Analysis and quantification of erosion by splash effect speckling on a quartzarenic neosol of the state university of Feira De Santana (BA)

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ABSTRACT
Erosion is a natural process of the Earth, which has been occurring over time, preceding even the first forms of life on the planet. Before these first forms of life existed, erosion was quite intense, because the rocks and soils were exposed to atmospheric weather, but with the appearance of plant life, this intensity of erosion was drastically reduced, thus causing the formation of thick soils. However, with the appearance of man and his modifications in nature, this process considered natural began to accelerate again, thus breaking the balance between erosion and soil formation, since to have the formation of 1 cm of the same, it is estimated approximately four centuries, while in a few years with anthropography, tons of soils can be lost through accelerated erosion. The "splash effect" also known as splash erosion, is the first stage of the erosive process, in which the particles that make up the soil are prepared to be transported by surface runoff, and this Preparation can occur in two ways: By breaking the aggregates, which consequently tends to reduce the size of the particles, or by their transport at the beginning of splashing, causing them to occupy the pores of the soil, covering it and preventing water from infiltrating, and so the tendency is for surface runoff to occur in the soil. But it is necessary to emphasize that the action of the splash effect under the soil is conditioned not only by the resistance that each soil presents to this phenomenon but also by the kinetic energy of the raindrops (GUERRA et al., 2007, p. 18). Bertoni & Lombardi Neto (1993) when studying the behavior of soil with an exposed surface found that the greater the intensity of rainfall (mm/h), the greater the amount of breakage and detachment of aggregates from the soil mass. These authors highlight that generally aggregates between 0.063 and 0.250 millimeters are the most vulnerable to detachment, coarser aggregates are resistant to detachment due to the weight of the particles being Larger. In addition, during a high-intensity rain the ruptured particles can be released up to 0.6 m high and 1.5 m lateral, contributing to the erosion of three main shapes: a) detaching and breaking the soil particles in the place that suffers the impact of the drop of water with the surface; b) transporting by splash the detached and ruptured particles; (c) printing energy, in the form of turbulence in shallow surface runoff. Studies related to splash have improved significantly over the last two decades, however, most of these studies are developed through laboratory experiments, and there are few studies developed from an

interpretative perspective of the processes of individual form. Unfortunately, the results of laboratory studies are not easily converted to field situations, as work with simulated rainfall has kinetic energy, drop sizes, and rainfall intensities most often different from natural rainfall. In natural rains, there are times when the size of the drops can increase with the variation of intensity, and even in low-intensity rains there are drops with high erosive capacity. Being the yes, the present work has as its main objective to present some data referring to the production of sediments by the action of a splash in a flat area, thus with a unidirectional splash, the characteristics of this material and the relationship between the quantities and intensity of rainfall with the quantity of material produced during the events.

KEYWORDS: Erosion, Runoff, Soil, Sprouting.

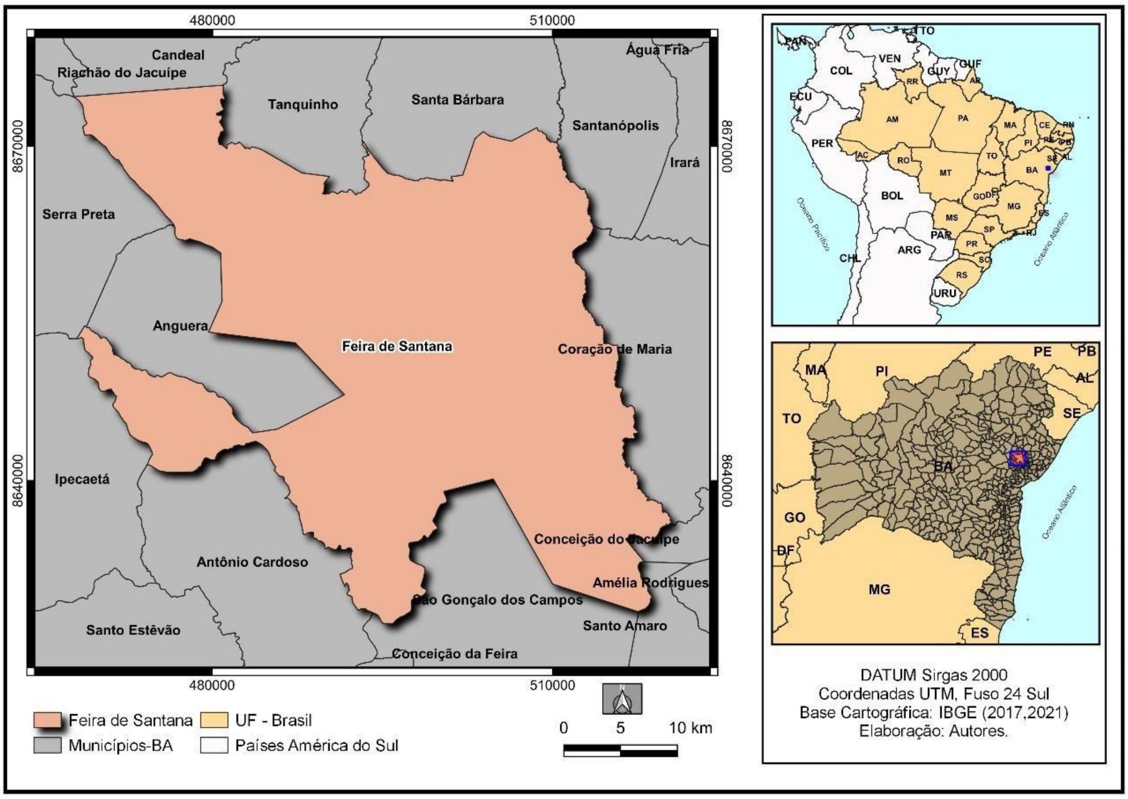
1 INTRODUÇÃO

Erosion is a natural process of the Earth, which has been occurring over time, preceding even the first forms of life on the planet. Before these first forms of life existed, erosion was quite intense, because the rocks and soils were exposed to atmospheric weather, but with the appearance of plant life, this intensity of erosion was drastically reduced, thus causing the formation of thick soils. However, with the appearance of man and his modifications in nature, this process considered natural began to accelerate again, thus breaking the balance between erosion and soil formation, since to have the formation of 1 cm of the same, it is estimated approximately four centuries, while in a few years with anthropography, tons of soils can be lost through accelerated erosion. The "splash effect" also known as splash erosion, is the first stage of the erosive process, in which the particles that make up the soil are prepared to be transported by surface runoff, and this Preparation can occur in two ways: By breaking the aggregates, which consequently tends to reduce the size of the particles, or by their transport at the beginning of splashing, causing them to occupy the pores of the soil, covering it and preventing water from infiltrating, and so the tendency is for surface runoff to occur in the soil. But it is necessary to emphasize that the action of the splash effect under the soil is conditioned not only by the resistance that each soil presents to this phenomenon but also by the kinetic energy of the raindrops (GUERRA et al., 2007, p. 18). Bertoni & Lombardi Neto (1993) when studying the behavior of soil with an exposed surface found that the greater the intensity of rainfall (mm/h), the greater the amount of breakage and detachment of aggregates from the soil mass. These authors highlight that generally aggregates between 0.063 and 0.250 millimeters are the most vulnerable to detachment, coarser aggregates are resistant to detachment due to the weight of the particles being Larger. In addition, during a high-intensity rain the ruptured particles can be released up to 0.6 m high and 1.5 m lateral, contributing to the erosion of three main shapes: a) detaching and breaking the soil particles in the place that suffers the impact of the drop of water with the surface; b) transporting by splash the detached and ruptured particles; (c) printing energy, in the form of turbulence in shallow surface runoff. Studies related to splash have improved significantly over the last two decades, however, most of these studies are developed through laboratory experiments, and there are few studies developed from an interpretative perspective of the processes of individual form. Unfortunately, the results of laboratory studies are not easily converted to field situations, as work with simulated rainfall has kinetic energy, drop sizes, and rainfall intensities most often different from natural rainfall. In natural rains, there are times when the size of the drops can increase with the variation of intensity, and even in low-intensity rains there are drops with high erosive capacity. Being the yes, the present work has as its main objective to present some data referring to the production of sediments by the action of a splash in a flat area, thus with a unidirectional splash, the characteristics of this material and the relationship between the quantities and intensity of rainfall with the quantity of material produced during the events.

2 METHODOLOGY

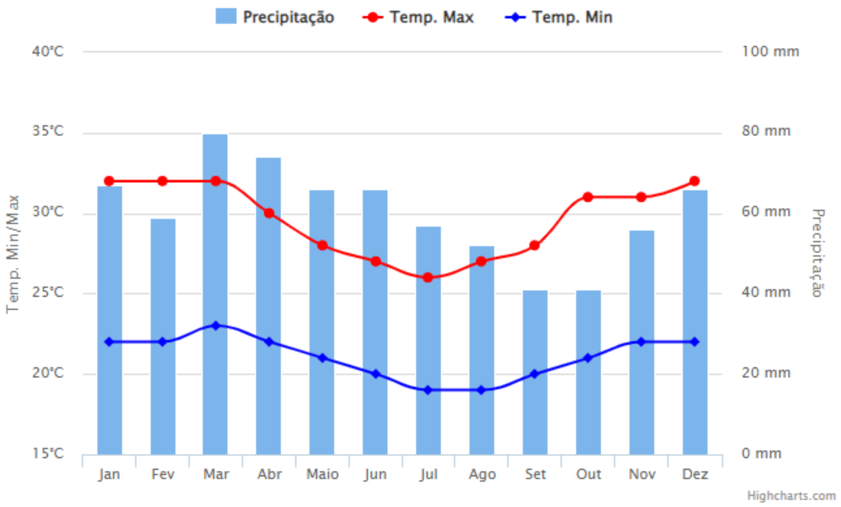
The experiment was carried out at the Climatological Station of the State University of Feira de Santana (UEFS), located in the municipality of Feira de Santana, Bahia (Figure 1). This municipality is located in an intermediate area between the humid climate of the coast and the semi-arid interior. It has an average annual rainfall index of 800mm and an average annual temperature of 24ºC. It presents a very different rainfall regime, with autumn/winter rains and spring/summer drought. Despite this, it presents a bimodal rainfall regime, with low-intensity rainfall and well distributed in the autumn/reverse period, and torrential rains (tropical storms) episodic and of short duration between the end of spring and the beginning of summer (Figure 2).

Figure 1 – Location Map of the Municipality of Feira de Santana (Bahia)



Source: Prepared by Luana Almeida (2022)

Figure 2 – Thermo-Water Graph of Feira de Santana

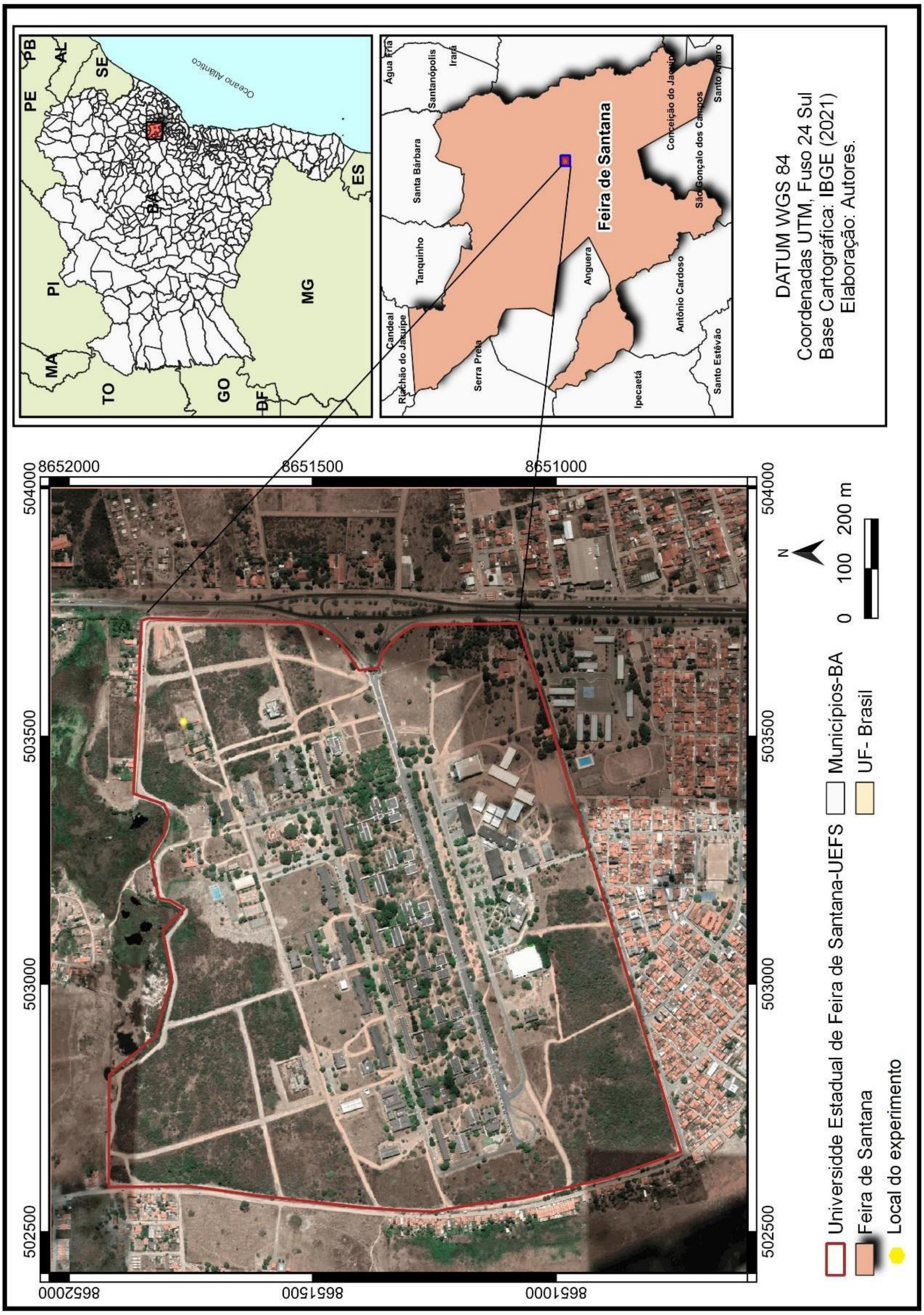


According to Jesus et al (2017), there is a very specific spatialization on the UEFS campus with the predominance of Quartzarenic Neosols in the low areas, near the lagoons, particularly in the region and in the vicinity of where the experiment was mounted. The experiment was implemented in the external area of the climatological station of UEFS (Figure 5), in a soil clean of vegetation, which makes it more prone to this type of erosion. A fixed bulkhead was mounted, positioned perpendicular to the ground, whose equipment measurements are 30 cm high by 30 cm wide, and on the surface of the bulkhead was fixed a foam of 0.5 cm thickness. On this set was placed a protective plate so that the raindrops did not directly affect the foam, thus squeezing the soil particles that would be fixed there by splashing (Figure 4). This equipment collected the material in two preferred directions, called "front" and "bottom" which, in the samples, were treated respectively as "a" and "b".

Figure 4: Field experiment awaiting withdrawal.

Source: Prepared by the authors (2018)

Figure 5 – Location of the experiment at UEFS (Climatological Station)

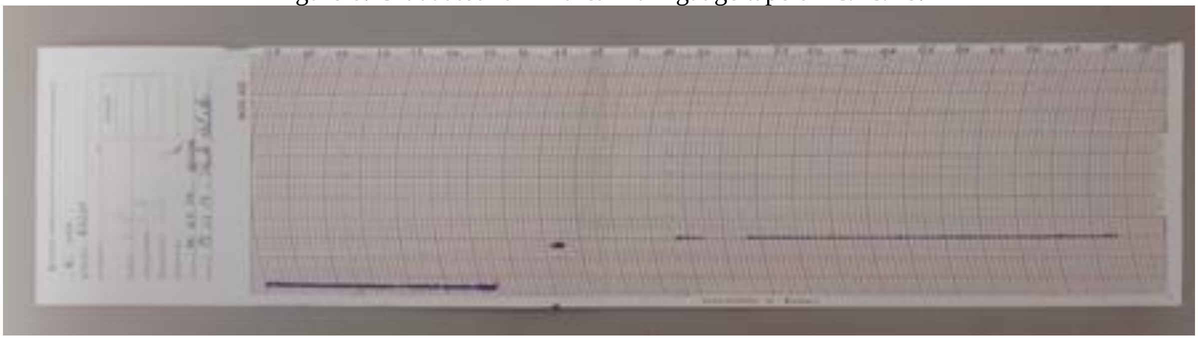


Prepared by Luana Almeida (2022)

This study was carried out during the occurrence of natural rains with different intensities, which were estimated from the conversions of the readings made on the tapes (Figure 6) taken from the rain gauges

(Figure 7). The Quartzarenic Neosols are formed mainly by sands, and, in the study site, its granulometry varied from fine to average, with approximately 50 cm of depth (Figure 8).

Figure 6: Graduated rain marcan rain gauge tape on 3/15/18.



Source: Prepared by the authors (2018)

Figure 7 - Pluviograph: Instrument composed of a rain gauge and a watchmaking mechanism that draws on paper the amount of water with time control, thus enabling the determination of rainfall intensity, in millimeters/hour

Source: Prepared by the authors (2018)

According to Silva & Schulz (2002), to quantify the sediment that the kinetic energy produced by the impact of raindrops on the soil can disaggregate and transport is necessary to perform the following steps:

1º The weight of the foam should be quantified before it is placed in the field and after each rainy event.

2º The foam should be transported to the laboratory and dried in an oven at 90°C for 48 hours and then weighed.

3º Subtract from the final weight the weight of the previously known foam thus obtaining the amount of sediment that was detached from the soil and that reached the surface of the foam.

Figure 8 – Soil of the Quartzarenic Neosoil type, located in the area of the experiment

Source: Photo by Jhenifer Gonçalves (2022)

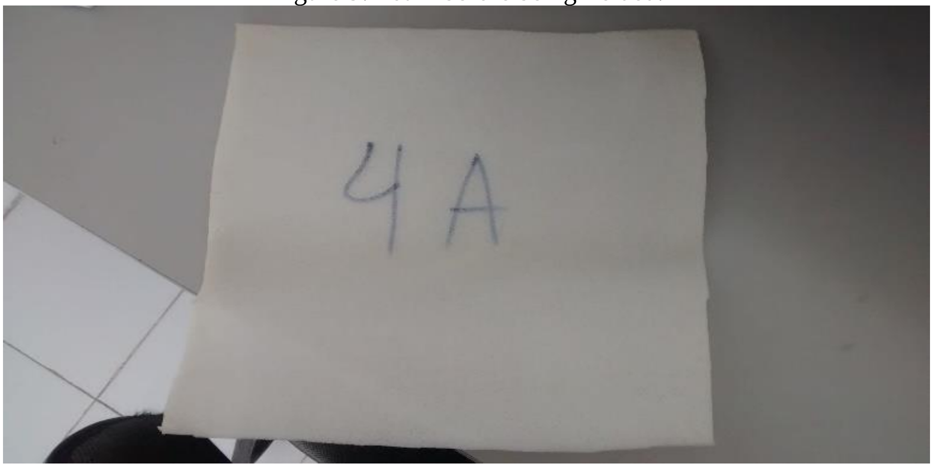
Rainfall of greater intensity and with great frequency increase the risk of erosion. These characteristics are more significant than those associated with busy relief conditions, adverse physical-water soil characteristics, inadequate land use, and management. Rainfall shall be considered erosive and individually provided that it is greater than or equal to 10 mm or greater than or equal to 6,0 mm, provided that it occurs in a maximum of 15 min and separated from each other for a period of at least 6 h with a rainfall depth of 1,0 mm or less. (WISCHMEIER & SMITH, 1978; ALMEIDA, 2009). To this end, it is essential to determine the degree of erosivity of rainfall in the respective climatic region. Conceptually, this erosivity is described as an interaction between kinetic energy and runoff momentum. The erosivity index is a function of the intensity and duration, precipitation, mass, diameter, and speed of the raindrop (HUDSON, 1971). To determine erosivity, rainfall records of rainfall periods of 20 to 30 years are necessary and should be analyzed (CASSOL et al., 2008). Of the factors responsible for this process, the ability of rain to cause erosion, that is, its erosivity, is considered the most active factor of water erosion (MACHADO et al., 2008). And it is this erosive factor and its occurrence throughout the year that will determine the best time for the establishment of soil management and conservation practices (VAL et al., 1986).

All four rainy events were recorded and recorded in March, where it was possible to observe rainfall of relevant intensity, above 30mm/hour. To know the intensity of the rainfall, the relationship between the time and the amount of precipitated water was performed, and data were provided by the rainfall of the climatological station (Figure 6) and recorded on its millimeter tape (Figure 5). The foams were collected soon after the respective rainy events when they were measured before and after drying in the greenhouse, to obtain, thus, the respective weight losses before and after the rainfall event and to allow the quantification of the sediments captured by the foam, transported by the action of splashing.

3 CONCLUSION

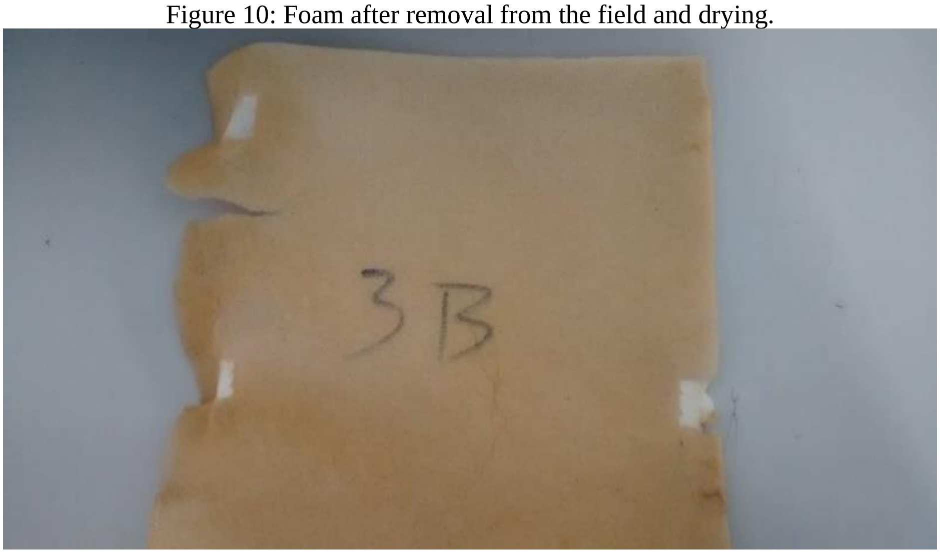
After the removal of the samples from the field, they were transported to the Soil Laboratory to be submitted to the drying process in the greenhouse, to ensure that there was no influence of moisture on the weighing (Figures 9 and 10). Thus, the weights of the foams were compared before and after being placed in the field. Thus, the following results were obtained, explicit in Table 1:

Figure 9: Foam before being fielded.



Source: Prepared by the authors (2018).

Figure 10: Foam after removal from the field and drying.



Source: Prepared by the authors (2018).

Table 1: Result of weighing the foams before the rains and after the rains

Espuma	Antes (em gramas)	Depois (em gramas)	Chuva (em mm/h)	Taxa de salpicamento (em gramas)
1ª	4,12	5,47	7	1.35
1b	4,5	5,34	7	0.84
2ª	4,3	4,7	2	0.4
2b	4,4	4,8	2	0.4
3ª	4,6	5,15	3.1	0.55
3b	4,6	5,08	3.1	0.48
4ª	4,5	4,67	1	0.17
5b	4,5	4,73	1	0.23

The samples were collected in two forms, one in the "front" part and the other in the "back" part of the equipment, after weighing the difference between the foams "a" and "b" was extracted. As can be seen from the results of Table 1, the intensity of the rainfall is directly linked to the sediment rate detached from the soil and transported by the splash effect. However, we have to point out that, the experiment was carried out in uncovered soil, which makes it more conducive to the actions of erosion by speckling, which although it seems insignificant, at the end of the amount after a year, would be equivalent to a loss of 46 kg/ha/year, a loss considered average by Carvalho (2008) who classifies erosion rates according to the estimate of loss d and soil from zero to very strong, in a total that is due both to the direct impact of the raindrop when it collides with the soil and releases the aggregate particles, without considering the action of soil compaction, which will also reduce the rate of water infiltration, and, over time, will eventually impair the replenishment of the water table, as well as increase the rate of surface runoff, thus favoring erosion in sheet or linear terrain, triggering a greater intensity of erosive processes superficial.

The proposed experience proved to be efficient in quantifying soil loss by splashing because it allowed, from the measured area, it is possible to estimate soil loss by that process. It is noteworthy that erosion by the splash effect is greatly underestimated by the irrelevant amount of material transported, but when it is transposed to a scale at the municipal and temporal levels, it is perceived that this loss can be significant. Thus, it is emphasized that no erosive process is irrelevant, and even a few quantities, when extrapolated to larger areas, in a given time interval can be seen as significant losses, in the general picture of soil losses.

The performance of the device used for the development of the experiment was considered good. However, as it is the first version of this apparatus, it is recommended that it be made and used in the same ways mentioned in the text in other localities and under different conditions of soil, relief, and vegetation cover, aiming at an evaluation of the performance in situations different from those found in this study.

The splashing results obtained with the use of the methodology proposed here revealed important information about the first stage of the erosive process that occurs at the moment when the drop of water reaches the soil and also allowed us to quantify the first stage.

The results of this work demonstrate that the intensity of rainfall is not the only determining factor in the mobilization of sediments by the splash effect, it depends on other variables such as time, duration of the event, and the antecedent unity of the material. Studies on experimental variability have shown large percentage variations even if working with a high number of replications.

Among the activities developed in this work, it was possible to identify new gaps to be answered in future work, among them, the role of the antecedent soil moisture in the reduction or intensification of the breakdown of the particles during the event, the characterization of the kinetic energy of the rains and the distribution of the size of droplets.

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