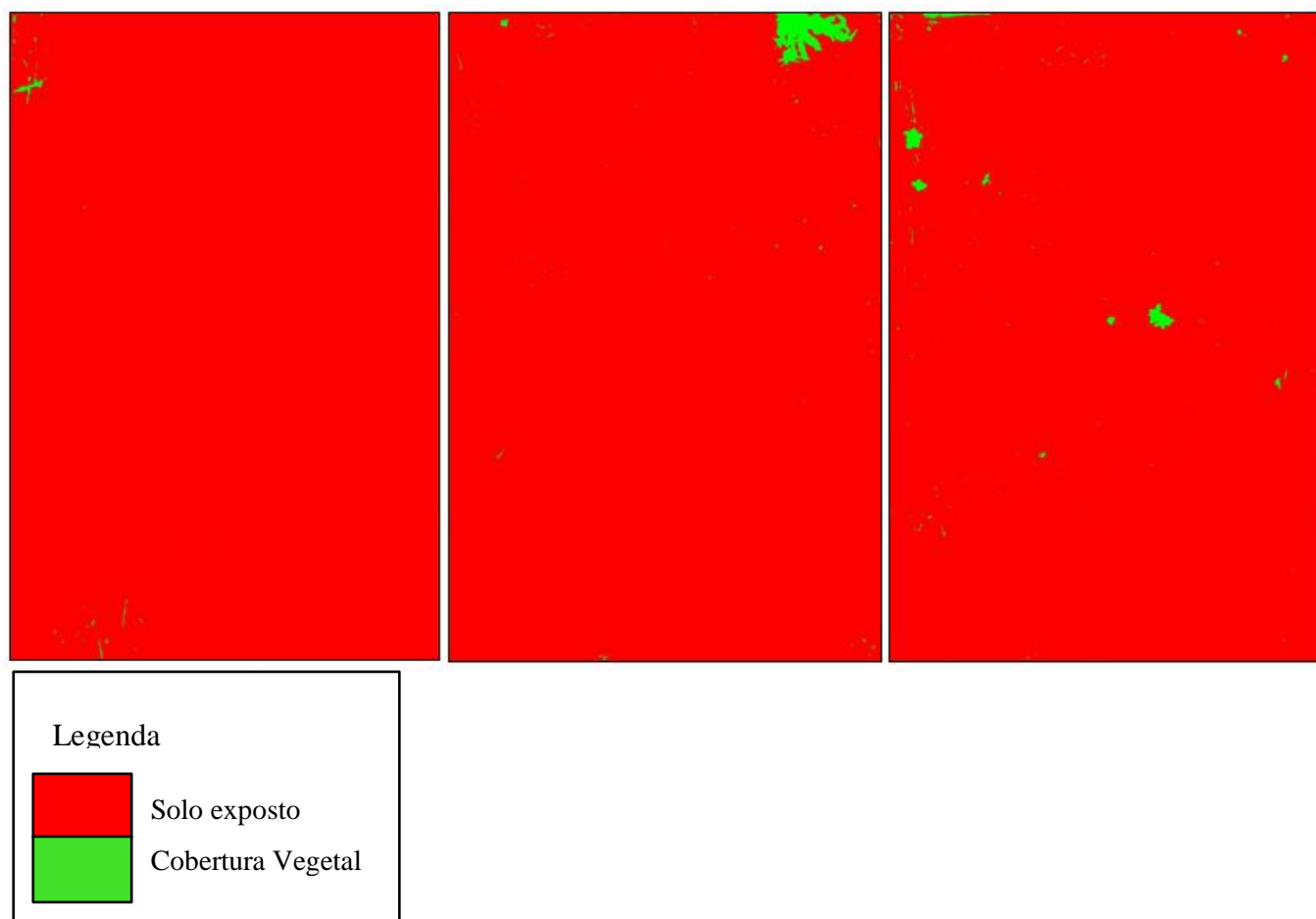


Figure 9: Photo comparison of plot A, elaborated in the software ENVI 4.2, from the lines of tensiometers A, B and C. (1st Stage)
Source: Authors, 2017.

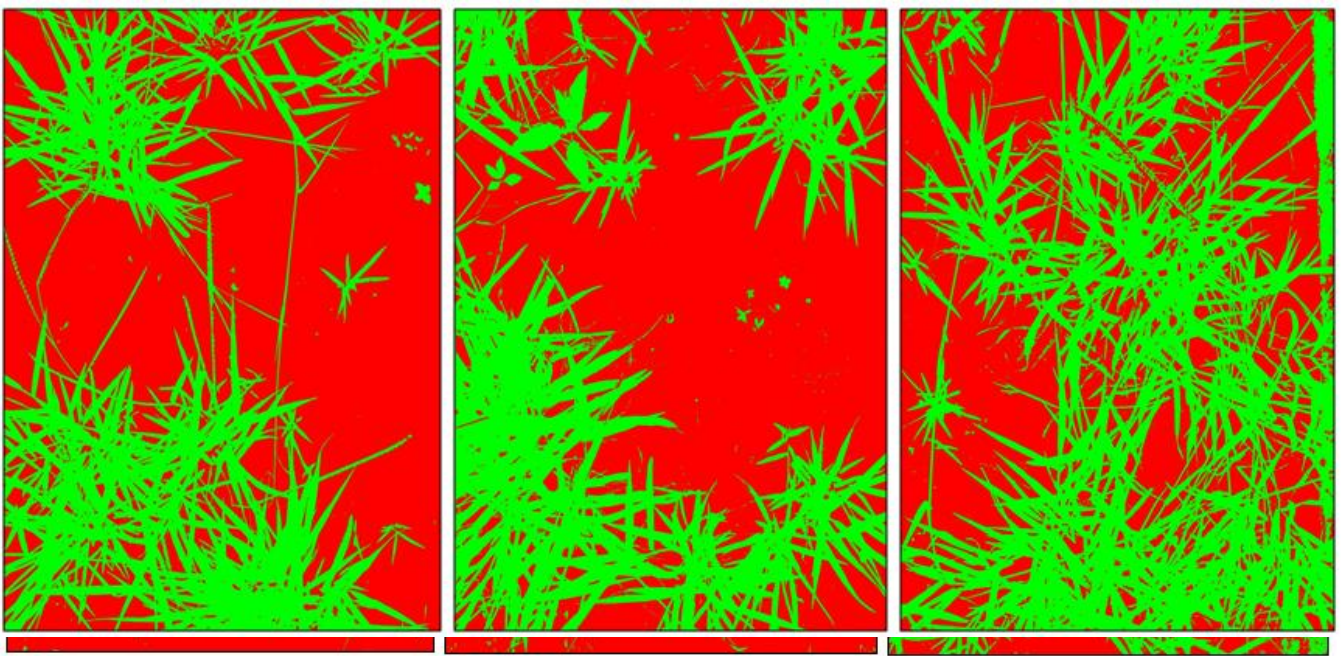


Figure 10: Photo comparison of plot A, elaborated in the software ENVI 4.2, from the lines of tensiometers A, B and C. (2nd Stage)
Source: Authors, 2017.

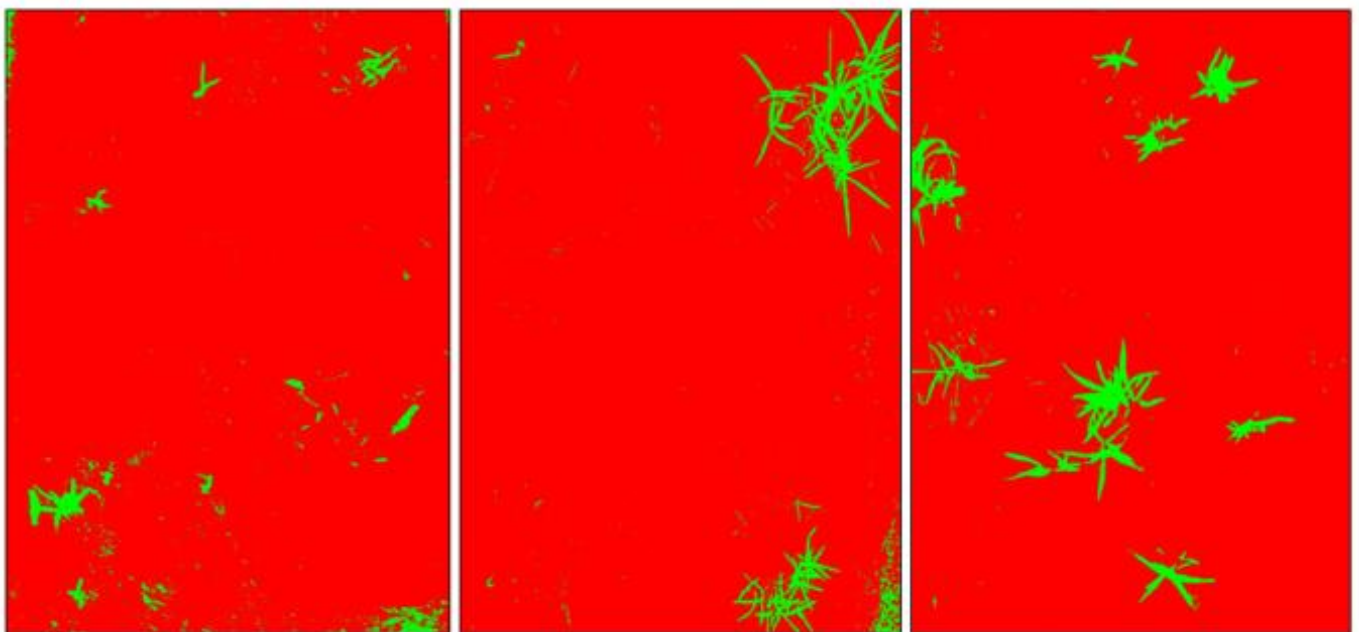


Figure 11: Photo comparison of plot B, elaborated in the software ENVI 4.2, from the lines of tensiometers A, B and C. (1st Stage)
Source: Authors, 2017.

Final Considerations

According to the results obtained in the course of the research we have that the data of matric potential in the different depths associated to the results of surface runoff show a very close relationship between the pore distribution soil pressure and surface runoff formation. The plots in the first stage of the research showed results close to the saturation of the water due to the little vegetation existing in their interior contributing to higher rates of surface runoff and sediment production.

In relation to the second stage, the plots presented their most developed vegetation, but we did not obtain results that expressed a relation between the matric potential and the vegetation cover, since there was no pore pressure intervention to improve the water circulation in the soil, even though the surface runoff rate expressed a significant reduction in relation to the previous stage.

Therefore, the use of capsule tensiometers is of great assistance in researches that seek to understand the dynamics of erosive processes from the relation that has to the internal flows of water in the soil. As a consequence the analysis of the matric potential allows the understanding of this internal dynamics and its connection with the external factors of each plot, due to the several factors that are related to this pore pressure, such as precipitation, the evaporation and absorption of the roots and the humidity in the micro and macro pores of the soil.

In this way the present work allowed the identification of the hydrological behavior of the soil and its connection with the erosive processes that occur in the study area, making the use of tensiometers fundamental for the knowledge and, consequently, for the management and prevention of erosive processes.

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